The Digital Cast of Being

Metaphysics, Mathematics, Cartesianism, Cybernetics, Capitalism, Communication

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(O my shining stars and body!) how hath fanespanned most high heaven the skysign of soft advertisement! But was iz? Iseut?
James Joyce *Finnegans Wake*

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1. Approaching the question concerning digital being[1]

To take up again theses on a digital casting of the world from some years ago,[2] the question concerning digital being is posed, for its origin, which lies ultimately in Western metaphysics, is by no means clarified in a philosophical sense. What is digital is usually counterposed to what is analogue. This amounts to a technical definition. Nowadays, this distinction relates primarily to the difference in electromagnetic signals of all kinds, whether it be in telecommunications, electronic music or in computer data processing. Digital beings are characterized by the fact that they are composed of binary digits or bits. Signals in telecommunications, for instance, are transmitted in a digital or binary form through a medium (cables of many different kinds, the air, space). Basically, an ordered sequence of zeroes and ones (nothing and something, pure difference) is transmitted which at the other, recipient's end can be and must be recomposed in such a way that the appropriate result (a voice, a text, an image, a sound, a TV spot, a control command, etc.) is brought about. The difference between 0 and 1 may be any arbitrary difference in physical beings such as transmitting a signal with two different frequencies or two arbitrarily different energetic states of

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1 This study originally arose out of an e-mail exchange with Rafael Capurro at artefactphil in 1999. I am therefore indebted to him for important impulses. Cf. Rafael Capurro's analogous study *Beiträge zu einer digitalen Ontologie* (Contribution to a Digital Ontology) at www.capurro.de, from which the present study deviates considerably in both content and scope of presentation. The English Versions 2.0 and 3.0 are thoroughly and multiply revised, reworked, extended, deepened and retitled compared to 2001. The old German version from January 2001 is thus superseded and has been withdrawn.

2 Cf. thoughts presented at a colloquium in Stuttgart in November 1996 (M. Eldred *11 Thesen zum heutigen digitalen Entwurf des Seins* at www.arte-fact.org) convened by Rafael Capurro. Cf. R. Capurro *Digitaler Weltentwurf* at www.capurro.de.

an electromagnetic system such as the orientation of iron molecules. Maxwellian electromagnetic force-fields of all kinds (radio waves, electricity, magnetism, light, molecular bonds, etc. etc.) may be harnessed to generate a binary difference. The difference *as* a difference is something that we humans understand, i.e. we are able to understand (binary) difference *as* such and thus to bring forth digital effects. Already in Greek metaphysics, the category of τὸ ἕτερον (the other) vis-à-vis τὸ αὐτό (the same, identical), the difference of the one from the other, plays an important role in the thinking of being and non-being, especially in Plato's dialectic.

Electromagnetic signals as physical beings (φύσει ὄντα or beings that of themselves stand in presence including, in this context, also produced things, cultural things), however, in their natural state are not structured or discretely articulated in any form, but continuous. They can be represented mathematically by continuous functions of time (y = f(t)). Aisthaetic beings (Gr. αἴσθητα, sensuously perceptible beings) are naturally or of themselves (φύσει) continuous. At first we always perceive a whole (ὅλον) that is not articulated, e.g. we see a car drive past down the street. This is a continuous happening in time. A video camera can record this scene, and the video film can be broadcast on television. The television viewers will still perceive a whole, namely, the scene of a car passing by. Between the live scene and the perceived television sequence there lies the articulated dissolution or taking-apart or decomposition of the scene and its technical reconstitution as a moving image.

So far, so good. This articulated dissolution of what is perceived requires, however, ontological clarification. What is happening, i.e. what must be already given a priori, for digital technology to understand and gain an effective grasp? What does it mean for a being to be whole or one (ἕν)? What does dissolution, decomposition or taking-apart (διαίρεσις) mean ontologically? What does it mean for a being to move continuously in time, i.e. what is *movement*, *continuity* and *time*? What does the discreteness of digital beings have to do with beings as such? What does number have to do ontologically with beings as such and

with movement? And what is the connection between digital dissolution and λόγος (language, reason, knowledge)?

In digital technology, there must be two different, constant signals, polarizations, bits, states of matter, or the like which are *understood as* (interpreted *as*) 0 and 1, as nothing (κενόν) and something (τί). The categories of something (τί) and another something (τὸ ἕτερον) in constancy (ἀεὶ ὄν) are presupposed metaphysically. Furthermore, there is also unity (μονάς) and duality (δύας). How are all these categories indispensable for grasping the digitization of beings ontologically interrelated?

We perceive and understand electromagnetic currents, states, etc. not only *as such* but *as* binary difference because these currents, etc. have from the start, i.e. a priori, been interpreted, for instance, by the technological knowledge of the hardware or the communication technology, *as* such binary differences.

It is impossible to explain, say, the perception of a whole as a temporal process in the brain, for the categories of the whole (ὅλον), of something (τί) are already 'visible' to the mind's eye in advance, i.e. before any 'data' have been 'registered' by the brain. This a priori dimension — the very general and universal schemata or scaffolding of the categories (cf. also the as-structure with its "pre-structure" (Vor-Struktur) as the "scaffolding" (Gerüst) "from which something becomes understandable as something" (aus dem her etwas als etwas verständlich wird, SZ:151[3]) — must be attributed to the metaphysical (or ontological) power of human vision and has been traditionally the subject of metaphysics today despised by the modern sciences, which have long since staked their pretension to be *the* 'natural' locus of truth. The sciences investigate their respective subject matters on the basis of an a priori, presupposed understanding of the being of the region of beings into which they do research. Thus the mathematical casting of nature — which made possible modern physics from the seventeenth century on as one of the most momentous events in the history of

[3] References to M. Heidegger *Sein und Zeit* (*Being and Time*) Niemeyer, Tübingen 1984 are given in the form SZ:151.

Western thinking and, in view of its far-reaching consequences, in the history of the world — is not itself a question within physics but rather is presupposed by it. Analytic philosophy of science aids and abets modern mathematical science as its haidmaiden by failing to pose the pertinent ontological questions since, for analytic philosophy, ontology has shrivelled to a matter of classifying what ‘exists’, where the meaning of ‘existence’ is taken for granted. The same unquestioning stance pertains to the digital dissolution of beings in progress today which, as we shall see in more detail, is the consummation of the mathematical casting of being. These interrelations with metaphysics wilfully suppressed, denied and dismissed as ‘non-verifiable’ and ‘speculative’ guff by modern scientific thinking, and innoculated and defanged by analytic philosophy, must be brought expressly to light in order to see the cast of being on which digital technology is unknowingly, unwittingly based.

Not only Plato (and the Pythagoreans), but above all Aristotle are called upon for assistance, for their thinking is not something past, but, whether we admit and comprehend it or not, maintains its hold on us to this very day. As a starting-point for these considerations, we may take the following passage from Martin Heidegger’s *Sophistês* lectures in Winter Semester in Marburg in 1924/25.

> Dabei ist zu beachten, daß für Aristoteles die primäre Bestimmung der Zahl, sofern sie auf die μονάς als die ἀρχή zurückgeht, einen noch viel ursprünglicheren Zusammenhang mit der Konstitution des Seienden selbst hat, sofern zur Seinsbestimmung jedes Seienden ebenso gehört, daß es ‘ist’, wie daß es ‘eines’ ist; jedes ὄν ist ein ἕν. Damit bekommt der ἀριθμός im weitesten Sinne — der ἀριθμός steht hier für das ἕν — für die *Struktur des Seienden überhaupt* eine grundsätzlichere Bedeutung als ontologische Bestimmung. Zugleich tritt er in einen Zusammenhang mit dem λόγος, sofern das Seiende in seinen letzten Bestimmungen nur zugänglich wird in einem ausgezeichneten λόγος, in der νόησις, während die geometrischen Strukturen allein in der αἴσθησις gesehen werden. Die αἴσθησις ist das, wo das geometrische Betrachten halt machen muß, στήσεται, einen Stand hat. In der Arithmetik

> dagegen ist der λόγος, das νοεῖν, am Werk, das von jeder θέσις, von jeder anschaulichen Dimension und Orientierung, absieht.[4]
>
> It must be noted here that for Aristotle, the primary [i.e. conceptual ME] determination of number insofar as it can be traced back to the μονάς as the ἀρχή has a much more originary connection with the constitution of beings themselves insofar as the determination of the being of any being includes that it 'is' and that it is 'one'; every ὄν is a ἕν. Thus the ἀριθμός in the broadest sense — the ἀριθμός stands here for the ἕν — gains a more fundamental significance for the *structure of beings as such* as an ontological determination. At the same time, it enters into a relation with the λόγος insofar as beings in their ultimate determinations are only accessible in a special λόγος, in νόησις, whereas the geometric structures are seen solely in αἴσθησις. Αἴσθησις is where the geometric contemplation has to stop, στήσεται, has a stand. In arithmetic, by contrast, the λόγος, νοεῖν, is at work which abstracts from every θέσις, from every intuitive dimension and orientation.

The oneness of each being is indebted to its unambiguous presence within the well-defined contours of its εἶδος, its look. These are only initial, bare hints from Heidegger, and the passage requires further commentary and deeper probing under the guidance of his phenomenological hermeneutics,[5] to which task we will now turn. Later on, we shall have to take leave of Heidegger's guidance to escape the orbit of what will be called the *productionist paradigm* of metaphysics.

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4 M. Heidegger *Platon: Sophistes* Marburger Vorlesung WS 1924/25 *Gesamtausgabe* Band 19 ed. Ingeborg Schüßler 1992 S. 117 = GA19:117. English translation: *Plato's Sophist* Indiana U.P. 2003, Excursus: General Orientation Regarding the Essence of Mathematics, pp. 69-82.

5 Stuart Elden, too, takes up Heidegger's *Sophistês* lectures with different intent in his *Speaking Against Number: Heidegger, language and the politics of calculation* Edinburgh U.P. 2006.

2. Number and being

2.1. Aristotle's ontology of number and geometric figure

In Aristotle's thinking, number is something distilled out of, drawn off, abstracted from physical beings. The distilling or abstracting consists for Aristotle in a being becoming placeless; i.e. it is separated off from its surroundings (χορίζειν), in order to become a number in the abstraction. Physical beings (φύσει ὄν) are beings that come to a stand in presence of themselves in a place (τόπος) that encompasses (περιέχον) them like an envelope (*Phys*. IV 211a1). They are characterized by *continuity*, whereas the numbers which originarily arise by counting, i.e. an iterative procedure, are *separated* from each other, *discrete*. The geometrical figure of a physical being is likewise abstracted from it, and hence placeless, but the figure's points, although likewise placeless, still have position, and the figure, like the physical being itself, is continuous. Continuity consists in the way the points (στίγμαι) of a figure or the parts of the underlying physical being, which all have a position and are thus posited, hold and hang together. The points hang together by touching each other at their extremities (ἔσχατα). They even share their extremities. The points are all identical but are differentiated through their differing positions. On the other hand, the numbers are without place and also without position but are differentiated within themselves. They bear the difference within themselves, whereas the points can only distinguish themselves one from the other through a difference in position. For instance, 3 is to be distinguished from 5, but two points on a line are identical (αὐτό). The distilling of numbers out of physical beings opens up the possibility of calculating with numbers; they are open to λογισμός, but at the price (or the advantage) of becoming placeless and positionless. Such a lack of place and position, it seems, characterizes also the digital beings which we deal with today. For them, matter in its continuity and its fixedness of place becomes indifferent.

For Aristotle, the μονάς is the ἀρχή (principle, starting-point) of arithmetic. It must not be confused with the ἕν, which belongs still to physical beings as an ultimate categorial determination of their being. When some people say that, according to Aristotle, numbers have to be plural, i.e. at least 2, in order to be numbers, this is only sensible when one proceeds from the *counting process* (cf. *Phys*. Δ 12;220a27). If, however, a number is the answer to the question, How many?, then 1 is already a sensible answer and hence a number. The distinction between μονάς and ἕν is more important in demarcating arithmetic from ontology. Proceeding from the μονάς, one comes to two as the first successor in the counting process, and this may be taken as the first counting number. But the μονάς itself must already distinguish itself from something else, from nothing, a nil number, i.e. there must be a difference between 1 and 0 which corresponds to the difference between a unified something (τί, ἕν) and nothing, emptiness. Only from the principle of unity (monad) can arithmetic, i.e. numbers in the Greek sense, be built up one by one through the iterative counting process. In a further development, and because the base for counting, in principle, is arbitrary, today, all numbers can be represented, manipulated and calculated on a binary basis. The Greeks thought number from the counting process and therefore had no zero, which prevented the assimilation of geometry to arithmetic. To do so would have required the insight into the correspondence between the geometric point and the number 0.[6] Aristotle sees that there is a smallest number, and, proceeding from the geometric line, also that there is no smallest magnitude, but does not resolve the disparity (12;220a30). Even continuity can be captured by a process of limitless approximation by binarily represented numbers, since modern mathematics demonstrates that the continuum consists of the limits of infinite, countable, rational number series. The analytic geometry and differential calculus which Descartes, Newton and Leibniz discovered and developed in the

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[6] Jacob Klein *Greek Mathematical Thought and the Origin of Algebra* transl. Eva Brann, Dover Publications, New York 1992, first published by M.I.T. Press, Cambridge Mass., 1968 p. 193.

seventeenth century make geometry itself a matter of *calculation*. We will have to investigate further (cf. *2.6 Bridging the gulf between the discrete and the continuous*) the ontological conditions of possibility for bridging the gulf between Greek arithmetic, which was conceived as a discrete counting process, and Greek geometry, whose sensuously imaginable figures are all representable in continuous magnitudes.

2.2. Heidegger's review of Aristotle's thinking on modes of connectedness from discreteness to continuity

Heidegger presents the distilling or 'drawing off' of geometric and mathematical structures from physical beings according to Aristotle in his *Sophistês* lectures (GA19 § 15 *Excursus: General orientation on the essence of mathematics according to Aristotle* pp. 100ff). The essential, basic act of mathematics for Aristotle is χορίζειν and ἀφαίρεσις, separating and abstracting or drawing off from the φύσει ὄντα which all have a place, topos, locus (τόπος, χώρα) enclosing and touching them at their outer extremes to which they belong that enables them to come to presence. For instance, a plant belongs to the soil in which it is planted as its proper place to *be* a plant; an eagle belongs to the mountainous habitat where it builds its eyrie to *be* an eagle; an actor belongs on a theatre's stage to *be* an actor. The abstracted geometrical elements and structures already no longer have any place (ἄτοπος), but they are posited, positioned (θετός) with respect to us and to each other. Geometric entities are no longer in place. The πέρατα are no longer understood *as* the limits of the physical body, but through the θέσις they obtain a peculiar autonomy which then can be treated in geometry in this autonomy. This autonomy is heightened even more with numbers (ἀριθμοί), which have neither a place (ἄτοπος) nor a position (ἄθετος). Each number stands on its own (χωρισμός, discrete), whereas the points of a geometric figure are all identical and are what they are only in relation to other points, i.e. in their position in relation to each other. In other words, they require in addition the determination of πρός τι, of relation, to be geometrical. Whereas arithmetic entities are formed by sets of numbers in which each number is discrete, geometric

figures are not simply composed of points (a line is not simply a collection or heap of points; a surface is not simply a collection of lines; a solid body is not simply a collection of surfaces), but rather they each possess a characteristic complex *connected* structure which Aristotle sets out progressively in seven steps in his *Physics* Bk. E Chap. 3. He is concerned with the differing ways in which points and physical beings 'hang together' where continuity, which is closest to the aisthaetic outline of physical beings we perceive with the senses, is ontologically the most complex.

i. ἅμα = coincident; when things are in one place
ii. χώρις = separate; when things are in different places
iii. ἅπτεσθαι = two beings touching (in one place at the extremes)
iv. μεταξύ = the connected in-between or medium in which a movement takes place (such as the river in which a ship moves)
v. ἐφεξῆς = the consecutive; between what comes first and what follows there is nothing in between of the same genus (origin in being) as what is connected. Thus, the houses in a street are in a row but in a medium which is not a house (so that movement from house to house passes through a medium that is not a house). This is the mode of connectedness of the μονάδες or natural numbers, and also the rational numbers, which do not have anything of the same genus in between. They do not touch each other like connected things, and do not hold onto each other like the συνεχές, that which holds-itself-together (cf. vii)
vi. ἐχόμενον = that which closely follows, a consecutive sequence which touches within itself; the extremes of the elements come together, i.e. touch each other in one place, are contiguous (as in a chain, a concatenation or a series of houses whose outer walls touch each other)
vii. συνεχές = continuum. Here there is no in-between, just as with the ἐχόμενον, but, even more, it is an originary ἐχόμενον, a συνεχόμενον or positively holding- and clinging-together, in which the limits of the individual elements not only touch but are identical with each other as, say, in a row of terrace houses in which the adjacent walls of the individual houses not only touch but are one and the same. (It should be noted that the mathematical concept

of continuity developed in the infinitesimal calculus does not distinguish between vi. and vii. This is so because a continuous mathematical function is a rule for assigning a number to a number of the kind y = f(x), and numbers have no place. In intuitive terms, a function f is continuous at point p simply if there is no gap at p, which corresponds to ἐχόμενον.)

What is ontologically most complex in the way it hangs together, i.e. the continuous geometric figures and physical beings, is most simple for sensuous perception, but is very unwieldy for calculation. And conversely: what is ontologically more simple, i.e. the arithmetic entities in their ordered, countable succession, is not as easily accessible to sensuous perception but can be calculated (λογισμός) without any difficulty. This means that the arithmetic entities and their interrelations can be more easily brought to presence by the λόγος (or the λογισμός in this case) than geometric entities which, in turn, are closer to sensuous experience, i.e. not so abstract. Herein resides the calculative power of mathematical analysis which reduces the geometric to the arithmetic, the continuous to the discrete, irrational (real) number to rational number, by conceiving real numbers as (Dedekind) cuts or partitions in the (infinite, but countable) sequence of rational numbers. The reduction facilitates calculation in the mathematical language of algebra, and, conversely, the results of the calculation can be translated once again back into the sensuously aisthaetic intuitions of geometry which have a representation in the imagination. With the arithmetization of geometry, the mathematico-logical manipulation of beings thus attains a hitherto unprecedented power.

Heidegger also provides a review in the *Sophistês* lectures of *Cat.* 6: ‘On Quantity’ (ποσόν). Quantity is in some cases discrete (διωρισμένον or marked off from itself within itself), and in some cases continuous (συνεχές or holding itself together within itself). (Cf. *Met.* V, 13: quantitative means that which can be decomposed into several immanent components. That which is quantitatively countable is an amount; what is measurable is magnitude. An amount is potentially decomposable into discrete components; magnitude is potentially decomposable into continuous components). Continuity “is the

ontological condition of possibility for there being something resembling length, μέγεθος" (ist die seinsmäßige Bedingung dafür, dass es so etwas wie Erstreckung, μέγεθος, gibt, GA19:118; cf. extensio in Descartes' metaphysical casting), and motion is only comprehensible when "continuous progress can be made from one point to another." (von einem Punkt zum anderen stetig fortgeschritten werden kann, ibid.)

The numbers and the λόγοι are marked off from each other, i.e. discrete, whereas the geometric figures such as line, surface, solid body, time and places are continuous. Discrete entities are *articulated* into parts which are not posited, i.e. they do not have any position; the continuum, by contrast, consists of parts which are posited, positioned with respect to each other. Hence figures. Their respective manners of connectedness or their unity therefore differ. The parts of numbers do not have any common ὅρος or limit. The number 10, for instance, has parts 5 and 5 which do not have any common limit; each part is for itself; the parts are marked off from each other, διωρισμένον, each is different, just as with 7 and 3. The μόρια (parts) cannot be taken together; there is no κοινόν (common element) with respect to which each number would be an instance, i.e., it is not possible to generalize the numbers. How, then, is a connectedness possible? Aristotle explains this using the example of the λόγος: it is μετὰ φωνὴ γιγνόμενος, spoken with the voice. This speaking (a sensuous experience for both speaker and listener) is articulated into individual syllables as its στοχεῖα (elements) which are marked off from each other. There is thus a peculiar unity of a non-continuous, articulated entity in which each part is autonomous, individual. The syllables are autonomous, individual. There is no syllable in general, and also no number in general. The unity of the manifold elements can only lie in the λόγος or νοῦς itself which gathers together and holds together the parts, for there is no merely sensuously perceptible connection, for instance, why certain syllables or numbers should stand next to each other. When the λόγος appropriates beings in their self-disclosure, it articulates them at the same time into their 'articles'. A diairetic taking-apart takes place which may, in turn, be further articulated into numerical digits. The logic

of the λόγος ends ultimately in the digital de-ciphering of beings in toto, which is equivalent to an en-ciphering of beings. The decryption (disclosure) of beings in their being amounts then to en-ciphering them articulately into digits.

By contrast, one point is like all others. A line has another mode of unity. One can remove something from it and address it in the same way as any other part. The points are all the same. But a line is more than a multitude of points; the points are put in position (θετός) and they do not just touch, but hold themselves together (συνεχές). This is missing in the sequence of numbers which is only determined as ἐφεξῆς (consecutive, sequential) and where no medium in between is necessary. Number is therefore ontologically prior to the points in their continuum. Number is still free of orientation and position and is therefore autonomous and can and must be taken in and comprehended without αἴσθησις only by means of the intuition of νοῦς. As ontologically simpler and more originary, number is set in an originary connection with the simplest categories such as the something (τί) when one asks for the structure of beings (τὸ ὄν). “This is the reason why Plato’s radical ontological determination starts with number.” (Darin liegt begründet, daß die radikale ontologische Besinnung Platons bei der Zahl ansetzt. GA19:121) Nevertheless, for Aristotle arithmetic is not the most originary science of beings in their being, for the ἀρχή of number, i.e. the counting unit (μονάς), must be clarified metaphysically in its connection with the one (ἕν). And this connection provides the key to the ontological interconnection between number and the metaphysical access to beings as ὄν λεγόμενον in general.

Insofar as physics is mathematical, it relies on the discreteness of numbers because it has to perform calculations on empirical data; however, numbers can also be made to approximate the φύσει ὄντα arbitrarily closely. That was the great discovery of the mathematical differential/infinitesimal/integral calculus by Newton and Leibniz, for only in this way were physical beings made arbitrarily calculable, i.e. the arbitrarily close approximation of number to the continuum (the digital dissolution of beings to any arbitrary degree of resolution) became

possible. For a long time, physics has been marked by a dispute about the fundamental nature of physical beings: wave or particle (atoms)?, continuous or discrete?. This dispute is not decidable within physics itself because the distinction has to be clarified in ontology itself (i.e. coming from being) where the distinction between the continuous and the discrete, i.e. that which holds itself together within itself (the geometric), on the one hand, and that which is marked off from itself from within itself (the arithmetic), on the other (cf. GA19:118), can and must be interpreted as modes of being. Moreover, as we shall see (cf. *2.9 Time and movement in Aristotle's thinking*), the phenomenon of movement in time will demand consideration of a *twofold presencing* in whose light the Heisenberg indeterminacy principle receives a phenomenological interpretation prior to its mathematical cast (cf. *7.1 The Heisenberg indeterminacy principle reinterpreted*). The infinitesimal calculus, which enables an approximation (a nearing) of the continuous and the discrete, the geometric and the arithmetic, represents a crucial historical event in the ontology of the mathematical that opened the vista of a mathesis universalis. We shall return to the question of infinitesimals below (cf. *2.8 The calculative assault on movement and time through infinitesimal calculus*).

2.3. The crucially important analogy between logos and number for the appropriation of beings: arithmological knowledge

It is a surprising difference between numbers and points, that each number is autonomous, whereas all points are the same. The analogy between number and logos is also striking and has essential consequences for grasping the being of beings. In the preparatory section of his *Sophistês* lectures, Heidegger emphasizes the access to the being of beings through the logos for the Greeks. For Plato and Aristotle, Heidegger maintains, a being is ὄν λεγόμενον, i.e. beings as they are said. At the same time, with the phenomenon of sophistry, it is a matter of beings in the first place being uncovered or covered up and distorted by the logos as speech, even though for Aristotle, the highest

form of knowledge, σοφία, is said to come about through the human mind (temporarily) attaining νοῦς, which, he says, is ἄνευ λόγου (without logos). Whereas the λόγος, as Aristotle discovered, is always a λέγειν τὶ κατὰ τινός, and thus is *articulated* by way of the apophantic As or Qua as a saying-something-about-something, νοῦς, by contrast, is a direct looking-at or intuition (Anschauung) of the most general and universal ideas, εἴδη or sights, i.e. the categories, which cannot be broken down any further and articulated in a διαίρεσις as saying something about something.

If number and logos are both abstracted ('drawn off') from aisthaetically given, sensuous beings, then in this discrete taking-apart, decomposition or resolution of beings there is simultaneously a distancing from beings which makes it possible for beings to be made present by the logos (and by number) in a *different* way from the way they show themselves of themselves (aisthaetically). With the logos, another way of making beings present is given. Heidegger writes, for instance, in a striking formulation, "*This invasion of the* λόγος, of the logical dimension in this strict Greek sense, *into this question concerning the* ὄν *is motivated by the fact that the* ὄν, *the being of beings itself, is interpreted primarily as presence and the* λόγος *is the way in which I primarily make something present*, namely that about which I am speaking." (*Dieser Einbruch des* λόγος, des Logischen in diesem streng griechischen Sinn, *in diese Fragestellung nach dem* ὄν *ist dadurch motiviert, daß das* ὄν, *das Sein des Seienden selbst, primär als Anwesenheit interpretiert ist und der* λόγος *die Art ist, in der ich mir etwas,* nämlich das, worüber ich spreche, *primär vergegenwärtige*. GA19:225, italic emphases by Heidegger himself)

As we shall see (*2.7 Cartesian rules for an algebra of magnitudes in general as foundation for the modern mathematical sciences*), this "invasion of the λόγος" that articulates beings discretely is exponentiated when paired with the discreteness of the ἀριθμός which enables also a *calculability* of beings in their being with historically far-reaching consequences of such *arithmological knowledge*. The pinnacle

is reached when the ἀριθμός and the λόγος fuse into abstract algebra in the nineteenth century.

2.4. Prelogical access to beings in their being

> Worte springen wie die Affen von Baum zu Baum, aber in dem dunklen Bereich, wo man wurzelt, entbehrt man ihrer freundlichen Vermittlung.
> (Robert Musil *Der Mann ohne Eigenschaften* I Tl. 2 Kap. 40)
>
> Words jump like monkeys from tree to tree, but in the dark region, where one is rooted, one has to do without their kind mediation.

Here, the sense of being as presence and, more particularly, as presence-at-hand (Vorhandenheit) uncovered by Heidegger, and the mutual entanglement of logos and being are at work. The primary sense of being according to Heidegger, οὐσία or what underlies, i.e. the ὑποκείμενον, is what lies at hand for speaking about it in the present. What is of interest here is that the early Heidegger is seeking an access to the phenomenon of truth without the logos. What does he have in mind? This mode of access is not simply Aristotelean νοῦς, i.e. the immediate intuiting of the categories, but the two fundamental modes, understanding (Verstehen) and attunedness (Befindlichkeit, Gestimmtheit) in which world opens up to Dasein. To start with, this search can be marked off against Gadamer's:

> *Sein, das verstanden werden kann, ist Sprache.* Das hermeneutische Phänomen wirft hier gleichsam seine eigene Universalität auf die Seinsverfassung des Verstandenen zurück, indem es dieselbe in einem universellen Sinne als *Sprache* bestimmt und seinen eigenen Bezug auf das Seiende als Interpretation. [...] Denn sprachlich und damit verständlich ist das menschliche Weltverhältnis schlechthin und von Grund aus.[7]

[7] Hans-Georg Gadamer *Wahrheit und Methode* Tübingen 4. Aufl. 1975 S. 450, 451.

> *Being that can be understood is language*. The hermeneutic phenomenon throws, so to speak, its own universality back onto the ontological constitution of what is understood by determining this ontological constitution in a universal sense as *language* and by its own relation to beings as interpretation. [...] For, the human relationship to the world is, quite simply and from its foundations, linguistic and thus understandable.

Gadamer's hermeneutic approach makes it manifest that his starting-point is not as originary as Heidegger's, for the latter is essentially concerned with breaking the hegemony of the λόγος in philosophy after two-and-a-half millennia precisely by situating the originary disclosure of the world prior to the articulate interpretation of the world in language. Heidegger's "hermeneutic as" (SZ:158) is prelinguistic. Dasein has always already discovered the world and interpreted it in dealing with practical things "'without losing a word'" ('ohne dabei ein Wort zu verlieren', SZ:157). When the world comes to language, articulating itself in the λόγος of the proposition, beings are shown up in saying something about something. This is the phenomenon of "'something as something'" ('etwas als etwas', SZ:159) or the "*apophantic as*" (*apophantisches Als*, SZ:158) which itself is derivative of the more originary "hermeneutic as". In uncovering a prelinguistic access to the world in its truth, Heidegger follows the guiding thread of the sense of being as presence and comes upon time as the originary transcendence to the world. Now, instead of presence as the temporal sense of what lies to hand *for* speaking about it, the phenomenon of time itself in its *multi*dimensionality (enabling also a simultaneous presencing and absencing) comes into the intense focus of thinking. It is thus not a matter of Heidegger's having set his gaze on something resembling a "Ding an sich" (Kant), i.e. something which he properly cannot speak about, which he cannot grasp and conceive, but which he names nevertheless, nor is it the immediate, intuitive, noetic sight of the most universal ideas, but rather it is a matter of a world-opening which lies prior to speaking-about, as demonstrated in the equipment analysis in *Being and Time*.

Equipment (practical things, πράγματα) in its being-(good)-for... (Um-zu) is discovered, understood and interpreted in its being prior to

any grasping in language by Dasein, and Dasein's taking care of daily life using practical things is interpreted ultimately in its temporality as the everyday sense of Dasein. In *Being and Time*, Heidegger takes great pains with a "demonstration of the derived nature of the statement" (Nachweis der Abkünftigkeit der Aussage, SZ:160), i.e. of the λόγος, in order to "make it clear that the 'logic' of the λόγος is rooted in the existential analytic of Dasein" (deutlich zu machen, daß die 'Logik' des λόγος in der existenzialen Analytik des Daseins verwurzelt ist, ibid.). He wants to retract the "λόγος as the sole guiding thread for access to beings proper and for the determination of the being of beings proper" as it "functioned in the decisive beginnings of ancient ontology" (in den entscheidenden Anfängen der antiken Ontologie der λόγος als einziger Leitfaden für den Zugang zum eigentlich Seienden [...] fungierte, SZ:154). A corollary of this is the future historical possibility that calculable, discrete number as the hegemonic "guiding thread for access to beings proper" in the mathematico-scientific age could also be retracted. The 'one-dimensional' sense of being as standing presence or "standing presence-at-hand" (ständige Vorhandenheit, SZ:96) is unfolded into the full three-dimensionality of temporality.

2.5. The essentially 'illogical' nature of time

Next to the phenomenon of being, time is perhaps the most abused phenomenon in the whole of Western philosophy and its aftermath. In modern theoretical discourse, time is taken for granted as the washing-line on which events are hung to generate an explanatory narrative. Onto-genetic, logical-historical theories are accepted unquestionably as cogent and rule the day, even for sophisticated modern understanding. In mathematical physics, the presupposed washing-line of time becomes the imagined straight line of the real continuum indispensable for physical equations of motion. Nevertheless, it is still possible to raise the question concerning time.

Time, being-in-time enables an access to being, i.e. it holds it open, without the logos, or prior to the logos. After Heidegger's momentous incursion into Western metaphysics, the temporality of human being

(Dasein) can no longer be clarified by following the guiding thread of the logos, but rather, the logos and its hegemony as ontology can only be clarified by starting from the multidimensional, temporal meaning of being and Dasein's temporality. Time, however, is neither linearly continuous nor logically discrete; it therefore cannot be dissolved and grasped digitally, because it does not lie before us as something present from the start. It does not lie before us like a ὑποκείμενον to be spoken about; it is not a something (τί, οὐσία) lying before us to be spoken of, for a something lying present at hand is only present, which would reduce time proper to the instantaneous now (νῦν) which, tellingly, has the ambiguous ontological characteristics of both discrete presence-at-hand or standing presence, and fleeting continuity or non-being. Time is and, simultaneously, is not. "From the hegemony of this concept of being it becomes clear why Aristotle interprets time itself starting from the present, the 'now'." (Aus der Herrschaft dieses Seinsbegriffs wird deutlich, warum Aristoteles die Zeit selbst aus der Gegenwart, dem 'Jetzt', auslegt. GA19:633) Does this mean that the decomposing taking-apart (διαίρεσις) of physical beings, including practical things, performed by the logos and mathematics depends essentially on the state of beings as things lying before us as present? Yes, indeed. Whereas Dasein has to be interpreted in the full temporal three-dimensionality of its existence as a cast and casting already-being-with... (entwerfend-geworfenes Schon-sein-bei...) that understands and interprets the world in attunement with it, in order to adequately capture the phenomenon as it shows itself of itself, what is already lying ready before us to be spoken about can be clarified, starting from this fully unfolded interpretation of Dasein, as present merely in a derivative mode of temporality. As we shall see (cf. *2.9 Time and movement in Aristotle's thinking*), the phenomenon of time itself cannot be interpreted within the metaphysical framework which has only been able to grasp time ontologically on the tacit assumption that it could be captured as standing presence.

The hegemony of the meaning of being as presence-at-hand (οὐσία as Vorhandenheit or standing presence) tacitly assumed and established

already in ancient Greek ontology carries over to how the λόγος as proposition itself is understood, namely, as something present-at-hand that can be taken apart into its components, the (syntactical) sequence of words and in particular the sequence of subject and predicate joined by the so-called copula, "is". A simple proposition of the form, S is P, is then taken as the starting-point for all philosophical reflection on the λόγος, starting with Plato and Aristotle themselves. The proposition, however, is rooted more originally in the "phenomenon of 'something as something'" (Phänomen des 'etwas als etwas', SZ:159) according to which something — a hammer, for example — is understood and interpreted wordlessly as being something, namely, "'too heavy'" ('zu schwer', SZ:157) for the job at hand. Whereas Aristotle at least still saw the paradoxical simultaneous putting-together and taking-apart, i.e. the σύνθεσις and διαίρεσις, characteristic of every λόγος as proposition, later philosophy formalized this to a relation in a "system of attributions" which "becomes the object of a 'calculating', but not the topic of an ontological interpretation" (in ein System von 'Zuordnungen' aufgelöst, es wird zum Gegenstand eines 'Rechnens', aber nicht zum Thema ontologischer Interpretation, SZ:159). From here it is not far to interpreting the merely formal copula as an equals sign in an equation or as the subset sign in a Boolean algebra of sets. The proposition, S is P, hence becomes interpreted as the statement, 'S is an element of the set of all things having the attribute P'. Such sets and their interrelations can be calculated in a formal algebra that presupposes that the S, P and sets of suchlike are all things present-at-hand open to such calculative manipulation. Finally, in particular, the elements of the λόγος thus decomposed and formalized are all representable in binary code that can be organized into a calculus. The incompleteness theorems of Gödel within mathematical logic point to an excess of the truth or otherwise of what can be said (predicated) that always remains outside what can be grasped calculably by the λόγος, thus vitiating the dream of total machine calculability within mathematics (through recursive functions).

2.6. Bridging the gulf between the discrete and the continuous

From the logical side, the side of the λόγος, there is no difficulty in representing any statement in numbers, and, in particular, in numbers to the base 2, i.e. binary code, since both number (ἀριθμός) and λόγος are discrete. But how was it possible to gain a mathematical hold on real, physical beings? For this, the geometric (based on points, lines, planes and solids) and the arithmetic (based on counting starting with the unit) had to be brought together. As Jacob Klein's thorough study shows,[8] this process of historical transformation passes through the key figures Diophantos, Vieta, Simon Stevin, Wallis and Descartes. The difficulty obstructing this convergence resides in the circumstance that the Greeks thought the ἀριθμός as countable, starting with the unit or μονάς. As unit, the unit is indivisible, discrete, so the best Greek mathematics could do was to form proportions of natural, counting numbers, that is, positive fractions, broken integers or so-called rational numbers. From the geometric side, however, the Greeks were aware that somehow there were some numbers missing from the countable integers and fractions, namely, those numbers 'in between' the fractions that could not be brought into the form of a fraction, i.e. a ratio of two whole numbers. They were therefore called irrational numbers or surds or incommensurable because they could in no way be measured by the unit for counting, the μονάς, by way of creating a ratio (λόγος). The simplest irrational number arises already in considering the diagonal of the unit square, whose length is the square root of two. These irrational numbers are the magnitudes arising from geometric figures which, in turn, are obtained by abstracting the contour outlines of continuous, physical entities. Geometric figures clearly (i.e. for the visual imagination) hold themselves together; they are continuous. How are all the points on the fundamental geometric figures of a line or a plane to be captured numerically if number is conceived as fundamentally countable? This countability, in turn, derives ontologically from the

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8 Jacob Klein *op. cit.*

implicit Greek preconception of being as presence-at-hand: a definite number arises from actually counting the things lying present at hand. For Greek thinking, that which lies present at hand is the ὑποκείμενον, and such ὑποκείμενα in a multitude are countable. As we have seen above, Aristotle thinks the phenomenon of continuity ontologically starting from discrete beings which can touch, be lined up in succession, hang together and, finally, hang tightly together.

The counting unit is indivisible, whereas the unit line is infinitely divisible. Not all the possible magnitudes contained in the unit line can be captured by countable, i.e. rational numbers. The rational numbers have to be complemented by the irrational numbers to attain the entirety of a continuous line with all the possible magnitudes it contains. Although rational numbers can be made to approximate each other as closely as one likes, between any two rational numbers whatever there is an irrational number, i.e. a magnitude that cannot be expressed as a fraction of two integers. How are the countable, rational numbers to be completed to get the real numbers? Real number is an appropriate term because only by means of these real numbers can *all* the magnitudes of sensually perceptible, real, physical bodies be assigned a number. The task is how physical *res* can be captured mathematically by number, and not merely by geometry. Only number opens the possibility of calculation, whereas geometry has to rely on intuitive proofs for which the geometrical objects have to be imagined sensuously in an immediate intuition. To be continuous, and thus to capture *all* physical magnitudes of any kind, number has to become real, uncountable. Uncountability implies that, since the rational numbers are countable, between any two rational proportions of integers, no matter how minimal the difference between them, there are always non-rational numbers, i.e. rational numbers can come infinitely close to one another without ever gaining continuity, i.e. there is always a gap between them that is not rational (i.e. irrational), and in this sense they do not hang tightly together like the geometric line. Richard Dedekind’s small but crucial step was to fill in the gaps between the rational numbers by conceiving the real numbers as the limits of infinite, but countable sequences of rational numbers.

2.7. Cartesian rules for an algebra of magnitudes in general as foundation for the modern mathematical sciences

> ...wenn Licht, Wärme, Kraft, Genuß, Bequemlichkeit Urträume der Menschheit sind, -- dann ist die heutige Forschung nicht nur Wissenschaft, sondern ein Zauber, eine Zeremonie von höchster Herzens- und Hirnkraft, vor der Gott eine Falte seines Mantels nach der anderen öffnet, eine Religion, deren Dogmatik von der harten, mutigen, beweglichen, messerkühlen und -scharfen Denklehre der Mathematik durchdrungen und getragen wird. (Robert Musil *Der Mann ohne Eigenschaften* I Tl. 1, Kap. 11)
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> ...if light, warmth, power, enjoyment, comfort are primal dreams of humanity, then today's research is not just science, but a magic, a ceremony of the highest power of heart and brain before which God opens His mantle one fold after the other, a religion whose dogma is permeated and borne by the hard, courageous, agile, scalpel-cool and knife-sharp doctrine of thought of mathematics.

So the problem becomes, how can there be a mathematical calculus of uncountable, real numbers, and what is the ontological (pre-)conception or (pre-)casting of number on which such a calculus could be soundly based? That is the problem of the ontological recasting of mathematics as algebra in the modern age. Number has to become magnitude pure and simple, which is uncountable, but nevertheless calculable. Magnitude is the quantity pertaining to any extension whatsoever of a real, sensuously perceptible being from which sensuous data, and

therefore quantifiable data, can be received. Such extension need not be only spatial extension such as the three Euclidean dimensions of length, width and depth, but can be any one of the countless dimensions whatsoever of a perceptible *res* such as colour or "weight" (gravitas, XIV.16). Thus, Descartes writes in the twelfth of his *Regulae*,[9] "For example, you may suppose whatever you like about colour, but you will not deny that it is extended and consequently has figure" (Verbi gratia, colorem supponas esse quidquid vis, tamen eundem extensum esse non negabis, et per consequens figuratum, XII.6). A figure is geometric, and a geometric figure of whatever kind has magnitudes. The Cartesian ontological casting of beings as *res extensa* is essential for their reduction to figure and thus, since figure is grasped as a simple manifold of magnitudes, to mathematically calculable magnitude.

Descartes goes on to show in Rule XII.6 that the dimension of colour (of any kind of physical beings), for instance, can be represented simply by different figures which amount to different symbols representing the various colours. And he notes, "The same can be said of all things since it is certain that the infinite multitude of figures suffices to express all the differences of sensible things" (Idemque de omnibus dici potest, cum figurarum infinitum multitudinem omnibus rerum sensibilium differentiis exprimendis sufficere sit certum, XII.6). When the intellect is examining something "that can refer to bodies, this idea must be formed in the imagination as distinctly as possible; to bring this about comfortably, the thing itself which represents this idea must be exhibited to the external senses" (quod referri possit ad corpus, ejus idea, quam poterit distinctissume, in imaginatione est formanda; ad quod commodius praestandum, res ispa, quam haec idea repraesentabit, sensibus externis est exhibenda, XII.11). But if the intellect is to think through and deduce (deducat, XII.11) from a plurality, "everything not requiring attention at present is to be thrown out of the ideas of the things" (rejiciendum est ex rerum ideis quidquid praesentem attentionem non requiret, XII.11). Therefore, "then the things themselves are not to

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9 R. Descartes *Regulae ad Directionem Ingenii* Philosophische Schriften Meiner, Hamburg 1996.

be laid before the external senses, but rather certain abbreviating figures" (non tunc res ipsae sensibus externis erunt proponendae, sed potius compendiosae quaedam illarum figurae, XII.11). These "abbreviating figures" are then elaborated in Rule XVI as "the briefest of signs" (brevissimas notas) which enable the intellect to think through things without being distracted by concrete details. All the dimensions of beings thus become insofar representable in a manifold of quantities represented by symbols.[10]

No matter whether the aid of the imagination is required to represent a state of affairs to the intellect, or whether this can be done through concise symbols, if the state of affairs is not simple and immediately apparent to intuition, it can only be clarified, as Descartes prescribes in Rule XIV, by comparing it with a known state of affairs. Such comparison consists in establishing that "what is sought is in this or that respect similar or identical or equal with some given" (quaesitum esse secundum hoc aut illud simile, vel idem, vel aequale cuidam dato, XIV.2). Equality, however, immediately becomes the standard of comparison between the unknown and the known. Where the comparisons of equals are not "simple and open" (simplices et apertas, XIV.3), but are concealed in "some sort of relations or proportions" (quasdam habitudines sive proportiones, XIV.3), the task of the human intellect lies in "reducing these proportions in such a way that the equality between what is sought and something known becomes clearly

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10 This is, of course, a questionable strategy, as can be learnt already from Hegel: "Due to their simplicity, the simple first figures and numbers are suitable for use without misunderstanding as symbols, but they always remain a heterogenous and paltry expression for thinking. [...] For richer concepts, these means are completely insufficient since their extrinsic composition and the contingency of the linkage in general is inadequate to the nature of the concept..." (Die einfachen ersten Figuren und Zahlen eignen sich ihrer Einfachheit wegen, ohne Mißverständnisse zu Symbolen, die jedoch immer für den Gedanken ein heterogener und kümmerlicher Ausdruck sind, angewendet zu werden. [...] Aber bei reicheren Begriffen werden diese Mittel völlig ungenügend, da deren äußerliche Zusammensetzung und die Zufälligkeit der Verknüpfung überhaupt der Natur des Begriffs unangemessen ist... *Enz. II* § 259 Anm.).

visible" (in proportionibus istis eo reducendis, ut aequalitas inter quaesitum, et aliquid quod sit cognitum, clare videatur, XIV.3).

The culmination is then to note that the kind of equality required between the sought and the given, the unknown and the known, is an equality of magnitudes: "It is to be noted finally that nothing can be reduced to this equality if it does not admit a more or less and that all this is to be comprehended under the term 'magnitude' so that [...] we understand that from here on we are involved only with magnitudes in general" (Notandum est deinde, nihil ad istam aequalitatem reduci posse, nisi quod recipit majus et minus, atque illud omne per magnitudinis vocabulum comprehendi, adeo ut [...] hic tantum deinceps circa magnitudines in genere intelligamus nos versari, XIV.4). This holds true no matter whether the intellect is assisted by the imagination or is employed purely (intellectu puro utamur, XIV.5). The aim is to find a relation of equality between something unknown and something known, where both these somethings are nothing but "magnitudes in general". The "relations and proportions" that at first conceal the equality between the unknown and the known must be *equations* in "magnitudes in general" that can be reformulated so as to finally bring forth the required equality. But this is a description of the general algebraic procedure, no matter whether an image is used to assist the procedure or not. Magnitudes in general are represented in the equations by "brief signs" or symbols, and the equations themselves can be manipulated by the pure intellect to reformulate them in such a way that the unknown, x, is brought into equality with what is given and known. This amounts to solving a set of equations for the unknown, x.

"From here on" we are dealing only with sets of equations in "magnitudes in general" which are to be solved by algebraic methods. These magnitudes are the knowns and unknowns occurring in equations. They are no longer pinned down as continuous geometric quantities or discrete arithmetic ones but are simply *the data and solutions to sets of equations of such and such a type*. The data given by real beings are all quantitative by virtue of casting the being of beings solely as extension, so that all the many qualitative dimensions of a being, no matter what it and they may be, are reduced to magnitudes that can be inserted into

equations as knowns. What is unknown is then discovered by solving the equations for x. The behaviour of real beings must therefore be described in equations, and certain knowledge is to be gained by solving equations of certain kinds. Mathematics itself can then become the motor driving the quest for knowledge through the investigation of kinds of equations with the aim of being able to solve them algebraically for the unknown, x. Whether the magnitude in question is geometrically continuous or arithmetically discrete is no longer crucial, because magnitudes in general can be represented by symbols, and these symbols may be defined simply as the solution to a certain kind of equation within a certain kind of mathematical entity such as a field, ring or group defined solely by a set of logically consistent axioms whose validity relies on immediate intuition. The steps beyond the natural numbers to the rational numbers and on to the real numbers need not stop there. The complex numbers, for instance, can be introduced simply as the solution to certain kinds of equation that do not have solutions among the real numbers, but require the square root of minus one, the imaginary number i. And even these complex or imaginary numbers can still be represented to the imagination as planes, which themselves are imagined as extended. The quest for knowledge (starting with, but soon proceeding beyond, classical mechanics in the natural science of physics) is then guided by applying the mathematical intellect to finding solutions to ever more complex systems of equations in abstract, algebraic symbols standing for magnitudes in general. The future historical trajectory of mathematics for the next few centuries as an abstract symbolic discipline is thus fore-cast by the Cartesian ontological rules, thus laying down the blue-print for the modern age.

If the Greek beginnings of mathematics, in which there is an hiatus between arithmetic and geometry, is papered over in a Cartesian mathematics of magnitudes in general, culminating in abstract algebra, it may be objected that the distinction between digital discreteness and analogue continuity loses its importance and is overcome in the modern age. Accordingly, so the objection goes, analogue computing could, ‘in principle’, serve just as well as digital computing for the cybernetic cast of the Cartesian modern age. In fact, for certain species of problems

concerning especially the dynamics of physical systems that have to be formulated using differential equations, analogue computers have some advantages over digital computers, since the continuous, physical movements of voltages or fluids can be contrived to move *continuously* and *analogously* to a given dynamical system. This is correct. However, the antinomies between discrete number and continuous magnitude in mathematics remain (cf. Feferman 1997, Weyl 1918, *2.8.1 Excursus 1: On the antinomy between countable discreteness and the continuum in twentieth-century mathematical foundations (Solomon Feferman and Hermann Weyl)*) which makes itself felt practically in the convertibility between the two domains. Calculations also have to *read* by human beings or by digital computers, e.g. as inputs and especially as outputs, and such reading in or out demands a conversion of continuous physical magnitudes (such as lengths, voltages, currents or pressures) into definite numbers (with an accuracy specified by a number of discrete decimal/binary places) which, as definite, are necessarily finite, rational, that is, digital. At the interface, the error in the determination of significant figures by reading off analogue computers is considerably greater than for digitally computed measurements. Likewise, although the results of an analogue calculation may be stored more or less stably, say, as a voltage in a capacitor, or as a physical length, this is of no use for the arithmological human or digital interface which demands definite numbers either as a result or for further digital calculation.

The principal deficiency of analogue computers, however, is that they cannot be (logically) programmed, but must be (physically) constructed. A program is a pre-script, that is, it is logical, specifically, *arithmo-logical* (cf. *2.3 The crucially important analogy between logos and number for the appropriation of beings: arithmological knowledge*). A logical understanding of a segment of the world is pro-grammed ‘literally’, broken down into bits, into a digital machine for it to carry out the pre-scripted algorithmic calculations. With an analogue computer, by contrast, the computer itself has to be built *physically*, i.e. its circuits set up, for a *specific* calculation task. There is no universal analogue computer whereas, by virtue of logical programmability, there *is* a universal digital (Turing) machine which is first fed with the digital

program for the task at hand. A logical understanding is programmed and outsourced to a digital machine in which it can be set into motion to calculate and control movements/changes automatically. Digital calculation, and hence digital beings, 'live' off the intimate affinity between the λόγος and the ἀριθμός for human understanding. The human mind must define, delimit, articulate to understand, so that continuous physical magnitudes, as employed in analogue computing, have to maintain a convertibility with digital number. Hence it is incoherent to speak of continuous magnitude being representable as 'numerical code', for coding per se implies digitizable logification. It is therefore also no historical accident that digital computers have won out over analogue computers, and that today *hybrid* analogue-digital computers are employed for certain *specific* problems, especially where differential equations of motion arise. An analogue computer is incorporated into a universally programmable digital computer to perform a specific task for which an analogue computer (a suite of electronic circuits that behave *physically* in *analogy* to a given dynamic system) is particularly suited.

2.8. The calculative assault on movement and time through infinitesimal calculus

To launch the calculative assault on movement and time, time itself must be conceived as a magnitude that can enter into equations as a variable. This was first achieved through Cartesian analytic geometry. In the classic case of the movement of physical bodies, movement is reduced to movement with respect to place, i.e. to locomotion, within a three-dimensional Euclidean space specified by the co-ordinates (x, y, z). Time is added as a fourth dimension, the variable t, which is represented to the imagination geometrically as a straight line. A four-dimensional space of space-time arises in which each co-ordinate point is an "event" called the "here-now".[11] Time is thus thought in the interstellar cold of this natural-scientific ontology as a manifold of *now-points* or *instants*, i.e. as presence; both future time and past time are

[11] Cf. the article on "space-time" in *Encyclopaedia Britannica* Chicago 2008.

only now-points greater than or less than a given now-point, respectively. Time is measured empirically by gathering the countable data now-points of some very regularly periodic physical process (just as Aristotle's *Physics* laid down: "Not only do we measure movement through time, but also time through movement because they mutually determine each other." (Οὐ μόνον δὲ τὴν κίνησιν τῷ χρόνῳ μετροῦμεν, ἀλλὰ καὶ τῇ κινέσει τὸν χρόνον, διὰ τὸ ὁρίζεσθαι ὑπ᾽ ἀλλήλων. *Phys*. Δ 12;220b15)). Equations of motion in (x, y, z, t) arise according to physical laws of motion whose solution can be sought, depending on which variables are known givens and which unknown.

When the mathematically formulable Newtonian laws of classical physics are modified to take into account that there is no absolute time variable, t, but rather that there are differences in time between two inertial frames of reference (the 'proper time' with the symbol tau, τ) which are determined mathematically by the Lorentz transformations involving the speed of light, c, the movement of bodies (particles) in such a (Minkowski) space-time is still formulable in four-dimensional equations in which the resemblance to the classical Newtonian laws of motion is still clearly recognizable.[12] Calculation with both classical Newtonian and relativistic equations of motion requires the use of *infinitesimal* calculus because the velocity of a body is the derivative, and its acceleration is the second-order derivative of a space 3-vector (with respect to time, t) or a 4-vector (with respect to the time-difference, τ), respectively. Rates of change of continuous mathematical variables of whatever kind necessitate a calculus with infinitesimal magnitudes to gain a calculative hold on the phenomenon of movement (strictly: locomotion, i.e. only one kind of movement) through real, continuous variables such as space and time co-ordinates.

Space-time — no matter whether Newtonian-Galilean, Minkowski-relativistic or Riemann-relativistic (including gravitational mass points) — is the context for the motions or, more precisely, locomotions of physical bodies which may be celestial bodies, including stars, planets,

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12 Cf. the article by Gary William Gibbons "relativistic mechanics" in *Encyclopaedia Britannica Ultimate Reference Suite* Chicago 2008.

galaxies, black holes, supernovae, pulsars, etc., bodies moving on Earth such as cannon balls, ballistic missiles, ships, etc., or those peculiar invisible particles of quantum physics whose motions are governed by complex differential equations. As Descartes' *Rules* already prescribed, however, extension is not restricted to spatial dimensions, but covers anything admitting of "more or less", including time, colour, weight, stress, pressure, reproductive potency (biology), emotional tension (psychology), propensity to consume (economics), ad infinitum. It depends solely on scientific ingenuity whether any phenomenon at all can be reduced, or led back, to the movement of a magnitude. Such quantification demands a mathematics to calculate such movement through the appropriate equations. It makes no difference whether the magnitudes are exact or inexact, or the equations involved can be solved uniquely, approximately or only within certain ranges of probability. Mathematical statistics as a calculus of probability distributions is the way, in the modern mathematical age, of making those phenomena that do not move with necessity, but only with regularity (Aristotle's category of ἐπι τὸ πολύ), calculable nevertheless.

Because of the universal applicability of quantitative mathematical methods to all regions of phenomena, it was crucial for mathematics to put the infinitesimal calculus on a firm foundation. This was begun by Augustin Cauchy in the nineteenth century and finally accomplished by Karl Weierstrass with the rigorous, epsilon-delta definition of limit, which obviated having to introduce infinitesimals as mathematical magnitudes smaller than any real number. Any number on the real continuum can then be defined as the limit of a countable, infinite sequence of rational numbers. Continuity and differentiation (and its inverse operation: integration) could then be rigorously formulated within the real numbers, perhaps with the aid of the imaginary number i, and the historically momentous nineteenth century program of the arithmetization of geometry, or the convergence of the discrete and the continuous, consummated.

All mathematico-scientific treatment of movement of whatever kind requires at least a quantifiable concept of time, which may be conceived, or rather: imagined, as a simple, continuous, 'linear' variable of now-

points usually taken to be non-reversible, but not necessarily so.[13] Why time should be non-reversible remains undecidable in a purely mathematical conception of time. No matter whether an absolute or relativistic time is assumed, this time is regarded as scientifically 'objective', as opposed to the so-called 'subjective' time of psychological, cultural, historical, poetic, etc. experience. But objective time is the conception of time employed by a certain kind of thinking in order to make movement of all kinds calculable and, in many cases, predictable. That is, the concept of objective time is such only for a subject, viz. human being, underlying this kind of calculative will to power over movement. The ontological casting of the phenomenon of time quantitatively as amenable to mathematical calculation is a determinate historical conception of time that determines, i.e. truncates, also the possibilities of the human experience of time and hence also of the human experience of movement.

2.8.1 Excursus 1: On the antinomy between countable discreteness and the continuum in twentieth-century mathematical foundations (Solomon Feferman and Hermann Weyl)

The antinomy between the discrete and the continuum returns at the beginning of the twentieth century with the crisis in the foundations of mathematics involving questions concerning how the continuum of real numbers necessary for mathematical analysis can be derived logically from primitive elements, plus, perhaps, the arithmetical basis of the natural numbers taken as given: "... it is when we come to the real numbers that we get into serious problems about the logical foundations of mathematics..."[14] The foundations of mathematics become logically

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13 Ibid.

14 Solomon Feferman 'The Significance of Hermann Weyl's *Das Kontinuum*' second of three lectures for the conference *Proof Theory: Historical and Philosophical Significance* held at the University of Roskilde in Denmark, 31 October - 01 November 1997, http://math.stanford.edu/~feferman/-papers.html accessed July 2009. All further quotations in this excursus are also from this paper.

problematic at the beginning of the twentieth century, most strikingly demonstrated by Russell's paradox, related to the ancient Greek liar's paradox, which Russell communicated to Gottlob Frege with depressing effects on the latter logician.

As Feferman clearly and succinctly lays out in his 1997 lecture, Hermann Weyl did not accept Russell's attempted resolution and put forward his own attempt in his 1918 book *Das Kontinuum*. The antinomies unearthed in mathematical logic concern the limits of what is predicable, sayable at all with mathematical exactness of a mathematical entity. Russell's antinomy shows that it is not possible to take any predicate at all (Russell spoke of "properties") and then posit the underlying ('subject') set of mathematical entities to which that predicate/property applies. The property was then said to be "non-predicative" for it had no "extension" in an admissible set conceived as a collection of mathematical entities (and in this sense a *res extensa*). In other words, the saying was unsayable, the proposed predicate impredicable, for it referred to a logically inadmissible mathematical entity. What is sayable has to refer to (mathematical) entities whose existence is established by an appropriate definition or proof invoking only already existing mathematical entities. A mathematical predicate is said of a mathematical subject which cannot be simply posited by positing the set of all entities satisfying the predicate (the so-called Axiom of Separation), but whose existence has to be secured in terms of a construction from entities whose own existence is already assured.

Russell hence proposed a stepwise procedure starting with the simplest entities of type 0 and then proceeding to successively define higher types in terms of sets of elements of the same or a lower type. One could not presume the existence of a totality (such as the set of all sets) containing the entity-subject to be defined by a predicate/property (such as the set of all sets which are not members of themselves). That way lies patent nonsense. Russell therefore built up mathematics on the basis of a so-called Ramified Theory of Types (RTT) that respects the stepwise, countable procedure in building up authentically predicable mathematical entities, i.e. entities that can be said, defined without saying demonstrable nonsense. Because of countability (which is a

natural feature of anything sayable, predicable, which, in turn, can always be broken down into bits) it is straightforward to logically define the natural numbers simply as equivalence classes of equinumerosity of finite sets. From the natural numbers, one can then proceed to logically define the integers and the rationals, both of which are also countable.

How then to define real numbers, which exceed any finite, countable definition in terms of natural or even rational numbers? They can be defined either as an infinite, countable, convergent series of rational numbers (Cauchy series) or as Dedekind sections, which can be regarded as infinite, countable, upper-bounded sets of rational numbers (namely, such a set which does not have a maximum element). If the rationals are cut, or bisected, in this way, the cut is precisely at an irrational real number. A single real, or a finite set of reals, or even a countably infinite set of reals (such as a real sequence) can still be conceived, i.e. built up logically, on the basis of countable sets of rational numbers, and so remain within the bounds of countability and thus of sayability, predicability.

But, as Feferman outlines, when one comes to the least upper bound axiom for the reals, which is indispensable for classical mathematical analysis, reference has to be made to the total set of all the upper bounds for a bounded set of reals, which is uncountable and exceeds all the levels through which definitions of the reals have been built up. From the uncountable set of all real upper bounds, a least one has to be picked, and this proves to be impredicable, unsayable, illogical. Uncountability thus proves itself to be the limit for the sayable in a mathematical domain based only on basic logic and the natural numbers. The reals themselves can just barely be reached through countable sets of rationals, but that is also the boundary of logical rationality, i.e. of what can be said mathematically. Feferman concludes, “[a]nd since that [the least upper bound axiom] seems to be a basic essential principle of analysis, RTT proves to be unworkable mathematically”.

He then goes on to discuss Weyl’s proposed axiomatics which makes do with being able to say anything about natural numbers and (countable) sets of natural numbers, but not about the (uncountable) totality of sets of sets of natural numbers. (Note that this is not the

problem of Gödel incompleteness, for this latter concerns not what is sayable, predicable as a set but whether what can be said *truly* within an axiomatically generated, consistent system rich enough to generate the natural numbers is also *provable* within that system. Nevertheless, countability plays an essential role in Gödel's proofs because statements/predicates within a theory have to be counted.) Weyl arrives at the same impasse that Russell arrives at with the least upper bound axiom but, instead of attempting to form a least upper bound of a bounded, uncountably infinite *set* of reals, he forms only the upper bound for a bounded, countably infinite *sequence* of reals. This is admissible because it remains within the pale of countability, and therefore of sayability and logicality.

With this weaker, but logically admissible, least upper bound axiom, mathematical analysis happily can still be done, but only up to a point because, as Feferman puts it, a "continuous function ... (say on an interval) is determined by its values at rational numbers". Hence, one can fill in the gaps in continuity of a real function from the rationals and therefore one does not have to assume the existence of the uncountable set of reals making up a real interval. The interval may just as well remain rational, countable, sayable, and the uncountable real continuum as a totality is not derivable within the Weylian axiomatics. Since continuous real functions can be brought within the pale of logicality, differentiation and integration also pose no problems and "all reasonable 19th century analysis can be reconstructed, or redeveloped, on the basis of Weyl's system".

But it is not possible to logically build up discontinuous real functions in this way, so the sophisticated functional analysis required for twentieth century mathematical physics falls by the wayside. Presumably, the perplexing quantum indeterminacy struck upon early in the century hangs together with the strange illogicality of the uncountable continuum and also with the supposed continuity of movement and time. Is the phenomenon of time already beyond the reach of what can be said logically? Is time itself discontinuous? Is time outside the domain of the mathematical and exact altogether? These are not merely rhetorical questions, but go to the heart of this study and of

still unresolved antinomies in both mathematical logic and quantum physics. (See also Ch. 7 Excursus 2 and 3.)

To sum up and also to anticipate later chapters:[15] An irrational, real number can be regarded as an infinite, countable sequence of rational numbers approaching a non-rational limit. Thus, an irrational, real number can only be *approached* by an infinite counting process that gets as close as you like to it without ever reaching this limit. This implies that an irrational real number can only be conceived as a *counting movement* toward that can never be made present as a logical, computable ratio of natural counting numbers. An irrational real number is forever absent from the infinite series of rationals approaching it in a counting movement. The irrationality of an irrational real number could therefore be said to consist in its *being never present, but forever arriving, forever heralded by the endless row of rational numbers announcing its arrival*. The irrationals fulfil the illogical condition of the Aristotelean ontology of movement in general as a twofold of presence and absence (cf. *2.5 The essentially 'illogical' nature of time* and *2.9 Time and movement in Aristotle's thinking*). They are illogical because they can never be brought to a standing presence by the rationals. Otherwise they can only be symbolized by algebraic symbols (cf. *2.7 Cartesian rules for an algebra of magnitudes in general as foundation for the modern mathematical sciences*) symbolizing numbers that are forever absent and beyond the grasp of a calling to presence by the logos in a definite rational number amenable to arithmetic calculation.

Moreover, this movement of counting infinitely through a rational sequence toward an irrational limit takes place within the continuum of real numbers, so that each step from one rational number to the next must pass through an infinity of irrational real numbers. The movement of rational counting itself requires the medium of the real continuum, which is largely irrational. The continuum of real numbers can be imagined geometrically as an endless continuous line. It is geometrical figure that contours real, physical bodies, so the name 'real' for the real

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15 See my *Digital Being, the Real Continuum, the Rational and the Irrational* 2010 available at http://www.arte-fact.org/untpltcl/dgtlcntm.html

numbers is well-chosen. On the other hand, however, only rational numbers can actually be calculated to obtain a definite arithmetic number that is a kind of logos as the result of a calculating λογισμός.

What can we infer from this antinomy between the real, irrational continuum and countable rational discreteness for the being of digital beings (cf. Chapter 3)? A digital being is, in the first place, a finite sequence of binary code, consisting perhaps of billions and billions of bits, that is interpreted and calculated by the appropriate hardware in sequences of nested algorithms to bring about a foreseen effect. As binary code, i.e. a string of zeroes and ones, a digital being is nothing other than a finite rational number, whereas even a single irrational real number is a countably infinite string of bits[16] and therefore never can be inscribed logically-digitally. And yet, this binary code, interpreted as commands to be processed by a digital processor, brings forth change and movement in the real world of real, physical beings. A digital being can only represent the real world in terms of binary bits, which are logical, rational, computable numbers that always must miss the irrational continuum of the real.

For example, a computer-controlled robot on a production line can bring the robot's arm into a precisely precalculated position, which is always a rational number or an n-tuple thereof. The robot's arm, however, will always be in a real, physical position, no matter how accurate the rational position calculated by the computer is. There is therefore always an *indeterminacy* in the computer-calculated position, a certain *quivering* between a rational position and an infinity of irrational, but real positions. An irrational, real position can never be calculated by a computer, but only approximated, only approached, forever just beyond a final, rational grasp. This signals the *ontological* limit to the calculability of physical reality for mathematical science. It is not an experimental result, but is obtained from simple, self-evident-but-

[16] If, following Cantor, Aleph is the symbol for the countable infinity of the natural numbers, the smallest infinite number, then the infinity of the real continuum of numbers is 2 to the exponent of Aleph and the real continuum, in binary representation, is the set of all countably infinite strings of bits.

overlooked, phenomenological, ontological considerations. We must conclude: *physical reality is irrational*.

What does this imply for the understanding of being as standing presence? The standing presence of being is a temporal determination that goes hand in hand with the understanding of time as composed of a continuum of now-instants. According to the ontology of standing presence, a physical body assumes a definite position at a definite instant of time. In mathematical physics since the beginning of the modern age, the position and motion of physical bodies become calculable, but only by developing a mathematics of the continuum of real numbers that allows also the calculation of velocity and acceleration as infinitesimal differentiations of position with respect to the real, continuous variable, t. An irrational, real instant of time or an irrational, real position, however, can never by precisely calculated, but only approached by rational approximation. Insofar, a phenomenological interpretation of the calculability of the real position of physical bodies by means of the infinitesimal calculus shows that there is *no definite position of a physical body at time, t*, but only ever an *indeterminate quivering* of it between a *here-and-now* and an incalculable infinity of irrational *there-and-thens*.

Since, as we have seen in *2.7 Cartesian rules for an algebra of magnitudes in general as foundation for the modern mathematical sciences*, the mathematical access to being is generalized to *all* properties insofar as they are represented quantitatively by magnitudes, changes of all kinds in physical beings can be conceived as movements of a variable with respect to the one-dimensional, real, continuous variable, t, that is always essentially both rational and irrational, standing and quivering, present and absent. The state of a real physical being, however, can only be calculated from real, rational data as a countable *rational* number. *Hence the state of any real physical being is always an indeterminate quivering around a rationally calculable state. Physical reality, even on a banal macroscopic level, therefore always exceeds what can be logically, mathematically, rationally, definitely calculated.*

2.9. Time and movement in Aristotle's thinking

If in the modern age, the phenomenon of movement has been reduced to a differential ratio dm/dt, where m is the magnitude lifted off any phenomenon at all, and t is the continuous variable measuring the uniform passage of the time variable conceived as a continuum of now-moments, for ancient Greek philosophy, all the terms in this conception, i.e. movement, magnitude, continuum, time, were still questionable phenomena with which it grappled.[17] This may allow us to come to a more adequate understanding of movement and time, of their

[17] With his thesis that "being, qua being [sic], is [...] pure multiplicity" (Badiou *Being and Event* continuum, London 2007 p. xiii) and that therefore axiomatic, set-theoretical mathematics could serve as the ontological foundation of a critical social theory, Alain Badiou is faced with the futile task of showing how such a basis could generate an ontology of movement. He could have learned from Hegel: "One could even further conceive the thought of a *philosophical mathematics* which knew from concepts that which the usual mathematical science derived from presupposed determinations according to the method of understanding. However, since mathematics is the science of finite determinations of magnitude that are valid and remain fixed in their finitude, are not supposed to change, it is essentially a science of the understanding." (Man könnte noch weiter den Gedanken einer *philosophischen Mathematik* fassen, welche dasjenige aus Begriffen erkennte, was die gewöhnliche mathematische Wissenschaft aus vorausgesetzten Bestimmungen nach der Methode des Verstandes ableitet. Allein da die Mathematik einmal die Wissenschaft der endlichen Größenbestimmungen ist, welche in ihrer Endlichkeit festbleiben und gelten, nicht übergehen sollen, so ist sie wesentlich eine Wissenschaft des Verstandes;. *Enz. II* § 259 Anm.) Mathematics, whose subject matter is magnitude and number in their relations as simply *present* and *static*, cannot properly conceive transition, becoming, movement. Mathematics must therefore conceive time simply as a real variable, t, that is no different mathematically from the spatial dimensions x, y and z. What time itself *is* is left to the scientist's intuitive imagination; it is not *conceptualized*, but rather taken for granted as already more or less understood from the everyday, vulgar conception of time as a line on which an interrupted sequence of happenings is hung. Mathematized time is therefore a non-concept and returns to haunt mathematical physics.

paradoxicality that defies an all too self-confident, arrogantly narrow-minded, 'logical' rationality. Aristotle's *Physics* represents the culmination and consummation of the Greek attempts to think through the ontology of the φύσει ὄντα, whose being is characterized by their being κινούμενα (*Phys*. A 2;185a13).[18] It starts in the first book A with a critical review of his predecessors' thinking on the being of movement, κίνησις, including that of Parmenides with his mono-archic determination ἕν τὸ ὄν, "being is one", which leads to a denial of the possibility of movement altogether.

On pronouncing that "it must not remain hidden what movement is" (δεῖ μὴ λανθάνειν τί ἐστι κίνησις. *Phys*. Γ 1;200b13), Aristotle proceeds to introduce the ontological concepts that will allow him to overcome the shortcomings of his predecessors, namely, above all, the famous triad δύναμις, ἐνέργεια and ἐντελέχεια, a triad as hackneyed as any other from ancient Greece in our snotty unphilosophical times. Although we are entirely familiar with the phenomenon of movement, Aristotle claims that it remains hidden to us. This is the classic situation of philosophical thinking: it starts with what is most familiar, and thus in some sense known, in order then to show that we have always already skipped over the simplest of questions and appeased the understanding with only apparently adequate notions that take the phenomenon in question for granted.

In the following I will provide a condensed re-run of Aristotle's stepwise unfolding of an ontological concept of movement.

Movement concerns all beings in the world, not just beings in some kind of 'nature'. In the Greek understanding of being, that which is

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[18] Cf. on this entire section M. Heidegger *Grundbegriffe der aristotelischen Philosophie* Marburger Vorlesung SS 1924 *Gesamtausgabe* Band 18, ed. Mark Michalski 2002 § 26. Bewegung als ἐντελέχεια τοῦ δυνάμει ὄντος (*Phys*. Γ 1) et seq. English translation: *Basic Concepts of Aristotle's Philosophy* Indiana U.P. 2009, Second Part., Ch. 2 pp. 192-222. Cf. also M. Heidegger 'Zeit und Sein' in *Zur Sache des Denkens* Niemeyer, Tübingen [1]1969 [2]1976 SD:1-25 and Thrasybulos Georgiades *Nennen und Erklingen: Die Zeit als Logos* Vandenhoeck & Ruprecht, Göttingen 1985.

present *is*, and what is present most of all is the εἶδος, look or sight that a being presents of itself. The εἶδος is ἕν, one, i.e. a well-defined, single look or Gestalt that can also be addressed by the λόγος through the manifold of simple categories that define (ὁρίζειν), predicate the being in how it is present in its predicament. Movement is the phenomenon of change (μεταβολή), and that with respect to four categories: a being can change with respect to what it is (τόδε τι, οὐσία), how it is (ποιόν), how much it is (ποσόν), and where it is (που, κατὰ τόπον) associated with the phenomena of becoming/decay, mutation, waxing/waning and locomotion, respectively.

Significantly, Aristotle does not consider anywhere, as a kind of movement sui generis, the change that takes place through the *exchange* (μεταβολή, ἀλλαγή) of one thing for another, as in exchange in the market-place, which would have brought in the category of πρός τι, relation, and *another kind of movement*, namely, the *social movement of interchange*.[19] The ambiguity residing in that crucial Aristotelean term, μεταβολή, which can mean both 'change' and 'exchange', has had fateful consequences for Western history. Replacing one light bulb by a new one is a banal example of movement as exchange which can still be thought as a composite movement composed of the movements of the old and the new light bulb. But the social exchange among human beings in which goods exchange or in which mutual recognition takes place can by no means be thought through merely by composing individual movements, because the starting-points of the movement are multiple and also interlinked in a mirroring process (as captured, for instance, in the process of recognition in Hegel's *Phänomenologie des Geists*). The μεταβολή of greeting *each other* on the street, for instance, is an interchange whose ontological structure is already more intricate than the productivist movement of a δύναμις being realized one-sidedly through its ἐνέργεια.

The peculiarity of the phenomenon of movement is that it cannot be pinned down to the present. Anything in movement has a *twofold*

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19 Cf. on social interchange Eldred 2008/2011, esp. Chapter 5.

(διχῶς *Phys*. Γ 1;201a3[20]) presence: first of all it shows itself in the look of its εἶδος, but secondly, it also has a lack (στέρησις) that points to something absent which it could also *be*, i.e. which could also be brought into presence. For instance, a full moon has the lack that it could also be a new moon, or vice versa. In what it *is*, it is also in a certain way, i.e. potentially or 'absently', what it is *not*, a μὴ ὄν. Or a piece of timber presents itself in its εἶδος as timber and also as lacking what it could also be, namely, a table, for instance. What/how/how much/where something could be through the appropriate movement is its δύναμις, i.e. its potential, potency or power to be something else, which is more than a mere formal or so-called 'logical' possibility. The thing itself has an *inherent* tendency to become other than it is; it is not yet finished. Aristotle conceives the lack in the twofold presence of a being in

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[20] Cf. also *Met.* 1009a32ff: "Namely, being [presencing] is said in a twofold way, so that in one way a being [a present] admits becoming something out of a non-being [a non-present], and a way it does not; and the same can be [presence] and not be [not presence] at the same time, but not according to the same mode of being [presencing]; potentially, [35] namely, the same can admit being [presencing] at the same time as its opposite, but not in actual, finished presence." (τὸ γὰρ ὂν λέγεται διχῶς, ὥστ᾽ ἐστιν ὂν τρόπον ἐνδέχεται γίγνεσθαί τι ἐκ τοῦ μὴ ὄντος, ἐστι δ᾽ ὂν οὔ, καὶ ἅμα τὸ αὐτὸ εἶναι καὶ ὂν καὶ μὴ ὄν, ἀλλ᾽ οὐ κατὰ ταύτὸ [ὄν]· δυνάμει [35] μὲν γὰρ ἐνδέχεται ἅμα ταύτὸ εἶναι τὰ ἐναντία, ἐντελεχείᾳ δ᾽ οὔ.) If (the meaning of) being is confined to presence in the present, then the principle of non-contradiction (*Met*. Γ 3;1005b30) holds water, but if (the meaning of) being encompasses also the modes of absencing, as in the case of potentiality, then a contradiction can 'be', namely, as a twofold presence-and-absence. Potentiality is the presence of a future presence that is as yet absent which, however, is also present in the present being [present] *as* an absence. Anything capable of change/movement must have this twofold presence. Aristotle goes on immediately to admit also another kind of (ever-)presencing that is compatible with Parmenides by "assuming also another being of beings [another mode of presencing of presents] as springing up thoroughly without movement or decay or becoming" (ὑπολαμβάνειν καὶ ἄλλην τινὰ οὐσίαν εἶναι τῶν ὄντων ᾗ οὔτε κίνησις ὑπάρχειν οὔτε φθορὰ οὔτε γένεσις τὸ παράπαν. 1009a36f).

movement through the pair of concepts, δύναμις and ἐντελέχεια. A being with a potential, a δυνάμει ὄν, has the power to become something else, but as it is in its presence, it is still ἀτελής, unfinished. It could only *have* itself in its finished presence in achieving ἐντελέχεια, i.e. through its having-itself-in-its-end. Thus does Aristotle come to his first definition of the being of movement. It is the presence of the potential being *as such*, stretching itself toward its finished presence, and thus a peculiar *twofold* presence of both presence and absence in which the potential being is *on its way* to becoming other than it is, in a finished state in which the movement will have ceased and come into its end. In achieving its presence *as* a potential being, the δύναμις is already fully present, i.e. in its ἐντελέχεια, insofar as it is δυνάμει ὄν, but it has not yet attained finished presence as something else in its realized potential. In movement, the potential being is still exercising its power of change. "The finished presence of the potential being insofar as it is such is movement." (ἡ τοῦ δυνάμει ὄν ἐντελέχεια, ᾗ τοιοῦτον, κίνησις ἐστιν. *Phys*. Γ 1;201a10f). In movement, the being's power to be what it *can* be is *at work*, i.e. it is ἐνέργεια. Therefore, Aristotle can say that movement is the ἐνέργεια of a δύναμις in its ἐντελέχεια. Movement itself is a phenomenon that cannot be defined by a single category; it has, at least, a twofold presence and therefore must be addressed by a *double* concept, i.e. by a pair of ontological concepts, δύναμις and ἐντελέχεια as lack (στέρησις), whose unified twofold presence is a third phenomenon, namely, the at-work-ness of the potential *under way* or *in transition* to finished presence.

Now, if the being does not have the source of its movement within itself, which would make it an ensouled (ἔμψυχον), living being, it suffers itself to be moved by something else. A being with the potential to be moved has a δύναμις παθητική, whereas a being that is potentially a mover has a δύναμις ποιητική. A piece of timber has the *passive* potential, or power, to suffer itself to be transmuted into a table, and the know-how of carpentry has the *active* power to move or transmute the timber into a table. Despite this twofold, passive-and-

active, aspect of movement, the movement at work, its ἐνέργεια, is still just one movement, and not two.

Moreover, movement is a continuous (συνεχές, *Phys*. Γ 1;200b19) phenomenon which means that it is connected (ἐχόμενον) and also that it holds itself together within itself (συνέχειν). The continuum is that which can be divided limitlessly (ἄπειρον διαιρετόν, 200b21), i.e. for which there is no discrete limit where the division has to stop. The indefinite, double or twofold determination of movement as both δύναμις and ἐντελέχεια at once would seem to have to do with its continuous, limitlessly divisible nature. The presence of the δύναμις cannot be separated from the likewise present absence or lack of the ἐντελέχεια as the perfect, finished present toward which the δύναμις in its ἐνέργεια is stretched. Instead of a well-defined, unambiguous presence of one (ἕν) that could be captured by a single category, we have an ambiguous, inseparable presence of *both* a power and the not-yet-finished end-presence of its being-at-work. Even more than that, with the advent of ἐνέργεια, there is a *triad* of elements whose unity constitutes the full ontological structure of movement of all four Aristotelean kinds.

With this triad, Aristotle has all the elements in his hand to think through also the ontology of the phenomenon of *time*, albeit he goes a completely different path in his chapters on time in *Phys*. Δ Chaps. 10-14.[21] There he notes that "it is obvious that time is not

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[21] Traditional commentators on Aristotle have not made the connection, or rather misconnection, between the ontological concepts Aristotle develops in order to grasp the phenomenon of movement and his investigation of time. Not even Heidegger, in his thorough-going interpretations of the *Physics* on movement and time in *Gesamtausgabe* Band 18 and Band 24 (*Die Grundprobleme der Phänomenologie* Marburger Vorlesung SS 1927 ed. F-W. v. Herrmann 1975 § 19 a) β) Auslegung des Aristotelischen Zeitbegriffs GA24:336ff; English translation: *The Basic Problems of Phenomenology* Indiana U.P. 1982, Section 19, a) Historical Orientation Concerning the Traditional Concept of Time, pp. 231-256) makes the link between the triad of concepts fashioned to capture movement and the triad of temporal dimensions into which time stretches.

without movement and metabolism/change" (φανερὸν ὅτι οὐκ ἔστιν ἄνευ κινήσεως καὶ μεταβλολῆς χρόνος. Δ 11 219a1). The gateway to the phenomenon of time is thus through movement: Something present has the potential, the power to be something else, which it can become through the appropriate movement which itself comes to presence when the potential achieves its finished presence *as* a potential, namely, in being at work as movement itself toward its end. *What was (past) a potential power at rest is now (presence) a power at work toward (future) a realization of the potential in a perfect presence*. The three ontological elements of movement thus map onto the three dimensions or 'ecstasies' of time itself which, two-and-a-half millennia later, and foreshadowed by Husserl's phenomenology,[22] will be explicated as the temporality of Dasein in *Sein und Zeit*, whereas the Aristotelean conception of quantifiable time, now designated as the "vulgar conception of time" (vulgäres Zeitverständnis, SZ:428 §82a), will be shown to be derivative of a more primordial conception of the phenomenon of time (cf. *Sein und Zeit* Division 2, Chap. 6). When a power is at work, all three elements of movement are present, albeit that two of them, namely, the power as potential and the power realized in a finished presence, are present *as* absence, i.e. as *no longer* and *not yet*. This ontology of time is therefore thought on the basis of the *paradigm of production*, a *particular* kind of movement. A piece of timber, for instance, has the potential to be a table. This potential becomes present *as such* when the timber is worked upon by the carpenter on its way to attaining a perfected presence in a finished table. The piece of timber is thus *stretched* in time between what it *was* potentially and what it *will be* finally, and only in this transition as a simultaneity of presence and absence is it in movement. Being itself is thought in Greek ontology as a pro-duction, a Her-Stellung, namely, as a coming from an origin, a whence (ἀρχή, γένος, τὶ ἦν) into the perfected presence of its sight (ἰδέα, εἶδος) most succinctly summed up in Aristotle's famous formula

[22] Edmund Husserl *Vorlesungen zur Phänomenologie des inneren Zeitbewußtseins* (ed.) Martin Heidegger, Max Niemeyer Verlag, Halle a. d. S. 1928.

for the beingness (οὐσία) of a being: τὸ τί ἦν εἶναι (the what-it-always-was-ness).

Aristotle eschews the possibility residing in the triad of concepts he has fashioned to grasp the ontology of movement, and famously determines time instead *quantitatively* as the number (ἀριθμός, 219b2) or measure (μέτρον, 221a1) of movement: "This namely is time, the number of movement with respect to earlier and later. Time is therefore not movement but movement insofar as it has a number." (τοῦτο γάρ ἐστιν ὁ χρόνος, ἀριθμος κινήσεως κατὰ το πρότερον καὶ ὕστερον. Οὐκ ἄρα κίνησις ὁ χρόνος, ἀλλ᾽ ᾗ ἀριθμὸν ἔχει ἡ κίνησις. 219b1ff).[23] And "time is the measure of movement" (ὅ χρόνος μέτρον κινήσεως, 221a1). The now (τὸ νῦν) divides the earlier from the later like a point (στιγμή, 219b18) divides a line (γραμμή) into two parts (220a21). The succession of nows counted off as 'now', and 'now', and 'now' is the progress of time coming to presence and simultaneously disappearing from presence. Aristotle raises the aporia that only the now is, so that time consists predominantly of that which is not, namely, the no-longer and the not-yet. As a quantity lifted off the phenomenon of movement, "we

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[23] Although M. Roubach cites this famous core Aristotelean definition of time in the chapter he devotes to "Number and Time in *Being and Time*" (p.55, mistranslating κίνησις as motion, i.e. locomotion, rather than the more encompassing phenomenon of movement), he discusses neither Aristotle's deep ontological analysis of movement in four senses (with its famous triad of characteristic concepts), nor Heidegger's extensive and continuing interpretations of Aristotelean movement in the 1920s (e.g. GA18, GA22, GA24) and thereafter. He therefore fails to make any connection whatsoever between the enigmatic twofold present-absent nature of movement itself and the fleeting present-absent nature of time itself, but instead deals with time only insofar as it is a finite or infinite number, i.e. only in relation to the finite and infinite in mathematics. But number itself, as unmoving, is outside time altogether, whereas number, according to Aristotle, counts time. The 'nows' themselves, therefore, must be, in some sense, moving, transitional - the enigmatic ontology of movement and time. Cf. Michael Roubach *Being and Number in Heidegger's Thought* Continuum, London 2008.

measure" (μετροῦμεν, 220b15) time; it is a number, a measure, a magnitude (μέγεθος, 220b27), and, like movement itself, it is continuous. Insofar as it is simply a number, time is unmoving, i.e. outside time, so it is crucial that the counting of nows in the progress of a movement refers to the *transitional* character of the nows that they are *underway* from...to, i.e. always both present and absent.

As a *continuous* magnitude, there is no smallest time, because any continuous magnitude can be divided further, but as a number (ἀριθμός, 219b2), there is a smallest one, which Aristotle takes to be two (220a28) because that is the first number one comes to in the act of counting, starting with the one (μονάς). Time is counted by saying 'now' at least twice in succession, thus marking an earlier and later. This raises the aporia in the nature of numbers as either countable and discrete or as endlessly divisible and continuous, an aporia which, as we have seen (cf. *2.6 Bridging the gulf between the discrete and the continuous*), was solved in mathematics as late as the nineteenth century with the concept of mathematical limit which allowed the infinitesimally small to be coherently calculated without assuming the infinitesimals as infinitely small magnitudes smaller than any real number. Infinitesimals can be dealt with as the limits of *countable*, infinite sequences of rational numbers, thus bringing countability and continuity together.

But why should time be quantitative at all?[24] Time is something lifted off (ἀφαίρεσις) movement itself in its transitional character and, as such, is an abstraction. Saying 'now', or a succession of 'nows', is an abstraction from any particular quality of the movement concerned, capturing only the phenomenal moment of transition from what was to what is to what will be. The only difference between successive 'nows' is earlier and later, which makes of the counting of now-moments passing through, the abstracting counting of time itself. Hegel

[24] In his detailed interpretation of Aristotle's ontology of time in GA24, Heidegger himself does not question the quantitative nature of Aristotelean time.

determined quantity as the abstraction from all quality,[25] and the counting process of successive 'nows' is indeed an abstraction from all quality of movement apart from its transitional, never-to-be-pinned-down character 'between', underway, or as *both* presence and absence. A kind of ordinal counting as a steady drumbeat of successive nows can therefore be phenomenally justified, and the successive nows can be added up to attain a succession of (ordinal) counting numbers going on indefinitely, which is the counting of time that can be made mechanical and arbitrarily refined in a clock (beyond the rough counting of days, months, years, which are all regular movements of celestial bodies). The difference between any two counted now-moments can be measured, and since they are read off movement, which is continuous, the measured magnitude of time itself is also continuous. Why the passage of time should be *uniform* at all is a question taken up at a later stage of our investigation (cf. *5.5 Time in a capitalist economy*).

We conclude this section by noting that the quantitative ontology of time has its origin already with Aristotle. The ontology of time offered in Heidegger's *Sein und Zeit* implicitly breaks with this quantitative ontology but remains within an ontology of time still determined by the paradigmatic movement of *production*. Now it is not a piece of timber that is produced into a table through the realization of a potential, but Dasein itself that casts its self into the future in a kind of self-production: "Preparing its potential for being, Dasein *comes to itself*." (Das Dasein *kommt*, sein Seinkönnen gewärtigend, *auf sich zu*. GA24:375) Is there a possibility of an alternative ontology of time residing in the paradigm of social interchange, according to which each human being finds its self as it comes about as a who-stand in the intricate, haphazard interplay with others? We shall return to this question in *5.5 Time in a capitalist economy* and *5.7 Recovery of the three-dimensional, complexly interwoven social time of who-interplay* (cf. also *7.2 The necessity of introducing three-dimensional, ecstatic time*).

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[25] Cf. G.W.F. Hegel *Enzyklopädie I* §99 Bd. 8 *Werke* Suhrkamp, Frankfurt/M. 1970.

3. Digital beings

What is a digital being? To give an answer to this question presupposes that digital technology and its essence have been clarified, which in turn presupposes an understanding of the λόγος. We will first give a provisional answer which grasps the initial manifestation of a digital being. Accordingly, a digital being is nothing other than binary code, i.e. an ordered, finite sequence of binary numbers. How these numbers are arrived at is at first not visible, but only that they have been 'lifted' from physical beings, including practical things, in some (knowing) fashion, thus enabling a certain function. Since the numbers are not only placeless, but also positionless, digital beings themselves are also placeless. This sequence of numbers, however, is also 'written down' somewhere, i.e. inscribed in a material medium like a printed book. Viewed from the outside, a book can also be regarded as an ordered, countable, finite sequence of letters and other orthographic characters, where all these characters can be represented in numbers and thus ultimately also in binary code. Whereas, however, a book is read by a human, the binary code is usually read, not by a human (except a programmer), but by another digital entity, namely, the software program which calculates and processes the read digital being in a predictable, i.e. programmed way, as *commands*, hence bringing forth effects such as a visible image on a screen or the result of an arithmetic calculation.

3.1. The appropriation of the truth of beings, digital interpretation of world-movement and its outsourcing through executable, cybernetic machine-code

In order to clarify the essence of digital beings a step further, they have to be viewed from digital technology which up until now has been left out of consideration. The binary code of a digital being is writing, script, i.e. it is the inscription of a λόγος into a medium where this

λόγος can also contain numbers, i.e. ἀριθμοί, and thus can have mathematical character in the narrower sense. This logos is that of a techno-logical know-how, which is a special case of the λόγος as conceived since the Greeks: "*In knowing and speaking, the truth of beings, their disclosedness, is appropriated*." (*Zugeeignet wird im Erkennen und Sprechen die Wahrheit des Seienden, seine Unverborgenheit.* GA19:276 emphasis in the original; cf. 274, 391) Technology is essentially a knowledge which provides insight into beings with a view to their manipulation. Productive technology or τέχνη, i.e. knowing ποίησις, is a knowledge of *how* an envisaged product (a change or movement of any envisaged kind, which may be regarded simply as an effect or a result) can be brought forth.

Here a distinction must be drawn between digital beings which are in some way or other read by humans, and digital beings which are employed to automatically control some process or other. Productive know-how can be written down. Written-down knowledge was first of all read by humans who appropriated and applied the knowledge for their own purposes, e.g. in artisanal production. With digital technology, however, knowledge is not only written down in a written script legible to humans, but in a written script which can be read by a machine as a sequence of machine commands bringing forth envisaged results in a certain, determinate context. The written script itself can be input into a machine to control it. Written script thus becomes a digital program, or literally, a pre-writing or pre-script, which controls a machine of one kind or another and is 'productive' in the sense of bringing forth an effect which is always some sort of change (μεταβολή).

Written script as binary code, i.e. as a finite sequence of discrete binary numbers (for any written script at all can be represented in binary code), is 'read' sequentially (ἐφεξῆς) by the machine, i.e. each digital character or each string of digital characters taken together (i.e. syllables in the Greek sense of συλλαβεῖν, aor. inf. act. 'taken together') serves to control the machine's movements by means of commands that the machine (its 'chip') has been preprogrammed to 'understand' and 'interpret'. The hardware and software mesh together like a σύμβολον,

a ‘symbol’ in the Greek sense, as in two pieces of code that only make sense when fitted together. They fit together to form an ‘automatic computing machine’, or Turing machine, for a certain calculatory task. The hardware itself is the computer, a universal Turing machine, into which a “description number” (Turing 1936) is first input that today is called software, which is then able to operate on and compute data (a number) that are fed in to produced another number. Turing’s ingenious insight (Hodges 2007) was that the instructions for a definite computing task (the software) are just a single digital number that works on another digital number (the data).

An elementary example of such control is when a binary-coded, digital text is ‘read’ by a digital device such as a word processor, mobile telephone or PC, etc. in order to represent or reproduce the text on a screen through an ordered sequence of pixels. The pre-script in this case is not merely the text itself in a digital form (the data-number), but the word processing program and the control characters embedded in the text which together compute a number that, translated back to the physical world, enables the text to be reproduced on a screen by means of control instructions. The program pre-script used to control a machine is always a ‘logically’ fixed knowledge insofar as the λόγος appropriates beings in their truth with a view to some practical end (in this example, an electromagnetic state of matter interpreted as an ordered sequence of pixels and legible to the eye as text). The essential and immensely powerful characteristic of digital technology is that human knowledge can be *outsourced* by the pre-script of a program into a machine where it then automatically brings about effects at any place whatsoever. Already the idea of a Universal Turing Machine (Turing 1936) provides for outsourcing the algorithm for a computing procedure into the tape-memory of a computing machine. The knowledge is a theoretical pre-understanding of a certain matter or state of affairs which, as a digital program, enables certain predefined procedures to be automated. In principle, *all* human tools are the outsourcing of a knowledge or know-how. A tool as simple and banal as a potato peeler, for instance, is the outsourced knowledge of how to peel a potato effectively embodied in a practical thing designed for the specific

purpose. A better potato peeler is the embodiment of a better, more efficient potato-peeling know-how. The potato peeler is not simply a tool for an operative execution of human know-how but rather *as such*, in its very fashioning and making, already *embodies, materializes* partially a restricted kind of practical culinary know-how.

Outsourced know-how, however, comes into its own when it is automated, e.g. when the know-how of how to produce a table is outsourced via a digital program into a automatic, numerically controlled lathe. Contemporary debates over artificial intelligence and expert systems turn upon the extent to which, and which kinds of, practical human understanding can be digitally, logically encoded and thus outsourced. Digital technology opens up hitherto inconceivable possibilities for outsourcing (segments of) practical world-understanding in such a way that movements of all kinds (e.g. the motion of a door, the movement producing the result of a calculation or a signal that a predefined state has been achieved) can be automatically brought about. Computer programs inscribe a partial practical understanding of world, say, into the hard disk of a network server, and make the interpretation of this understanding processable and calculable by a microprocessor, thus producing functional effects (such as the ‘production’ of a search result by a digital search ‘engine’). The digital capture and taking-apart of the totality of beings thus goes qualitatively beyond mechanical technology, which is still oriented toward physical (loco)motion, into the dimension of the automated control of systems of movement of all kinds.

Since the onset of modernity, in which beings were cast as *res extensa* for the first time, the theoretical access to beings in their being has been enabled through measurability. The theoretical appropriation of beings is then a disclosing of beings by quantitative measurement, both practical (e.g. empirical data collection) and theoretical (e.g. postulating algebraic variables for certain physical dimensions). The way a given matter behaves is then graspable and knowable theoretically through quantitative relations (equations), and this knowledge can then be programmed into computing machines of all kinds which further calculate what is measured on beings in accordance with a theory. For instance, digital photography is enabled firstly by casting colour itself

ontologically as a purely quantitative multi-dimension (i.e. a triple of positive integers plus other numerical parameters to form a colour vector). The further calculation then serves either a deeper knowledge of the matter (e.g. digital chromatic rendering) and/or the (possibly automatic) control of a process already set in motion in which the measured or further calculated matter or state of affairs is fed back into the process as a control variable (e.g. to produce a colour print).

Whereas the written, legible logos preserves knowledge — i.e. in this context, primarily technical knowledge —, with executable digital character sequences, knowledge is converted into a functional form which allows it to bring forth effects and to control processes automatically. The logos in the form of digital code is thus fed back into beings in order to manipulate them in a kind of self-poiesis. Digital beings legible for humans comprise not only text-like files, but all code sequences such as images, sounds, moving images which, when they are re-presented by the appropriate hardware, have effects on the senses and can be taken in by sensuous perception and understood as a meaningful whole. Machine code, on the other hand, controls processes in pre-understood and pre-calculated ways. To do this, the process itself must have been already understood and taken apart in a mathematically calculable way which itself builds on various natural and technological sciences such as physics and electrical engineering. The programmer transforms this understanding into machine-readable, sequential digital code (for every programming language must be ultimately translated into digital machine code in the narrow sense which consists exclusively of binary bits to be processed stepwise by the digital processor or ‘chip’ as executable commands) which then brings forth calculable control effects in a definite, foreseen context. Thus, cybernetic-technical knowledge becomes automated and tendentially makes itself independent vis-à-vis humans for, although each program can still be read and understood individually, the possible implementations of automatic control are well-nigh unlimited and thus lead to intricate, intermeshed, non-transparent control complexes that may even feed back automatically into each other in feedback loops — including in unforeseen ways.

Control processes that are no longer co-ordinated with the particular context foreseen, automatically bring forth nonsensical or even detrimental effects. An understanding programmed in digital code can thus possibly turn into a severe misunderstanding with serious consequences. If each digital program can be conceived of as the implementation of a partial understanding of the world, then the possibility of arbitrary replication of binary code means that the digitized cybernetic knowledge transformed into software is available and can be called up anywhere, including in wholly unintended contexts.

The *interpretation* of the world through executable machine code takes place *factually* and *mechanically* (i.e. without understanding) in the interpretative processing of what is given by the world (data) and this interpretation is already latent in the pre-script of the program itself that just 'mechanically' processes the data. Viewed thus, a computer program pre-script is not only a productive technical know-how producing functional effects, but, more deeply and prior to that, a *pre-interpretation* of (a restricted segment) of the world written down by us which is ready to receive data at any time in order to calculatively interpret the world, on the basis of the data fed in, in a certain predefined direction and to control some system or other on the basis of this interpretation. Human being, for which the world opens up in understanding, can today outsource to a computer its interpretation of the ontically understood world in segments into binarily programmed, functionally effective pre-interpretations of the world, where the understanding of world itself already has to be compatible with a digital decomposition (e.g. time has to be conceived quantitatively as a continuum of timeless now-points). Such a world-understanding as a whole is oriented toward setting up and controlling the various kinds of *movements* of beings in their totality.

3.2. Digital beings arbitrarily reproducible in the electromagnetic medium

To return to the simple example of a book compared with a digital being consisting of binary code: the difference between a book and a digital being is that books still have to rely on the stampable mass

(ἐκμαγεῖον), paper, for their replication, whereas today's digital beings need only an electromagnetic medium (floppy disk, hard disk, magnetic tape, memory stick, etc.) which, moreover, is also arbitrarily and conveniently replaceable and reproducible. In the possibility of replication there lies also an arbitrariness of place, even for manuscripts that can be copied. This is ontologically possible only because of the essential placelessness and discreteness of the logos itself which, regarded merely as something which is itself present-to-hand, available (zuhanden, cf. SZ:224), can call the beings which are being spoken of to presence anywhere, anytime (the inscription is time-less). Digital code, too, as essentially related to the logos like any number or sequence thereof, participates in this essential discreteness, placelessness and timelessness. Whereas the spoken, expressed logos calls beings to presence in a situation, i.e. a place of togetherness (*Mitsein*), a book or digital code only calls beings to presence in being read where, with respect to digital code, 'reading' here is always a sequential processing of commands with respect to the function envisaged and foreseen in the program pre-script. (Even parallel processing in multiple processors has to be sequenced, which presents computer science with problems.) The writing preserved in a book or the stored binary code, however, is also a being present-to-hand in itself which is stored in some place or other, even though this place is completely arbitrary, or at least, the place where a book or a digital being is stored is a place in the topological manifold for Dasein where it is kept 'ready-to-hand'.

3.3. Loss of place in and connectedness of the electromagnetic network

In any case, digital τέχνη lifts a logical-digital structure from physical beings where there is no longer any topos, i.e. specific place (i.e. apart from the electromagnetic medium in general), where the digital being would 'naturally' belong and towards which it would 'naturally' 'gravitate' and upon which it were dependent for coming to presence at all. Like the λόγος of communication through which human beings can share an understanding and interpretation of an aspect of the world in its

disclosure, and which can be degraded into mere hearsay in being prattled on (especially in the modern media), so too is the passing-on of digital code as something available to hand devoid of any understanding of the originary appropriation of beings in their calculable truth achieved by the digital technological λόγος. The knowledge embodied in digital computing machines is totally inconspicuous; the user appropriates only the desired, useful functions and effects of such machine-embodied know-how without any insight even into its technological truth. Digital beings still require a material, namely, an electromagnetic medium, which is situated somewhere, but, since this medium is homogenous, this place is arbitrary and stands at the disposition of Dasein which, as the modern subject, orients its world as it sees fit. Or, even more, digital beings are placed at the disposition of the set-up and drawn into the circling of the endless movement in quest of gain (cf. *5.6 The global power play measured by money-value and its movement*). Cyberspace itself has its own peculiar spatiality; it is not merely 'virtual' but has its own orientation and dimensionality (cf. *4.2 Dasein's spatial being-in-the-world: approximation and orientation*), and in this cybernetic space, the digital beings can be arranged, moved and reproduced arbitrarily at will. Cybernetic (from κυβερνᾶν, 'to govern') space is called thus because, inhabited as it is solely by digital beings composed of bits, it enables total control through digital know-how. In a certain way, digital beings, insofar as they are viewed merely as ordered sequences of binary code, are nothing other than written 'texts' stored in the electromagnetic medium which can be called up arbitrarily at will, including by that automated will preprogrammed into computer programs. Because the electromagnetic medium is homogenous, and digital beings are nothing other than an impression or imprint in this medium, any topologically continuous network of such electromagnetic medium, such as the internet, potentially facilitates total control through total traceability, for each and every digital being leaves its *calculable, recallable* 'footprint' in the electromagnetic medium.

Such arbitrariness of place stems from the circumstance that, viewed ontologically, logos and number are both attained by being 'lifted' or 'drawn off' from physical beings. The placelessness of the logos thus

assumes a new meaning: not only is arithmological knowledge attained by an abstraction that 'lifts' measurements from beings, but this knowledge now assumes the garb of binary code in a technically ubiquitous form. Binary code as a pure form impressed in an electromagnetic, ubiquitously present, physical medium is entirely compatible with all kinds of *formalistic thinking* that abstracts from the *particular situation*. These include especially the formalistic bureaucratic and legal thinking that the state employs to impose its rule 'neutrally' over its subject populace. Knowledge is then not only universal in the sense of a universal comprehensibility and applicability but also materially universal in the form of universally accessible binary code that can be embodied arbitrarily as executable code in the homogenous electromagnetic medium of the appropriate digital devices for the control of movements of all kinds.

A medium is something through which other beings can move. The technically produced electromagnetic network technically enables the arbitrary movement of digital beings through the medium of the network. Every place in the network can be specified by co-ordinates. Since the electromagnetic medium is homogenous (every place is thus equivalent to any other place), each place in the network can be specified by purely numerical co-ordinates. These co-ordinate places are therefore not places in the Aristotelean sense to which a digital being essentially belongs and to which it owes its presence, nor even geometric positions, but rather, paradoxically, merely positionless, placeless, numeric n-tuples enabling calculation. Branches of mathermatics called combinatorics and graph theory even arise to enable the calculative control of networks. Networking means only that all co-ordinates are connected with each other (Aristotle's ἐχόμενον cf. *2.2 Heidegger's review of Aristotle's thinking on modes of connectedness from discreteness to continuity*) directly or indirectly in such a way that digital beings can move without obstruction through the homogenous medium from one arbitrary co-ordinate place in the network to any other arbitrary network address. The restrictions to this movement are of a merely technical nature which, in turn, can be overcome technically (or, conversely, even imposed technically for security reasons).

3.4. The forgetting encouraged by digital code and automated cybernetic control in the robotic age

Whereas the logos that is spoken and read by humans calls the beings which are spoken of to presence for understanding, binary cybernetic machine code executes cybernetic control processes unseen in the background. Only the effects of cybernetic processes are brought forth into presence, bypassing understanding. The technical knowledge hidden behind these cybernetic processes can be 'forgotten' since the processes themselves proceed automatically. Only the technician or engineer needs to know how these cybernetic processes technically produce their effects. Understanding itself has passed over from human being into electronic digital devices. Such forgetting of technical knowledge in the broadest sense can be observed today everywhere, such as in the circumstance that people are no longer able to carry out even simple arithmetic operations in their 'heads', but rather have to reach for a digital pocket calculator to do so.

In a computer program, technical knowledge itself translating a partial understanding and interpretation of some aspect of the world is made into something lying present at hand and to hand, i.e. it is then available as something that can be called up ubiquitously, and it is a being which is good for something (mode of being as being-(good)-for...). Whereas the 'logical' or logos-like call-up of beings takes place through language calling beings to presence by addressing them, with the digitally decomposed beings this presencing is different, for here, binary code is called up through the electromagnetic medium, i.e. is de-distanced or approximated[26], in order to be processed further, e.g. read by a human, or to unfold automatically its programmed effects. One could say that for the construction of many kinds of digital beings, physical beings serve as models, for binary code represents technical knowledge of the world and of practical ways of comportment in the world in some respect or other. Physical beings are brought to presence in knowledge through the numbers and language 'lifted' from them in a way different from their

[26] In the sense of OED: "approximate: 1. trans. To bring close or near, to cause to approach or be near (to)..."

presencing of themselves unmediatedly for aisthaetic perception in a situation. The knowing re-presentation of physical beings in digital code depends on both the geometric abstraction from physical beings and the discrete arithmetic abstraction that is able to algorithmically approximate continuity to any desired degree of accuracy.

When, as we have seen, the knowing, disclosing appropriation of beings through numbers and language, i.e. *arithmological knowledge*, is inscribed in a computer program, physical beings too then become cybernetically manipulable and that not only merely by a technically skilled human hand, but by automatic machines controlled by binary machine code, where such machines can assume also the most subtle and inconspicuous forms of appearance such as biochemical nano-machines. As cybernetic programming, arithmological knowledge intervenes 'in writing' in the world of things. Arithmological knowledge not only enables a technically productive manipulation of beings, but arithmological script as cybernetic program code transforms this arithmological knowledge automatically into effects. Such automatic cybernetic systems represent a hybrid between φύσις in the sense of beings which bear the governing source of their own movement within themselves, on the one hand, and a technique under the control of a human hand in which the governing source of movement lies in another being (the producer, the programmer), on the other, for these automatic systems have something φύσις-like in their nature, where φύσις is understood as self-poiesis.

Tellingly, Aristotle conceived φύσις precisely as self-poiesis, so the cybernetic, auto-poietic systems confronting us today are the consummation of his ontological dream which is now revealing its ambivalence as a nightmarish dream. An auto-poietic being in the Aristotelean sense is one that has the principle (ἀρχή, starting-point, source) of its movement and change within itself. We may as well call these auto-poietic systems and things *robots* and note that we have long since been living in the *robotic age*, the epoch unwittingly cast by digital ontology. In automatic cybernetic systems, the governing source of movement no longer resides in a living, breathing human operator, but has been outsourced knowingly (i.e. through knowledge) into material

beings insofar making it seem that these systems themselves had souls and were in this sense alive, animated (anima = soul). Such outsourcing introduces a split between the knowing designer (electrical engineers, programmers, etc.) of the cybernetic system, and the users, who need know nothing about how the system works, but only its operating instructions, thus deepening the gulf between technically skilled labour and unskilled labour. Unskilled workers have not even forgotten something they once understood in principle or in technical detail, but inhabit the cybernetic world as if in a fog in which beings are discernible only in fuzzy outline.

The phenomenon of digital automation also reflects back, through the totalizing tendency of the digital cast of being, onto the self-conception of human being itself: a science of neurophysiology arises which conceives of human thinking as an intricate, auto-poietic computational program, residing in the brain, which reacts to sensory impulse-data given by the outside world. This is a kind of forgetting of an entirely different order: truth is understood then only as effective knowledge, and human thinking is conceived as the effectivity of its functionality, i.e. through the interconnections between cause and effect, stimulus and response, data input from the environment and brain-calculated reaction. The thinking human brain is then considered to be simply extremely good in calculating given inputs, but in principle (i.e. ontologically) as the same as a digital computing machine. In this kind of effective scientific thinking, the ontological difference itself has been forgotten, i.e. consigned to oblivion.

3.5. The onto-theological nexus in abstract thinking, cybernetic control and arithmological access to movement and time

To come back briefly to the Greek origins, there is no denying that, under the influence of the Pythagoreans, Plato accorded a special place to the abstraction of number on the way to the ideas, which are the ontological abstractions enabling beings as such to come to appearance, i.e. to show their looks, their sights. Learning geometry and arithmetic

demands a kind of abstract thinking necessary also for grasping the abstract ideas at the heart of ontological thinking, and so these disciplines may be regarded as preliminary finger exercises in philosophical thinking. Just as the Pythagoreans accorded divine and mystical status to numbers, so too does Plato regard the ideas as divine and located in a special, transcendent place beyond the heavens. Aristotle also sees philosophical thinking as a divine (θεῖον), happy activity enabling the philosopher to catch a glimpse of the divine precisely through being able to see the sights beings offer of themselves in the εἴδη. This is *the* key to understanding why metaphysics can be understood both as ontology and as theology, a double trait, the view of which has been clouded by Christian theological metaphysics.

Be that as it may, with regard to digital ontology we could ask what has become of the theological aspect of metaphysics and answer that the (Cartesian mathematical) ideas enabling a productive power and cybernetic control over the movements of (both non-human and human) beings in the world are the sober Cartesian ideas setting down the rules for modern mathematical sciences which, however, precipate in material beings themselves insofar as (pieces of) human understanding of the world, borne tacitly by the implicit digital-ontological thinking that has made the dissolution of beings in the world (ontologically) conceivable, can be coded (piecemeal) into executable binary computer code. Human subjectivity in the modern age has insofar assumed god-like cybernetic powers. But this engenders only the *illusion* that we human beings are in control.

It is not simply a question of complexity that, say, because of the countless aspects, we cannot see through what computing machines of all kinds perform and hence become entangled in an intransparent, automated, cybernetic web, but already, prior to that, there is the primal onto-arithmological casting of access to the world which today enables the outsourcing of productive world-interpretations in a digital form. These autonomized systems now turn upon us, challenge us. And even more, the arithmological way of thinking is an access to disclosing beings as such that also *obscures* the phenomena. It is important to recover from historical oblivion that the ontological origins of the

powerful onto-arithmological casting of the world lie in Greek metaphysics that implicitly understood being as constant, standing, defined, and therefore unambiguous presence that underlies beings' as such themselves being addressed as 'one' (ὄν = ἕν) and as a well-defined look (εἶδος). As we have seen (cf. *2.9 Time and movement in Aristotle's thinking*), the categories appropriate to grasping ontologically the phenomenon of movement (κίνησις) are not just one, but at least two, and thus lie on the other side of the famous diagrams (διάγραμμα) of Plato and the Pythagoreans in which the elements on the left belonging to εἶδος face their opposites, such as finite-infinite (πέρας – ἄπειρον), resting-moved (ἠρεμοῦν – κινούμενον), reason-opinion (νοῦς – δόξα), one-many (ἕν – πολλά).[27]

The achievement of metaphysical thinking has been to grasp the phenomenon of movement in terms of both presence and absence (εἶδος and στέρησις) in such a way that what is present (τὸ δυνάμει ὄν) *governs* the pro-ductive coming-to-presence of what is absent. This is the *Western will to power over movement* of all kinds, an all-pervasive megalomania inspired also by 'good causes'. Access to the world through the λόγος depends on beings' being grasped in a well-defined, discrete way as ὂν λεγόμενον, and the discrete λόγος can be broken down into countable, finite, calculable number as binary code that articulates numerically a piece of world-understanding in executable digital pre-script or pro-gram that mirrors our world-understanding in automated processes/movements (mathematized as Turing machines). Such logical pre-script is outside of time; it is timeless. Why? Because time is conceived simply as the real variable, t, consisting of pure now-points which are either present or absent, but not both. The unity of time in its ambiguity as both presence and absence simultaneously eludes pure number which, as the Greeks knew, is outside time. And yet, modern physics discusses the question of the possibility of the

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27 *Themistii in Aristotelis Physica paraphrasis. Consilio et auctoritate Academiae Litterarum Regiae Borussicae* (ed.) H. Schenkl. Commentaria in Aristotelem Graeca. Voluminis V pars II. Berlin 1900, 211:19f, cited in M. Heidegger *op. cit*. GA18:319.

reversibility of time purely in terms of dynamical *equations* ("of Newton, Maxwell, Einstein, Schrödinger, Dirac, and others", Penrose 1989, 1999 p. 454) in which time, t, occurs merely as a variable, so that, of course, they can be read symmetrically either forward or backward.

It is therefore an historically momentous *obscuring* of the phenomena of time and movement to conceive time as a mathematical variable. If, however, human being itself is, in truth, exposed to three-dimensionally stretched, ecstatic time, then the productive power enabled by metaphysical thinking that culminates in today's digital technology, is a narrow-minded access to the world that makes certain phenomena *inconceivable,* i.e. *invisible* to the mind's eye. It thus fails to allow room to move for those movements, including the movement toward death and the movements in interplay with free others, that are beyond the reach of the Western will to epistemic power over movement including, in its latest historical garb, as automated cybernetic systems of all kinds.

4. Spatiality of the electromagnetic medium

4.1. A stampable mass (ἐκμαγεῖον)

The electromagnetic medium is, like paper for a book, a stampable mass. Τὸ ἐκμαγεῖον is the mass on which something is stamped or impressed such as wax, clay or plaster, and τὸ ἐκμάγμα is that which is stamped or impressed into wax or plaster and therefore a true image. This word would correspond to the Latin "in-formo" where here the form, and not the stampable mass, would be expressed. In philosophical usage, the ekmageion comes from Plato, from the famous passage in *Timaios* on χώρα (52b). It is a matter there of the element that can receive all beings, the "wet-nurse of becoming" (52d) which, itself free "of all visibilities (εἰδῶν), [...] is to receive and take in all genera (γένη) into itself." (50e). Plato maintains, "that which, however, is neither on the earth nor somewhere in the heavens, is not" (52b). Translated, this means that every being requires a medium.

The electromagnetic medium is precisely an ἀναίσθητον which accepts all possible impressions and can be written over again at will, re-inscribed by means of electronic signals. The impressions, however, are digital, i.e. sequential binary code, i.e. minimal electromagnetic differences, which we understand *as* 0 or 1 and which can be represented in various sensuous ways with various contents and differing functions. The bits are invisible in themselves, but they can be transformed into αἴσθητα by the appropriate hardware and software which are then accessible to the human senses. Itself neither air, water, earth nor fire, the electromagnetic ἐκμαγεῖον enables beings to "appear" (φαίνεσθαι 51b).

In which sense, however, can we speak of the electromagnetic medium as a *space*? The electromagnetic medium is a stampable mass which is able to take in digital beings. Digital beings, however, can also move arbitrarily through this homogenous medium and find an arbitrary,

or placeless, place in it. Insofar, the electromagnetic medium is, like the χώρα, a space for accepting digitally, i.e. arithmologically decomposed or dissected beings. The electromagnetic medium as a dimension that can be passed through insofar deserves the name cyber*space* which now has to be investigated more closely. The treatment of space in Heidegger's *Being and Time* will serve us as a guiding thread.

4.2. Dasein's spatial being-in-the-world: approximation and orientation

As spatial being-in-the-world, Dasein is characterized by *approximation* and *orientation* (*Ent-fernung, Ausrichtung,* SZ:105). "Approximating is at first and for the most part circumspective nearing, bringing close as acquiring, making available, having to hand. But also certain types of purely epistemological discovery of beings have the character of nearing. *In Dasein there lies an essential tendency to nearness*." (Das Ent-fernen ist zunächst und zumeist umsichtige Näherung, in die Nähe bringen als beschaffen, bereitstellen, zur Hand haben. Aber auch bestimmte Arten des rein erkennenden Entdeckens von Seiendem haben den Charakter der Näherung. *Im Dasein liegt eine wesenhafte Tendenz auf Nähe*. SZ:105) And in a marginal scholium from Heidegger's personal copy we read on the same page: "Nearness and *presence*, not the size of the distance is essential" (Nähe und *Anwesenheit*, nicht die Größe d. Abstands ist wesentl. ibid.) Approximation (or nearing) is thus a bringing-into-presence. "Dasein is essentially approximating; as the being which it is, it causes, in the given situation, beings to be brought into nearness." (Dasein ist wesenhaft ent-fernend, es läßt als das Seiende, das es ist, je Seiendes in die Nähe bringen. ibid.) The second existential which characterizes Dasein's spatiality, i.e. orientation, is described in the following way: "Every nearing has a priori already taken up a direction into a region from which what is approximated nears in order to be found in its place. Circumspective taking-care-of is oriented approximation. In this taking-care-of, that is, in the being-in-the-world of Dasein itself, there is a need for 'signs'; this equipment takes on the express and easily applied

specification of directions. It holds the circumspectively used regions expressly open, the place in each case of where something belongs, of going-to, of bringing-to, of picking-up." (Jede Näherung hat vorweg schon eine Richtung in eine Gegend aufgenommen, aus der her das Entfernte sich nähert, um so hinsichtlich seines Platzes vorfindlich zu werden. Das umsichtige Besorgen ist ausrichtendes Ent-fernen. In diesem Besorgen, das heißt im In-der-Welt-sein des Daseins selbst, ist der Bedarf von 'Zeichen' vorgegeben; dieses Zeug übernimmt die ausdrückliche und leicht handliche Angabe von Richtungen. Es hält die umsichtig gebrauchten Gegenden ausdrücklich offen, das jeweilige Wohin des Hingehörens, Hingehens, Hinbringens, Herholens. SZ:108) With regard to an electromagnetic medium such as a network, the role of the direction-giving "sign" in the electromagnetic "region" is taken on by the (ultimately: numerical co-ordinate) network addresses which themselves are only possible because Dasein is essentially approximating and orienting.

The essential approximation and orientation of Dasein means that it is 'always already' away from its bodily place of sojourn and that Dasein as oriented-approximating is always already reaching out spatially toward faraway places and that this is the condition of possibility for its being able to be *there* also *factually* (bodily, or medially through speech, writing, voice, image). We approximate bodily by reaching for, looking at, going to, etc. Hearing speech, however, approximates — through the presencing inherent in speech — also what is to-hand or that with which we have dealings in the world. Heidegger even adduces the example of the electromagnetic medium, radio: "All kinds of increasing of speed which today we go along with more or less under coercion push toward the overcoming of distance [Entferntheit, in contrast to Ent-fernung, approximation, nearing, de-distancing, the elimination of distance; ME]. With the 'radio', for instance, Dasein today performs an approximating of 'world' by way of an extension and destruction of the everyday world surrounding us which is not yet assessable in its sense for Dasein." (Alle Arten der Steigerung der Geschwindigkeit, die wir heute mehr oder minder gezwungen mitmachen, drängen auf Überwindung der Entferntheit. Mit dem 'Rundfunk' zum Beispiel vollzieht das Dasein

heute eine in ihrem Daseinssinn noch nicht übersehbare Ent-fernung der ‘Welt’ auf dem Wege einer Erweiterung und Zerstörung der alltäglichen Umwelt. SZ:105)

This passage provides an important clue for thinking through the multimedia in their spatiality, especially since it also poses the question of the “sense for Dasein” of the electromagnetic media in general, for it does not make any difference in this connection whether one is speaking of radio, television or the internet. The “everyday world surrounding us” is not only extended but also destroyed by the telemedia; there is thus no change or extension of the everyday world without loss, which, however, should not mislead us into making pessimistic pronouncements on civilization or about the destructive nature of technological progress. Hearing a report on the radio is an approximating of the region itself from which the report comes. The media allow other regions of the world over *there* to presence *here* through approximation. Later, too, with the example of the “ear-piece of the telephone”, the “inconspicuousness of what is at first to-hand” (Hörers am Telefon ... die Unauffälligkeit des zunächst Zuhandenen, SZ:107) comes into play. Dasein is always already far off beyond what is close at a physically close distance. The acquaintance with whom I am talking on the telephone is closer to me than the telephone’s ear-piece which I am holding physically and bodily in my hand and to my ear. Accordingly with the internet too: the entire hardware and software which is used as medium is “inconspicuous”, far away, absent, but enables, through electromagnetic approximation, the encounter with beings and other Dasein which are then close to and present for Dasein.

The approximation of regions, however, has various modes; there is, for instance, a difference between seeing/hearing a live report from Moscow on the internet or on television, and reading about it in the newspaper, or reading about Moscow in Tolstoy’s *War and Peace* (which last is a literary casting, and even founding, of the city of Moscow itself, and not merely a description of Moscow). These are different ways for presencing the city of Moscow. Live reports on television are accorded a high ranking only insofar as they are nurtured by the sense of being as presence in the now (simultaneity) and the

priority of the sense of sight. Since time is conceived proceeding from the standing presence of now, the future as what is yet to come and the past as what is no longer *now* are experienced as a 'less' in being, e.g. as passé or guesswork. The 'immediate', 'simultaneous' presence of a live television report (or better still, an image and best of all a moving TV image) *now* is nevertheless highly mediated (through the electromagnetic medium). The medium itself, however, is inconspicuous and in the main even an ἀναίσθητον, unless there is a disturbance, such as a flickering of the image, which draws attention to the medium itself. A live TV news report suggests im-mediacy, i.e. an absence of medium, and also that truth resides in what you can see 'with your own eyes', but in truth, a live TV news report is an impoverished presencing of the happenings on which it is reporting.

When one walks on the street, the medium for walking, the street "slides underneath, so to speak, certain parts of the body, the soles of the feet." (schiebt sie sich gleichsam an bestimmten Leibteilen, den Fußsohlen, entlang, SZ:107), i.e. this medium can at least be experienced bodily whereas movement on the internet is experienceable in a bodily way only through clicking on the pointing device (mouse) or shifting one's eyes slightly. This is an approximation without movement or, in other words, one moves through cyberspace with a minimum of bodily involvement. Dasein's approximating does not depend on the physical, bodily movement, but can also be performed without an involvement of the body. "The spatiality of Dasein is therefore not determined by specifying the point at which a body-thing is presently occurrent." (Die Räumlichkeit des Daseins wird daher nicht bestimmt durch Angabe der Stelle, an der ein Körperding vorhanden ist. SZ:107) This implies that the spatiality of the internet, albeit mediated by a mathematico-calculative reduction of space effectively to Cartesian co-ordinates, is a genuine spatiality conforming to Dasein and is not *merely* virtual. Dasein orients itself in this space and is able to purposefully approximate digital beings through this space. Even more than that: the internet as a navigable cyberspace is only possible at all because Dasein *is* spatial a priori.

4.3. Abstraction from bodily experience in cyberspace through reduction of place to numeric co-ordinates

If digital technology ‘advanced’ so far as to be able to decompose the body itself into electromagnetic waves (and not merely take measurements on the body by ‘lifting’ numbers from it) and to reconstitute the body at will (through a conversion of energy back into matter), then, to this extent, there would no longer be any *bodily* experience of space at all, but there would still be an experience of space in the sense of *Dasein*. Then, the finger movements of clicking on the pointing device, which serves to orient and approximate in the electromagnetic medium, would also be done away with. The history of the technical overcoming of distances is simultaneously a history of the smoothing out and elimination of the bodily experience of space. Even with the transition from the horse to the automobile, the bodily experience of space through approximation regressed, for there is a difference between riding on a horse and gliding through a region sitting comfortably in a motorized limousine. On the internet, spatial orientation is provided by URLs (= DNS = a number) and signposts (with numerical links). Approximation is done by clicking a pointing device. The pointing device points to what is to be approximated. Insofar, cyberspace is a very simple space, but nevertheless a space to which both the essential existentials of orientation and approximation specified in *Being and Time* have to be attributed.

In *Being and Time*, the place where equipment belongs is given through the totality of applicability in use (Bewandtnis), which is the understood interconnection in which the various useful things stand in relation to each other. Equipment must be in its proper place for it to *be* to-hand and so that it *can* be put to use. Each piece of equipment thus belongs somewhere in its place. This is quite different from the way in which Aristotle thinks the belongingness to place of physical beings. We also do not cease to be in the mode of taking-care-of (daily life) when we approximate things in a different way in a digital, electronic medium. When, say, we call up a digital being which then flickers on the screen and can seem to us to be very near or very far, this seeming is not merely

virtual or 'subjective', but rather: "*Only in such 'seeming', however, is the world in each particular situation properly to-hand*." (*In solchem 'Vorkommen' aber ist die jeweilige Welt erst eigentlich zuhanden.* SZ:106, italics in the original) This means that digital beings and the electromagnetic media can also be interpreted from being-in-the-world and not merely from the standpoint of the arithmological casting of being. This also implies *inter alia* that the electromagnetic medium enables a mode of Dasein's being together with other Dasein. Insofar it is erroneous to speak of a merely virtual being-together in the network, for being-together means fundamentally a sharing of the truth of being by Dasein and other Dasein and not merely a bodily adjacency at one place in space. Communication by no means requires a bodily togetherness of human beings, nor even a simultaneity of presence, whether bodily or otherwise. Communication can take place across centuries and epochs through legible signs in various media.

4.4. Dreaming in cyberspace

As already pointed out, the electromagnetic medium is a kind of ἐκμαγεῖον. It is not uninteresting to note that whilst *dreaming* we are situated in a medium in which some of the remarkable properties of cyberspace occur such as the immediate, 'instantaneous' relation to spatially far-off places. These remarkable properties have something to do with our bodiliness, for normally, in a waking state, we move bodily through space; our body participates in this movement and itself performs movements through space. This bodily co-performance of movement, however, is obviated in both cyberspace and when dreaming. Cyberspace has a genuine spatiality in which we orient ourselves and approximate beings (cf. *Being and Time* as presented above), but in this space we move bodily by merely clicking with a finger and do not experience any bodily presence of what is called up. Even bodily clicking could be made redundant by having signals sent directly from the brain to the computer, which, for instance, is already the case today for some severely disabled people. The movement of an eyelid or even mere brain activity is then sufficient for steering oneself through cyberspace. The parallels to dreaming are thus pronounced. Lying in

bed, we fly to any arbitrary place and approximate to ourselves anything in the world without having to make a passage through time or through physical space — which we can also do on the internet as long as there are no technical disturbances in the network. Movement and approximation through the electromagnetic medium is ghostly and banal at one and the same time. It is ghostly or eery because a space is opened up in which we can move without our bodies, and it is banal because we move in this space so matter-of-factly, without really knowing (neither technically nor ontologically) in what kind of dimension we are moving.

4.5. Inside and outside the digital electromagnetic medium

Even though the (sophisticated) hardware required to make an electromagnetic network has its own physical, visible, palpable, etc. form, the electromagnetic medium is still completely formless, i.e. without digital difference, *vis-à-vis digital beings themselves and the dealings with digital beings in the network*, and therefore infinitely ready to accept what is given (data). Only when one looks from the outside, from the physical-bodily world, onto the hardware can it be seen that the electromagnetic medium as a technically produced, artificial being also has a certain form (and consists of certain formed materials such as metal, plastic, wire, glass fibre, transmitters, etc.). What is decisive is whether one moves within or outside the electromagnetic dimension, i.e. within the physical world or the digital world. It is always possible to move in and out of these worlds. As long as one is looking through the interface window into the network, one is dealing with digital beings which move through an invisible, sensuously non-experienceable medium. This means that we move in different casts of being simultaneously even though we do not perceive them as such and have always already forgotten them. The mathematically in-formed, electromagnetic ἐκμαγεῖον thus becomes a dimension in its own right. It is the χώρα in which the digital beings are inscribed and where they are located. Thought in a Platonic way, this space intermediates between sensuous beings (from which a digital abstraction is performed) and

'transcendent', super-sensuous beings (here: mathematical, technical constructions). These beings, stamped thus, can move through the medium, and the supersensuous mathematized knowledge has thus been materialized in the digital electromagnetic medium.

4.6. Spatiality of Dasein with regard to the global electromagnetic medium

Let us return to the question of the spatiality of Dasein with regard to the global electromagnetic medium. What is fundamental is Dasein's potential to be *there* with far off beings *as* such. Only because Dasein *is* always already *there*, is it able also to perhaps approximate the beings situated *there* in various ways by physically going there or by acquiring or bringing the beings situated there to itself. Bow and arrow is a physical way or a means (but not a medium) of approximating, say, a bird. Reading news about a far-off city is another way of approximating, or acquiring, through the appropriation performed by the λόγος. Dasein's bodily approximation by reaching out for, grasping, going to, etc. is only one mode of approximation. The appropriation of beings through the λόγος, i.e. by speaking of things, is another. Dasein participates in the openness of being in which beings show themselves as such. This openness of being is spatial (and also temporal).[28] Being-in-the-world means also being-spatially-in-the-world, and this spatiality of Dasein constitutes the condition of possibility for Dasein's being able to approximate any being as such. Approximation is a fundamental, namely, the spatial way in which Dasein comports itself toward beings *as such*. The 'as such' is essential in this connection because, say, other living beings do not comport themselves toward beings *as such* even though they obviously participate in some kind of openness. Approximating via the logos (and here this means: bringing to presence, vergegenwärtigen) takes place, for instance, through letters and

[28] This statement is too undifferentiated to be tenable, since i) being means time and ii) time itself (what I call the time-clearing) is pre-spatial. For details on this see my 'Being Time Space' at http://www.arte-fact.org/untpltcl/bngtmspc.html

newspapers. Here, the words written on paper is the *medium* in which the approximation takes place. The logos, i.e. language, frees itself from the beings about which it speaks and makes itself independent vis-à-vis the physically given, bodily experienceable beings. A medium is fundamentally a dimension through which beings (here: written or printed words on paper) can move. Words enable a different mode of being-with-beings from bodily presence alongside them.

What can be designated as a technicization of approximation is the point where τέχνη comes into its own with regard to spatiality. Τέχνη ποιητική always rests upon a mode of disclosing or decrypting beings and therefore also on an understanding of being which is mostly implicit and thus forgotten *as such*. It is always a knowledge enabling a know-how, and can and must be implemented in technical devices. In particular, the various media such as paper, the printed word, etc. are enabled by technical knowledge such as printing technology. The digital electromagnetic medium is the consummation of all technical media insofar as it not only appropriates beings in arbitrary far-off places through the logos, in 'lifting' the logos from beings, but also appropriates them through numbers which then also enables further calculation. The beings situated *there* are given a digital (i.e. basically arithmetic) representation through calculation, whether it be in words, sound, images, video, which can then be sent at will to any place through the electromagnetic medium. Thus, digital, electromagnetic approximation arises which of course presupposes the knowledge of digital technology as well as the mathematical casting of the totality of beings. I.e., situated a priori or 'before' technical knowledge is the (invariably implicit) ontological understanding of the arithmological decomposition and appropriation of beings which has come down to us from Aristotle via Descartes.

There are thus two steps: first of all, the digital, calculative appropriation of beings through which they attain a purely numerical representation in digital code, and secondly, the digital medium through which the digital beings can pass through and 'measure through' as their own di-mension. Because digital approximation takes place through the electromagnetic medium without bodily experience of space, this kind of

spatial experience is somewhat ghostly. Dasein spirits bodilessly through the electromagnetic medium without having to leave its place bodily. This signifies in a certain way a collapse of all places into one place which insofar destroys the possibility of farness. But that has always been the case with technology; it destroys an old world by opening up a new one. The special feature of the digital, electromagnetic medium is that it is a *mathematical* space which can also be represented numerically, thus opening possibilities of calculation and cybernetic control. Since, however, numbers are not only placeless but also without position, the movement of Dasein in cyberspace is reduced to a game of numbers even though the user interface presents itself to Dasein in a sensuous form, say, with 3-D graphic elements, etc. The interface with Dasein must adapt itself to the sensuous, bodily givens of Dasein, which is, however, only an illusion, a simulation resembling physical reality in its sensuous givennes. Behind the interface there is merely a numerical representation of the beings shown along with the network which is physically spread over the entire globe without the geographical scattering being sensuously experienceable *as such*, and without the user having to understand anything at all about digital code. Nevertheless, Dasein knows that it is approximating beings from all over the world and thus appropriating them. By virtue of the sensuous graphic interface, Dasein can immerse itself in a simulated reality generated by digital code as if cyberspace were a second world for leading a second life. Much has been made of this 'virtual reality' of cyberspace without, however, its ontological underpinnings in the digital dissolution of being having been adequately clarified.[29]

The two steps named are supplemented by a third which, however, goes far beyond the first two. This third step, as already explicated, is the further cybernetic calculation of the beings appropriated in digital form in computing machines of all kinds, such as PCs, movement sensors, robots, implanted microprocessor chips. I.e. it is not simply a

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29 Cf. Michael Heim *The Metaphysics of Virtual Reality* Oxford U.P. New York 1993; Michael Heim *Virtual Realism* Oxford U.P., New York 1998; David R. Koepsell *The Ontology of Cyberspace: Philosophy, Law, and the Future of Intellectual Property* Open Court, Illinois 2000.

matter of presenting the appropriated being merely as linguistic or image information (which, of course, also presupposes a certain amount of further processing of the digitally captured beings), but, furthermore, the measurement data obtained are processed further in a digital program (which always represents a certain, fixed pre-understanding of the data) in such a way that control functions are triggered in a cybernetic system. For instance, numerical data on traffic flow on various roads are automatically gathered through electronic sensors by telematics services, and calculated and processed in such a way that the driver of an automobile can be offered a graphic representation of a congestion-free route on the screen of the car's navigation system. This example shows how the spatiality of the digital-cybernetic network intermeshes with and feeds back into the spatiality of bodily being-in-the-world. *The will to power over movement and time thus extends also to a will to power over space on a global scale.*

4.7. The global network: geometric (θετός) or purely arithmetic (ἄθετος)?

Does the electromagnetic medium as a global network have a geometric (θετός) or a purely arithmetic (ἄθετος) character? If one conceives of or represents the network as points which are connected or not connected by lines, then it has a geometric character which is called a 'graph' in mathematics. Graph theory today is an autonomous area of mathematics. But is the specifically geometric character of networks relevant here, or can the points and lines of a (global) network be represented purely arithmetically or numerically? This is indeed the case, since we do not at all have to conceive of the electromagnetic network in a geometric or aisthaetic way, but rather, it suffices to represent the network with its connections by numerical co-ordinates (vectors or k-tuples) such as (n1, n2, n3, ... , nk), i.e. only the numbers and an ordering of these numbers is necessary along with a mathematics (a calculus) for calculating with these numeric entities. Can the network be represented as a kind of matrix calculus? Indeed it can! The electromagnetic medium is representable as a matrix where the matrix =

mother = Plato's "wet-nurse of becoming" in a binary numeric guise. So-called analytic geometry, which was developed by Descartes (today we still speak of Cartesian co-ordinates), is based on the fact that all geometric objects can be dissolved or abstracted into (a calculus with) numbers if the numbers assume the form of co-ordinates. Co-ordinates, however, are simply ordered numbers which can be computed in a matrix calculus within a vector space. What remains of the posited character of geometric figures is the indispensable ordered sequence of the co-ordinate numbers, e.g. the point (2, 5, 5) differs from the point (5, 2, 5) even though the same numbers occur in both co-ordinates. The task of mathematics consists in calculating with these co-ordinates whilst respecting the ordered sequencing of the numbers contained therein. This problem has long since been solved by mathematics. Only for this reason can arbitrary geometric figures in n dimensions be represented via equations in computers, for computers only *compute, calculate*; they cannot deal with geometric figures *as such* because computers *are* not aisthaetic but rather purely calculative (in their mode of being). A microprocessor can only work through consecutively a countable number of arithmetic operations.

A necessary precondition for breaking down networks into a matrix calculus is the study of networks through graph theory, combinatorics and topology. Topology as a branch of mathematics clearly shows its geometric origins, and it deals especially with the connectedness and non-connectedness of geometric objects (therefore covering also problems of graph theory) easily representable sensuously to the imagination, but very hard to calculate. The topographical objects of geometry therefore had to be reduced to a kind of calculus by abstract algebra in which not merely numbers play the key role, but symbols representing the placeless and positionless elements of abstractly defined mathematical objects such as groups. The elements of a group are abstract symbols representing magnitudes in general, and therefore can be calculated. Whether a given geometric object is connected or not is converted into a problem in abstract algebra involving chains of groups. The geometry of a space thus becomes *algebraically calculable* (more powerful than arithmetically calculable, because more general) which, in

turn, is a precondition for it becoming amenable to digitization and specifically digital calculation.

If place in the global network is made mathematically calculable, the electromagnetic network is placeless, and positional only insofar as the co-ordinate numbers or symbols preserve an order (τάξις). It is not a genuine geometric structure, or rather: all geometric structures can be represented algebraically and thus become representable and manipulable by computing machines. Hence, the global electromagnetic network itself can be represented as a mathematical, i.e. digital, structure which accordingly can be controlled in a mathematical, calculative way. The technically constructed world of cyberspace is thus a mathematically comprehensible space in which beings appropriated by mathematical knowledge circulate. But the reduction of physical beings to geometric figure and further to algebraic magnitudes accomplished by modern mathematics is not a one-way street: the calculative manipulation of digital entities in the global network also has a translation back into a sensuous form. This is the so-called graphic interface that makes the handling of computers and the ‘sojourn’ in cyberspace itself more natural for Dasein. Dasein can therefore experience cyberspace from the non-technical ‘inside’ as an independent spatial dimension in which it can orient itself and also approximate digital beings, and which also maintains easily negotiable interfaces with the surrounding sensuous physical space of the world.

4.8. Difference between Aristotelean/Platonic and digital ontology and the latter’s specifically totalizing nature - Merely an oppressive over-presence of digital beings?

How is the being of beings thought in a digital ontology *differently* from Aristotelean and also Platonic metaphysics? A digital ontology views beings neither from a supersensuous topos where the ideas reside, nor only from the categories (without which there would be no world-understanding at all), but ultimately from the calculating mathematical dimension inhabited by *abstract algebraic symbols* whence physical

beings appear only insofar as they are representable as algebraic symbols, thus becoming also measurable and digitally decomposable. The λόγος has become not only logically and mathematically calculable, but also, as we have seen (cf. *3.1 The appropriation of the truth of beings, digital interpretation of world-movement and its outsourcing through executable, cybernetic machine-code*), outsourced into self-poietic things. In the everyday world, it may very well happen that digital beings gain an overwhelming precedence over continuous, physical, 'analogue' beings, which means that dealings with the medial dimension of the electromagnetic medium would attain the upper hand in the life-world vis-à-vis other possibilities of existing. For instance, the practice of reading news reports digitally could gain the upper hand over reports which are simply printed on paper and circulated. The reading of newspapers actually printed on paper in the literal sense could thus die out since, in the digital world, the messages and news may continue to circulate only in digital form. Or digital products such as computer games may make youths completely insensible to what is going on outside the digital cyberspace dimension. Their life-world may then be totally absorbed into the digital dimension. Or movies, today increasingly reliant on digital technologies, may almost totally smother the viability of live theatre.

If, however, through digital ontology it can be seen that digital beings still represent something abstracted from the sensuously experienceable world, then the digital beings will appear as the technical constructions which they *are* in truth, i.e. in the complete uncovering of their being. Despite all the digital technology, humans remain bodily, mortal beings that experience the world sensuously with its dust, dirt, blood, sweat, wine, meat, light, its fragrances and colours, etc. and can also sometimes bash the table forcefully, take a walk through woods, recite a soliloquy on the stage, etc. And even digital beings have to take account of the bodiliness of Dasein, e.g. that messages and images have to be legible to the physical eyes, and a computer or a mobile telephone has to be operated by hand. Cyberspace can also present its digital beings to Dasein in a strikingly natural, sensuous way. Despite all the abstraction that makes calculation possible, digital technology can be translated

back to humans in their bodiliness as sensuously experiencing beings. Is this sufficient to appease qualms about the invasion of robots from cyberspace?

The question is not just whether all these sensuous bodily aspects are only admitted as existing when they appear from the digital dimension, but whether the digital way of thinking totalizes to become *the* natural mode of human thinking, along with all the convenience and cybernetic control that goes along with having digital devices of all kinds ‘at one’s fingertips’. No doubt, the omnipresence of digital beings can become oppressive and absorb or push aside the natural life-world. Like any other casting of being, digital ontology makes an absolute, totalizing claim which, however, cannot be relativized simply by referring to natural ontic givens (dust, fragrances, walks, live theatre, etc.) and life-nourishing practices in the ‘old’ physical world in a competition with the seductions of dwelling in cyberspace. A relativization of the digitally decomposed world is only possible through an ontological destruction that goes to the root of the digital way of thinking as it has been cast throughout the centuries and millennia of Western history, as we have outlined. It cannot be a matter of repeating the ‘call’ of other castings of being and keeping them alive and vigorous alongside this historically ‘latest’ casting of being. For instance, it cannot be a matter of reviving Christian ‘spiritual’ ‘values’ to compete alongside the seductive convenience of a digitized ‘materialism’, because the very core ontological concepts of ‘spirit’, ‘matter’, ‘value’ are themselves in question and have to be *recast in another historical time which are our own times*. The conflict among historical castings of being arising in this way opens up again the forward-looking γιγαντομαχία περὶ τῆς οὐσίας (Plato), the question of being concerning how beings as such are to shape up and appear in their truth.

Western history has been and, insofar as it still has a future, remains the struggle (especially against the powerful complacency of established ways of thinking) to cast being alternatively and thus to fore-cast future historical ways of thinking-and-living in the world, starting always from what has already been cast as an historical world based subterraneanly and obliviously on a definite cast of ontological thinking. The digital

casting of being totalizes to cast all that is — i.e. ‘reality’ as a whole, the ‘universe’ or the world — as digitizable, computable ‘information’. An alternative casting is not just another way of understanding and experiencing the world, thus shaping it historically, but, more deeply, has to prove itself in the struggle as more adequate to the phenomena and thus to human being itself as an historical way of dwelling on Earth (and perhaps elsewhere?). This leads to Heidegger’s insight that the ‘place’ where the question of being is posed is the clearing of Dasein, and that Dasein is fundamentally open to understanding being as a casting of beings in their totality. The ‘natural ontic givens’ and traces of other world-experiences referred to above which do not properly fit into the mould of a digital casting of world therefore serve merely as a reminder that the question concerning who we are has to be posed more fundamentally than how it is implicitly answered by the digital casting of world, which is only able to grasp, i.e. to see, humans from the possibilities and potentials of digital technology, right up to biotechnology with its genetic code and its genetic understanding of ‘life’ as well as neurophysiology with its conception of human being as a whole in mechanistic terms, where the preferred paradigmatic machine for conceiving human being today is the computer. The digital casting of being makes it seem that certain questions concerning human being are impossible, senseless questions. Therein lies the grave historical danger of being absorbed by the Cartesian-mathematico-digital way of thinking.

The totalizing nature of digital ontology is therefore not merely a matter of cyberspace — along with other, now digitized media such as radio, television, telephone, portable music players, etc. — ‘invading’ our life-world as *the* ubiquitous medium. In these shiny forms of appearance, digital ontology does indeed already dominate the surface of everyday life in technologically advanced countries. It is only a small step now from having a mobile telephone permanently glued to one’s ear to having a chip connected to the internet implanted in one’s brain. Digital technology itself is only the consummating tip of the mathematico-Cartesian iceberg. Underneath it is the epoch-making mathematical casting of being, which is deeper and truly totalizing. Why? Because the Cartesian casting today underlies all science, and

science, with its empirical, quantifying mode of access to the world, has become *the* locus of truth in the modern age. Truth for us has become universal, generalizable, 'objective' truth established by scientific method. All else has become mere 'subjective' opinion, at most a colourful embellishment not 'properly' grounded in scientific methodology. Or quantitative scientific methodology has been applied to phenomena that do not at all fit the mould of precalculative reason, notably, the entire gamut of phenomena associated with social interplay including economic interplay (thus, for instance, we thoughtlessly put ontological faith into sophisticated computer models of the economy to precalculate its movements).

Truth has become that which is established by scientific method according to experimental observation of the facts. If the experimental data agree with the theoretical model, the scientific theory is held to be true until further notice. This seems self-evident, and thus it is believed. But what guarantees the truth of scientific method itself? It specifies that scientific truth resides in the *correctness* of theoretically predicted observations *corresponding* to the experimental facts. On its own terms, therefore, scientific method itself cannot be true because its own correctness cannot be verified. For the issue of the truth of scientific method, correctness will not do as criterion, let alone the 'success' and pracitcal 'effectivity' of science. Scientific method depends on a *prior* (Cartesian) casting of the access to the world whose truth or otherwise can only be assessed by *questioning* how such a mathematically cast world shapes up, for this casting determines from the outset *as what* and *as who* beings as a whole take shape, come to a stand in understanding and show themselves in the world. The *untruth* of scientific method lies in its riding roughshod over the phenomena in its inexorable striving to ascertain the correctness or otherwise of the empirically testable scientific theory with the facts, without ever questioning that the beings interrogated have always already been precast in the science's foundational concepts.

Our ways of thinking about the world and our own being have long since become totally infiltrated and infected by modern scientific ways of thinking, indeed, so much so, that we can scarcely even *imagine*

another way of thinking and are all too quick to reject other modes of thinking as pre-modern, unscientific, merely poetic and subjective, ideological, or similar. (Or, conversely, one champions the poetic and artistic over the ‘coldness’ of calculating, scientific rationality, which is the *same* as its opposite, just with a minus sign, but not an *alternative*. Or one seeks a counterweight in ethics and morality.) Computer science is only one science among others, but *all* sciences today process empirical data using mathematical formulae, and therefore rely more or less on computers to automatically carry out the required, preprogrammed calculations.

But that is not what is decisive. The striking hallmark of digital ontology in today’s world is also not so much the ubiquity of digital media but, more essentially, that through digital technology our world-understanding can be *outsourced* piecemeal to computing machines (automatons, robots) for the sake of automated cybernetic control over movement of all kinds, especially the free movement of human beings. This outsourcing is often seen one-sidedly as allowing us human beings to make our lives more comfortable and convenient, as relieving us from unnecessary toil, and this perspective has its justification, but the other side is that we become entangled more and more in cybernetic systems that function inexorably and inflexibly according to the logic, i.e. the world-understanding, that has been programmed into them. The possibilities this opens up for state political control are only one aspect, albeit one not to be underestimated, for the state’s will to power, including its will to power through caring for its populace, is insatiable.

5. Digital technology and capital

When the digital casting of being becomes widespread and turns into an ubiquitous mode of disclosure of beings as a whole materializing in autopoietic, cybernetic systems of all kinds, when the electromagnetic medium establishes itself as ‘natural’ in parallel to the traditional media, then economic life also becomes infected by digital being. Thus today, we have become accustomed to speak quite ‘naturally’, say, of e-commerce, e-tailing and e-conomy and also of virtual universities, virtual communities, internet democracy, digital libraries, etc. There is indeed a doubling of beings into physical and digital beings, for the correspondences suggest themselves naturally. Familiar beings, which we understand and can analyze mathematically, can be encoded into digital code that is outsourced to the electromagnetic medium. A book, for instance, can be stored equally well on paper or in a digital form. The ontological precondition for this is that the discrete λόγος consisting of syllables and letters is decomposed further and represented in numbers (arithmetized). Or, just as well, people can meet in the electromagnetic medium of the internet and exchange views, learn from each other or trade.

5.1. Two exemplary industries at the forefront of the digitization of beings: telecommunications and banking

In particular, it is instructive to see how the disclosure achieved implicitly by the digital casting of beings as such has its effects in the world of capital, i.e. in the economy. There are two exemplary industries mightily affected by the new dimension of cyberspace and digitization in general: the telecommunications industry, and the banks or finance industry, and this for reasons which have to do with the essence of digitization itself. The telecommunications companies are subject to the compulsion to techno-logically bring forth the unified, all-comprehensive (ὅλον) dimension of the electromagnetic medium, to open it up and to make it available so that the digital beings can move

freely, without borders and limits. This dimension must encompass the entire globe if such a telecommunications capital is to survive in the long run. The digital entities must be able to move through cyberspace anywhere on the globe without resistance; this is the final sense, the teleology of networking. At present, huge transnational capitals in the telecommunications industry are still working on this. Under the coercion and discipline of competition they are corresponding to a metaphysical destiny (the digital encoding of the totality of beings) without inkling at all that they are doing so. “They do not know it, but they do it.” (Marx) The essence can remain unknown — and as a rule it remains unknown — whereas the phenomenal forms of appearance, such as an opportunity for revenue growth and competitive pressure, thoroughly correspond to it nevertheless.

Another industry significantly affected by digitization is the banking or finance industry. The banks are also forced to completely explore and exploit the homogenous, unified dimension of the electromagnetic medium, and they can and must do this because the ‘commodity’ which they trade in, namely, money, on the one hand, as universal equivalent of commodity wealth, is universal and, on the other, it can be stamped into an arbitrary material as a number. Coins are already stamped material; today, it is enough for a (state sanctioned) number to be stamped electronically into the electromagnetic medium and that this number, which is owned by someone or other, can be transferred from one owner to the other. This is already money and in this form it can move freely also as capital.

Capital needs the dimension of value[30] which is also determined in an abstract, quantitative way. Only in this quantitative dimension of being

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[30] Cf. M. Eldred *Critique of Competitive Freedom and the Bourgeois-Democratic State: Outline of a Form-Analytic Extension of Marx's Uncompleted System* with an Appendix *A Value-Form Analytic Reconstruction of ‘Capital’* co-authored with M. Hanlon, L. Kleiber & M. Roth, Kurasje, Copenhagen 1984 (digitized edition 2010 available at http://www.arte-fact.org/ccfbdspf.html) and *Capital and Technology: Marx and Heidegger*, available at http://www.arte-fact.org/capiteen.html and on

which admits of a more and less *is* money what it is, and only in this quantitative, monetary dimension can and must capital calculate. All economic phenomena can be grasped quantitatively, i.e. measured, more often than not in monetary terms, and this circumstance forms the essential precondition for all economic phenomena potentially and necessarily being taken into the grip of digital technology, whether it be, say, through macroeconomic simulation models based on econometric data, or through decisive statistics such a inflation rates, unemployment rates, etc. which provide guides for the attempt to steer the economy. The essence of capital is a movement of objectified value which is also essentially quantitative, and the competition among capitals has to correspond to this essence and thus also obey the movements of the value-numbers. From here comes the compulsion for banks to merge. Either they do so, or they go under, or are swallowed by a larger capital, for cost-savings are achieved mainly by facilitating the relentlessly increasing masses of monetary transactions which can be processed most efficiently, i.e. automatically, by computers at nodes in the electromagnetic network. Since the business of banks to a large extent consists of monetary transactions and monetary movements, such movements can be registered electronically in a digital form and thus executed in such a way that enormous costs can be saved. Bank customers too must be enticed, partly through monetary incentives, into learning to deal with digital technology and thus into contributing to their banks' cost-saving drives.

Of course, the revolutionizing effects of the digital casting of being (which is a mathematical way of *thinking* the being of beings as a whole that is also *materialized* as digital code embedded in electromagnetic media, thus *doubling* beings into physical beings and their digital, virtual counterparts) are not restricted to only two exemplary branches of industry, but these two industries are particularly suited for illustrative purposes because they themselves are so digitally abstract, i.e. in the one case, they do their business with the 'formless',

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paper in *Left Curve* No. 24, May 2000 (also in German and Chinese). Cf. also, more recently, my *Social Ontology*, *op. cit.* esp. Chaps. 4 v), 5 iv), 9 vi).

homogenous electromagnetic medium itself, and in the other, they do their business directly with money which is determined purely quantitatively in its form and can be materialized simply as a stamped number, including in the electromagnetic medium. In electronic commerce, too, it is primarily and decisively the monetary side (order processing, accounting, inventory control, etc.) which is exclusively carried out in the digital dimension and automated as far as possible, whereas the goods (‘unfortunately’) still have to be produced, packaged, despatched, etc. physically, of course with the assistance of a massive employment of digital technology in automated logistics. In the finance industry, the commodity itself is a money-form or a money-near form, and this then does not require any physical supplementation (transportation, etc.), but rather the trade can be carried out completely within the digital-arithmetic dimension with all the accompanying advantages of cybernetic automation.

5.2. Globalization driven from afar by the digital casting of being

The entire phase of economic globalization we are going through today is borne by the digital casting of being (whereas the historically first phase of globalization was presumably enabled inter alia by the knowledge enabling the technical development of ships, i.e. by an approximating technology with global reach). It is this casting of being which, through digital technology, abolishes distances and levels time differences and enables the world as a unified, ‘simultaneous’ globe in the first place. In cor-responding to the digital casting of being, we humans are forced to keep up with the new opening of world and the new, digital beings that take shape in it. One aspect of this is that, because of the acceleration brought about by approximating technologies and cybernetic automation, we have less and less ‘time’. The time-saving technologies do not lead to any time-saving for humans, but a time-saving for capital, such as the reduction of turnover time for the circuit of capital or the just-in-time production-flow that reduces costly inventory (cf. below *5.5 Time in a capitalist economy*). The digital casting of being is ambivalent; it opens up existential possibilities

for us on the one hand, through digital "conveniencies of living" (Adam Smith), and on the other, it makes us into mere cogs in developments which roll in over us. We mesh in like cogs and run along, somewhat breathlessly, behind 'developments'.

In all the hype (idle chatter) about globalization today, the essence, of course, is not seen at all. People are ontologically completely blind and forgetful in this regard and are satisfied with sociological explanations. It is still unfathomable, incalculable and unforeseeable how the digital casting of being will further unfold, say, in the next fifty years. What is most questionable, however, is that the origin of digital technology as a *mode of being* is not a question at all. We have lost sight of the indispensable role of philosophical knowledge which, in Hegel's words, consists in "investigating what is normally regarded to be well-known". "But such well-known phenomena are usually the most unknown." "The business of philosophy consists only in bringing expressly to consciousness that which, with regard to thinking, has been valid for human beings from ancient times. Philosophy thus does not set up anything new; what we have brought out through our reflection is already the immediate prejudice of each individual."[31] Instead of telling the story of the string of events through which globalization has been enabled by a string certain key (digital) technologies and other events (the ontic narrative so amenable to normal understanding), the deeper, philosophical task is to uncover how the digitization of the world is enabled by a certain, historical way of thinking the being of beings.

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31 "das zu untersuchen, was man sonst für bekannt hält". "Aber solch Bekanntes ist gewöhnlich das Unbekannteste." "Das Geschäft der Philosophie besteht nur darin, dasjenige, was rücksichtlich des Denkens den Menschen von alters her gegolten, ausdrücklich zum Bewusstsein zu bringen. Die Philosophie stellt somit nichts Neues auf; was wir hier durch unsere Reflexion herausgebracht, ist schon unmittelbares Vorurteil eines jeden." G.W.F. Hegel *Werke* Frankfurt/M. 1970 Bd. 18:39, Bd. 8:85, 8: 79.

5.3. Does the essence of capital correspond to the essence of technology?

At this point we still require further consideration of the essence of capital and how it corresponds, or does not correspond, to the essence of technology.[32] Both are associated, but in different ways, with the Aristotelean-Cartesian, ontoarithmological casting of the totality of beings and its consummation in the dissection (or taking-apart or decomposition) of beings into logical bits which, as placeless, calculated beings can be inscribed arbitrarily in the dimension of the electromagnetic network whence they can be called up to present themselves anywhere, anytime. In particular, *in money, the value of beings, their valuableness, is embodied quantitatively in a reified way, i.e. in a separate thing (res).* Money as the "universal equivalent" facilitating universal exchange is an arithmetic (and therefore ἄθετος, ἄτοπος) abstraction which can be calculated, and insofar it corresponds to the digital casting of being and thus also to the world-encompassing, unified, techno-arithmologically produced cyberspace; it is absorbed in this medium and the circuits of capitals can assume in virtual reality, too, their own, independent life, just as Marx analyzes in the fetishism section of *Das Kapital* and elsewhere. This is an autonomization of capital vis-à-vis human existence and it is enabled in a consummate form through the digital casting of being, for both capital and digital beings are in their essence arithmo-logical, i.e. they both have a numerical, calculative, calculating nature.

So one might be tempted to think of capital and capitalist economy like a machine that can be controlled calculatively, just like a technological cybernetic system. In this case, the essence of capital would correspond entirely to the pro-ductive, calculative, controlling essence of technology that sets up the totality of beings as a standing reserve for endless circuits of production, and the political polemic against the machine-like 'capitalist system' would have some

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[32] Cf. M. Eldred 2000 *op. cit.* and M. Eldred 2008 *op. cit.* Chapter 9 vi) for more details.

justification. To clarify this, and without yet having answered the question posed in the subheading, we have to dig deeper into the essence of capital and tease out two quite different meanings of ‘calculating’. To this end, we first consider what it means for beings to be *valuable*.

5.4. The casting of the totality of beings as valuable and capital as value power play

Everything that *is* opens itself to us as valuable in the broadest sense (including also that which is valueless, worthless or even detrimental, harmful), since everything that *is* has a relation to human being, either enhancing, detracting from or being indifferent to a possibility of existing in the world. The valuableness of beings, in the first place, is their use-value, their being-good-for a definite, concrete application that contributes to living well. In the second place, however, (and as already Aristotle teaches us) such use-values are also good for *others*, and because this is so, they have the *power* to acquire something else of use in exchange for it. This is their exchange-value, and it arises just as naturally from human being itself as use-value does through the sheer fact that we human beings are a plurality and can enhance our living by acquiring use-values that others can provide for us. Hence both use-value and exchange-value are categories conceptualizing the relation of human being to beings in the world on a simple, fundamental level.

The exchange of use-values is the exercise of a certain *power* inhering in the use-values concerned to exchange or *interchange* for each other. The exchange-values possessed by the exchangers constitute starting-points (ἀρχαί) governing an exchange (μεταβολή, which can signify both ‘change’ and ‘exchange’) and insofar fulfil a *modified* ontological definition of power as laid down by Aristotle in his *Metaphysics*, where only a *single* starting-point is considered. The exchange of use-values for the sake of enhancing living (which Marx calls “simple commodity circulation”, einfache Warenzirkulation, MEW23:164) is therefore already a *power play* in the strict ontological sense of the term, ‘power’. Money arises (both ontically and ontologically) as the *universal equivalent* facilitating the exchange of everything offered for exchange.

As a *thing* (*res*), it therefore itself embodies the *power of exchange* for everything with a price, i.e. it is the reified crystallization point for *exchange-value* which is nothing other than an ongoing power play of the exchange of everything valuable. Since use-values are generally (i.e. apart from purely natural products that 'come forth' entirely without labour) the result of the exercise of *human labouring powers*, i.e. of human *abilities* and *excellences*, the power play of exchange is fundamentally an interchange of human labouring powers, so power is implicated even on the most 'innocent' level of exchange.

Whereas the power play of the exchange of use-values can be viewed as the *metabolism* of the goods of living to enhance living, i.e. exchanging one use-value for money in order to acquire another, desired use-value, or C - M - C', the play of exchange can also be inverted in order to make more money from money, or M - C -M', where M' > M. This is the simplest formula for *capital*: advancing a principal sum in order to have it return augmented from its circular movement. A production process P may or may not be incorporated in this simple circling of exchange-value as capital, thus distinguishing between industrial and commercial or finance capital. The power play played by exchange-value advanced as capital is subject first and foremost to the simple rule that M' ≥ M. Otherwise, if M' < M, the power play would consume itself until eventually nothing more were left to advance. The power play of capital as a *movement* from M to M' requires at least two, and in general many, exchanges, each of which is a power play between the exchangers, most notably between the capitalist (large corporation, small firm, or whatever) and the hirers of labour power, the workers, who comprise *all* those (including even the top managers and executives) contributing to this movement.

5.5. Time in a capitalist economy

Like all movement, insofar as it is determined and therefore *measured* according to the Aristotelean casting, the value-movement of capital is *counted* by *time* (cf. *2.9 Time and movement in Aristotle's thinking*),

which in this case is the *turnover time* of capital,[33] the measure of a circular movement (κυκλοφορία, *Phys*. Δ 14;223b19) from M to M'. The success or otherwise of the circuit of capital can thus be *measured* by the simple finite-difference formula dM/dt = (M' - M)/(t' - t), where t and t' are the points in time at which a capital sum is advanced and returns. Such a formula measuring the result of the capitalist value-play relies, of course, on the reduction of the phenomenon of time to a linear variable consisting of now-points and also on the reduction of the phenomenon of value to a quantitatively determined money-value wherein the power play underlying value becomes invisible. The differential calculus developed by Cartesian (Newtonian/Leibnizian) mathematics in the modern age for physical movement therefore applies also to the social movement of value as capital, albeit without necessarily requiring infinitesimals but only a calculus of finite differences.

In decisive and essential contrast to the movement of physical bodies described by Newtonian (or even Einsteinian) laws of motion, however, there is no formula to compute the difference M' - M, because this difference is merely the outcome of a value power play in which exchange-values are actually exchanged. There is no intrinsic potential exchange-value inhering in a use-value that could pre-determine its quantitative exchangeable value simply because exchange-value itself only *comes about* or *happens* in a power play on the market among at least two, and usually many players. Such is the power play played by capital in its plurality whose ontology represents a *rupture* with traditional metaphysics because it can cope only with mono-archic movement, not with the poly-archic, 'playful' movement of social interchange. Capital is therefore *calculating* in that it reckons with a surplus value at the end of its circuit, but it cannot *precalculate* this surplus with calculative certainty, for the gainful interplay on the markets is essentially risky and uncertain.

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[33] Cf. my *Critique of competitive freedom and the bourgeois-democratic state* 1984/2010 Appendix §§42ff.

Moreover, the *time* required for the movement of an exchange transaction also has no ground in a law of social movement according to which it could be calculated, nor is this time interval uniform. Commodities offered for sale on the market are at rest (ἠρεμεῖν, *Phys*. Δ 12;221b28) with respect to their value-transformation and only jolt into movement upon being sold. They are nevertheless at rest only within the overall movement of capital, so that this their being-at-rest is only a limiting case of their movement as value, just as, analogously, a piece of timber at rest on the carpenter's bench is still within the overall productive movement of being made into a table. The movement of a single capital involves many individual transactions and therefore many individual value transformations, each of which takes its own time, so that the overall movement of one turnover of capital depends on many, even myriad value transformations being achieved before the advanced money-capital returns. This circumstance implies already that the circular movement of even a single capital comprises a series of jerky movements of value transformation plus the movement of production itself, which may be organized technically, through logistics and supply-chain management, to run smoothly. Especially at the interfaces where commodity-value has to be transformed into money-value, the movement of value comes to rest for a time which may be brief or extended depending upon market conditions.

The circular movement of a single capital is hence both *incalculable* and *uneven*. The reproduction of an entire capitalist economy involves the intricate intermeshing of many individual circuits of capital. The turnover of the total social capital is therefore even more complicated and intricate than that of a single capital, so that the counted number or time associated with this total social movement is both *incalculable* and *non-uniform*, since the underlying movement of total social capital itself is both *incalculable* and *uneven*. This contrasts with Aristotle's determination of the measure of time as an "even circular motion" (κυκλοφορία ὁμαλής, *Phys*. Δ 14;223b19). The regular period of even circular motion makes counting easier and its number, viz. time, easier to deal with calculatively, and a *public measure of time* in a standard periodic movement facilitates the co-ordination of movements not only

of capitals but among the economic players in general. A uniform measure of time, such as the year, can be imposed on the movements of value as capital, but this is only the abstract subsumption of many complicated, uneven movements under a convenient standard.

If the turnover of the total social capital is the basic, underlying movement of a capitalist economy, the measure of this turnover also provides the basic measure of time in such a society whose rhythm is determined by the circular, augmentative movement of capital. As we have seen, this underlying social movement is uneven, which implies that time in such societies is also uneven (not like the more regular movement of, say, an agricultural society in tune with the movements of the seasons). Furthermore, the measure of the success of a turnover of capital is not only the amount of surplus value it throws off on its return as money capital, but also the turnover time taken for this circular movement, i.e. the faster the turnover, the more profitable the capital. Since capital is this augmentative movement from money to more money, it achieves greater augmentation by shortening as far as possible its turnover time, thus reducing the denominator in $dM/dt = (M' - M)/(t' - t)$ and increasing it overall. If the turnover time of total social capital is an underlying, basic measure of time in a capitalist society, the tendency of capital to shorten the turnover movement means that *time in such a society becomes shorter and shorter*. That is, a capitalist society tends to continually *accelerate* time, even though such acceleration is not precalculable (but at most postcalculable), depending as it does already on the simple, but nevertheless incalculable transformation of commodity-value into money-value (sale of the finished product on the market) and money-value into commodity-value (e.g. if supply on the market is short).

Since the augmentative movement of value as capital is the fundamental underlying movement of a capitalist economy, and this movement draws in *all* the players striving to earn income in the gainful game, and participation in the competitive gainful game is a vital aspect of social life in such a society, any obstruction to the gainful game threatens the very movement of society, and time stutters and in some places can even come to a standstill. Essential reasons for obstructions to

the underlying valorization movement of capital reside in disproportionalities among economic sectors in the reproduction of total social capital and overaccumulation.[34] Some industries and some regions may lose out in the competitive struggle and be transformed into industrial wastelands where time has come to a halt. To the competitive players themselves on the surface of society, however, hindrances to economic movement can have many phenomenal guises and may even be caused contingently when, for instance, some (entrepreneurial) players misjudge risk. A capitalist society therefore has a vital interest in keeping the gainful game moving at any cost. Once the state proclaims by fiat that its paper money is legal tender within its territory, it also has a way of steering, or interfering with, the gainful game through central bank monetary policy, and may or may not be partially successful in preventing the gainful game, and time itself, from faltering and coming to a standstill.

5.6. The global power play measured by money-value and its movement

Today, at the culmination of the modern age, the power play of capital has become *the* global game in which everybody is involved as a player. The players are not merely the capitalists, but everybody who has an exchange-value with which to play on the markets, especially working people from the unskilled to the highly skilled, and the entrepreneurs. Everybody, whether on a modest or grand scale, is caught in the game of acquiring exchange-values either to use them or to accumulate savings, wealth and capital itself. Therefore, everything that *is* (including, say, icons, art works, white beaches, 'untouched' nature in general, etc. etc.) appears in the light of the global power play as a value, and everything is viewed from the viewpoint of its value for the power play in which value is augmented, for it is not only the capitalists who are involved in

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[34] Cf. my 'Anglophone Justice Theory, the Gainful Game and the Political Power Play' Section 8. 'Anomalies in the gainful game and the political power play' http://www.arte-fact.org/untpltcl/angljstc.html#8.0 and *Critique of competitive freedom and the bourgeois-democratic state* §§65ff.

gainful activity, but *everybody*. The world therefore opens up in such an age as the *gathering of all the opportunities for gain to be had through the interplay of powers of various kinds*, starting with *labouring* powers. The world is therefore a *global power play promising gain*, and, due to the incalculable nature already of the simple exchange-value relation, the power play itself is essentially *incalculable* and a *successful* outcome cannot be precalculated or guaranteed. The ongoing power play of value in movement has both winners and losers, although not necessarily winners only at the 'price' of others losing, for there are also mutually beneficial or win-win situations. In particular, the working class itself is not necessarily the loser in this gainful game, and the quantitative comparison of incomes gained is only on a superficial level the yardstick for success or failure.

Money is the mediator in this dimension of quantified value, the medium which enables universal access to acquiring what is valuable. It is inconsequential in this context whether what is valuable is a thing, a human service (i.e. the exercise of labour power of some kind or other), a piece of nature or — in a derived way and, so to speak, of second order — money itself (interest). Money is then, as the representative of wealth in general, the universal key, by means of exchange, to, the universal social *power* over all that is valuable. Money is reified social power par excellence. All possibilities of existing in the world are enabled by valuable things and therefore entertain, directly or indirectly, relations with money as mediator. In any appropriation of valuable things in the broadest sense by human being, a more or less is disclosed from the perspective of the gainful game through the proportions in which they are exchanged on the market. Therefore money, as universal mediator of exchange and the abstractly universal representative of what is valuable, is abstracted from any quality and is thus only quantitatively distinguished within itself. Hence it can assume the form of pure countable number (ἀριθμός) which, in turn, of course, can also be digitized. As universal mediator for the exchange of what is valuable, money itself is valuable, i.e. a social power, and therefore access to it must be regulated. Money must be acquired according to certain rules for acquiring it (*property rights*, especially those pertaining to *contracts*

of all kinds that regulate the interplay). The rules for exchange and acquisition constitute the framework of the gainful game in which human beings must participate insofar as they exploit their options for existing well.

The way of viewing everything from the perspective of money, which allows beings to *be* in a certain mode of quantitative valuableness, means that money is something resembling the material precipitate of a homogenous, universal, quantitative dimension in which value discloses itself, also quantitatively. Even when a satellite is sent into space or make observations of distant galaxies, etc., or research is done into the sub-atomic world, these activities are guided and constrained also by flows of money, i.e. money mediates, through enabling and constraining, the dimension within which we also measure and fathom our existential possibilities and activities, our movements as social beings, as well as their limits. It is a medium for the movement of human living itself. Money and value, too, distinguish us from animality insofar as we are exposed to fathomless value and thus also to limitless *greed* and *desire*. Animals do not have desires, but only limited drives which can be satiated by their environment. They do not look at anything *as* valuable; they are not exposed to the apophantic *as* which shows up beings *as* such and in such a way that they can be addressed by the λόγος, including in the category of quantity (ποσόν). Only we humans can *be* voracious and greedy, and voracity as a mode of human being's comporting itself is a possible way of responding and corresponding to the gathering of promising possibilities of gain (of course, including also the 'negative' or detrimental possibility of losing, of failing to achieve success). Money has assumed historically differing garbs such as gold, silver, state paper money and today, strictly guarded numbers stored in the electromagnetic medium. Digital money is the pure consummation of money in its purely quantitative value-being for it hardly requires matter at all, only the electromagnetic alignment of a couple of molecules. These numbers and their flow (cash flow) encompass, and insofar steer, all possibilities of human existence either directly or indirectly. Without a flow of money mediating the gainful power play, human being itself cannot move in its existence, something that becomes painfully

experienceable in every severe economic downturn in phenomena such as the so-called ‘credit crunch’.

We could also formulate the fundamental condition of a capitalist world (i.e. of a world that is sustained in its movement through the power play of gain) in the following way: Nihil est sine valore — Nothing is without value, in resonance with Leibniz’ principium grande: Nihil est sine ratione — Nothing is without ground or reason. But value itself is not a ground, coming about as it does groundlessly in the interplay only as a promise. This means that everything has its value in the sense that all beings are open, disclosed, first of all as use-values, but also as exchange-values suitable as pieces in the gainful game. Like every ontological world-opening, this casting of world as a value game is itself ungrounded, i.e. there is no founding ground or reason why all beings should be caught up in the gainful power play of values and also no reason or ground for value, measured in money as price, having a definite quantitative magnitude. The principle, nihil est sine valore, posits of itself — fathomlessly, from the very depths of being — a mode of disclosing beings as a whole and setting them into motion in the gainful game whilst enticing human beings as the players in this game. If the use-value of a commodity, depending as it does on the constantly shifting ways of living in which human beings customarily live, is without ground and thus also quantitatively indeterminate as an exchange-value, then it is also the case that *nothing is without risk*, for the values are determined only through the interplay among many players in which they are exposed to validation by others. The circling of value as capital has to pass through several or many value-validations on various markets before the success of its circuit is ‘home and hosed’. Risk is that which cannot be brought under the control of an ἀρχή, but just happens, comes along contingently (τὸ συμβεβηκός).

The entrepreneurial risk familiar to capitalism itself derives from the fundamental groundlessness of values as they come about in the power play of exchange-values of all kinds. Above this groundless abyss and before the horizon of the being of exchange-value, all the players in a capitalist economy play, above all, however, the entrepreneurs themselves who, as the lead players and initiators of a circuit of capital,

are exposed to the essential contingency of value. Having and spending money is indeed a deeply rooted historical custom enabling our existential options. Money, however, is not simply a technical instrument but the ontic, material precipitate of an ontological dimension, namely, the dimension of value, which is an historical way in which world opens up for human being. Money as capital is the autonomized movement of the augmentation of money with its own simple, finite-differential formula for success or failure denoting the accumulation or destruction of value as capital. Since money and capital as embodiments of value are infected with the groundlessness of an *interplay of powers*, there are no laws of motion for the economy analogous to the laws of motion for physical beings investigated by physics.

5.7. Recovery of the three-dimensional, complexly interwoven social time of who-interplay

The global gainful game that assumes the form of the movement of value as capital has a Janus face. On the one hand, it shows the face of the striving for the limitless accumulation of value as capital, the modern consummation of Aristotle's chrematistics. On the other hand, the simplest of exchange relations in which one use-value is exchanged for another is already, at root, when deciphered, the interchange of human *powers*, i.e. human *abilities*. Such an interchange — a power interplay — can be, and often is *mutually beneficial*. This is the fair face of Janus. As the movement of social life itself, this interchange of powers is endless, limitless, for there is no end to how human beings can exercise their powers for each others' benefit. Thus there are two different perspectives for looking upon the constellation of being called the gainful power play of value, one fair, and one not so fair, and sometimes even downright ugly, that consists in employing our powers *against* each other, to unfair advantage. There are countless ways of playing the gainful game unfairly, both subtle and blatant.

To bring the fair face into perspective requires, as an ontological condition of possibility, reappropriating the time that has been quantified as a mere mathematical (and hence timeless) variable t in the formula

given above for the success of a circuit of capital, for the time in which we play the gainful game is our own, finite life-time of our own finite life-movements. Firstly, as elaborated in *Sein und Zeit*, the mathematical variable t has to become thought and experienced as the three-dimensional ecstatic, finite time of human being itself that casts its *self* into the open dimension of the future by retrieving who it has been and fashioning its ownmost, *singular* possibility of existing. Such self-casting, however, is close to being misunderstood as auto-production. Therefore, in a further twist, this three-dimensionally stretched time has to become thought and experienced as the *social time* of social movement itself, which is not just the measurable movement of total social capital, but the immeasurable, complexly interwoven movements of social interplay in which each individual haphazardly comes to stand (or fall) as somewho, to gain or lose its self, in the power play of social recognition and social validation of its powers and abilities.

5.8. Fetishism

For Marx, fetishism means that the products of human labour *as commodities, i.e. grasped and disclosed from the dimension of value,* seem to be imbued with a 'magical power' of themselves. Under the commodity form, the products themselves (which can, of course, also be service-products and by no means have to assume a palpable objective form like industrial products) assume the ontological character of *values*. In the exchange interplay on the market, commodities as embodiments of value take on a life of their own as vehicles of value and its movement. Fetishism is most blinding in the value-form of money, for money itself as a thing seems to have a magical power, whereas 'in truth' this power as universal equivalent for all commodities has an origin in the value interplay itself, according to which beings disclose themselves in practice to each other and to human being as valuable, and so beings as a whole and human being are transpropriated to each other in this dimension of value.

A further form of fetishism inheres in interest-bearing capital which seemingly 'of itself' brings forth precalculably an interest yield: M becomes M' = M + i over time t. 'In truth', however, i.e. in the full

disclosure of its essence, the interest yield is a form of appearance of the augmentation of value in analogy to the quantitative growth of reified value through its productive circuits as capital which sets human abilities into motion. Everything thus depends on clarifying the ontological origin of value, i.e. on entering and thoughtfully deciphering the value dimension itself as a dimension seemingly with a life of its own.

Marx's concept of fetishism includes as its foil the thought of the loss of (socialized, collective) human control, for the value dimension in his thinking is traced back ultimately to labour (which is thus implicitly proclaimed to be that which ultimately is solely valuable and quantitatively determining for exchange relations) and it is shown that, because of the commodity form predominating in capitalist societies, consciously organized social labour *as such* does not serve as the underlying basis, i.e. as the subject, of human economic activity, but rather that this subject role is usurped by objectified labour itself as capital. This Marxian retracing to the essence is located in modernity's metaphysics of subjectivity in the form that the (sociated, collectivized) human is postulated and cast as the ultimate subject of the totality of beings. Only within such a metaphysics can capital be designated as something resembling an (alienated) 'human product' or even as alienated human freedom. For how could humankind be free as a socialized collectivity whilst quashing the interplay of individual human powers in rivalrous, gainful play with one another?

Nor can capital be addressed at all as a kind of technology, a 'machine' that could be mastered by (collective, socialized) humanity, but rather it can at most be brought into a connection with Platonic τέχνη κτητική (an art of acquiring) *in contradistinction to* τέχνη ποιητική (cf. *Sophistês* 219c and GA19:272ff). Capital is the wager to augment value through the interplay of exchange, and not a fore-knowing, precalculable movement of bringing forth a value-product, for value itself cannot be pro-duced. The fetishism of capital therefore has nothing at all to do with technology and technical products or any autonomization of suchlike, nor with surface phenomena such as consumerism (but solely with the appearance that value, as the power to

exchange, seems to inhere in certain things of themselves). That would be a complete misrecognition (all too common) of the phenomenon of economic fetishism as first brought forcefully into view by Marx. Rather, the origin of fetishism has to be sought in the ontological dimension of value and the interplay in which value comes about in a power play, and the phenomenon of technology can be brought in only indirectly, via this value-dimension, for instance, as a factor for enhancing the *chances* of value-augmentation in the competitive power play.[35] Value itself, the disclosure of beings as valuable, is not a human product, not a human machination, even though humans necessarily participate in the value dimension in the same sense as they 'participate' in the ideas, for it is 'natural' for human being to be open to understanding and 'practising' use-value and therefore also use-value-for-others, i.e. exchange-value.

5.9. A capitalist economy is not merely complex, but simply ontologically playful

It is often observed that modern technical systems, including organizational systems, are highly complex and therefore non-transparent, which leads to a certain autonomization because they are then hard to control. If, proceeding from this fact, one tries to clarify the non-transparency of the capitalist economy (which, as we have seen, is not merely a technical system, but a value power play) as a complexity, then the ontological dimension of value is lost sight of and instead an ontic explanation in terms of complicated causal interrelations is offered. The being of capital, however, can never be captured or clarified by a concept of causal complexity (reciprocal, 'dialectical' or otherwise) or a

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35 Valorization is here the translation of the Marxian concept of *Verwertung*. In normal German usage, *Verwertung* is the utilization or commercial exploitation of some resource or other. In Marxian thinking, however, *Verwertung* is always *Verwertung des Werts*, valorization of value, i.e. the 'utilization' or 'exploitation' of value (in the form of money or commodities, including especially means of production and labour-power) to augment itself in a circuit of capital.. Valorization of value is thus always the movement of quantitative self-augmentation of value.

concept of system, since such concepts blindly skip over the question of value and explain the interconnections among beings only by attributing causal blame (Gk. αἴτιος = blame = cause) instead of allowing that which simply comes along (τὸ συμβεβηκός = contingency) to come into play.

Early on in the analysis of the essence of capital in *Das Kapital*, capital is determined as an "automatic subject" (automatisches Subjekt, MEW23:169) in the sense of the self-valorization of value. Capital is not anything resembling a cybernetic subject controlling a total-social economic reproduction process. Rather, the subject-character of capital must be sought via the concept and dimension of value. Capital is then subject only in the sense of the underlying (ὑποκείμενον, subjectum), incessant and therefore "automatic" movement of value through the value-*forms* of money, commodity and back to money in the striving for an augmentation of value. This (formal) movement takes place according to the rule of play that the rate of change of capital be positive, i.e. $dM/dt = (M' - M)/(t' - t) > 0$. This rule of value interplay asserts itself inexorably in the long run. Value interplay itself is, in nuce, the game of mutual recognition of powers, starting with individual human powers or abilities, but including also derived powers inhering in property and money as exchange-values. Value can therefore be thought of in the first place as the dimension of *mutual social recognition*, a *simple* phenomenon lying at the basis of all human sociation: we *estimate* and *esteem* each other's powers, abilities (even, and especially, when we are *indifferent* to or *detract* from each other's powers and abilities).

As we have seen, capitalist economic activity is undertaken under the principle (ἀρχή) that from advanced capital (money M), more capital (money M') is supposed to flow back, which is a kind of rule of play, constraining boundary condition or condition of existence for capital: $M' - M > 0$. This principle is by no means complex but rather, extremely *simple*, and its origins do not lie in the nineteenth century but already in ancient times. Aristotle already thinks about the endless striving for the augmentation of riches by way of chrematistics. The principle of the valorization of money, its self-augmentation when viewed from the

standpoint of advanced money-capital bending back onto itself to determine a difference, comes to us from a far-off origin (as a sending from destiny), just as modern technology comes from τέχνη as a poietically knowing mode of disclosure that was taken as the foundational, paradigmatic phenomenon for Western (productionist) metaphysics that has subterraneanly shaped Western history. Marx says that since Aristotle not a single step has been taken forward in clarifying the concept of value, the key to deciphering the ontology of our social being. That sounds similar to Kant's parallel remark regarding Aristotelean logic.

"Destiny" here does not mean anything like a fate in the sense of an alien power that decides our fate, but rather the historical disclosure of a world sent, or eventuating, from being (hiddenness, nothingness) which we can never completely fathom nor control. This disclosure comprises the various historical ways in which we can encounter phenomena and address them and also be addressed by them. Certain simple 'ideas' form the ontological 'scaffolding' on which an historical world hangs. A world shapes up for us as historical beings existing in time, and *as* time, and the shape this historical world assumes is determined first of all by our deepest and simplest shared ways of thinking, the ones most unquestioned and apparently unquestionable in any given historical epoch which seem absolutely self-evident (such as 'objective' scientific truth seems to us today). The ground-categories of an epoch are also those with which our thinking *identifies* and hence those with which our very identities, i.e. *who we are*, are bound up. A shift in historical destiny is always a matter of a *disquieting, conflictual transformation* in the way in which world discloses itself to us and also of *letting go* of how we have understood ourselves hitherto in our self-standing. Destiny is not a being, an instance, but must be understood as a sending and receiving of deep, simple ontological 'messages', a giving and taking to which human beings belong as recipients. It should be apparent that only the strongest, and not the pusillanimous, are able to receive the message. The strongest here are not the most unbending and steadfast, but the most receptive and ontologically 'sensitive' who are able to suffer the

concussions associated with a seismic non-identity between thinking and established world.

To return to the question of complexity: Marx investigates the complexity of capitalist economies only in the second volume of *Das Kapital*, *The Circulation Process of Capital*, where the opaqueness and intricate complicatedness of the economic whole is dealt with, which leave open many possibilities in the overall process of reproduction of the economy for frictions to arise in the intermeshing and intertwining of the many individual capitals, etc. But already the simple value-form itself (which presupposes a *plurality*, a *sociating* of commodities) is essentially contingent and incalculably unpredictable, since what or how much a commodity is worth is determined only in the exchange interplay itself on the market. The analysis of the essence of the commodity, money and capital (their socio-ontology) is carried out already in the first two chapters of the first volume of *Das Kapital*. In the determination of the essence (the socio-ontological principle) of capital as self-augmenting value, it becomes apparent that this circling principle confronts humans as an alien, alienated power, not because of the complicatedness of the economic system, but because of the fathomlessness of *value* as the ongoing outcome of an interplay of powers and ultimately of the *gainful game* itself, to which, however, human being in its desirous striving for the goods of living, and evermore thereof, *belongs*.

5.10. The capitalist value-play an essential limitation to cybernetic technology

In the capitalist casting of being as the gainful game, as we have seen, commodities have to ‘prove’ or ‘validate’ themselves on the market, and whether and at what price commodities can be sold remains exposed to a fathomless incalculability. *Herein lies already an essential limitation to cybernetic technology*. The endless circuits engendered by standing orders, which Heidegger speaks of extensively[36] in connection with the

[36] Cf. e.g. ‘Das Ge—Stell’ in *Bremer und Freiburger Vorträge Gesamtausgabe* Band 79 *Einblicke in das was ist*.

essence of technology and its eery will to will, according to which all beings are set up sense-lessly for endless production, do have a kinship relation with the circuits of capital, and this not even necessarily in another phenomenal guise, *insofar* as it is the capitals, that is, the enterprises themselves, which forcefully promote the development of technology and control technicized production in order to stay ahead in the competitive, gainful game. Not only with technical progress, but also with capital accumulation there is an endless progress for the sake of progress at work where the two tendencies intermesh with each other, for staying ahead technologically is *one* major way in which an individual capital, through increased productive efficiency, enhances its *chances* of survival in the competitive power play of exchange-values. But the kinship in essence between technology and capital, between precalculative, productive setting-up and calculating, risky valorization of value — ultimately by virtue of the difference (διαφορά) between one (ἕν) and many (πολλά) and the consequent incalculability of movement (κίνησις) as interchange (μεταβολή) (cf. *3.5 The onto-theological nexus in abstract thinking, cybernetic control and arithmological access to movement and time*) — *breaks down* and an estrangement between the two emerges *insofar* as the will to productive control so exquisitely consummated in automated digital cybernetics is the very opposite of the willingness to risk engagement in the incalculable play for gain with its many, competing players. Insofar, in answer to the question posed above (cf. *5.3 Does the essence of capital correspond to the essence of technology?*), we have to say that the essence of capital (whose ontological structure is that of poly-archic interplay) *does not correspond but runs awry* to the essence of technology (whose ontological structure is that of mono-archic production) which, especially since the advent of the Cartesian mathematical casting of world, seemed to be close to fulfilling the dream of total, calculable, even materialized, automated control, the ultimate consummation of the will to power as pro-ductive power governing the movement that brings beings to stand in presence. The essence of capital, by contrast, is playful.

What, then, do the essential contingency and incalculability of the value-form have to do with Heidegger's characterization of the consummation of subjectivity as the "securing" of the will to will. He writes, for instance, "Humans of themselves align their essence with security in the midst of beings, against them and for them. They seek security amidst beings through a complete ordering of all beings in the sense of contriving a planned securing of standing reserves, which is how setting up in the correctness of security is to be performed." ("Der Mensch stellt von sich aus sein Wesen auf Sicherheit inmitten des Seienden gegen und für dieses. Die Sicherung im Seienden sucht er durch eine vollständige Ordnung alles Seienden im Sinne einer planmäßigen Bestandsicherung zu bewerkstelligen, auf welche Weise sich die Einrichtung im Richtigen der Sicherheit vollziehen soll."[37]) First it should be noted that security is the antithesis to the groundlessness of *freedom*, so the passage points to the headlong rush of human being from the possibility of freedom into a subjugation to calculable security. Moreover, Heidegger's gaze is directed at totalizing cybernetics which, however, has to be uncovered as a self-delusive illusion insofar as cybernetics only calculates and can only calculate with beings pro-ductively, for it is impotent vis-à-vis value as a mode of being which is unfathomably incalculable and beyond any cybernetic control, but is nonetheless an historical way of world-disclosure for a *plurality* of human beings at mutually estimating play with one another. The dimension of value in its economic sense is never a subject in Heidegger's writings, and we have to learn this in an 'unsettling' re-reading of Marxian texts inspired by Heidegger: *Inherent in the interplay promising gain is an essential limitation to productive technology in general, and cybernetic technology in particular, for technology is essentially not able to steer and control the augmentation of value* for which there is no sure-fire, calculable, winning strategy.

To see this requires going beyond the horizon of Heidegger's thinking. It is noteworthy that in the above quote, Heidegger speaks of "der Mensch", which is here translated naturally as "humans". What is

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37 M. Heidegger *Nietzsche II* Neske, Pfullingen 1961 S. 378.

singular in German translates naturally into plural in English. This is because the phenomenon of value of its nature involves a plurality of commodities and of exchangers of commodities. Whereas use-value always signifies a usefulness for a human user, the second-order exchange-value always signifies a usefulness for *another* human user. Now there are at least *two* free starting-points demanding ontological consideration. Something useful has to be offered by a seller, and someone else has to bid for what is offered, and only in this ongoing *interplay* of offers and bids does the exchange-value come about, or happen, as an abstract, quantitative exchange proportion (since anything at all can be exchanged for one another, all quality is abstracted from in generalized exchange). Exchange-value is therefore essentially *quantitative* (ποσόν) and *relational*, πρός τι, and not a substance, an οὐσία. Contra Marx, whose thinking was still held fast by the Cartesian casting, there is no "value-substance" (Wertsubstanz, MEW23:49). The human world is characterized by a *plurality* of human beings engaged with each other in *exchanges* and *interplays* of all kinds. Economic interchange is only one kind of human interplay.[38] *All* human interplay, however, is fathomless because each human starting-point in the interplay among at least two is *free*, i.e. essentially abyssal, fathomless, groundless. It is this essential groundlessness in the plurality of human interplay that vitiates any dream (or Heideggerian nightmare) of total cybernetic control through digital technology, even though the possibilities of *surveillance* and *welfare* from 'above' of human beings and their intertwined movements opened up by automated digital technology conforms entirely to the state's caring will to political power. In itself, the economic game of striving for gain is a groundless, incalculable interplay subject only to the simple principle or rule of play that it be gainful rather than loss-making.

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[38] Cf. my *Social Ontology* 2008 *op. cit.* Chap. 5 vi) Exchange as core phenomenon of social intercourse: Interchange and interplay.

5.11. Recapitulation: Digitization of the economy

The digitization of the economy represents the incorporation of digital beings into the economic game which themselves are a technological, binary-code precipitate of the mathematico-scientific casting of the world. Given that the paradigm of production (on which all metaphysical thinking since its inception is based and which is driven covertly by a will to power) and the paradigm of interplay (on which the economic gainful game is based) are in essence different, we have to clarify further why a digitization of the capitalist economy takes place at all. We have already pointed out that productivity gains, which can be achieved also through the deployment of digital technology, enhance the chances of winning in capital's competitive striving for economic gain. Furthermore we have noted that any reduction in turnover time also enhances the capital's (chances of) profit. Turnover time itself comprises production time and circulation time. The diminishment of the former is an increase in productivity. The diminishment of circulation time involves making all the necessary transactions faster and improving logistics for the speedier transportation and delivery of sold products.

The productivity of the *labour of circulation* can also be boosted through the employment of digital technology, although here it is important not to confuse the productivity of the labour of circulation with that of the labour of production. Labour of circulation includes all the 'backroom' operations of invoicing, accounting, etc. along with sales, marketing and advertising efforts. Since accounting is performed in quantitative monetary dimensions, and is thus of its nature arithmo-logical, it is particularly amenable to digitization by means of appropriate accounting software that enables automated cybernetic processing of all sorts of transactions such as purchase of raw materials, payroll processing. invoicing of customers, etc. etc. It must be kept firmly in mind that the labour of circulation is not a pro-ductive bringing-forth, but rather a *retro-spective mopping-up* or a *pro-spective smoothing-the-way* for value-form transactions which i) have to be processed and recorded for bookkeeping purposes after they have occurred, i.e. retrospectively, or ii) instigated through rhetorical

prodding in the market-place. Labour of circulation includes also retailing, which can be made more efficient in diverse ways by employing digital technologies, right up to setting up retailing outlets on the internet that can sell goods with all the efficiency advantages offered by trading in a purely digital, near-zero-cost environment in which the goods can be presented digitally and also sold via sophisticated cybernetic sales transaction and logistics systems. The movement of money-capital in the broadest sense (that is, not merely monetary movements, but also commerce, circulation, turnover and revenue/earnings transfers, financing, credit-lines, etc.) quickly makes itself at home in the electromagnetic, digital medium as a useful, cost-saving aid that also enhances oversight of the total process.

Digital technology can also be deployed for another kind of labour of circulation, namely, marketing and market research, especially where the markets themselves are digitized, as on the internet. Since all movements in the electromagnetic medium leave a data trace, these data can be mined to distil regularities in consumer behaviour which, in turn, can aid in conceiving marketing strategies. Again, such marketing strategies are not productive in the strict sense, but merely game strategies of enticement in the gainful capitalist game which nonetheless can *turn out to be* highly profitable. Prediction of, say, consumer behaviour (e.g. researching the market for a new fashion collection) or future demand for a certain raw material is done by collecting data on what has already happened or on what a sample of consumers say it intends to do, their ‘tastes’, etc. These data are then sifted using sophisticated statistical methods, and then extrapolated in some way into the future. Digital technology is today indispensable for such statistical processing which, nevertheless, in such prospective applications, does not have cybernetic, pro-ductive power, but only surmising, probabilistic power. Scenarios for future markets can be very useful for capitalist companies in planning their game strategies.

So, is there anything new in the digitization of the capitalist economy? Digitization means the breaking-down of beings into a digital (binary) representation that enhances their calculability. This is a legacy of the Cartesian rule that beings be approached through what can be abstracted

from them by way of magnitude, which presupposes the Cartesian casting of physical beings as a whole as *res extensa* culminating, as we have seen (*2.7 Cartesian rules for an algebra of magnitudes in general as foundation for the modern mathematical sciences*), in modern abstract algebra and its coupling with functional analysis. This is the ultimate basis of the modern mathematical sciences, both physical and social. What is new in the digital age is that our mathematico-scientific understanding has become representable piecemeal in chunks of automatically executable digital code that can be inscribed in electromagnetic media. This enables the doubling of familiar, physical beings into their digital, virtual counterparts already mentioned which, through sensual, graphic interfaces, behave in much the same way as their 'analogue' 'originals'. E-banking is just one familiar and now ubiquitous example, along with its inevitably associated e-fraud, which is anything other than merely virtual fraud. Robots (cybernetic devices) of all kinds controlled by executable digital machine code are the decisive step in materializing human mathematico-scientific understanding of movements of all kinds — including physical locomotion, the classic conception of a robot — to create automatons. Cyberspace, in particular, is a dimension in which all sorts of movements (e.g. pop-up advertisements, billing and logistics processes) are automatically triggered in a pre-programmed way through executable binary code embedded in matter. We have quickly become adept at digitizing and thus automating chunks of our practical understanding of the world, so much so that it already seems 'natural'.

The dimension of digitized beings also offers many new opportunities for playing the gainful game that are the doubles of their physical counterparts, e.g. e-casinos and e-markets such as online travel agencies and online stock exchanges. We have little trouble dealing with these virtual digitized entities because they duplicate the physical ones and rely on the same practical understanding. It is nevertheless eery that we encounter our own practical world-understanding, now automated and materialized in another medium that has quickly become familiar, ubiquitous and global. We are oblivious that, without an Aristotle who was the consummation of ancient Greek ontology, a digitally calculable

world whose calculability has today been materialized in automatic machine code embedded in its own medium could never have eventuated. The digitization of the capitalist economy is an adjunct of this materialized, outsourced, practical world-understanding, but what capital *is* and the gainful game in which we are entangled confront us with questions concerning the ontology of *interplay*, which is an *alternative* paradigm to that of production, of which the digital casting of the world and digitized cybernetics are perhaps the consummate historical consequences.

6. A global communication network?

6.1. What is communication in a global network?

Human being finds itself always already *attuned* with the world in one mood/mode or another and, equally primordially, it *understands* the world. As a *plurality* of human beings we are open to a world in *sharing* an understanding of it. We are in the clearing of the disclosure of beings as such *together*. *Communication* is the *sharing in common* (L. communis) of an understanding of world by *articulating* it in speech, spoken or written. Human being's openness to the world is always already broken down or articulated into a logos that can be shared with others, thus also sharing in language an understanding of the world. At first and for the most part, communication is concerned with sharing the ever-changing facticity of the world in its continual movement, that is, with *news* of all kinds. Most of the world's happenings we do not experience at first hand, but at second hand through a communication of news which we make sense of against the foil of our own world-experience. Written correspondence concerns mainly sharing the understanding of happenings in the world (news) and practical affairs in (business or personal) life. The movement of messages (communications) from one individual to the other is motivated by the practical movement of dealing with life itself and by keeping abreast of the movement of factical life.

The digitization of the logos is a special case of the digitization of beings in general, and is most natural because the logos itself is already a discrete articulation that can be easily broken down further into binary code or bits. Therefore letter correspondence and the postal system are quickly digitized as e-mail correspondence on the internet. But the spoken logos, too, and images of the world's happenings can also be digitized and made vehicles of communication with the aim of sharing an understanding of what is constantly going on in the world.

Written communication does not have to be one-to-one. It can be a *general, public sharing* of the world's moving facticity first enabled

historically by the printing press and the newspaper which employed paper as the medium for the articulated signifiers of a language. Digitization leads to an explosion of news because now factual world happenings can be shared worldwide in writing, voice and image easily and at zero cost. What has happened (historical fact) can also be shared in the same way. Digitized media are global as a matter of course because the worldwide circulation of messages in the electromagnetic medium knows no technical bounds geographically nor with regard to the type of message. All the various media (news'papers', photo journals, radio, television, video) are now one digital medium distinguished only by the source of dissemination. Hence, no doubt, we are suddenly living in a world of global digital communication.

These communications of news of the world's factical movements, however, are shared by countless individuals, each with a different perspective on the world, with a different basic world-understanding against which news events are assessed, evaluated. The basic evaluation is whether the news is good or bad, i.e. whether the factical movement of the world is deemed to be for the good of or to the detriment of humankind in general or particular (a particular country, region, industry, etc.). Insofar news is always political, always controversial and conflictual, concerning as it does the differing particular interests and more universal views of different groups of people. The divides in how news is understood do not depend on the news itself, but on the underlying understanding of the world, and ultimately and crucially, on the individual understanding of the deepest concepts of human being itself such as *freedom* and *justice*. The controversy over such issues *as such* is not a matter of the communication of news, and it is shared and fought out only by relatively few. Otherwise, the controversies continually raging over issues of freedom and justice take place only between divergent positions representing particular configurations within a deeper-lying problematic concerning the question of human being itself. In other words, these controversial issues lead us back ultimately to philosophy, whose movement in time is slowest of all and does not depend on the instantaneous ease with which messages today can be globally communicated.

Political controversies and conflicts of all kinds are waged between differing positions (parties, organizations, segments of the population, etc.) that depend on the dissemination of news messages. Hence there is a continual *power struggle* to get one's message disseminated and placed favourably, and most news messages have some political import, so that control of the disseminating media becomes a decisive and divisive political factor, for it is important to occupy the news audience's minds with the 'right' messages for the sake of legitimating a particular political constellation, especially a government's rule, or a particular political tendency or struggle. The understanding of world news events is only in part a matter of fact, and more deeply a matter of deeper conceptions of human being itself, which is always also a conception of the world, of how it shapes up for understanding in fundamental categories and concepts.

On both a deeper and a more superficial level, therefore, there is always an ongoing struggle to disseminate one's message and to get it across. The truth of the world at all levels is a power struggle. Getting a more superficial message across depends on the audience's preconceptions and prejudices, on what it is inclined to take in, on what it can understand easily, on what is pleasing or even flattering to it. The dissemination of an average message is therefore a *rhetorical power struggle* employing all the available techniques of rhetorical persuasion to flatter and thus win over the senses, hearts and minds of recipients. The power struggle over deeper messages is more difficult insofar as such messages are neither news nor views and are therefore not comprehensible in general, but demand for their reception a smaller audience's developed ability to comprehend. Such deeper-lying, but nonetheless crucial questions are therefore pushed into niches or pushed aside altogether in the global communication of messages.

The ease and cheapness with which messages can be communicated through the global network itself causes a problem of the *superfluity* of messages, of information of all kinds which materially are simply an informed electromagnetic medium. We become over-informed without necessarily improving our understanding one whit, for the latter can only take place outside of cyberspace in quiet study. Digital messages can

become a kind of plague. We are flooded with messages to the point of *over-saturation* and of being *overtaxed* by endless reports on factual movements in the world, to say nothing of advertising messages we would rather do without.

6.2. Communication among digital beings themselves

Communication proper is a human affair, but the term has long since been transferred also to digital beings themselves for the ‘communication’ among digital devices of all kinds that are controlled by executable binary code. They are fed with digital data to process and also receive control commands from elsewhere through the electromagnetic network. Such communication constitutes an automated cybernetic network, a kind of web-robot that spans the globe. The worldwide digital electromagnetic medium is the consummate *element* for cybernetic control because all the digital beings inhabiting cyberspace are calculable and can be calculably addressed by the appropriate binary command code. This provokes the question whether the global digital network is truly for the sake of human communication, as it certainly seems to be on one level, or, less apparently, for the sake of machine communication, i.e. of total cybernetic control as a covert realization of the will to (productive) power. Such a will can be discerned in communication theory.

Modern communication theory was founded in the wake of the emergence of electromagnetic communication media such as telegraphy, telephone and radio. With a mathematically brilliant, seminal paper published in 1948 entitled ‘A Mathematical Theory of Communication’, Claude E. Shannon, an engineer and mathematician, is generally regarded as the father of modern communication theory. It is no accident that precisely a *mathematical* theory was accorded the honourable status as founding theory and that this mathematical theory deals first of all with *digitizable discrete communication* between sender and receiver, which are the appropriate physical beings for transmitting and receiving discretely generated, digitizable messages. Human beings as communicators are initially put to one side so that communication is conceived as machine communication. As an engineer, Shannon was

interested solely in the efficiency of getting a message generated at a source through a medium to a receiver where the message is to be reconstituted with as few errors as possible. The amount of information transmitted in unit time was of prime concern, regardless of the message's content, let alone its interpretation and meaning. Abstracting from qualitative content left a *quantity* of information, whose amount was measured by the rate at which information was generated by the source and the channel's or medium's capacity to convey information in *bits per second* as the appropriate mathematical measure of the *entropy* of a source generating symbols (e.g. letters in a natural language, image pixels) with certain probabilities.

In digital code, of which a message considered as a digital being is composed, the information content is appropriately measured by the number of bits required to encode it, each bit representing a power to base 2 of binary code. When a bit code is extended by one binary place, the amount of information encodable together with the extra bit doubles. Therefore, the appropriate measure of information content is the *logarithm* to the base two, which gives the number of bits required for encoding and thus the amount of 'freedom' in 'choosing' a message, i.e. the amount of entropic *digital difference* among possible messages. A bit-coded message has to be conveyed through a channel whose capacity is likewise measure in bits (per second). Since the stochastic process probabilistically generating a message in a natural language is not completely random, but constrained by the probabilities of certain frequencies and sequences of letters or characters in the language, there is also statistical *redundancy* in the message and therefore a potential for saving channel capacity (bandwidth) by transmitting just enough bits to reliably and correctly reconstruct the message as a sequence of bits at the receiver's end.

Shannon proceeded first by assuming a transmitting source *discretely* generating a finite number of symbols that first had to be encoded by a *transducer* to produce a *signal* to be transmitted electromagnetically through the channel which, once received, first had to be decoded back into a legible symbol. Discreteness is the appropriate place to start for considering the transmission of a message in an articulated, finite logos

of some kind since, as we have seen in Chapter 2.3 on arithmological knowledge, the finite logos has an affinity in essence with calculability. The theory of discrete, finite message generation and transmission was then extended to consider *noise* interfering with the transmission of the encoded signal, thus giving rise to errors for which the transmission procedure had to make allowances. Finally, the theory was extended to cover *continuously* generated messages such as (radio) voice or (TV) moving image by the usual approximation and limiting procedures familiar from differential and integral calculus. Shannon was therefore interested in *productive power*, i.e. the power to bring about a change, namely the correctly delivered message, at the receiver's end. This abstract mathematical perspective is the appropriate one for setting up a reliable, effective process of message transmission, entirely regardless of the content of the messages transmitted which may equally well be highly semantically charged, like James Joyce's *Finnegans Wake*, or trite.

In subsequent work, Shannon's collaborator, Warren Weaver, broadened the communication model beyond a purely mathematical engineering problem to take into account the social dimension of communicating messages. The effectiveness of message transmission therefore no longer had a merely technical measure, but a (non-mathematizable) social one, namely, "the success with which the meaning conveyed to the receiver leads to the desired conduct on his part". Now the criterion of effective communication is no longer simply a message correctly decoded, but a message whose meaning is correctly interpreted and executed in the sense that the recipient's behaviour accords with the sender's desires. This is now a question of *social power*[39] that, at least tacitly, brings into play the interplay of acknowledgement and estimation among social players in communication without, however, ever clarifying the ontology of social power.

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39 Cf. my *Social Ontology* Chapter 10 and my 'Social Power and Government' 2010 at www.arte-fact.org

One communication theorist, Harold Lasswell, characterizes the seminal Shannon-Weaver theory as regarding communication as a matter of "who says what in which channel to whom and with what effects?"[40] This characterization makes it apparent that modern communication theory proceeds unwittingly and unquestioningly from a problematic of social power whose origin lies in Plato's and Aristotle's treatments of *rhetoric*[41], without ever unearthing this source. Subsequent elaborations of the Shannon-Weaver theory introduce other communication 'factors' such as feedback (N. Wiener 1948), two-way communication between 'communicators', gatekeepers filtering or censoring information-transmission between source and recipient (a kind of social noise distinct from technical noise interference, although the two can be coupled, e.g. in politically motivated transmitter jamming), the social status of 'transmitter' and 'recipient', social contexts, etc. The core problematic of *communicative power*, however, is tacitly adopted and left unchallenged and unclarified by such later theoretical 'models', which usually have merely schematic form.

6.3. The intermeshing of the movement of digital beings in the global network and the movement of value as capital

The efficiency of the cybernetic digital network is welcome to the movement of capital because, as we have seen in the preceding chapter, both productivity increases and the acceleration of turnover time boost the self-augmentation of value by enhancing the chances of coming out on top in the competitive struggle for gain. Capital therefore slips into the global digital network like a hand into a glove. The speed with which messages can be communicated accelerates the circulation labour and shortens the circulation phase of capital. Moreover, the near-zero

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40 Cf. http://collaboratory.nunet.net/dsimpson/comtheory.html accessed July 2010.

41 Cf. my 'Assessing How Heidegger Thinks Power Through the History of Being' 2004 Section 3. 'Rhetoric as a test case for power over the other' at http://www.arte-fact.org/untpltcl/pwrrhtrc.html#3.

reproduction costs of digital code lead to dissemination throughout the global network and massive cost reductions for many productive and circulation functions of capital. A banal example: invoices can be communicated, i.e. billed, by sending a digital being (a digital-electronic invoice-file) through the network both *quickly* and at *zero cost*. Both tendencies lend themselves to maximizing the value-augmentation-formula for capital's gainful movement: dM/dt = (M' - M)/(t' - t) (cf. *5.5 Time in a capitalist economy*).

Consumers too, who are just as much enticed by and caught up in the gainful game as capital itself, benefit from the near-zero cost of all sorts of digital 'messages' in the global electromagnetic network, where such messages comprise written texts of all kinds, music, photo, film, etc. Although the original 'production' costs for a digital being may be considerable (programming, writing, recording, photographing, filming, etc.), the reproduction and distribution costs are next to zero, requiring only the cost factor of the electromagnetic medium itself. This provokes the question whether the deeper-lying telos of the global digital network is for the sake of sustaining, expanding and accelerating the movement of value as capital and, more generally, whether it is bouyed by the striving of *all* economic players for gain, which can take the form simply of saving money.

The will to power in the guise of total digital cybernetics therefore dovetails neatly with the striving for gain, especially with capital's incessant striving to bloat value with surplus value through the course of its circular movement. It is therefore justified to speak of an *inversion of human purposes behind our backs*, for what seems to be simply a desire for ease of communication globally and for cheaper, more convenient products and services, turns out to further something unintended, but perhaps inkled, viz. the will to (cybernetic, pro-ductive) power over all movement and the incessant acceleration of the rivalrous power play of all kinds of powers (labour powers, personal skills and abilities, productive powers of means of production, the power of money as capital, the power of land and sea as factors of production) for the sake of monetary gain.

6.4. An alternative message from outer cyberspace

When human beings communicate with each other, this by no means implies necessarily that they come to an understanding. Rather, humans communicate with each other only within the common-sensical horizon of always already having understood, so that any differences in views that arise are only differences of configuration within an unquestioned, presupposed world-understanding that is taken to be 'naturally' self-evident and unquestionable. The ever-widening possibilities of communication opened up by digital technology lead only all the more to a global levelling into an average understanding of how the world *is* (factually), *including* the never-ending conflicts over matters of fact, that is reflected in and presupposed by media reports and discussion on the factual state of the world. The invariable compass in the bit-torrents of information is common-sense, that is, if orientation is not lost altogether in constant cross-currents of inane chatter and drivel. The as-yet unbroken, holiest taboo of global communication, that excludes through its 'democratic' all-inclusiveness, is to address the intellectual pain and harm it inflicts on the mind. Within the bounds of sound common-sense, it is tacitly assumed that truth is a matter of factual correctness, which is then supplemented by differing personal 'subjective' 'values', 'belief systems' or even 'philosophies'. A deeper-lying telos of the global communication network could then be lurking in the levelling of understanding to a kind a global common-sense and hence in the suppression of any kind of thinking that puts common-sense pragmatism and the hegemonic mathematico-scientific truth of the world into question.

The discourses of the media communicate, and must communicate, in terms of people's average understanding and cater to their tastes and what they want to hear. Average understanding is broken down into many different segments, some of which are inconsistent with one another, or downright contradictory, whilst nevertheless co-existing, each catered to by a segment of the media. But underlying them all as the 'natural' foundation of average understanding is the unquestioned, hegemonic mathematico-scientific worldview, if only because it is

immensely *effective* in shaping our world on all levels. Furthermore, scientific method consists in a theoretical modelling of 'the facts' which, again, as mathematically souped-up common-sense, appeals to it. Truth is measured by undeniable effectivity. The esoteric discourse of mathematical physics, especially in connection with deeper questions concerning the cosmos, is unquestionably given credibility in the media because of its experimental basis in 'the facts' (measurable) and the incontestable effectiveness of such discourse in life-shaping phenomena such as cars, aeroplanes, power plants, atomic weapons, etc., etc., whereas the esoteric discourse of philosophical thinking is regarded as speculation in the pejorative sense or as a matter of personal taste and values. Even an apparently critical questioning of science in media discourse is unable to unearth anything like the simple ontological presuppositions of the modern casting of world, because such an unearthing requires a kind of questioning alien to any segment of people's average understanding, including especially the complacent, know-all world-views of the highly educated and scientifically trained comfortably established in our age.

Our communication consists for the most part in keeping in touch and keeping abreast in terms of that which we always already know, namely, the diaphanous categories and basic concepts within which an historical world shapes up. Only the facts, the ontic occurrences change endlessly within an unchanging, settled, historical constellation of world-understanding particularized into countless configurations as individual, differing, and often opposed, world-views. The fundamental historical casting of the world is *taken for granted* and as such remains *invisible*. To question the unquestionable amounts to leaving the community of common-sense in which communication about what is already all too firmly understood, whether digitally enabled or not, continually takes place.

An historical world shapes up only in an interplay, strife and struggle between hiddenness and disclosure in which the foundational categories

of a world are forged and recast.[42] Only insofar as we belong to this interplay and struggle can we take cognizance not only of what the case is, or adopt a political stance toward the state of the world and its injustices, but also engage in questioning the categories enabling, in the first place and from the ground up, the world to be understood *as* a world. Taking cognizance of beings in their respective modes of *being* is our destiny as human *beings*. Mostly we understand beings in their being implicitly, and without such an implicit understanding, we would not understand the world at all. Information as news is one way in which human being takes cognizance of the factual states of affairs in the world and their movements within an implicit, tacit categorial understanding. Taking explicit cognizance is philosophy.

As we have seen, such philosophical knowledge turns out to be a knowledge of whence (ἀρχή, γένος, τὶ ἦν) and what (εἶδος) enabling knowing insight into how beings come to presence (δύναμις, ἐνέργεια, ἐντελέχεια cf. *2.9 Time and movement in Aristotle's thinking*).Western ontological knowledge is a pro-ductive understanding of being that in its precipitates today confronts us as an oppressive wealth of productive scientific and technological knowledge that can now also be made digitally-cybernetically effective in automatons of all conceivable kinds. The question, however, concerns another kind of knowledge that is, in a certain sense, a not-knowing: What insight can we gain into that which eludes a knowing, in the sense of a productive grasp? What possibilities still lie latent in the first Greek metaphysical beginning that were addressed there already in passing, but had to be excluded or pushed to

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42 In his exchange with Makoto Nakada in 'A Dialogue on Intercultural Angeletics' (2011), Rafael Capurro says, "Although we mostly live immersed in the given openness of everyday existence, exchanging messages and maintaining communication through the phatic function, we have the potentiality to grasp a given (historical) disclosure of Being as a possible one, that is to say, to change its truth. [...] The radical questioning of a given world-openness by a messenger of Being that makes explicit this ontological or structural relation between Being and messenger, can lead to strong opposition from the defenders of the status quo and – to condemnation of the messenger, as in the case of Socrates."

one side for the sake of productive knowledge? We have pointed to one such possibility above (cf. *5.7 Recovery of the three-dimensional, complexly interwoven social time of who-interplay*), namely, an alternative to the conceptualization of movement enabling control from a single (ἕν) ἀρχή, which had to be demarcated vis-à-vis its polyvalent opposite (πολλά), thus provoking the alternative question: What happens to the ontological structure of movement when more than one ἀρχή comes into play? Movement as the transition from something to something (ἔκ τινος εἴς τι) then becomes interplay among two or many sources of power, including in particular human beings as sources of power. Interplay is not the causal power play among whats resulting in productive control, but a non-precalculable, and in this sense uncontrollable play among whos. This already represents a rupture with the will to power pure and simple underlying productivist metaphysics, under whose very success today all is "sicklied o'er" with the digital cast of being.

With the plurality of interplay, the Anaximandrian-Aristotelean question concerning *justice*[43] (the πρός τι among human beings, and perhaps among all beings) is posed anew in an alternative ontological landscape. Being κατὰ συμβεβηκός (contingency, or that which comes along without ground) — which as the opposite of being καθ᾽ αὐτό (being in itself) had to be excised from metaphysics — then invites renewed interest as a feature of interplay in its essential unpredictability and incalculability. Those features of phenomena that fail to offer an unambiguous, determinate, definite look and withdraw partially into the hiddenness the Greeks call λήθη from knowing, controlling insight then incite questioning attention. With such questions, we have already taken a step beyond digital ontology.

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[43] Cf. my *Social Ontology* 2008 *op. cit.* Chap. 8 i) a) 5. 'Anaximander and the justice of interplay' and my 'The Principle of Reason and Justice' 2006.

7. Appendix: A demathematizing phenomenological view of quantum mechanical indeterminacy

> [Es] scheint mir als Kennzeichnung unserer ganz anderen [phänomenologischen] Methode [gegenüber der modernen mathematisch-wissenschaftlichen] der Name des *'Eigens Sich-einlassens in unser Verhältnis zu dem Begegnenden'*, in dem wir schon immer uns aufhalten, notwendig zu sein.[44]
>
> [It] seems to me that the name *'expressly letting-ourselves-into our relationship to what we encounter'*, in which we always already dwell, is necessary to denote our completely different [phenomenological] method [in contrast to modern mathematico-scientific method].

7.1. The Heisenberg indeterminacy principle reinterpreted

> omnis singularis substantia agat sine intermissione, corpore ipso non excepto, in quo null unquam quies absoluta reperitur.[45]

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44 Martin Heidegger *Zollikoner Seminare* (ed.) Medard Boss, Klostermann, Frankfurt [1]1987, [2]1994 S. 143 emphasis in the original.

45 Gottfried Wilhelm Leibniz 'De Ipsa Natura sive de Vi Insita Actionibusque Creaturarum' (1698) *Philosophische Schriften* Band IV (ed.) Herbert Herring, Wissenschaftliche Buchgesellschaft, Darmstadt 1992 S. 288.

> Every singular substance acts without intermission, not excepting even the [physical] body, in which absolute rest is never to be found.

We must not pass up the opportunity to draw a corollary from the discussion of Aristotelean movement and time (cf. *2.9 Time and movement in Aristotle's thinking*) with regard to the obfuscation of the phenomena practised by modern physics. The Cartesian cast of modern knowledge prescribes that all phenomena must be approached by way of measurement to determine quantities that are entered into equations which, in turn, can be manipulated mathematically according to a mathematically formulated theory. This is accepted today unquestionably as the paradigm of scientific method. If the focus is on quantities and their measurement already from the outset, so that there is nothing to consider beforehand, then the ontological structure of the phenomena themselves, i.e. their modes of presence in the world, is obscured.

This obscuring, or a certain vacillation, is indicated already by the doubling of terminology for the Heisenberg principle, which is called both the *indeterminacy* principle and *uncertainty* principle or, in the original German, *Unbestimmtheitsrelation* and *Unschärferelation*. Uncertainty, however, refers to, and is mostly understood as, a lack of sharpness *in principle* in the *observed measurements* of phenomena of motion at the sub-atomic level, namely, the motion of entities such as electrons, protons, neutrons, photons and many other sub-atomic entities whose existence has been inferred from experiments based on theories of the physics of very small entities imperceptible to the unaided senses. The uncertainty principle is then understood as a limitation in principle to the accuracy of experimental measurement observations of the motions of sub-atomic entities due to the unavoidable interference to the physical system observed caused by the physical process of observation itself. The macroscopic clumsiness of the experimental apparatus needed to make sub-atomic motion visible to the human senses is said to introduce myriad hidden, uncontrollable variables, a viewpoint based on

still unshaken conceptions of causality from classical mechanics. Thus, for example, to determine observationally the position of an electron, a photon is 'shot' at it, which itself disturbs the electron's position and thus causes it to be observed somewhere else than where it would have been if it had not been observed. On this conception, if the system is left unobserved and therefore un-interfered-with, it evolves over time according to deterministic laws of motion, and the uncertainty principle becomes almost common sense.

Werner Heisenberg's deeper insight is that it is in principle already in theory, and not just in experimental practice, impossible to determine accurately, say, both the position and speed, or both the position and momentum, of sub-atomic entities in motion (and they are always in motion), quite independently of whether they are experimentally observed or not. Hence we read in the article on the Heisenberg "uncertainty principle" in *Encyclopaedia Britannica*, "that the position and the velocity of an object cannot both be measured exactly, at the same time, even in theory. The very concepts of exact position and exact velocity together, in fact, have no meaning in nature".[46] In the article on "physical science", section "quantum mechanics", Stephen G. Brush points out, "Heisenberg's principle is often called the uncertainty principle, but this is somewhat misleading. It tends to suggest incorrectly that the electron really has a definite position and velocity and that they simply have not been determined." To have any meaning within modern physics, such a statement of uncertainty or indeterminacy must have a quantifiable, i.e. mathematical, probabilistic formulation in the theory itself, which is then checked against experimental evidence that, in the case of quantum mechanics, apparently[47] has confirmed results

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46 Art. "uncertainty principle" in *Encyclopaedia Britannica 2008 Ultimate Reference Suite*. Chicago: Encyclopædia Britannica, 2008.

47 Cf. the entry on The Uncertainty Principle § 2.4 Uncertainty relations or uncertainty principle? by Jan Hilgevoord and Jos Uffink in the *Stanford Encyclopedia of Philosophy* 2006 (http://plato.stanford.edu/entries/qt-uncertainty/#UncRelUncPri), e.g. "Real experimental support for the uncertainty relations in experiments in which the inaccuracies are close to the

produced by theoretical physicists, including illustrious names such as Planck, Einstein, Bohr, de Broglie, Heisenberg, Schrödinger, Dirac, et al.

What the empiricist methodology of science overlooks, however, is that the theory has always already seen and precast, in its fundamental concepts won by thinking on the phenomena involved, more than could ever be checked through empirical observation. By the time science has thought up an hypothesis and set up its experimental harness to gather the hard factual data, the ontological horse has long since bolted. These precast theoretical concepts prescribe already where the empirical evidence has to be looked for to confirm or refute theoretical predictions concerning the behaviour in motion of physical systems which, in this case, happens to be on the sub-atomic level that is observable only through sophisticated macroscopic apparatuses that allow the physicist to bodily participate in an experimental observation construed according to the theoretical pre-casting.

To satisfy the prescripts of mathematical science, Heisenberg's indeterminacy can and must be expressed 'rigorously' in an equation for a sub-atomic entity such as an electron: $(\Delta x)(\Delta p) \geq h/4\pi$, where x is the electron's position, p is its momentum, which depends on both its mass and velocity, h is Planck's constant, and Δ stands for the standard deviations of the probability distributions for x and p, respectively. Thus, Δx is interpreted as the standard deviation of the probability distribution for the spatial position of an electron e, i.e. the quantified chance of e 'being' at position x over an entire infinite range of possible positions that exhaust the possibilities for where e could be, where 'be' is tacitly assumed to imply a determinate, unambiguous 'here'-answer. The interpretation of indeterminacy as a probability distribution is forced by modern physics' having to quantify all physical phenomena, including the phenomenon of indeterminacy, for probabilities are still mathematically calculable and insofar ascertainable. Even in the many-worlds interpretation of quantum mechanics, the many indeterminate

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quantum limit have come about only more recently [i.e. since 1983 ME]." Accessed March 2009.

positions of e are finally reduced by probability calculation to a real, observable position. This is the *indeterminacy* in e's position, i.e. its position as a moving entity cannot be pinned down *together* with its momentum, and the lack of accuracy can never be reduced toward zero under any circumstances, because the product of the indeterminacy of its position and the indeterminacy of its momentum of motion is always at least as great as a positive, albeit extremely small, real number, $h/4\pi$, of an order of magnitude of minus 34 to base ten in units of joule-seconds, or energy times time (the action of an energy and thus a motion).

In mathematical language, the indeterminacy of position and momentum taken together manifests itself in the non-commutability of these two dynamic variables describing a dynamical system, or in the vernacular, indeterminacy means position and momentum cannot be nailed down together. The units of the Planck constant, energy times time, are already a hint that movement *over* time here comes into play to account for indeterminacy of position and momentum together. The two parameters could just as well be taken to be position and velocity, for these, too, suffice to specify a dynamical system. The ineradicable indeterminacy of position and velocity taken together points to the impossibility of instantaneous velocity and to Zeno's ancient paradox of the flying arrow.

One may object that the uneliminable indeterminacy in x and p (or, equivalently, x and velocity, v) taken together, which dynamical variables specify the state of a physical system, applies only to actually obtained experimental observations of these two parameters due to interference with the dynamical system by the measurement process itself, and not to the system's state prior to or independently of observational measurement. This viewpoint would seem to be supported by Paul Dirac himself, one of the founders of mathematical quantum mechanics, when he writes,

> According to classical ideas one could specify a state by giving numerical values to all the coordinates and velocities of the various component parts of the system at some instant of time, the whole motion being then completely determined. Now the argument of pp. 3 and 4 [regarding disturbances to the system by the process of observation] shows that we cannot observe a *small*

> system with that amount of detail which classical theory supposes. The limitation in the power of observation puts the limitation on the number of data that can be assigned to a state. Thus a state of an atomic system must be specified by fewer or more indefinite data than a complete set of numerical values for all the coordinates and velocities at some instant of time.[48]

The indeterminacy would thus arise from a lack of observational data, from a want of 'experimental facts', which is a common-sense viewpoint. But Dirac then goes on to introduce the "principle of superposition" that postulates a superposition of dynamical states necessarily *prior* to any observation — *necessarily*, because any observation (according to physics' implicit ontological decree) can only ever determine a 'real' determinate state, and not an 'unreal' or 'imaginary' superposition of states (hence also the imaginary or complex numbers employed in the mathematics of the famous wave function that describes system states). The principle of superposition in quantum mechanics therefore refers to the indeterminacy or 'hovering' of states of a dynamical system independently of observation. From the indeterminacy, or rather observed variation, of the results of observation in sub-atomic experiments, results which nevertheless exhibit regularity, the theoretical principle of complex superposition of dynamical states was *inferred*, or rather *postulated* (like any other law of motion — which in itself is unobservable), and this indeterminacy of experimental results was then *explained* by saying that the experimental apparatus employed in the experimental process, which is itself a physical dynamical system, interferes with the original system, causing the wave function of a single quantum 'particle' to 'collapse'. But an explanation is something different from a postulated principle of quantum mechanical theory, viz. the principle of complex superposition. The explanation only explains something regarding a so-called 'quantum leap' from an indefinite superposition of states to a definite observed state.

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[48] Paul A. Dirac *The Principles of Quantum Mechanics* Oxford U.P. [1]1958 [4]1989 § 4 p. 11.

7.1.1 On Roger Penrose's interpretation of quantum mechanics

It is therefore false[49] to interpret the situation as a disjuncture between an unobserved, closed dynamical system describable *determinately* by mathematically expressed physical laws such as the Schrödinger equation, on the one hand, and the irreducible indeterminacy of experimental observations, on the other. Such an interpretation confuses determinacy with (effective causal) determinism (cf. below). Even the Schrödinger equation is formulated in quantum mechanics as a complex *superposition* of (usually) infinitely many dynamical states, and in the superposition lies already the quivering indeterminacy, so that the deterministic evolution over time described by the Schrödinger equation is beset from the outset in its 'innards' by indeterminacy in the very superposed entity (a quantum described as a complex wave function) whose evolution is being determined by the equation, for this superposed entity is described by "complex probability amplitudes which weight our linear superpositions", as Roger Penrose notes in his *The Emperor's New Mind* (1989, 1999 p. 332). The squared moduli of these complex probability amplitudes (a real number) then serve as the "probabilities describing actual alternatives" (ibid.) when a real, determinate observation here-and-now is experimentally forced upon the wave function by interrogative scientific method.

Notwithstanding this, Penrose writes on the one hand, "Quantum-mechanically, *every single position* that the [single quantum] particle might have is an 'alternative' available to it. [...] The collection of complex weightings describes the quantum state of the particle. [...The] state of an individual particle [...] described by its wavefunction [...] involves our regarding individual particles being spread out spatially [...] The quantum state of a single (spinless) particle is defined by a complex number (amplitude) for each possible position that the particle might occupy." (p. 314, 325, 356) But, on the other, he asserts, "[the wave-

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[49] As is done, for instance, in the entry on "quantum mechanics" in the *Stanford Encyclopedia of Philosophy* authored by Jenann Ismael 2000 at http://plato.stanford.edu/entries/qm/#Dyn accessed March 2009, and Penrose (1989, 1999; cf. below).

function] ψ is governed by the deterministic Schrödinger evolution. [...] It is the procedure R [wave-function reduction/collapse ME], and only R, that introduces uncertainties and probabilities into quantum theory" (p. 323). Effective causal determinism in time (as prescribed by an equation), however, is not the contrary of indeterminacy (of the superposed wave function), since these two go hand in hand; nor is Heisenberg's 'Unbestimmtheitsrelation' appropriately translated into English as 'uncertainty principle'. The "non-determinism of quantum theory" (p. 383) must be distinguished from the strange complex indeterminacy of the superposed quantum wave function which formulates unwittingly a deeper truth about physical entities in general, namely, that a physical being (i.e. capable of movement) *is*, in a certain way, also *where* it *is not*, even though it does so within the framework of one-dimensional time composed of present instants, as if the alternative positions for a quantum entity all had to 'be' lined up next to each other at the same time-point. By virtue of the complex-number character of the "probability amplitudes" in the wave function, one might equally well say that a wave-function entity is nowhere real.[50] One could perhaps even go one step further to assert that a wave-function quantum-particle is not a unified something, i.e. neither ἕν nor τί, but an imaginary superposition of infinite potentialities that only becomes real and definite, thus excluding infinite possibilities of being present, upon experimental interrogation, or the intervention of gravity (Penrose 1989, 1999 pp. 475f).

What is the nature of Penrose's wave-function collapse/reduction operator, R, that compels the indeterminacy of superposition of many, or even uncountably infinite, potential phase-states through a probabilistic quantum leap into unique definiteness? Penrose writes, for instance, presumably confusing discreteness with definiteness, "*discrete* states of an atom, for example are those with definite energy, momentum, and total angular momentum [which, however, assume values within a real,

50 "[A]ccording to quantum mechanics, in general the notions such as 'here' and 'now' could have only indefinite or potential meaning." Joy Christian 'Why the Quantum Must Yield to Gravity' 2001.

non-discrete continuum ME]. A general state which ‘spreads’ is a superposition of such discrete states. It is the action of R, at some stage, that requires the atom actually to ‘be’ in one of these discrete states”. (p. 521) Here, R is sounding awfully like the λόγος that gathers wavering indeterminacy into the well-defined definiteness of being such that something becomes visible *as* such to the human mind. The difference is that the physicist, Penrose, imagines some kind of real, ‘material’ process in R, thus overlooking that even ‘matter’ is an idea. Penrose’s proposed ‘one-graviton’ criterion for the onset of wave-function collapse (pp. 475ff) suggests that the world falls into definite place under the effects of gravity, whereas the gathering of the λόγος is simply the eventuation through which world shapes up, discretely and finitely, *as* world. Is it quantum gravity that grounds beings as such, or is it being itself that “*presences within itself as grounding*”[51] ? Is the “anthropic principle” Penrose adduces, “which asserts that the nature of the universe that we find ourselves in is strongly constrained by the requirement that sentient beings like ourselves must actually be present to observe it” (p. 524; cf. pp. 560ff), merely the latest ‘scientific’ edition of the famous Parmenidean belonging-together of being and awareness (Frag. 3)? And when Penrose adduces “insight” (p. 541ff and passim) in order to show the “non-verbality of thought” (p. 548ff) that sees more than any algorithm could ever achieve computationally, does this not amount, unbeknown to him, to a latter-day resuscitation of Aristotelean νοῦς?

Like most modern physicists, Penrose seems predestined to adopt an ontological position of naive empiricist realism averring the ‘objectivity’, ‘actuality’ and ‘reality’ of quantum-mechanical entities, whereby these terms and their origins remain philosophically unclarified and the truth of physical theories is established unquestioningly by scientific experiment (the theory delivers effective experimental results about the change of physical entities) without paying attention to how

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51 “*Sein west in sich als gründendes.*” M. Heidegger *Der Satz vom Grund* Neske, Pfullingen 1986 p. 90.

science has always already precast with its preconceptions what truth at all can be.

7.1.2 On quantum-mechanical indeterminacy and calculability

> ...daß unter der siegreich gebliebenen Wirklichkeit unzählige Möglichkeiten liegen, die auch hätten wirklich werden können. (Robert Musil *Der Mann ohne Eigenschaften* II Tl. 3 Kap. 48)
>
> ...that innumerable possibilities lie beneath the reality that has remained victorious, possibilities which also could have been realized.

In the complex-imaginary superposition of dynamical states resides also the incommutability of the operators for position and momentum, or position and velocity, of a dynamical system. With observational indeterminacy, which in turn induces the postulation of a theoretical indeterminacy (complex wave-function superposition of infinite possibilities for the phase state of a quantum entity), modern mathematical physics has come up against an (unbeknowns to it: *temporontological*) obstacle in its striving to govern motions of all kinds by mathematically formulated laws and has had to retreat from totally precalculable determinacy to probabilistic precalculability, which is still quantifiable and calculable. This is still removed, however, from the insight that movements can have wholly unforeseen outcomes or that they can be free and that physical beings per se, as changeable, are not solely present at an instant.

The so-called ‘uncertainty principle’ says that position and momentum, or position and rate of change of position, cannot be seen together or ‘at once’. There is a blurring or quivering. Position is the place assumed here and now, whereas rate of change of position, or motion, is not instantaneous, but involves both here-and-there and now-and-then, i.e. an ecstatic stretch of both time and space together, albeit possibly very small. Mechanics set out to lay down the physical laws of this motion, proceeding from the starting-point or ἀρχή of here-and-

now. There-and-then thus become controlled, predictable, precalculable from here-and-now. In classical mechanics, the laws of motion are deterministic, which means that, given the dynamical situation at one instant, t, the dynamical situation at a later instant t' can be calculated by applying the laws of motion to form the appropriate dynamical equations and solving them. This precalculation involves the differential calculus with infinitesimals through which an instant in time can be approached. In quantum mechanics the laws of motion become probabilistic because, surreptitiously, or rather unwittingly, an instantaneous here-and-now is no longer assumed in postulating the non-commutability of position and rate of change of position or, what is the same thing, the superposition of dynamical states. A (perhaps infinite) multitude of heres is admitted, whilst hanging on to a single now-point.

Non-commutability means that it makes a difference in which sequential temporal order position and velocity are measured. The quivering of the physical entity in space-time (which is something different from the *disturbance* to the dynamical system caused by any observational measuring process) introduces an indeterminacy in the position and rate of change of position, the parameters defining a physical entity in motion, taken together. The space-time co-ordinates of a physical entity become the probability amplitudes of the physical entity's having a given position at a given fixed instant or now-point, t, these probability amplitudes (defining the entity's potential to *be* at a certain point in space and definite point in time as a superposition of infinite possibilities) being derived from the physical entity's wave function which "is a complex function of the position eigenvalue x' [... that] can be used to reconstruct the state ket |A>," itself an integral over the infinite-dimensional ket-space of position spanned by the eigenkets of position[52]. Fitzpatrick notes that for "a simple system with one classical degree of freedom, which corresponds to the Cartesian coordinate x [... a] state ket |A> (which represents a general state of the

[52] Richard Fitzpatrick *Quantum Mechanics: A graduate level course* Chapter: Position and Momentum 'Wave-functions' http://farside.ph.utexas.edu/-teaching/qm/lectures/node22.html esp. equation (118) accessed May 2009.

system) can be expressed as a linear superposition of the eigenkets of the position operator." (ibid.) Even for such a simple system, the complex wave function says that the physical entity is spread out everywhere in the x dimension.

This description still falsifies the situation because time itself is not composed of now-points, t, but, as we shall see in more detail below (*7.2 The necessity of introducing three-dimensional, ecstatic time*), is itself three-dimensionally stretched. Only the counting of time introduces now-points which, however, also introduce the antinomy between time conceived as continuous and time conceived as countably discrete (see *7.3 The phenomena of movement and indeterminacy in relation to continuity, discreteness and limit*).

For normal everyday purposes in situations with macroscopic objects in motion, the indeterminacy in position and momentum or, equivalently, in position and speed of a moving object is said to be so small that it cannot be detected at all by any possible experimental arrangement, i.e. it cannot be *measured*, and thus 'scientifically' *observed* and is therefore beyond the bounds of what physical science can know according to its *method*. The indeterminacy pertains in theory nevertheless, however, independently of the practice of experimental observation. The laws of classical Newtonian mechanics, which make no theoretical allowance for indeterminacy, therefore apply practically to normal macroscopic situations as opposed to sub-microscopic, sub-atomic situations. The theoretical error is said to be negligible in practice and no quantitative correction has to be made in terms of quantum-mechanical considerations. But that does not mean that the same indeterminacy considerations cease to apply in principle, only that it cannot be experimentally detected and confirmed. The dynamical situation for macroscopic systems is thus treated theoretically as the extrapolation of the dynamical situation for microscopic systems (or macroscopic systems in terms of sub-atomic entities) which itself is accessible to sophisticated experimental verification and falsification. Quantum mechanics, it is claimed, provides a truer theory of physical reality, and normal, everyday, macroscopic physical beings are made up of quantum entities. If the quantum-mechanical access to normal,

everyday, macroscopic physical beings in principle allows for quantum-mechanical indeterminacy, the issue then becomes whether this indeterminacy is adequately conceived, quite apart from any neglible or non-neglible errors in calculating motion.

The term ‘quantum’ refers inter alia to the peculiar duality associated with sub-atomic entities which have been shown experimentally to exhibit the characteristics of both *particles* and *waves*. Light waves, for example, are quantized as *photons* or tiny packets of light that exhibit particle characteristics. This was shown by Einstein. De Broglie proposed an equation, subsequently confirmed experimentally, linking the particle characteristics and wave characteristics of all sub-atomic entities, namely, $\lambda = h/p$, where λ is wavelength (of a wave) and p is momentum (of a particle). This means that a sub-atomic entity, whatever it may be, is also a wave (a spatial vibration) with wavelength λ exhibiting wave phenomena such as interference, and by virtue of this dual nature it cannot be precisely localized to a determinate point-position, even in principle, i.e. even in theory. Its position is ‘spread out’ over a wave length so that the chance of finding it at a determinate point, when it exhibits particle characteristics, is given by regarding its associated wave as a probability distribution for its position, one accepted interpretation of the famous Schrödinger equation. The ‘spreading-out’ of the position of a sub-atomic entity when considered as a wave is therefore not a spatial spreading-out or ‘spreading-thin’, but a quivering indeterminacy that eludes visualization (Heisenberg[53] was the one who warned against the desire to visualize quantum-mechancial states of affairs). The wave itself is a quivering indeterminacy of position and momentum taken together.

Probability distributions are still mathematical entities occurring in equations that can be algebraically manipulated and calculated, and probability provides the bridge in the duality, or vacillation, between considering the same sub-atomic entity either as a wave or as a particle (or sub-atomic particle as a wave!) as suits the context, whether it be

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53 W. Heisenberg ‘Ueber den anschaulichen Inhalt der quantentheoretischen Kinematik und Mechanik’ *Zeitschrift für Physik* 43 1927 pp. 172-198.

theoretical or experimental. In experimental practice involving the taking of determinate, observable measurements on macroscopic experimental apparatuses, the sub-atomic entity conceived strictly as a wave is thought to ‘collapse’ into a determinate state appropriate for a particle so that it becomes a ‘real’ *res*. This apparently observed, i.e. measured, collapse of the wave function is most perplexing and to the present day gives rise to controversy within mathematical quantum mechanics as to how it is to be interpreted physically. In any case it is to be noted that the indeterminacy relation between position and momentum, insofar as it is conceived to go hand in hand with the dual nature of sub-atomic entities as both particle and wave, is postulated as a *spatial* indeterminacy; a *temporal* indeterminacy and what this could mean do not appear on the quantum physicist’s list of perplexities.

7.2. The necessity of introducing three-dimensional, ecstatic time

> Schließlich wird derselbe Fehler gemacht, wenn man, wie es in der Quantentheorie geschieht, die Zeit als einen reellen Parameter beschreibt. Zeit ist mit Uhren meßbar. Der Zeitpunkt ist eine Fiktion. Er könnte wiederum nur durch einen irreversiblen Vorgang, und durch diesen nur mit endlicher Ungenauigkeit bestimmt werden. Durch diese ungelösten Fragen weist die Quantentheorie zwar nicht in die klassische Physik zurück, aber über sie hinaus.[54]

[54] “Finally, the same mistake is made when, as is done in quantum theory, time is described as a real parameter. Time is measurable by clocks. A point-in-time is a fiction. It could, in turn, only be determined by an irreversible process, and that only with finite imprecision. Through these unsolved problems, quantum theory does not point back to classical physics, but beyond it.” C-F. von Weizäcker *Aufbau der Physik* 1985 Kap. 13: Jenseits der

But what does all this say about physical entities in motion *prior* to (Cartesian) quantification and mathematization? What *is* motion? This question is invariably skipped over in taking the phenomenon itself for granted. As we have seen from the review of Aristotle's thinking on movement (*2.9 Time and movement in Aristotle's thinking*), physics is the study of those *beings that (can) move*, κινούμενα. Beings at rest are physical only insofar as they are also able to move, i.e. rest for Aristotelean physics is a limiting case of movement (but what is a limit?). Hence numbers, for instance, are not physical, for they are outside movement altogether (to make numbers move, they have to be conceived as variables with respect to a variable for time, t, a crucial step in the development of differential analysis, or some sort of movement, such as a counting process, has to be introduced to make the numbers flow). In modern physics, movement is thought first and foremost as motion, i.e. as locomotion or change of place, which is mathematized as functions on four-dimensional space-time in which place has become position, and position is expressible as a Cartesian co-ordinate (x, y, z). All other types of movement, in order to be mathematized, must likewise be converted into change of a magnitude whose rate of change can be calculated, thus reducing the scope of the Aristotelean panorama of the phenomena, but with the gain of being able to mathematize them all in algebraic, usually differential equations.

We have seen that Aristotelean movement is characterized by a *twofold presence*, namely by the presence of the being in its potential (or power or propensity) and the absence of its realization. All physical beings, as beings that can move, have a tendency toward an end in which the potential attains its end. The potential itself, in *coming to presence as such* is realized and is on its way to attaining its end. In coming to presence as such, the potential is *at work*, and this situation of being at work is its actual movement toward an end that is absent (where this end may be rest, or a perfected motion, such as *circular*, or conceivably *elliptical* or *uniform linear*, motion). Energy is therefore the Aristotelean

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Quantentheorie, pp. 588ff, as communicated by Rafael Capurro on 11 August 2010.

term for movement expressing its ontological structure as the being-at-work of a potential under way toward its end, a conception still implicitly underlying modern physics' concepts of work, action and energy, despite modern physicists' being ignorant and arrogantly dismissive of Aristotle. A moving being is therefore not merely present, but also simultaneously absent as *under way toward*... This being-under-way-toward... may be called its *momentum*. Momentum itself refers to an absence, to a not yet, so the moving being is both present and absent, i.e. its *being* as *moving* is both a presence *and* an absence *together*. In motion, a physical being is both here and not here. Therefore, we note first that *its position is indeterminate*.

A definite position for a physical body in motion cannot be tied down. More generally, a determinate state for a physical body in (one of the four types of) movement cannot be tied down. A definite position is only presence here, i.e. where the physical body in question is *now* at a certain *point* in space (amenable to geometrization and mathematization), thus eliminating motion by reducing time to an instant. But motion as motion refers also to the not-now, i.e. to an as yet absent future in which it will be somewhere else, and not here at this point. A physical body in motion is therefore both here-and-now in a position and also there, but not yet. It therefore has no definite, determinate position only now but is, as moving, both here and there, now and then. In its motion, it is now here and has *also* always already left its now-position on its way to somewhere else *then, which is already present in its being withheld*. As in motion, it *is* also futural *toward* a presence that is still *withheld*[55] in absence. To reduce the being of that which *is* to that which can be ascertained to be present at a point (or instant) in time, t, at a certain point positioned in space like a point in a geometrical figure is to deny the very phenomenon of movement altogether — the moving being's being *as* moving is not only presence but *simultaneously* its future, which is still absent, and its position is

55 "Vorenthalt", Martin Heidegger 'Zeit und Sein' in *Zur Sache des Denkens* Niemeyer, Tübingen [1]1969, [2]1976 SD:1-25, here p. 16.

stretched or *quivering in a propensity* between here and there, now and then.

Similarly, a moving being that is now here is simultaneously just arrived from somewhere else where it has been and is no longer, but which is still present as an absence. Simultaneity here can no longer mean, as it usually does, the coincidence of two now-points or instants, but rather the sameness of time of simultaneity (from L. simul 'at the same time') is here to be understood as the tight togetherness or 'at once' of the three temporal ecstasies of past, present and future within the unified three-dimensional structure of time, where dimension is now not conceived quantitatively as a Cartesian mathematical dimension, but as a space 'measured through' or 'traversed' (from Gk. διαμετρεῖν and μετρεῖν). This three-dimensional ontological structure cannot be captured by conceiving time as a continuum of successive instants, one after the other, and in truth introduces a conception of time foreign to both classical and quantum physics, whether relativistic or not. Rather than confront itself with the phenomenon of three-dimensional time staring it in the face, today's most advanced quantum gravity theory would rather escape to the esoteric dimensions of 'parallel worlds' in super-string theory, thus also pandering to human curiosity in strange and grotesque sci-fi scenarios. Traditional conceptions of time tacitly presuppose that time itself is determinately present, i.e. the now as the instant of time. This positive conception is complemented by two negations of now-time as time that *is no* longer and time that *is not* yet, without the phenomenological sense of these two negations coming into their own as a refusal or withholding of presence. Insofar as the being of time is thought simply as presence and its negation, there is no ambiguity or indeterminacy in time.

But the three-dimensional, ecstatic conception of time introduces an indeterminacy by tying together the three ecstatic dimensions in an inseparable 'at once' of presence-and-absence, so that the absence of later and earlier is present *as* a specific absence. This is apparently a self-contradictory, logic-defying formulation as long as it is taken for granted that presence and absence exclude each other. The phenomenon of movement itself, however, compels us to learn to see, although this

may be difficult, that the future, although absent, is present as an absence along with the now in three-dimensional ecstatic time. To put it negatively: it is a misrecognition of the phenomenon of time itself to conceive it as a succession of now-instants, each one relieving the preceding one in coming to presence, just as it is a misrecognition of the phenomenon of movement (in any sort of phase-space) to regard it as movement along a continuous geometrical line composed of now-points, a conception congenial to mathematization.

A being in motion *is* arrived from where it was, i.e. whence it is come, just as it also has a momentum and *is* underway toward where it will be, or whither it is going, although both this where and when are still absent, still withheld. Past, present and future are connected and hold on to each other in a togetherness of presence and absence, and *this* is the *continuity* of its motion in three-dimensional time. Accordingly, *any* physical being in motion (and not just sub-atomic, quantum-mechanical entities described by a wave function) does not have a determinate position at a determinate time, but, granting for the moment the questionable three-dimensionality of Euclidean space, is six-dimensionally stretched and quivering *potentially* into three spatial *and* three temporal dimensions. This phenomenon of time-space can only be seen *ontologically* before any mathematization sets in, i.e. before any numbers are lifted off the phenomena related to movement, because the mathematization of time and motion misleads us to conceiving a physical being in motion as being simply in a present state at any instant of time, moving along some sort of continuous geometrical line as time itself moves along its linear time-line of successive now-points. A physical being in motion is under momentum from here-and-now toward there-and-then. It is here-*and*-gone, underway from now to then when it will be. Similarly, a physical being at rest is here-*and*-there, quivering in an indeterminacy between now-*and*-then when it will be what it *can* be (potential).[56] Whether moving or at rest, a physical being *is* futural, i.e. it *exists* also *as* what it

[56] Cf. Aristotle: οὐ γὰρ μόνον κινήσεως ἐστιν ἐνέργεια ἀλλὰ καὶ ἀκινησίας (“Namely, there is an energy not only of movement, but also of non-movement...” *Eth. Nic*. VII 1154b27).

will and can be, ex-sisting, i.e. standing-out three-dimensionally somewhere and three-dimensionally sometime. Temporally, a physical being exists once, now and later, where the verb 'to exist' is conjugated grammatically in its tenses as: it existed once, it exists now and it will exist later, this three-dimensional existence *is* all at once. This formulation includes the respective negations, such as once it did not exist. To summarize: existence must not be truncated to now-presence. All three moments of a moving physical being's temporal being exist together, at once, in a presence that includes the presence of two kinds of absence, namely, the refusal of what, how, how much and where it was and the withholding of what, how, how much and where it will be.

Time itself is the making-way of movement. Movement requires time as its element, and conversely, time itself is only generated by movement, that is, by the *physical* (from φύειν 'to arise'), i.e. emerging, arising, nature of being itself. Hence time is not composed of instants that flow through the now, as if the not-yet and the no-longer *were* not. Movement requires the as-yet withheld later of the future and the refused earlier of the past in order to *be* movement traversing 3-D time-space, and the not-yet itself *is* in the mode of being of being withheld in absence, just as the no-longer or once *is* in the mode of being of being *refused* in absence. Both withholding and refusal are also positive modes of temporal being in their own right, and not merely negations of presence now. Therefore, to designate the absent dimensions of time as no-longer and not-yet is inadequate. Any physical being, i.e. any being capable of movement/change, therefore is temporal, i.e. it *is* not merely at an instant in time, but *is* or *exists* only in standing out into a three-dimensional stretch of time. Similarly, it makes no sense, properly speaking, to talk of an instant in time, for this is to deny time's three-dimensionality, and a moving being *as* moving has no instantaneous position at an instant in time but *exists* only ever in a three-dimensional temporal ecstasy in which it is both present *and* absent in a twofold way.

Heisenberg's indeterminacy principle therefore has an Aristotelean interpretation that is closer to the phenomena and reveals to the phenomenologically thinking mind, already at the everyday level without recourse to sub-atomic experiments, a tempero-ontological

structure *prior* to any quantification, measurement and mathematization in equations. The interpretation depends solely on considering the simple, hard-to-see phenomenon of movement itself in which the togetherness of presence and absence in 3-D stretched time is revealed. In other words, the conception of the very being of time has to be revised and recast ontologically to get any further with so-called quantum indeterminacy, and this 'illogical' recasting is not amenable to geometrical or mathematical representation. The corollary of a retrieved Aristotelean phenomenology of movement (which, in our interpretation, stops short of the counting and measuring, and thus the incipient mathematization, of time) with regard to Heisenberg's indeterminacy principle is that a physical body in motion, whether large, very small or middling, does not have a determinate position at a determinate time, t. Furthermore, since rest is only the limiting case of motion, even any physical being at rest is itself an indeterminacy of presence and absence *together* or '*at once*'; it is both here and there, now and then, an undecidable quivering, an 'illogicality', because as potentially moving it is always already stretched both toward its possibility of being elsewhere, a possible presence as absence, as a lack, and also toward its retained history of where it has been.

Determining a physical entity's position more precisely here and now makes its momentum and speed more indeterminate, to the point of complete indeterminacy. That is, the greater the accuracy with which a physical body's present, instantaneous position *now* is determined, the less its momentum under-way-toward... comes into view, for time itself is thus truncated to an instant. Like Zeno's arrow, it comes to a standstill. In other words, the sharper the focus is on the body's present position *now*, the more the body's momentum, its stretchedness toward its future position, is lost sight of or obliterated, for a body's velocity, i.e. the *rate of change* of its position, or momentum shows itself, even within modern physics, only in a span of time, in stretching toward the future, and not frozen stationary at a point-instant in time (as encouraged by the fateful counting of instants in the Aristotelean conception of counting-time according to which only the instantaneous now properly *is*). This simple phenomenological consideration allows us to see why

there is an inverse relationship between the indeterminacy of position and indeterminacy of momentum in the above Heisenbergian mathematical probability equation for indeterminacy. It is a matter of focus, or one-sidedness, of the mind's eye based on a misconceptualization of the phenomenon of time. Such a phenomenological consideration is not merely 'intuitive' or 'heuristic' with the connotation of a lack of rigour that has to be remedied through experimental, quantitative 'verification', but arises prior to mathematization by looking at the simple, simultaneous presence-and-absence, or threefold presencing characteristic of the phenomenon of movement itself.

This threefold presencing is entirely overlooked in modern physics as being beneath serious consideration precisely because it is prior to the dogmatically presumed exactness and rigour of 'scientific' quantification and mathematization, and thus eludes any experimental measurement according to the similarly dogmatic prescripts of modern physics' method. Under these scientific prescripts, time can be only a one-dimensional numerical variable, i.e. a varying number-point itself amenable to mathematical manipulation, i.e. to analytic differentiation in theoretical physics, and obtained experimentally by an apparently precise, finite counting of a regular, periodic physical movement. The three-dimensional conception of time outlined above *must* be anathema to modern physics, for it defies mathematization and its sham rigour, precision and certitude. Such mathematization as the postulated indispensable mode of access to truth is the totalizing Cartesian prejudice of our age. The phenomenological way of viewing is not 'less exact' than modern science, but sees more, and more simply, namely, the ontological structure of movement itself and its intimate relation with that of multi-dimensional stretched or ecstatic time whence a more adequate sense of being itself can be derived that does not collapse into its tacit traditional sense as standing presence. The phenomenologist has the ontological vision others lack. We will approach the phenomenon of three-dimensional time once again by another route in the next section.

7.3. The phenomena of movement and indeterminacy in relation to continuity, discreteness and limit

The conjugate indeterminacy of position and momentum (or velocity or motion) of physical entities discussed above is closely associated with the problems of conceptualizing continuity and discreteness in mathematics, and the distinction therein between the countable rational numbers and the uncountable real numbers. Both the rationals and the reals are infinitely divisible, i.e. there is no smallest rational or real number that can no longer be divided to obtain a rational or real number, respectively, so in some sense neither the rational nor the real numbers are suitable for capturing indivisible discreteness. Furthermore, the rationals are not continuous because between any two rational numbers there is always an irrational, i.e. strictly real, number. Insofar, the rationals do not hang together tightly, which is required of continuity. Any real, irrational number, however, can be approached as closely as desired by a countable, infinite sequence of rational numbers, without ever reaching it. Thus, although numbers are not physical beings, are placeless and positionless, and therefore also unmoving, movement can be introduced into mathematics as an endless counting toward a limit that is never attained, i.e. is always absent, because the irrationals are absent, or always withheld, from the rational numbers. The irrationals never arrive in the rational, no matter how far one counts. Any determinate rational number reached along the way of this counting movement along an endless sequence is not the real, irrational number itself, but can be made arbitrarily close to it by counting far enough. In other words, the always elusive real, irrational number itself can only be determined to lie somewhere within a certain rational interval that can be made arbitrarily small by counting far enough (such a rational interval can always be constructed from a converging rational series), but is never reduced to nought. Viewed from the process of sequential counting (originating from the ἀριθμός of Greek arithmetic), the irrational real itself is only ever an interval which can never become a determinate point, that is, the irrational real number itself, which in this way altogether eludes counting, i.e. is always absent from the counting

that is on its way toward... In particular, one could say that the clock-counting of time can only ever determine an interval, and not a point in time.

How does this relate to the phenomenon of movement, or rather (loco)motion? Motion grasped mathematically is a continuous function of the three Euclidean dimensions and time f(x, y, z, t) or the position 3-vector r is a continuous function of time t: r = f(t). The continuous function of time traces the movement of a physical body represented as a geometric point through three-dimensional real space. Each point in time maps continuously to a point in 3D real space. The solution of the problem of motion thus becomes the mathematical problem of analyzing the curve traced by the vector equation r = f(t) where the vector function f, in turn, may be derived from physical laws of motion, Newtonian, Einsteinian or quantum mechanical (where, with superposition, the real function f becomes a complex Hermitian matrix). Hence mathematical analysis, i.e. the infinitesimal calculus, a powerful branch of mathematics for grasping motion based on the ontology of time as now-presence.

As we have seen (*2.2 Heidegger's review of Aristotle's thinking on modes of connectedness from discreteness to continuity* and *2.6 Bridging the gulf between the discrete and the continuous*), the infinitesimal calculus makes the geometrical calculable. It does so by calculating derivatives and their inverses, i.e. by differentiating and integrating, both of which require the formation of mathematical limits through an adequate calculus with infinitesimals formalizable as a counting process toward... Without the infinitesimal calculus, there would be no motion along a curve, but only stationary points succeeding one another along a curve. Motion enters the mathematics through differentiation that introduces something like an instantaneous velocity which, strictly speaking, is an illogicality, for there is no motion in an instant, but only in an interval of time. A point on the curve can only indicate a motion mathematically by also being in transition, i.e. here at a single point and *also* under-way-toward..., this latter aspect being captured by the infinitesimal. The point on the curve is in its co-ordinate position and *also* infinitesimally removed from itself at an infinitesimally later point

of time. Thus is the *indeterminacy* of a point in motion captured mathematically without, however, the applied mathematician or physicist taking cognisance of the ontology of time he is implicitly presupposing.

Now, if, on the one hand, time is conceived mathematically as a continuous real variable, t, that is continuously increasing, it is always assuming also irrational values. If, on the other, time is also conceived as the counting of a regular, periodic physical movement, no matter how fast, such as the natural wave frequency of a Caesium atom, this counting can never determine a point of time, t, but only ever a counted interval between 'now' and 'now' (whose smallness depends upon the finite frequency of the period taken as counting measure or, equivalently, upon the wavelength of one period) within which t is supposed to lie. For any moving physical entity, within this time interval defined by steady counting, no matter how small, it has moved, and so, assuming Cartesian co-ordinates, its position can be determined only to within a certain segment of co-ordinate space. In particular, since rest is only a limiting case of movement, even a physical body at rest has no determinate space-time co-ordinates, but only ever hovers within a segment of space-time where its here-now and potential there-then are indeterminately 'located'. This indeterminacy is not merely a matter of the accuracy of physical measuring instruments, which may be further refined with the progress of physics (without ever attaining continuity), but is an indeterminacy in principle residing in the postulated *continuous* nature of movement in relation to the countable, and therefore *discrete* nature of (clock-)time as conceived by both Aristotelean and modern physics (for time is only ever determined by a finite counting of a regular, periodic movement).

Another way of looking at this is that countable, discrete, rational time only ever defines a segment of space-time containing also irrational numbers and *already in principle* an irrational number cannot be counted, i.e. it cannot be made present within the counting process, so that continuous motion would have to pass through points in space that are outside assumed countable time! Hence we can conclude that if time is conceived mathematically as a continuous real variable, it cannot be

counted, and if it is conceived as countable, i.e. as the counting number lifted off a highly regular, periodic movement, it is not continuous, but is a regular sequence of discrete, temporal 'quantum' leaps (cf. *7.3.3 Excursus 3: On time in (a quantized) special relativity theory (Joy Christian)*).

7.3.1 From antinomic discrete vs. continuous real time to complex-imaginary time

> I believe there is something we are all missing [...] My guess is that it involves two things: the foundations of quantum mechanics and the nature of time. [...] I have the feeling that quantum theory and general relativity are both deeply wrong about the nature of time. [...] We have to find a way to *unfreeze* time — to represent time without turning it into space. I have no idea how to do this. I can't conceive of a mathematics that doesn't represent a world as if it were frozen in eternity. It's terribly hard to represent time [...]
> Lee Smolin 2007 pp. 256, 257.

Let us push beyond the problematic duality of continuity and discreteness to consider the complex-continuous superposition of discrete-quantum states (in a Hermitian space of infinite dimensions), which complicates the situation beyond the antinomy between assumed continuous real time and actually measured, discrete, counted clock-time. Modern physics tells us that there is a limit to the divisibility of physical bodies which is reached with sub-atomic entities, which are the smallest of all possible physical entities. These smallest of physical entities, however, even at rest, cannot be pinned down by determinate space-time co-ordinates, but, as quanta, are nonetheless, at any real instant t, a complex superposition of (usually) infinitely many quantum states (expressed as an integral over *space*). This is the formulation provided by Heisenbergian matrix mechanics. Alternatively, for the

physicist, Erwin Schrödinger, on the other hand, who developed wave mechanics, "*it is declared that the atom in reality is nothing more than the refraction phenomenon of an electron wave so to speak captured by an atomic nucleus*"[57] , a wave-mechanical quantum formulation that has been shown to be equivalent to matrix mechanics.

The break with the scientific conception of time as a one-dimensional variable, t, that ties time to a real instant must be made to see quantum superposition properly, but at the price of sacrificing the causal-determinist time-evolution of a quantum wave-function provided by the Schrödinger equation. Time itself must be conceived as three-dimensional, and this can be done, for heuristic convenience, in a pseudo-mathematical way, by thinking of it as a complex, rather than as a real variable, as it is in modern physics from Newton to the present day. The 'pseudo' nature of these considerations derives from their having to do, properly speaking, with phenomena of movement, which have to be seen, rather than with mathematical numbers, and functions and matrices thereof. If time is conceived as complex, it has both a real and an imaginary part that are independent of each other, so that time now has two degrees of freedom (on the Argand plane). This can be written down in the pseudo-equation for time, $t = b + id$, where b and d are real numbers and i is the imaginary number, the square root of -1. If $d > 0$, it is taken to refer to the future and if $d < 0$, it is taken to refer to the past, where past and future are absent at the now-instant and in that sense 'imaginary'. The real number b pin-points the present now-instant, but does not exhaust time because now, a real time b is coupled with a continuum of imaginary times d referring to what could be potentially at future time d, if $d > 0$, or to what could have been at past time d, if $d < 0$, where future and past are considered from the now-instant, b.

The spatial state of any physical system, whether quantum or classical, is now not a complex superposition of infinitely many *spatial* basis

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57 "*... man erklärt, das Atom sei in Wirklichkeit gar nichts weiter als das Beugungsphänomen einer vom Atomkern gewissermaßen eingefangenen Elektronwelle*." Erwin Schrödinger 'Der Grundgedanke der Wellenmechanik' Nobel lecture held in Stockholm on 12 December 1933 in *Die moderne Atomtheorie* Verlag S. Hirzel, Leipzig 1934 S. 32 emphasis in the original.

states at the present instant, as in the multiverse interpretation of quantum mechanics (cf. *7.3.4 Excursus 4: On quantum computing and qubits (David Deutsch)*), but an indeterminate complex superposition of infinitely many independent spatio-temporal basis states deriving from complex time, where time past is captured by negative d and time future is captured by positive d in complex time. The spatial state now depends on complex time. At a real instant b, the system's spatial state is given by a linear superposition of a real state and infinitely many imaginary states, both past and future, all of which are situated in an Hermitian space spanned by the basis eigenkets |b> and |d>, where the real component of the instantaneous state at |b> is complemented with the infinity of superposed imaginary states for the temporal infinity b + id, where the free eigenvalue d ranges from minus infinity to plus infinity.

The interpretation for negative d is that, in the past relative to b, the physical system could have been 'historically' in a spatial state that is the complex superposition of the position at the past real now-instant b+d and *also* infinitely many imaginary states corresponding to t = b+d + ie, where now the eigenvalue e ranges over the real numbers. The interpretation for positive d for a given real instant b is likewise a complex temporal superposition of the position at the future real now-instant b+d and the infinitely many imaginary past and future states corresponding to t = b+d + ie, where e ranges over the real numbers, providing quasi-eigenvalues and quasi-eigenkets in a pseudo-Hermitian space in which complex time itself constitutes an infinite-dimensional basis. This is a pseudo-mathematically fancy way of saying that the spatial state of a physical system cannot be separated from its possible past history nor its potential future, both of which are present imaginarily as specific forms of absence in the Hermitian pseudo-ket. In particular, if only an interval of real time terminating with a fixed future point in time, d, is viewed (i.e. b an element of, say, the closed interval [0, d]), this amounts to a twofold focus on now and a fixed, final, future-then. Under such a restricted focus, the system's spatial state for each point of time, b + id, where b is within the real time interval, is a linear superposition of a real present state and relatively independent imaginary states, including the imaginary future final state at d, in a two-

dimensional Hermitian space. The superposed imaginary final future state at id is not constant as b varies, nor does it depend tightly on b, so there is no law-like evolution of the instantaneous state at b to the finally realized state at d.

Let's take a simple example outside the mathematics. Suppose I have a tennis ball on the edge of my desk. I see it there now sensuously and realize that it could easily roll off the table and fall onto the floor. I thus see the ball both *now* and a possible imaginary spatial state for it at a *future* time (imaginary positive d). Or I see the ball on my desk and tell myself that I must not forget to take it with me tomorrow for my game of tennis with friends. I thus see the ball now and also its imaginary future trajectory tomorrow to the tennis game tomorrow where it *will be* spatially (imaginary positive d). Or I look for the ball on my desk and now see that it is not there — it is absent. So it has probably fallen onto the floor at a now past time (imaginary negative d). I look on the floor and don't find the ball. I see it absent now both from my desk, where it definitely was at a past time, and also from the floor, so it might have been taken by my dog, who loves chewing on balls. I thus imagine a past time (imaginary negative d) at which the dog might have taken the ball, thus making a movement in space from the area around my desk to an indeterminate place somewhere else. In each of these situations, I have double vision, i.e. I see the situation *now* of presence or absence (which is not a sensuous seeing), and also an imaginary *future* or *past* situation implying a certain movement that is uncertain, and by no means calculable. My temporally twofold vision, however, is intelligent and entirely adequate in the context of everyday life, although non-scientific in the modern sense (cf. *7.4 A mundane example to help see movement in three-dimensional time*, for another, entirely demathematized example).

The present spatial state *now* of a dynamical system can only be supposed to be determinate by ignoring the imaginary component of complex time that cannot be brought under calculative control. The complex superposition ranging over the imaginary component of time allows for limitless indeterminacy. A real, (experimentally) observed observable of a dynamic system is no longer approximated by a

measurement in rational, countable clock-time, but now must first be conceived as the projective collapse of state in complex-imaginary time onto the one-dimensional determinate state for the real component, b, of complex time from the indeterminacy of the spectrum of imaginary time, both future and past, which then is approximated by clock-time. This approximate clock-time is correlated with a sensuously registered, observed experimental result that is said to be the guarantee of scientific truth according to modern scientific method. There is no sense in which the determinate, real time t = b approximated by an observed, discrete clock measurement, were a definite function, whether probabilistic or not, of time's many superposed associated states in imaginary time given by the d's. Because the components, b and d, of complex-imaginary time are independent of each other, there is no necessary causal-deterministic equation tying the dynamical state at the present instant b to the imaginary dynamical states ranging over an infinity of d's or vice versa. d marks and ranges over an imaginary, immeasurable time, independent of the real time of the present observed and recorded state at this instant, b, of the dynamical system.

This pseudo-mathematical interpretation of complex-imaginary time corresponds to the Aristotelean insight that movement is characterized by a twofold presence, namely, the presence now of a definite state, and the unfinished presence of a future definite state toward which the dynamical system is under way. Likewise, retrospectively, a dynamical system in its present state now *is* also the absent states in which it has been previously (its 'history') and also the absent states in which it *could* have been, since we are assuming efficient causal determinism neither prospectively nor retrospectively. The Aristotelean insight can therefore be extended to a *threefold* presencing of present, future and past as three-dimensional time, where the presencing of the latter two temporal dimensions are forms of absencing.

Modern mathematical physics is characterized by the striving to make a necessary mathematical link, by means of equations (hence the mathematization), between a unique system state at real time b and a real future state at time b + d, with positive d, so that future time loses its imaginary independence and collapses, at b + d, into the real continuum

in which b is also situated. Time is then a one-dimensional real continuum of one real instant inexorably and tightly following another rather than a free threefold presencing of the present instant and of other imaginary moments from the future or past. Modern physics is concerned with governing the future physical state of a system from the present moment b, either by bringing it about or by predicting it, so that position can be expressed as a mathematical function of real, present time. Equivalently, the equations can be read backward (for negative d) to determine causally a present state now as effected by states at a past point in time. Because modern physics views movement through mathematics, whose equations can be read either forward or backward, it is confronted with the dilemma of the irreversibility of time that it has manufactured for itself. It seeks a resolution in a particular movement that it claims is one-way, being governed by the second law of thermodynamics, in which entropy is formulated mathematically and therefore in the proper form for scientific truth.

With the Aristotelean insight into movement as a twofold of presence and absence, the complex superposition of quantum entities loses its singular, paradoxical nature because not just sub-atomic entities, but *all* physical (movable/changeable) beings are characterized by complex-imaginary superposition of present and absent dynamical states, where the imaginary refers to potentiality and the possibilities of what might be and what might have been. The definite real observables observed at a real time b (perhaps, for the sake of scientific ‘objectivity’, read off measuring instruments and a clock inaccurately as rational numbers) result from their observation by an observer, no matter whether this observer is a physicist-experimenter or somebody else dealing with affairs in everyday life. It is a matter simply of turning one’s attention toward the physical state of affairs presently surrounding one and does not depend necessarily on measurement and quantification.

The observer’s mind, whether physicist’s or not, can and does range temporally over both past and future in imagination, and this is the phenomenological justification for introducing an imaginary positive or negative component into time to denote the focus of attention, employing the pseudo-mathematical notation merely as an heuristic

device for those familiar with modern mathematical physics. The mind's attentiveness is itself double: on the one hand, the observer is more or less aware of his present physical surroundings and, on the other, he can be, and usually is, also focused in the imagination on a prospective or retrospective state of affairs that is situated, no matter how vaguely, spatio-temporally in the future or past, over which the mind can range freely. In this sense, and in paradoxical contradiction to a physicist's 'realist' common sense, the observer's physical, sensuously observable surroundings are precisely *not* present, but absent, and the mind calls to presence a future or past, and therefore absent, state of affairs! The imagination can, and often does, go even further in abstracting also from time-space altogether to turn its attention to wholly abstract thoughts lacking a spatio-temporal place. Such is the power of human imagination (φαντασία, Vergegenwärtigung, calling-to-mind).

7.3.2 Excursus 2: On quantum physics' assault on time (Hermann Weyl, J. A. Wheeler, Julian Barbour)

> Die Frage des continuum ist in der heutigen Mathematik wieder aufgerollt. [...] Die Arbeit in dieser Richtung hat der Mathematiker Hermann Weyl geleistet und sie vor allem für die Grundprobleme der mathematischen Physik fruchtbar gemacht. Auf dieses Verständnis des continuum kam er im Zusammenhang mit der Relativitätstheorie [...] Aus diesem Entwicklungsgang kann man erhoffen, daß die Physiker mit der Zeit vielleicht dazu kommen, mit Hilfe der Philosophie zu verstehen, was Aristoteles unter Bewegung verstanden hat,...[58]

[58] M. Heidegger *Sophistes* GA19:117f. Heidegger made this remark in winter semester 1924/25, and his hope that, in the course of time, modern physics would learn to appraise Aristotle's concept of movement "more radically" remains scarcely fulfilled to the present day. The translated quotation reads

more fully: “The question regarding the continuum is again being unfolded in today’s mathematics. One comes back to Aristotelean thoughts insofar as one learns to understand that the continuum cannot be resolved analytically, but that one must get to the point of understanding it as something *pregiven*, prior to the question concerning an analytical penetration. The work in this direction has been performed by the mathematician Hermann Weyl (*Raum - Zeit - Materie: Vorlesungen über allgemeine Relativitätstheorie* Berlin 1918) and has been made fruitful for the foundational problems of mathematical physics. He came to this understanding of the continuum in connection with the relativity theory of present-day physics for which, vis-à-vis the telegeometry resulting from the Newtonian approach in modern physics, the concept of field is definitive. Physical being is defined by the field. From this course of development one can hope that, in the course of time, physicists will perhaps come to understand, with the help of philosophy, what Aristotle understood by movement, and that they give up the old prejudices and no longer hold the opinion that the Aristotelean concept of movement was primitive and that movement had to be defined only by velocity which, indeed, is a characteristic of movement. Perhaps, in the course of time, one will also come to appraise more radically the Aristotelean concept of movement. I make this remark in order to indicate just how much Aristotle, free from all over-hasty theory, has come to findings which today natural-scientific geometry is striving for on a path in the opposite direction.” (Die Frage des continuum ist in der heutigen Mathematik wieder aufgerollt. Man kommt auf aristotelische Gedanken zurück, sofern man verstehen lernt, daß das continuum nicht analytisch auflösbar ist, sondern daß man dahin kommen muß, es als etwas *Vorgegebenes* zu verstehen, vor der Frage nach einer analytischen Durchdringung. Die Arbeit in dieser Richtung hat der Mathematiker Hermann Weyl geleistet und sie vor allem für die Grundprobleme der mathematischen Physik fruchtbar gemacht. Auf dieses Verständnis des continuum kam er im Zusammenhang mit der Relativitätstheorie der gegenwärtigen Physik, für die gegenüber der Ferngeometrie, wie sie sich im Ansatz der modernen Physik bei Newton ergab, der Feldbegriff maßgeblich ist. Das physische Sein ist bestimmt durch das Feld. Aus diesem Entwicklungsgang kann man erhoffen, daß die Physiker mit der Zeit vielleicht dazu kommen, / mit Hilfe der Philosophie zu verstehen, was Aristoteles unter Bewegung verstanden hat, und daß sie die alten Vorurteile aufgeben und nicht mehr meinen, der aristotelische Bewegungsbegriff sei primitiv und man müsse die Bewegung lediglich durch die Geschwindigkeit definieren, die ja ein Charakter der Bewegung ist.

Vielleicht wird man mit der Zeit auch den aristotelischen Begriff der Bewegung radikaler würdigen. Ich gebe diesen Hinweis, um anzudeuten, wie sehr Aristoteles, frei von aller vorschnellen Theorie, zu Tatbeständen gekommen ist, die heute auf umgekehrtem Wege die naturwissenschaftliche Geometrie anstrebt. M. Heidegger *Sophistes* GA19:117f.) In an e-mail dated 08 August 2010, Rafael Capurro told me of Carl Friedrich von Weizäcker's attendance at discussions between Heidegger, Heisenberg et al. on modern physics, and quantum physics in particular. Weizäcker writes that "Heidegger's analysis of the foundations of ontology and logic, if it pertains, is of direct significance for the core of all natural science" (daß Heideggers Analyse der Grundlagen der Ontologie und Logik, wenn sie zutrifft, für den Kern aller Naturwissenschaft von direkter Bedeutung ist. 'Heidegger und die Naturwissenschaft' (HNw) in *Der Garten des Menschlichen: Beiträge zur geschichtlichen Anthropologie* Munich 1977 pp. 420). Weizäcker has deep insights: "Because reality hangs together (con-tinens), I cannot arbitrarily apply the concept of number to it. On the other hand, the number-concept is not therefore inapplicable; I *can* apply it, but in an ambivalent way. [...] Our usual thinking that naively regards itself as the sole rational thinking, the thinking that uses the natural number and has brought forth natural science that has precipitated in classical physics and classical ontology — this thinking tries instinctively to elminate the concept of possibility [which is oriented toward the temporal exstasis of the future ME]." (Weil die Wirklichkeit zusammenhängend (con-tinens) ist, kann ich den Begriff der Zahl nicht ohne Willkür auf sie anwenden. Andererseits ist der Zahlbegriff darum nicht unanwendbar: ich *kann* ihn anwenden, aber in mehrdeutiger Weise. [...] Unser übliches Denken, das sich selbst naiv als das einzig rationale Denken ansieht - das Denken, das die natürliche Zahl benutzt und die Naturwissenschaft hervorgebracht hat, das sich in der klassischen Physik und der klassischen Ontologie niedergeschlagen hat - dieses Denken versucht, den Begriff der Möglichkeit instinktiv zu eliminieren. 'Kontinuität und Möglichkeit' in *Zum Weltbild der Physik* Stuttgart 1976 pp. 223f) And Weizäcker knows that Aristotle still has something to teach us today: "[...] the description provided by Aristotle of the continuum, time and movement, is philosophically better founded than the usual description in today's mathematics and physics." ([...] die Beschreibung, die Aristoteles vom Kontinuum, Zeit und Bewegung gibt, sei philosophisch besser begründet als die in der heutigen Mathematik und Physik übliche. 'Zeit und Wissen' in *Aufbau der Physik* Munich 1985 p. 854, referring to Weizäcker's own paper presented to a conference on Aristotle in September 1985, 'Möglichkeit und

A paper presented in 1986 by the renowned quantum physicist, John Archibald Wheeler (1911-2008), in honour of the equally renowned, then-deceased mathematician, Hermann Weyl (1885-1955), both of whom held appointments at the illustrious Princeton University, is highly instructive for seeing the different directions in which modern physics and phenomenology look.[59] The physicist (who collaborated on the Manhatten Project) proceeds from the axiom or dogma that there is a knowing and that this knowing has to be exact in the sense that it can be formulated in mathematics.

In his eulogy on the greatness of Weyl as a mathematician, scientist, philosopher and highly cultured individual, Wheeler first formulates four questions with affinity to Weyl's concerns that serve as the structure for his talk: "(1) What is the machinery of existence? (2) What is the deeper foundation of the quantum principle? (3) What is the proper position to take about the existence of the 'continuum' of the natural numbers? And (4) what can we do to understand time as an entity, not precise and supplied free of charge from outside physics, but approximate and yet to be derived from within a new and deeper time-free physics? In brief, why time? What about the continuum? Why the

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Bewegung. Eine Notiz zur aristotelischen Physik', written in 1966 and published in *Festschrift für Joseph Klein* 1967 as well as in *Die Einheit der Natur* dtv 1974 pp. 428-440). These words from someone of the stature of Weizäcker (a doctoral student of Heisenberg's) continue to fall on deaf ears today in the ceaseless headlong rush of modern physics to realize its will to power over movement. Since Weizäcker was convinced that Heidegger, owing to a lack of mathematical knowledge, was unable "to think through the reality of physics deeply enough (die Realität der Physik tief genug zu durchdenken vermocht hat, HNw), the question is whether Weizäcker himself was able to take up Aristotelean insights to radically question concepts of the "continuum, time and movement" in today's physics.

59 John Archibald Wheeler 'Hermann Weyl and the Unity of Knowledge' *American Scientist* Vol. 74, July-August 1986 pp. 366-375. Adapted from W. Deppert (ed.) *Proceedings of the Internationaler Hermann-Weyl-Kongress: Exakte Wissenschaften und ihre philosophische Grundlegung* Peter Land 1986, accessed at www.weylmann.com in July 2009 from which the quotes below originate.

quantum? What is existence?" Wheeler's speech ends with the demand, "that we can and must achieve four victories: Understand the quantum as based on an utterly simple and — when we see it — completely obvious idea. Explain existence by the same idea that explains the quantum. Through this larger vision of existence and the quantum, recognize that the continuum of that physical world out there and the bit-by-bit means by which alone we can define that world are not contradictory, but complementary. Reduce time into subjugation to physics." The enumeration of challenging problems here amounts to linking being and time, discreteness and the continuity, and also these two couplets into a quartet in a simple way to achieve "victory". The lead role is given explicitly to the quantum, i.e. to the discrete primal physical entity, which, once understood in a completely simple, hitherto unseen way purportedly will solve also the question concerning "existence", i.e. being.

As discrete, the quantum also provokes the question as to the relation between bits (digitized, in-forming information) and the continuum, which, in turn, leads back to time as a continuum. The "victory" to be achieved amounts to a "subjugation" of time to quantum physics and, as a precondition, a subjugation of the continuum to the discrete. Only in this way will time no longer be a free lunch thankfully received by physics but will itself be "derived from within a new and deeper time-free physics". Hence, time is to be derived from being (as Aristotle did) and ultimately from the quantum and thus a "unity of knowledge" attained. Such is the structure of Wheeler's envisaged research program, and he is presumably speaking in the name of quantum physics with its pretensions to be the foundational science par excellence of the modern age that has already celebrated, at least, its 350th birthday.

The toughest nut to crack in this research program, Wheeler says, is time: "Time, among all concepts in the world of physics, puts up the greatest resistance to being dethroned from ideal continuum to the world

of the discrete, of information, of bits."[60] But why is this reduction to discrete bits necessary? Because, Wheeler goes on, the, "continuum of natural [sic] numbers, Weyl taught us, is an illusion. It is an idealization. It is a dream. With numbers of ever increasing mathematical sophistication we can approach that infinity ever more closely; but we commit a folly if we think we can ever get there." Numbers are thus only ever potentially infinite, on their way to an infinity that can never become actual, i.e. never be 'had' in its end as a perfected, completed presence. Accordingly, time, imagined as a continuum, is as such an illusion, a mirage that continually recedes into the distance the more we approach it, and which has to be reduced to bits, that is, to the hegemony of the λόγος, which calls beings to presence and itself is present at will and always discrete and hence digitizable, computable, i.e. within the domain of the calculative power of mathematics.

Let us look more closely at what Wheeler means by existence and its link to the quantum. The allusion to "the machinery of existence" indicates some kind of efficient causality, albeit indeterminate, according to quantum-mechanical laws: "Machinery of existence for us means laws of physics under the overarching governance of the quantum principle". Existence itself for Wheeler means, in traditional metaphysical fashion, the thatness of beings as a whole, simply, *that* they are. But that they are, it is claimed, also has a meaning, and for this totality of existing beings to have a meaning, Wheeler claims, citing Weyl, "it is necessary that the world be governed throughout by simple elementary laws," to wit, by the laws of quantum dynamics, which are assigned the task of accounting for both the sheer existence and also the movements of beings as a whole, now broken down into bits of digitized information. But this elucidation of a purported link between the sheer thatness of existence and its meaning in terms of "simple elementary

60 Likewise in the context of endeavours toward a unified quantum (gravity) theory, Roger Penrose expresses the conviction "that our present picture of physical reality, particularly in relation to the nature of time, is due for a grand shake up — even greater, perhaps, than that which has already been provided by present-day relativity and quantum mechanics" (Penrose 1989, 1999 p. 480).

laws" does not say what existence itself means, but rather presupposes it: that something is means simply that it is. But what does 'is' mean? Does it mean experimental observability?

Once this 'is' of beings is presupposed, their dynamics can be accounted for by laws, hopefully, simple quantum laws. This is the will to power to discover a '*Weltformel*', a formula for the world. This all-powerful mathematical formula would make the movement in time of all entities, no matter of what kind, mathematically calculable in a unified way. Hence the title of Wheeler's paper: "Hermann Weyl and the Unity of Knowledge". Furthermore, Wheeler wants quantum laws to account not only for the dynamics of existents, but also for the very thatness of their existence: "Existence? How else is it brought into being except through elementary quantum phenomena?" The coming-into-being is to be explained in terms of quantum phenomena. But even this still does not answer the question concerning the very meaning of this "being" into which beings come.

Putting that aside for the moment, what is meant more precisely by "quantum phenomena"? Wheeler explains with regard to the "objective description" of reality: "Not until the observing sense, or observing device — by its geometry, its layout, and its adjustment — has chosen the question to be asked, and by its registration has made a record long enough lived to produce internal or external action, has an elementary quantum phenomenon taken place that contributes to the formation of what we call reality." An "elementary quantum phenomenon" is therefore an observed measurement in which there is a quantum leap from unobserved indeterminacy to observed determinacy as an ascertained, present measurement, in which the probability wave mathematically describing the quantum-mechanical situation collapses from a superposition of (even uncountably) many states to an eigenvalue. Only on the basis of this observed, present determinacy can there ever be an "objective description" "of what we call reality". Reality (the totality of that which *is*) is thus conceived as an assemblage of sense impressions gathered and registered by human observation with the aid of experimental apparatus: "There is not a single sight, not a single sound, not a single sense impression which does not derive in the

last analysis from one or more elementary quantum phenomena." Accordingly, reality is the perceivable, since science is always referred to the empirically perceivable, even if elaborate experimental apparatuses are required for such perception, and objectivity itself is subjective in the sense that objective reality is that which is perceived by the human subject which, in turn, is subject to the conditions only of experimental scientific *method*.

The meaning of being tacitly underlying this conception is therefore that of scientifically registered presence for a perceiving subject. It is scientific method that bridges the gap between subject and object, making of merely subjective description an ostensibly objective one. The key feature of scientific method, in turn, is that the experimental experience gone through is amenable to both mathematical quantification and experimental reproducibility. Scientific method makes merely 'subjective' experience exact, rigorous, mathematizable, even though experience, even scientifically methodical, 'objective' experience, can only be experience *for* a subject. The mathematical quantification prescribes, or precasts, that the observations made must be able to be entered into pre-existing mathematical formulae of a theory modelling reality, and the reproducibility requirement aims at overcoming the opinionated subjectivity of the individual human subject in favour of a collective scientific human subject so that science can be of one opinion. Objectivity is thus such for a human subject experiencing within the bounds of scientific method, and such experiences are to be explicable in terms of quantum laws of physics. A unified physical theory, a *Weltformel*, would account in a unified way for all the various dynamic forces physics has discovered and thus put precalculable domination of all movements in the universe, of whatever kind, into the hands of scientifically methodical humankind.

The "complementary description of nature as it is seen in quantum theory", which presumably refers to the indeterminate dual nature of sub-atomic entities as both wave and particle, i.e. as both continuous and discrete, is thus claimed to be the "only possible" human experience according to the scientifically valid, mathematically quantifying method, or path, for experiencing "reality". Such quantifiable, 'objective'

experience for humanity as subject is a mass of “bits of information”, “at most a countable infinity” amenable to calculation and digitization. This, in turn, inevitably throws up the problem of the apparent “existence” of “a continuous infinity of locations for particles, a continuous infinity of field strengths, a continuous infinity of degrees of freedom of dynamic space geometry”. Instead of accepting this apparent existence, Wheeler asks: “Do we not do better to recognize that what we call existence consists of countably many iron posts of observation between which we fill in by an elaborate papier-mâché construction of imagination and theory?” In other words, the continuum has to be reduced to the discrete if it is to conform to scientific mathematical method which, ultimately, is digitizable, and it is the encounter with quantum phenomena that induces the scientific conviction that the continuum indeed does collapse to the discrete and finite.

Hence reality is ultimately nothing other than a heap of experimentally accumulated information bits that hangs together by virtue of mathematical equations. “When Bohr tells us that quantum theory gives us the only objective description of nature of which one can possibly conceive, is he not also telling us that no description can make sense which is not founded upon the finite?” *Quantum theory therefore is the prescription that reality conform to the digital cast of being.* Quantum theory, in turn, is the model based on the experience of observed reality according to mathematico-scientific method. “Encounter with the quantum has taught us, however, that we acquire our knowledge in bits; that the continuum is forever beyond our reach.” This “reach” is the reach of “absolute logical rigor” which stands in contradiction with any conception of the continuum beyond such reach. Wheeler, however, does not want to declare a contradiction, but speaks rather of a “complementarity between the continuum and logical rigor” which purportedly has been achieved as a “hard-won power ... to assess correctly the continuum of the natural numbers [growing] out of titanic struggles in the realm of mathematical logic” in which continuity has succumbed to governance by the discrete, i.e. by the exactly calculable mathematical λόγος.

In these “titanic struggles”, which must be regarded as the modern scientific analogon to Plato’s γιγαντομαχία περὶ τῆς ουσίας, mathematical logic is said to play the role of the “courageous outpost-cavalry”, preparing “the way not only for the main cavalry that is mathematics, but also for the army that is physics”. Accordingly, the theatre of war has purportedly shifted historically from ontology, i.e. the question concerning being, to the question in mathematical logic concerning continuity. In its supreme, unquestioning self-confidence, quantum physics, and modern science in general, has entirely lost sight of the question concerning the very *meaning* of being and its connection with time. All of observable reality, that is, all sense data, seems to be reducible to finite bits according to the scientific program laid down long ago by Democritus which Wheeler paraphrases by quoting Weyl, in turn, citing Democritus: “‘the doctrine of the subjectivity of sense qualities has been intimately connected with the progress of science ever since Democritus laid down the principle, >Sweet and bitter, cold and warm, as well as the colors, all these things exist but in opinion and not in reality; what really exist are unchangeable particles, atoms, which move in empty space<’ (*Philosophy of Mathematics and Natural Science*, p. 110). In accordance with this view of Democritus, we understand green today as a characteristic frequency of 5.7×10^{14} vibrations per second,” etc. Everything that is, according to this Democritean-Cartesian-Leibnizian cast of being, is reducible to a finite number. In “reality”, everything is a bit. The ultimate quanta are the smallest (observable, measurable) bits from which everything else is composed.

Only the continuum of time, which is not simply a sense datum, shows itself to be refractory to this digital cast of being, perversely defying mathematical logic. “But time: how is time to be reduced to more primitive concepts? Reduced from the continuum to something built on bits?” Wheeler thus concludes his survey of the four major questions confronting mathematical quantum physics as a unified theory of all that is and its movement with a conundrum and a deferment: “Of all obstacles to a thoroughly penetrating account of existence, none looms up more dismayingly than ‘time.’ Explain time? Not without explaining

existence. Explain existence? Not without explaining time. To uncover the deep and hidden connection between time and existence, to close on itself our quartet of questions, is a task for the future." The antinomy of the continuum, time, in connection with the question of being (and hence, after all, the logically boggling task of an ontology of time) is said to be a cause for dismay which challenges future quantum physics, fired as it is by a will to power over moving reality, to "achieve four victories", as quoted at the outset of this note. And so we return to the challenge to "[u]nderstand the quantum as based on an utterly simple and — when we see it — completely obvious idea" from which the continuum of time could be derived. Only thus could the will to mathematically calculable power over the dynamics, i.e. the movement in time, of beings as a whole be satisfied.

Someone who has taken up Wheeler's program in his own way by striving to eliminate time from physics is Julian Barbour, an English researcher into the foundations of modern physics. He has done so with his 1999 book, and other papers.[61] For the project of bringing together "Einstein's general theory of relativity and quantum mechanics" into a "single over-arching theory", a "quantum theory of the universe (also called quantum gravity)", Barbour claims, similarly to Wheeler, "the 'problem of time' is perhaps the most severe".[62] John Wheeler actually voiced a glowing comment on Barbour's book (cf. ibid.). Here, for the sake of simplicity, we shall concentrate on a shorter, prize-winning essay by Barbour, 'The Nature of Time',[63] in which the issue of the elimination of time, at least from Newtonian dynamics, becomes clearly visible. The elimination of time is an important step in Barbour's approach on the way to formulating a unified theory of quantum gravity. As Barbour envisions this theory, "the quantum universe is *static*. Nothing happens; there is being but no becoming. The flow of time and motion are illusions" (NT op. cit.). This shorter essay of Barbour's will

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61 J. Barbour *The End of Time* Weidenfeld & Nicolson, London, and Oxford University Press, New York 1999.

62 J. Barbour http://www.platonia.com/books.html accessed October 2009.

63 J. Barbour 'The Nature of Time' available at http://www.platonia.com accessed October 2009.

be enough for my purpose here of showing what he skips over in his efforts to eliminate time.

Barbour's essay is ingenious. His attempt to banish time as a fundamental concept from physics, replacing it with spatial difference ("All we need are differences."), in truth deals exclusively with the *measurement* of time, i.e. with time *as* quantitative, not with time per se, which he surreptitiously continues simply to assume in his considerations. Barbour proceeds from Newton's conception of absolute time in the *Principia* of 1687 as *duration*, and hence does not go back to consider Aristotle's conception of time as developed carefully in the *Physics*. Such a concept of time as duration which, according to Newton, "flows equably without relation to anything external," immediately leads Barbour to ask the question, "What is a clock?". This question and Newton's positing that "[a]bsolute true and mathematical time [...] by another name is called duration," show that both Newton's and Barbour's focus is on the *measurement* of time and on time as a mathematical magnitude. Barbour takes as "[t]he best guide to the nature of time [...] the practice of astronomers", proceeding self-evidently from the assumption that astronomers are in the business of *predicting* the motions of planets (eclipses), etc., and his entire ensuing discussion of Newton and Kepler is therefore in terms of equations with whose aid motion can be predicted, precalculated. But how could a prediction (say, of an eclipse) be at all possible without the temporal dimension of the future being *understood a priori* and *taken for granted* by astronomers? By focusing from the outset on scientific attempts to quantitatively measure motion predictively (reduced to difference in position), the phenomenon of time itself is skipped over and taken for granted as self-evident. If, in line with Barbour's research program, there is, in 'scientific truth', no time, then the activity of predicting engaged in by astronomers, which presupposes some such thing as a future dimension, is merely an illusion based on astronomers' self-delusion. But such a temporal dimension is deeper-lying than any conception of duration as measured clock-time, on which Barbour concentrates. Barbour would have to argue *explicitly* that this deeper-lying temporal dimension, too, is an illusion, which would amount to asserting that all there *is* is

differences in position in a positional state space (with 3N dimensions for a 'universe' with N 'particles'). This assertion, in turn, would give rise to the question as to how *change* is at all possible in a universe in which there 'is' only static position and no difference in time? Does he deny the phenomenon of change itself and declare it, too, to be merely a human illusion? Does not Barbour end up proposing a static unified theory of all there is, eliminating what is genuinely dynamic? Has not Barbour unwittingly merely reproduced Parmenidean ontology, according to which all κίνησις is impossible, i.e. an illusion? Has he not once agin stumbled upon the problem that the preoccupied ancient Greek philosophy from Parmenides through to Aristotle, the problem of how to conceive movement and change *as such*? We shall see.

Barbour cites approvingly on the first page of his essay Ernst Mach, according to whom, "[i]t is utterly beyond our power to measure the changes of things by time ... time is an abstraction at which we arrive by means of the changes of things;..." Mach thus admits the phenomenon and concept of change, and treats time as an abstraction from such change. This accords also with Aristotle's conception of time, for whom time is the counting number abstracted from movement (κίνησις) of which there are four kinds (movement with respect to what, how, how much and where), one of which is change (ἀλλοίωσις) and another (loco)motion (κίνησις κατὰ τόπον). For Aristotle, the counting of time takes place with respect to before and after, which are themselves temporal terms referring to the dimensions of past and future. For Barbour, by contrast, there is no temporal order, no before and after, but only a jumble of atemporal differences in spatial states (to which he likes to refer as 'snapshots') and, apparently, atemporal changes between such states (on which more later).

Barbour's arguments against Newtonian absolute time first concentrate on the difference between solar and sidereal time, demonstrating that, in truth, Newton's absolute time, which is supposed to "flow equably without relation to anything external" turns out to be sidereal time, i.e. time as *measured* by the motion of the stars relative to the Earth. It is easy therefore to agree with the conclusion of Barbour's argument in this section: "As Newton himself defines it, absolute time is

by no means independent of the world; it is a specific motion, the rotation of the earth." This argument, however, does not impinge on a deeper-lying conception of three-dimensional, ecstatic time as enabling all kinds of movement from which, then, counted clock-time is read off.

Barbour's argument then proceeds on the basis of the assumption: "Since time must be deduced from change of position (motion), I shall here take position and differences of position as given,...". This is a first step toward eliminating both time conceived as duration, and also genuine motion, in favour of changes in position.

This first move of Barbour's warrants a recall of Leibniz' critique in 1698 of a contemporary metaphysician of physics, Sturm, who asserted, in a way not dissimilar to Barbour's argument, "*Motion*... is only the successive existence of the thing in motion at diverse locations" (*Motum*... esse successivam tantum rei notae in diversis locis existentiam[64]), to which Leibniz responds that these different locations is only "what results from motion" (quod ex motu resultat; ibid.) and "the body is not only in a location commensurable to it at the present moment of its motion, but also has the striving or strain to change its location, so that the following state is a consequence of the present state of itself by force of nature" (non tantum corpus praesenti sui motus momento inest in loco sibi commensuarto, sed etiam conatum habet seu nisum mutandi locum, ita ut statu sequens ex praesenti, per se, naturae vi consequatur; ibid.) Leibniz thus shows that he has learned something essential from Aristotle's *Physics*.

The second, crucial step for Barbour is actually replacing Newtonian absolute time, t, by "the angle ϕ through which the rotating earth turns relative to a fixed star". The temporal thus becomes spatial, viz. an area swept out by a motion. Barbour then shows that Kepler's discoveries demonstrated that clock-time as measured by the change of ϕ gives the same time as measured by the areas swept out by the planets' motion around the sun, which is simply another angular magnitude. Terrestrial sidereal time (equivalent to an area swept out by the Earth's rotation) and planetary areal-motion around the sun are thus the same measure

64 Leibniz 'De Ipsa Natura...' loc. cit. S. 296.

and the Earth's rotation and planetary areal-motion are equivalent natural clocks. Newton was able to formulate his famous mathematical laws of motion to capture these Keplerian planetary motions, and these laws were generalized axiomatically to all physical motions. "Newton had discovered dynamics," remarks Barbour, and the modern age had a powerful mathematical theory in its hands to predict and control motion of all kinds.

In the next section of his essay, Barbour introduces the conundrum presented to physicists in the 1890s that Newton's laws of motion could not account precisely for the moon's motion, which exhibited "a small but undeniable non-Newtonian acceleration". In an effort to get to the bottom of this anomaly, physicists redefined measurable clock-time so as to fit in with Newton's laws of motion, which thereby become axioms that can be applied to a closed dynamic system. *The problematic thus becomes entirely mathematical, a matter of writing and solving equations for a dynamical system.* Indeed, to be led by (ever more sophisticated, mind-bending, Magister Ludi) mathematics is the method of modern mathematical physics. The criteria for dealing with dynamical problems then become mathematical, which override any phenomenological considerations (which can then be dismissed as non-mathematical, non-scientific and human self-delusion). Barbour follows this lead of late-nineteenth century physicists by ingeniously proceeding from the Newtonian law of conservation of energy in a closed system. This allows him to write a first equation (1) for the potential energy, V; of a system consisting of a finite number of bodies in terms of the universal gravitational constant G, the masses of the individual bodies and the distances between them. Potential energy V therefore depends only on the masses and relative *positions* of the bodies. The system's kinetic energy, T, can also be written, classically, as a sum of the individual kinetic energies of the bodies in terms of product of half their masses and the square of their instantaneous velocities. Barbour takes as an approximation to these so-called instantaneous velocities the small distance dx covered divided by the small duration dt taken for such a small change of position. He has thus implicitly (and later explicitly; cf.

below) presupposed the notions of an instant of time, of instantaneous velocity, of infinitesimal distances and infinitesimal durations.

By appealing to the axiomatic principle of the conservation of energy, Barbour can now postulate a constant total system energy E which is equal to the sum of V and T. He then proceeds to solve this equation for the infinitesimally small time interval dt, thus obtaining an equation (3) for dt, so-called "ephemeris time", in terms of the individual masses, the individual small distances covered and the difference E-V, where, as we have seen, V depends only on the masses of the individual bodies and the distances between them. Expressed in words, equation (3) says that the time difference dt is equal to the square root of the sum over all the bodies in the system of the product of the mass and the square of the body's displacement all divided by twice the difference between total energy, E, and potential energy, V. For time mathematized in such a way by Barbour's equation (3), there is no before and after, and this is simply because mathematics itself abstracts from phenomena as they show themselves in the physical world, rendering them timeless. The quaking issue for mathematical physics is that mathematical entities are timeless. So it is inadmissible to argue from mathematical equations, which inherently eliminate the temporal, that they are 'time-symmetric' and that therefore time, or the so-called arrow of time, scientifically 'does not exist'.

Employing equation (3), Barbour can then eliminate dt from the equation for the "instantaneous speed of particle i" which is now expressed in terms of instantaneous displacements (i.e. infinitesimal distances), the individual masses, along with E and V. The antinomies inherent in the relationship between discreteness and continuity surface here, without Barbour making any mention of them. In particular, how can Barbour claim that "the ephemeris time defined by (3) runs continuously" whilst at the same time asserting that the time defined by (3) emerges "from observed positions of objects," i.e. from observed finite differences in position which, as observations, can never constitute a continuum? Barbour's self-evidently assuming the continuum, infinitesimals, and the like goes against Wheeler's and Weyl's caveat

"that the continuum is forever beyond our reach" (see above in this note).

If Barbour's equation (3) is regarded as one in terms of very small finite differences, rather than in terms of infinitesimals, then it can be used by astronomers to have time "truly emerge from observed positions of objects," namely, of celestial bodies, so that "[t]ime can be read off the heavens" in a finite, discrete, approximating, measuring procedure. This scientific method of determining ephemeris time will only be of use if the motions observed in fact give the same, uniform time. Barbour expresses this condition by referring to "the wonderfully correlated motions that nature exhibits" underlying "how *natural* clocks can march in step". Without such a marching in step of physical motions, there would be no way of postulating universally applicable, mathematical equations of motion. But are the wonderfully co-ordinated motions of celestial bodies, perhaps even in step with the counting of equally wonderfully construed artificial clocks, not a special case of motions and movements which in general are neither co-ordinated with each other nor uniform and "equable" within themselves? Is not the postulation of such co-ordinated uniformity (of *celestial* motion) more an axiomatic precondition for formulating mathematical laws of motion to which all kinds of movement then have to be made to somehow fit, or to which they have to be subjugated, to be governable, rather than an empirically verified fact? Why should *celestial* motion be *the* yardstick for all kinds of motion and movement and change? And is not the time that "emerges" from such co-ordinated motions only the measurable, mathematical time that suits the scientific will to know and, through this knowledge, to govern motions mathematically?

Barbour's equation (3) depends on the constant E for the total energy of a "perfectly isolated" dynamic system. From such a system, mathematical time dt is said to "emerge". But, "in reality there is no *perfectly* isolated system except the entire universe." So, strictly speaking, ephemeris time emerges only from the motions of the bodies in the entire universe as expressed in equation (3) which would then comprise a huge, finite number of bodies in motion, and imply a God's-eye view of the universe. Such a God's-eye view of the universe is never

to be attained scientifically, quite apart from the question whether the number of celestial bodies is finite, and quite apart from the impossibility of scientifically measuring their masses and displacements between two different instants. Hence equation (3), — which, significantly, is derived from considering astronomers' looking down on the solar system "from a 'crow's nest' very far 'above' the sun" — is an unverifiable and unfalsifiable Gedankenexperiment, just as Newton's first law of motion (the Galilean law of inertia) is. Only approximations to these axioms are to be had scientifically, and physics may well be satisfied that its theory of dynamics delivers very good, experimentally verified approximations. One could then say that Barbour's equation (3) represents the elimination of time from classical Newtonian physics by relying on Newtonian axiomatics. Barbour notes that "[e]ven in Einstein's much more sophisticated general relativity time emerges in much the same way" as in equation (3). The upshot is that time is eliminable from considerations of physical motion, and the calculation of such motion depends only on "snapshots taken [...] in quick succession" of the positional states of a dynamic system at different instants. In such instantaneous snapshots, however, there is also no motion, just as in Zeno's paradox of the arrow instantaneously frozen in flight. From his work overall, Barbour indeed draws the conclusion that "[t]he flow of time and motion are illusions". But one could turn this around and say that mathematical physics, precisely by virtue of its mathematical nature, is unable to truly capture the phenomena of time and motion and must declare them to be illusions. Hence, could not Barbour be accused of saving the mathematics in precedence to saving the phenomena?

After this excursion we return to Wheeler's search for "an utterly simple and — when we see it — completely obvious idea" of the quantum from which the continuum of time could be derived. One option is to go against the mathematical grain and to simply look at the problem the other way round, thus reversing the order of derivation here: time (along with movement of all kinds) itself would then become the originary phenomenon whence the existence of finite quanta would be derived. Time and movement always exceed what can be ascertained in

the present as observational data, even and *especially* by the most elaborate and precise scientific experimental apparatus of this *exact* science. Time and movement are always beset by the lack that they are also what is not present; time and movement are also a refusal and a withholding never to be made present as observational data. Refusal means that what has been in the past is no longer retrievable *as such* and within the reach of a will to mathematical cybernetic power. Withholding means that what is yet to come from the future is as yet withheld and also beset by an uncertainty, an indeterminacy evading mathematical precalculability. The dynamic laws of quantum physics, classical mechanics and general relativity are out to calculate motion, a primal phenomenon of the physical that goes hand in hand with time. Calculation is a kind of logic but, as Wheeler himself says, the continuum (and along with it time and movement) defies logic and the dissolution into logical, computable bits. An adequate phenomenology of motion (to which all movement is scientifically reduced in the modern age) shows that anything in motion is both present and absent, so that a mathematical account of motion based on observational data has always already truncated the phenomenon of motion itself to what can be ascertained in presence whence what is yet to come is supposedly governed, or whence what has been can be explained in retrospect as a law-governed motion.

What does this imply for the ambitions of quantum physics, or "quantum gravity", as Barbour puts it, to be *the* unified foundational science for the truth of all physical beings? The quantum itself seems to be an irreducible phenomenon, a 'hard nut' struck upon when physical entities are divided and divided (almost) endlessly that puts an end to any notion that physical reality is continuous (for continuity implies endless divisibility). Hence Wheeler's insistence on bits as ultimate, and hence also the various attempts at 'digital physics', "a collection of theoretical perspectives that start by assuming that the universe is, at heart, describable by information, and is therefore computable".[65] In truth, quantum physics claims, physical reality is ultimately, on the

65 http://en.wikipedia.org/wiki/Digital_physics accessed October 2009.

Planck level, discrete, and its continuity is merely an illusion arising from our everyday, ‘inexact’ dealings with the macro-world, which seems to be continuous. Quantum physics tells us that it has experimentally registered the ultimate building blocks of all physical entities, such as the electron and the photon. But at the same time, it has also ascertained that these ultimate physical entities, which are all in motion, cannot be pinned down determinately to a here-now point in space-time, and that this indeterminacy results in a range of possible measurements according to scientific measurement procedure itself, which always has to collapse wavering, superposed indeterminacy into the determinacy of an ascertained measurement. The collapse to observed, registered data through measurement by ‘interfering’ experimental apparatus is in truth the truncation of time and movement of all kinds to unambiguous, real (not imaginary), ‘instantaneous’ presence which, incidentally, gives rise to well-known, peculiar paradoxes such as Schrödinger’s cat and the quantum Zeno effect. These thought-experiments and other mysteries of quantum mechanics can only be misconceived as long as the tacit understanding of being as unambiguous, logically graspable, standing presence underlying all Western thinking since the ancient Greeks maintains its (strangle)hold on today’s scientifically-infected thinking.

7.3.3 Excursus 3: On time in (a quantized) special relativity theory (Joy Christian)

> It might appear possible to overcome all the difficulties attending the definition of ‘time’ by substituting ‘the position of the small hand of my watch’ for ‘time’. And in fact such a definition is satisfactory when we are concerned with defining a time exclusively for the place where the watch is located; but it is no longer satisfactory when we have to [...] evaluate the times of events occurring at places remote from the watch.
> Albert Einstein ‘On the Electrodynamics

of Moving Bodies' transl. of 'Zur Elektrodynamik bewegter Körper' 30 June 1905.

One might like to object to the critique of the mathematical approach to time presented in this study, which considers both classical and quantum mechanics, that it still has not taken into account the groundbreaking Einsteinian relativity theory in which something as unheard-of as curved space-time has come into view. The quick repudiation of this objection is that relativistic space-time, even when enriched with gravitational forces as in general relativity theory, still operates with a four-dimensional space-time in which t is simply a continuous real linear variable obeying certain equations, and this is preserved in recent advanced physical theories in which relativity is wed with quantum mechanics. Even when a crumbling of time into a grainy discreteness in the region of Planck time is theorized in some recent speculations (see below on Joy Christian's work), the four-dimensional space-time structure remains the mathematical framework. It is nevertheless instructive to take a look at that mysterious relativity of time which continues to exercise as strong a fascination on the physicist's and the layperson's mind as do the paradoxes of quantum mechanics.

In relativity theory, time loses its independence as an 'absolute' phenomenon and becomes 'relative'. Relative to what? Relative to a co-ordinate frame of reference in which the passage of time is measured by a clock for an observer-subject. Time is therefore measurable clock-time, measured by counting the ticks of the clock which is nothing other than a mechanism of some sort exhibiting a strictly regular, periodic movement such as the oscillation of a quartz crystal. Clock-time is the time counted off by a suitable detection mechanism from an underlying, natural or artificial, motion, a countable number of ticks that keeps on increasing endlessly. Each co-ordinate frame of reference has its own clock-motion, such as an oscillating quartz crystal or the circling of the stars, from which it counts off time. Relativity theory is a consequence of the theoretical discovery that the clock motions in reference frames moving at differing velocities differ, even though the clocks used to

count the time tell the same time, e.g. are derived from the same underlying crystal oscillation. How can this be? It is the consequence of both how time is ascertained and the discovery made during attempts to experimentally demonstrate an absolute inertial aether-medium for light-travel and then adopted as an axiom of relativity theory, that no entity can move faster than light in a vacuum, so that the movement of light represents an absolute maximum of motion. So *relativity* theory depends essentially upon postulating an *absolute* motion whose magnitude is an absolute maximum. Time in physics is the time ascertained within an experimental set-up as measured by a clock. The clock measurements are part of the observations recorded during the course of the experiment to which other events are assigned as having eventuated at such-and-such a time. Each inertial reference frame observes its own time on the ticking clock, and hence, paradoxically, time itself becomes dependent upon the observing subject, in genuinely Protagorean manner, even though the counting of time is performed by an 'objective' mechanism/movement. This Protagorean observer, however, is supposed to be general, i.e. any old observer will do to observe the results of the experimental set-up, thus puportedly guaranteeing 'objectivity'. Nevertheless, despite modern science's claims to 'objective truth' (queerly regarded as unloosed from any subjectivity whatever), relativity theory introduces a subjectivism of time into physics, more on which below.

Because the speed of light or, equivalently, of electromagnetic radiation, is an absolute maximum, the passing of time itself can be measured by the magnitude of the distance covered by light between an earlier and a later point in time. If time is measured this way, time itself can, in a certain way, be regarded as the movement of light (or, more generally, of electromagnetic radiation). All clock-time can be made equivalent to the movement of light by equating the time interval between two ticks to the distance travelled by light in that time interval. One second, for example, becomes the distance from the Earth to the Moon. Time measurements made in two different frames of reference moving uniformly (or, in general relativity theory, non-uniformly) in relation to one another, A and B, depend on the light paths between the

two frames to ascertain the time on each other's clocks. A only has access to B's clock by sending an electromagnetic signal to it and receiving back a signal with the information of the time read off B's clock. This signal has to travel a certain distance at the speed of light before A can read B's time, so this light-distance has to be added to the time measurement, and A's clock measures a later time (more ticks) than B's clock at the instant it receives the time signal back from B. Viewed from A, B's clock-time goes more slowly than A's clock-time if time is thus conceived by physics as factually registered clock-times on the basis of the postulate of the speed of light as an absolute maximum.

This is the kernel of relativity theory, which is elaborated mathematically with a focus on magnitudes, i.e. on time-measurements between different frames of reference moving in various ways (toward, away, uniformly, even non-uniformly) in relation to each other. The famous Lorentz transformations, that set up a mathematical relationship between space and time, arise from considering the change of space-time co-ordinates between two reference frames moving uniformly in relation to each other. Because, in relativity theory, time's measurement has become a spatial distance travelled by light, time and space are now interrelated instead of being independent variables in equations of motion for all sorts of physical entities. The more the relative speed between reference frames A and B approaches the speed of light, the longer the light-signal paths between A and B, and hence the greater the clock-times in A and B differ. They differ symmetrically, since the relative velocity between A and B has the same magnitude, differing only in sign: positive or negative.

In general relativity theory, the subjectivism of modern physics gains an added twist, namely, the *curvature* of space-time. Both special and general *relativity* theory are based on the postulate or axiom of the *absolute* nature of the movement of light or, equivalently, any electromagnetic radiation. The only pertinent movement of light that physics can see from its mathematical casting is change of place, i.e. locomotion, or simply motion as *measured* by change of place in unit clock-time. In *special* relativity theory, it is only the speed of light moving in a *straight* line that is of interest. According to both classical

Newtonian and Einsteinian relativity theory, the first Newtonian law or axiom is upheld according to which it is proclaimed, without ever any hope of experimental observation, that physical bodies continue to move uniformly forever in a straight line unless acted upon by a net external force. Any change of velocity, i.e. an acceleration in a particular direction, must be accounted for by the action of a net external force (and there is invariably some net external force acting). In general relativity theory, it is precisely accelerating frames of reference that are introduced, and such acceleration is, and must be, accounted for by the action of some external force or other. Any observed acceleration implies a force at work. Relativity physics is based on the (postulated absolute) motion of light relative to the observer subject's frame of reference. Since the speed of light (in a vacuum) is a constant absolute, the only way an acceleration of light can take place is through a change in *direction* of its vector of motion, i.e. its path is not straight, but curved, and this curvature is accounted for, as it must be, by a force called *gravity* that is attributed to the massiveness of matter, and mathematized as a force vector proportional to quantitative mass (as well as to the inverse square of distance from the mass). Since, however, light is the *absolute* motion, gravity can be conceived simply as this motion's equivalent, namely, as a curvature of space itself given by the path of light itself.

Light, or electromagnetic radiation, as the absolute motion, provides the standard reference frame for all time and space. Not only are time and space as mathematical quantities interrelated via the Lorentz transformations of special relativity, but this space-time is also curved, which is equivalent to postulating gravity as the force acting on light, thus changing (accelerating) its motion in a definite, calculable direction. This curvature of space-time is expressed mathematically by a set of differential equations encapsulating the vector force-fields of matter (or, equivalently, energy). Space-time is hence relative to an observer-subject according to how the subject observes the motion of light, or electromagnetic radiation of all kinds. The universe is thus centred on the observing scientific subject receiving electromagnetic signals at a point of observation in space-time from which, with the aid of the

appropriate equations of motion expressing causal interrelations among all physical phenomena, it calculates all motions in the universe and hence all events, both past and future. Thus it can be seen that the so-called *objectivity* of advanced physics as a much admired foundational scientific theory of the mathematico-scientific age goes hand in hand with an extreme *subjectivism* in a precise sense. As such, *relativity* theory, both special and general, is an apt name. For relativity theory in its mathematico-Cartesian, ontotheological cast, light as pure motion is the Absolute, and all scientific observers its calculating subjects.

The fundamental postulate of standard Einsteinian special relativity theory, that the speed of light is an absolute maximum that cannot be exceeded by any physical entity, plays a key role in the critical appraisal and further development of quantum mechanics with its postulate that, prior to measurement, the dynamical state of physical entities must be conceived as a superposition of possible or potential states that can actually be measured uniquely by an apparatus in an experimental set-up. An observable difference in measurements comes to light experimentally in factually registered data only at the sub-atomic level, with physical entities inhabiting dimensions in which the Planck constant makes a difference. Any dynamical state of a physical system must be regarded as an imaginary-complex probability distribution of possible states, so that the physical entity or entities in question are not well-defined, not definitely there *now* with certain determinate properties.

This indeterminacy in the state of a physical entity was repelling to some physicists, including most famously to Einstein who, although having been awarded a Nobel prize precisely on the basis of his work on quantized energy in 1905, together with Podolsky and Rosen, published

a thought-experiment in 1935.[66] This paper's paradoxical result was supposed to show that quantum mechanics was incomplete and would have to be supplemented by as yet unknown, hidden variables that would ensure a determinate, rather than an indeterminate dynamical state of a physical entity prior to measurement. EPR argued that "[s]tarting with the assumption [...] that the wave function does give a complete description of the physical reality, we arrived at the conclusion that two physical quantities, with noncommuting operators, can have simultaneous reality". Since non-commuting operators on a system, such as position and momentum, cannot be measured simultaneously, EPR concluded that the quantum-mechanical theory of physical reality must be incomplete. The future task for mathematical physics, therefore, was to attain completeness through the supplement of hidden variables. EPR take a complete theory of physical reality to mean that the parameters (or variables) accounting for a dynamical state must have "simultaneous reality definite values" (p. 778) which, starting from given initial conditions of a dynamical system, can be theoretically predicted. With its non-commutable operators, however, quantum mechanics does not fulfil the condition of "simultaneous reality" of "physical quantities" and instead treats the dynamical state of a system at any time as an indefinite superposition of potential states with complex-imaginary coefficients. Wave states composed by superposition cannot deliver such determinacy, and this was anathema to EPR. It should be noted and underscored that "simultaneous reality" means the determinacy of "physical quantities" at a point in time, t, so the conception of time as consisting of mathematizable, determinate now-points (no matter whether hanging together continuously or discretely separated or both) is fundamental for mathematical physics' conception of reality.

That the conception of time is fundamentally implicated in EPR's charge that the quantum-mechanical theory of physical reality is incomplete has been overlooked in the debate among physicists since

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66 Einstein, A., Podolsky, B., and Rosen, N. (EPR) 'Can Quantum-Mechanical Description of Physical Reality be Considered Complete?' in *Physical Review* 47 1935 pp. 777-780.

1935. Instead, the focus has been on finding an experimentally testable hypothesis to determine empirically whether quantum-mechanical indeterminacy is tenable. Superposition was approached through the complementarity of the dynamical states of paired physical entities emitted, say, by a change in energy state of an atom, whose states are said to be *entangled*. Thus, for instance, the spin angular momenta in a given direction of a generated photon pair must sum to zero, i.e. one is the negative of the other. If the one photon is measured as having positive spin, then one can immediately conclude that the other has negative spin. If, however, both photons prior to measurement *are* an indeterminate superposition of potential dynamical states, assuming a determinate spin only upon actual measurement, then the measured positive spin of photon A, physicists following EPR argued, must 'communicate' its spin to photon B which instantaneously assumes a determinate negative spin. But such an instantaneous communication or teleportation would violate the fundamental principle of relativity that no causative signal can travel faster than light.

Unfortunately for EPR's adherents, the physicist John Stewart Bell proved a theorem that provided a way of experimentally testing whether quantum indeterminacy or realist determinacy pertains to a pair of entangled sub-atomic entities prior to measurement. Bell's theorem shows that the expected value of the probability distribution for superposed dynamical states exceeds the maximum allowable expected value for the dynamical state of a well-defined, determinate entity.[67] Such expected values are open to experimental testing by registering statistical frequency. Experiments in a domain dubbed "experimental metaphysics" by Abner Shimony[68] have come down in favour of quantum mechanics and against so-called 'local realist theories' postulating hidden variables that account theoretically for dynamical

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67 Cf. Norbert Dragon *Geometrie der Relativitätstheorie* Chap. 1, Subsection 'Quantenteleportation und Bellsche Ungleichung' available at http://www.itp.uni-hannover.de/~dragon/ accessed August 2009.

68 Cf. Abner Shimony 'Search for a Worldview which can Accommodate Our Knowledge of Microphysics' in *Search for a Naturalistic World View* Vol. I Cambridge U.P. 1993.

states at any point in time. So theoretical physicists have set to work in an attempt to reconcile the paradox of apparent instantaneous teleportation of information between entangled quantum entities. Such attempts involve introducing alternative *mathematical* conceptions, above all related to the role of gravitational force in the so-called collapse, or reduction, of the superposed wave function to a definite measurement caused by an experimental apparatus (Roger Penrose, Joy Christian). The problem of measurement in quantum mechanics consists in understanding theoretically the transition from a superposition of many potential dynamical states of a system to a definite dynamical state as measured determinately by an experimental apparatus. Such a problem, of course, presupposes that there is such a transition from indeterminacy to determinacy. In what sense can it be said that a physical being, which is capable of motion and change, even when 'at rest', is in a definite dynamical state? Repeated measurements on a photon may confirm that it is stably polarized, within a very small range of measuring error, at alpha degrees within the constricted and artificially construed environment of the experimental apparatus. Who is to say, however, that the measuring error is not an indeterminacy of superposed potential states lying beyond the accuracy of the measuring macro-apparatus to measure?

The incompatibility between local realism and quantum-mechanical superposition brings up philosophical issues revolving around what it means for a physical entity to *be*. For local realism, a physical entity, whether on the quantum scale or not, is a something with definite properties inhering in this something at any given point in time, i.e. at any *present* instant. This invokes already two elementary Aristotelean categories, τί and ποιόν, something and quality, or *what* an entity is and *how* it is, both of which regarded as present and predicable of an underlying substrate that Aristotle terms the ὑποκείμενον or 'subject'. It has been recognized in quantum mechanics, however, in a naive and rather superficial retrieval of Aristotle's *Metaphysics*, that superposition must be conceived as a wavering bundle of potentialities: "The neo-Aristotelian notion of quantum-mechanical *potentiality* as a novel metaphysical modality of nature – situated between mere logical

possibility and *bona fide* actuality – was favoured by Heisenberg, and has been exuberantly endorsed by Shimony (1978, 1998)."[69] What a physical entity is becomes, in modern physics, a mathematical magnitude, and how it is, i.e. its quality, becomes a wave function on a (finitely or infinitely) multidimensional phase space which captures the entity's dynamical state via a vector within that phase space (viz. a unit ket in an Hermitian space).

As we have seen in *2.9 Time and movement in Aristotle's thinking*, however, being as potential, or a δυνάμει ὄν, has to be conceived as a twofold presence of both presence and lack, and a being can have multiple potentials. Hence Aristotelean δύναμις is compatible with quantum mechanical superposition, and indeed, *prior* to any quantification and mathematization of superposed states as (complex amplitude) probabilities of dynamical states. A twofold of presence and absence, to be sure, is necessarily anathematical to modern physics which tries to cope instead by employing a bundle of wavering complex probabilities at *any present point in time* to capture indeterminacy, thus salvaging mathematizability. As exposited in this book, the famous Aristotelean triad of ontological concepts, viz. δύναμις, ἐνέργεια and ἐντελέχεια, which he fashioned to come to grips with the phenomenon of *movement* (of four kinds), i.e. with the hallmark characteristic of *physical* beings, needs to become once again an intense focus of attention, even for today's thoroughly mathematized physics.

The basic postulate of Einsteinian relativity theory, that the speed of light is an absolute maximum, is also understood as a "causality condition".[70] Such causality is conceived exclusively as *efficient* causality, effects being caused via a transmission from one physical entity to another, as a signal or a bit of information, maximally at the

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69 Joy Christian 'Potentiality, Entanglement and Passion-at-a-Distance' in *Studies in History and Philosophy of Modern Physics* 1999. Available at http://arxiv.org/abs/quant-ph/9901008 accessed August 2009.

70 Cf. Joy Christian 'Absolute Being vs Relative Becoming' in *Relativity and the Dimensionality of the World* within the series *Fundamental Theories of Physics* ed. Vesselin Petkov, Springer, NY 2007, available at http://arxiv.org/abs/gr-qc/0610049v2 accessed August 2009.

speed of light. Hence, modern physics operates overwhelmingly with electromagnetic force-fields to capture the motion of physical bodies causally in force-field equations. Aristotelean material cause is implicitly also acknowledged by modern physics under the head of mass or matter, matter being conceived as the passive stuff on which force-fields act, and mass being cast as quantified matter that appears as a variable in the appropriate equations of motion and above all as the bearer of gravitational force. The other two kinds of Aristotelean cause, the final end of the movement and the mover, are rejected in modern physics as 'subjective' as opposed to 'objective' forces of nature, as if objectivity and subjectivity could be separated.

First of all, note that calling to mind an end is just one way in which the human mind calls beings into the presence of the mind's eye, and such calling to presence (German: Vergegenwärtigung) is not subject to an effective cause that can act only at the speed of light or less.[71] Such calling to presence in awareness by 'thinking-of' is not merely a fantasizing or an imagining but is the primary way in which beings come to presence for human being. All human action involves calling to presence the matter to be acted upon, for which the sensuous perception of what is present at hand is auxiliary. This holds true both for everyday life and even for the theoretical physicist, for whom physical beings are called to presence in the mind's eye predominantly via the theory that is at the focus of the physicist's practice. Calling to mind can be wordless, or it can be articulated in the λόγος, i.e. in language, including mathematical language, which addresses beings, thus calling them to presence *as* such-and-such. In particular, the concepts of a physical theory are the special λόγοι that call beings to presence for the theorist, often prospectively, which thus only shape up for the theorist's understanding *in terms of* such concepts, i.e., for instance, *as* masses, forces, force-fields, etc. Since the physicist is so intent on measuring by factual registration and theoretically precalculating effective causes among physical beings, above all in experimental set-ups, he overlooks

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71 E.g. "the most charming young man in the world is instantly before the imagination of us all." Jane Austen *Northanger Abbey* end.

and takes for granted the calling to presence of beings inherent in calling to mind conceptually in which he is constantly engaged and for which no superluminal restriction applies or even makes sense.

For any experiment to test an hypothesis, the physicist must first prospectively call to mind the experimental set-up in terms of fundamental physical concepts. He has a plan and an end, namely, to determine whether the hypothesis stands up to experimental testing. Hence it can be said that the experiment itself has a teleological cause, namely, to attain an experimental result, and that this teleological cause is not subject to any luminal limit in its action. Calling-to-mind as the hallmark *movement* of human being is not subject to the upper bound to the motion of physical beings postulated by relativity theory. Otherwise we human beings could not call to mind a star or galaxy millions of light-years away *as such*. We human beings can reach back in time *as such* without luminal limit. The *as such* means here that, say, the light received by a telescope from a distant star is not merely registered, say, on photographic film, *as* light in the present, but is identified *as* light that has travelled a certain number of light-years.

We can therefore say that Einsteinian relativity of time is no restriction for the movement of human calling-to-mind (the mind being not the brain, but awareness of the world in its coming to presence prospectively, retrospectively or momentarily). For instance, we can think of the sun in less than the eight minutes that it takes for the sun's light to reach us, and perceiving the sun's light sensuously is not the only way, nor even the usual or predominant or most interesting way in which the sun presents itself to human awareness. Distant galaxies millions of light years away play a role for human being principally in the context of cosmological theories for which quasi-sensuous perception through telescopes of various kinds supply only data. But isn't this the purest subjectivism, grossly at odds with the objectivity aimed for by modern physics for which hard, objective, quantifiable data provide the bedrock of testable physical theories? Don't physical theories have to be much more than a mere 'thinking-of' that is both subjective and anthropocentric? An apt response to such objections consists in asking for whom physical theories are developed, if not for

human being, and in pointing out not only that physical theories rely crucially on fundamental theoretical concepts which are ways of thinking of key physical phenomena such as motion, matter, energy, force, etc., but also that all the theoretical and experimental work carried out by a scientist according to the rules of scientific method is carried out by the scientific subject who is *motivated* by the τέλος of achieving experimental confirmation or falsification of an hypothesis under the impetus of an unbridled will to power over movement that shapes how the physical world shapes up for the mind. It is therefore a self-delusion of modern scientific method as practised today to claim that it has dispensed entirely with the 'superseded' Aristotelean notion of teleological cause and operates exclusively with objective, effective causes. Modern science disseminates obfuscation about the categories of subjectivity and objectivity.

For EPR, as a typical example, there is an "objective reality, which is independent of any theory".[72] But is "objective reality" such an innocent, unprejudiced title for 'out there'? Isn't "reality" already implicated in an understanding of 'out there' *as* such-and-such, e.g. *as* matter moving around in space rather than, say, as the gods' playground? If "objective reality" is supposed to be "independent of any theory, and the physical concepts with which the theory operates," but nevertheless, "these concepts are intended to correspond with the objective reality", how is such a correspondence at all possible? And don't these concepts already inevitably involve a preconception, a precasting of reality that opens it to human understanding in the first place? If "the correctness of the theory is judged by the degree of agreement between the conclusions of the theory and human experience" and this "experience, which alone enables us to make inferences about reality, in physics takes the form of experiment and measurement", is not this mode of access to reality not already preconceived and hence massively prejudiced, namely, as the way in which the world shapes up for modern humanity via scientific method?

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72 EPR op. cit. p. 777.

There can be no physical experiment whatsoever set up without the basic physical concepts in terms of which the experiment is supposed to test what it is set up to test, for otherwise experimenting would be a blind, senseless action. Experimental measurements are always measurements of theoretically preconceived and precast 'quantities', such as mass, energy, momentum, position, etc., and this presupposes, and ensures, that the physical phenomena in question are amenable to a quantitative grasp. Such amenability is a 'correspondence' to reality that can never be experimentally tested, but, on the contrary, is a *positing* of a theoretical casting of 'out there' through which it becomes visible ('to theorize' means originarily 'to look at') *at all* to the human mind. Insofar, it is a misconception cherished by modern science to imagine that there is such a thing as "objective reality" independent of human subjectivity. Objectivity is *always for* a kind of subjectivity that has conceptually precast this objectivity *as* such-and-such, and human being itself is conceived *as* subjectivity only within a certain historical epoch, namely, our own Western modern age.

In the present context, the objective world out there is precast on the basis of the experimentally confirmed axiom that no physical motion (and hence no causal effectivity) can exceed the absolute maximum of the speed of light. From this results, first of all, Einstein's theory of special relativity which compels an interlinking of time and space co-ordinates in four-dimensional space-time. This theory stands aloof from quantum theory that posits an ultimate discrete quantization of all physical entities. The holy grail of theoretical physics since the 1920s has been to unify (special and general) relativity theory with quantum mechanics. One such partial attempt on the way to a so-called "Complete Theory of Nature" via a "Quantum Theory of Fields" is presented in Joy Christian's article 'Absolute Being vs Relative Becoming' (op. cit.) which introduces Planck-scale magnitudes as upper and lower bounds in order to demonstrate how time itself is causally generated by the movement of the physical world.

Whereas Einsteinian special relativity deals only with the motion of physical entities relative to different four-dimensional space-time frames of reference moving uniformly with respect to each other, Christian

introduces in addition the *internal movement* or *change* of physical systems moving within such co-ordinate frames of reference. Hence, in an oblique way, the perspective is widened from modern physics' intense focus on motion (or more precisely: locomotion, change of position) to consider also other kinds of movement covered by the Aristotelean conception of movement of four kinds, namely, change with respect to what (becoming and perishing), how (qualitative change), how much (waxing and waning, growth and shrinkage) and place (locomotion). The difference from the four kinds of Aristotelean movement/change is that, for modern physics, all movement has to be conceived in quantitative, mathematical terms, so that the internal movement of a physical system consisting of N particles is considered as a phase space of 2N+1 dimensions representing the dynamical variables of the particles, position and momentum, plus one-dimensional time, t. Christian therefore calls his proposed theory a "generalized theory of relativity", not to be confused with Einstein's theory of general relativity that takes into account gravitational force and accelerating referential frames. Through this generalizing extension, time itself comes to be conceived as depending mathematically not only upon change of position (expressed by the Lorentz transformation), but also upon the change in phase space of the physical system under consideration. Again, this has an oblique affinity to the Aristotelean conception of time, which is not absolute, as in the Newtonian paradigm, but derivative of movement. Time for Aristotle, namely, is the counting number resulting from counting physical change/movement, e.g. the time counted in months by observing the waxing and waning of the moon.

In Christian's generalized theory of special relativity (quantum special relativity) it is no longer motion taking place in four-dimensional space-time, but, more generally movement/change taking place in a 4+2N dimensional space-time-phasespace. Relativity now means that time is relative not only to a spatial co-ordinate frame moving uniformly with constant velocity v relative to another co-ordinate frame, but in addition to a uniformly changing physical system whose (rate of) change Christian captures with a further constant, ω (omega). The transformation factor between reference frames hence becomes more

complicated, depending now not only on v, but also on ω, providing that one assumes that, just as it is assumed that the upper bound for the rate of change of position is the speed of light, there is also an upper bound for the rate of change of the physical system itself, with this upper bound depending on limiting Planck quanta deriving from quantum mechanics. The speed of light, c, is itself a Planck quantum, namely, $c = l_P/t_P$, where l_P is the Planck length and t_P is the Planck time.

Christian makes a crucial move by noting, "In particular, the Planck time t_P is widely thought to be the minimum possible duration. It is then only natural to suspect that the inverse of the Planck time—namely $1/t_P$, with its approximate value of 10^{+43} Hertz in ordinary units—must correspond to the absolute upper bound on how fast a physical state can possibly evolve". This postulated absolute maximum rate of change is then incorporated into the (usual Lorentz) transformation factor between inertial reference frames (the square root of the expression $1/[1 - (v/c)^2]$), yielding a factor with an additional term dependent on both v and ω, namely, the square root of the expression $1/[1 - (v/c)^2 - (t_P\omega)^2]$, where v is bounded above by c, and ω is bounded above by the inverse of t_P. With this neatly symmetrical addition there results a mathematically expressible, mutual interdependence among time t, position vector $\underline{x}$, and phase-state vector $\underline{y}$. In particular, the dependence of t upon $\underline{y}$ implies that the change in phase state of the physical system, its movement, induces change in t, i.e. it efficiently causes the growth of time.

Christian points out as an argument in favour of his generalized theory that, "unlike in special relativity, in the present theory physical quantities such as lengths, durations, energies, and momenta remain bounded by their respective Planck scale values". A consequence of this boundedness, however, is also a quantization of the physical magnitudes of length and time, in particular, and hence a breaking up of the space-time continuum into discrete time-space elements. How is this to be reconciled with the "instant-states" of the phase space of the physical system, with the "instants of time", with the "infinitesimals" of change of state, change of position and change of time that Christian invokes at various points throughout his argument, not to mention the various acts of integration over infinitesimals of time? If one takes the assertion

seriously that "Planck time t_P is [widely thought to be] the minimum possible duration", which is crucial to Christian's line of argument, then how can there be any instant of time?

Note first of all that, if there is an absolute minimum time interval, there can be no "clock of unlimited accuracy", as Christian assumes in his reasoning. Secondly, if the time increment, Δt, cannot approach the limit of zero required for infinitesimals, there can be no differentiation or integration with respect to t. This may not be an insurmountable problem if infinitesmals and integrals are replaced by finite differences and sums thereof. Thirdly, and most fundamentally, if t_P is indeed an absolute lower bound, there is no way of pin-pointing a point in time, i.e. an instantaneous now, and hence there is an indeterminacy about both the external position and internal state of the physical system under consideration, for neither are instantaneous any longer. That is, there is no way of describing the physical system's dynamical state as a function of the real variable, t. The physical system is in a superposition of infinitely many dynamical states over the infinite continuum of the time interval, t_P, which is, although finitely bounded, also composed of a continuous infinity of real numbers. Thus, whereas classical quantum mechanics after Heisenberg posits a superposition of dynamical states at any given instant of time, now there is no longer even the possibility of pin-pointing an instant, and the indeterminancy becomes also temporal. Within the temporal interval t_P 'now' and 'then' are indistinguishable, and the physical system *quivers* or *wavers* in an indeterminancy with respect to both dynamical state and time. Time itself would have to be conceived as the complex superposition of infinitely many time quanta t_P (cf. *7.3 The phenomena of movement and indeterminacy in relation to continuity, discreteness and limit*).

If, on the other hand, one wants to retain temporal instants in a time continuum (as required by differentiation with respect to time), one is faced with another dilemma if t_P is to be the absolute lower bound for a temporal interval, for then, an extended space-time-state phase-space either will have an instantaneous state in which it is forever fixed, or it will never be in just one instantaneous state, but both in a state at time t and also in prospective states at times greater than $t + t_P$, i.e. it must

straddle the gap between now and then, and in a sense 'be' both in a present state now and future states then. Why is this so? If the physical system has a uniquely determined instantaneous dynamical state now, and its change is to be *continuous* in time, how can it change continuously if the next instant in time is separated from it by an interval of at least t_P? The physical system would be forever frozen in its instantaneous state. Alternatively, the physical system must have always already bridged the temporal gap and 'be' both 'now' and wavering infinitely in all potential future 'thens', each separated by an interval of t_P. In other words, being itself would then not be a matter simply of instantaneous being now, but also of prospective being then (and also of retrospectively having been back-then). If a system *is* simply in an instantaneous state, then it cannot move (continuously), cut off from a state at a quantum leap t_P away, and the universe is Parmenidean. For the universe to be physically moving, all physical entities must always *be* both in a now-state and also all potential prospective then-states, and movement itself would have to be conceived as the wavering of quantum indeterminacy (with one quantum state coming into focus, and then another) rather than as a change from one definite state at one point in time to another at a later point in time. Hence, no matter whether instantaneous time or a minimum time-interval is postulated, the result is the wavering indeterminacy of dynamical states of physical systems over both space and time.

This state of affairs, however, should not be described as Heraclitean as Christian does, for the ontology of 'everything is in movement' is untenable, as Plato already demonstrated (cf. e.g. *Sophist* 249b and GA19:488). If everything moves, there can be no unmoving 'ideas' which, in the present context, means that there could be no 'unmoving', steady fundamental concepts of physics such as mass, force, energy, position, etc. by means of which the movement of physical entities is theorized. Knowledge must have steady foundations, even if it is a knowledge of movement in its quantum indeterminacy. The λόγος of scientific knowing, even in advanced quantum physics, must be stable, i.e. well-defined, in its fundamental concepts which, in turn, are called to mind by any theorizing movement/activity of the physicist's mind.

If there is an indeterminacy in the dynamical state of the system together with a temporal indeterminacy as a result of the minimum time-quantum demarcated by Planck time, then there is no way to causally determine a future state of a system starting with an initial state now, for this initial now cannot be singled out and privileged as the governing principle effecting later states. Rather, a dynamic physical system *is* always already hovering in its present dynamical state *together* with the infinite multitude of potential future states which, however, do not depend causally in a unique, efficient way on the present state.

The λόγος of modern mathematical physics comes up against a limit in the Planck scale where the continuity of the physical universe gives way to quantum discreteness and therefore to quantum indeterminacy and indefiniteness. The infinitesimal calculus employed throughout modern mathematical physics since Newton breaks down on the Planck scale, becoming finitely very small where the infinitesimally small should really count. Is this a matter of an empirically validated scientific discovery, or is it an effect of the scientific λόγος itself in its essentially discrete nature which perennially raises, over and over again and in ever new phenomenal garbs, the ancient antinomy between the continuum and discreteness that points to an unsurpassable limit to knowing the physical, moving world? (Cf. Excursus 1 in Chapter 2.)

7.3.4 Excursus 4: On quantum computing and qubits (David Deutsch)[73]

A recent development in quantum physics (Deutsch 1985) opens up the prospect of employing quantum indeterminacy in computing with the aim of increasing the computing power of computers. Computability, or computing power, is the concern of complexity theory which deals not only with what is computable at all (Turing machine theory), but with how much time the computation takes. Quantum computing theory already shows that, if and when a quantum computer can be built, it will significantly reduce the computing time required for computational tasks

[73] Stimulation for this section came from e-mail correspondence with Rafael Capurro in August 2010.

(e.g. Grover's algorithm), thus, among other things, endangering the security of encrypted code which relies on decryption computations requiring enormous amounts of time, such as years and centuries, to crack a code.

Quantum computing goes hand in hand with a *quantum-digital cast of being* which postulates that physical reality is dissoluble ultimately into discrete quantum bits so that a "universal quantum computer Q" can be devised "which is capable of perfectly simulating every finite, realizable physical system". (Deutsch 1985 p. 103). The practical-technological objective of quantum computing research is to build a quantum computer that will be even more effective, i.e. faster, than a classical Turing machine in producing its computational result. In conceiving computation as a physical process and physical processes as computations, the theoretical ambition is apparent to conceive human thinking itself as computation and therefore materialistically as a quantum-physical process.

"Like a Turing machine, a model quantum computer Q, consists of two components, a finite processor and an infinite memory, of which only a finite portion is ever used. The computation proceeds in steps of fixed duration T, and during each step only the processor and a finite part of the memory interact, the rest of the memory remaining static." (Deutsch 1985 ibid.) In addition to the finite number of bits in the processor (Turing's machine states, conceived as equivalent to states of mind) and the countable number of bits in the memory, the universal quantum computer Q has specified also an integer "'address' number of the currently scanned tape location" (ibid.) which, of course, can be expressed as a binary number. The input into Q is therefore a ket-vector consisting of an integer memory address, the processor bits and the memory bits. These "*computational basis states*" (ibid.) form the basis for a Hermitian space H spanned by these "simultaneous eigenvectors" (ibid.). The initial input is transformed, algorithmically one finite step after another, by "a constant unitary operator U" on H. The difference from Turing machines is that Turing machines "are those quantum computers whose dynamics ensure that they remain in a computational basis state at the end of each step, given that they start in one" whereas

"Q admits a further class of programs which evolve computational basis states into linear superpositions of each other." (ibid.)

A state of Q thus admits in its processor and memory cells qubits, each of which is a complex superposition of |0> and |1> specifying a unit ket in complex two-dimensional Hilbert space. These superposed kets can also be rotated on the unit sphere in this two-dimensional Hilbert space. The complex superposition amounts to doubling the basic Turing machine. The more qubit cells in Q, the more the doubling into parallel-computing Turing machines. Since the content of each complex superposed qubit cannot be ascertained (an observable must give a real number), Q must be left 'in peace' in its quantum indeterminacy to complete its calculations until finally, after a finite number of unitary transformations of the Hilbert space of Q, the result is output as a computational basis state, which is simply a discrete binary number. As a computer, Q therefore moves from a binary input to a binary output, with many complex-superposed parallel Turing machines in between that are finally collapsed to produce a result. Insofar, quantum computing remains within the digital cast of being.

A qubit is a physical system, each of whose non-trivial observables is Boolean, providing just two observations, that can be coded as, say, 1 and -1. This can be interpreted as meaning that the physical system either has a certain property or not. The qubit's state itself at any time (i.e. finite countable computational step) is a complex superposition of both having the property and not having it. Only if the physical system has assumed, or has been prepared with, one of its eigenstates for a given observable is this ambiguity resolved for this observable, and the observed observable will always give just one of the real eigenvalues 1 or -1. Because of non-commutability, however, other Boolean observables on the same qubit, however, will be a genuine complex superposition of basis states, and the hovering ambiguity will remain: the qubit as physical system both has the property and does not.

This unwittingly retrieves Plato's dialectic in *The Sophist,* according to which any being that can move is, in a certain way, also what it is not. A movable/changeable being is a μὴ ὄν, and a μὴ ὄν, or non-being, *is* in a certain way. This perplexing ontological insight into changeable being

is also at the heart of Hegel's dialectic: every being *is* also its negation. The decisive difference from quantum-mechanical computing is that, whereas quantum mechanics must resort to postulating 'many worlds' or, in the case of a qubit, dual worlds at any given real time t — viz. the one in which the property is present and the other in which its negation is present — as we have seen (*2.9 Time and movement in Aristotle's thinking*), the Aristotelean solution in the *Physics*, which builds upon Plato's, is to conceive any physical, movable being as a superposition of its present state and the absence of the state(s) toward which it is potentially under way (cf. *7.3.1 From antinomic discrete vs. continuous real time to complex-imaginary time*). This solution is only possible because, in contrast to quantum physics, for which only the real time of the *present* instant *is*, the Aristotelean insight means that future time, which is not yet present, also *is* in its own way in being withheld in absence.

7.4. A mundane example to help see movement in three-dimensional time

> It always bothers me that according to the laws as we understand them today, it takes a computing machine an infinite number of logical operations to figure out what goes on in no matter how tiny a region of space and no matter how tiny a region of time. [...] I have often made the hypothesis that ultimately physics will not require a mathematical statement, that in the end the machinery will be revealed and the laws will turn out to be simple.
> Richard P. Feynman *The Character of Physical Law* 1967 p. 57.

To see the phenomenological point more clearly and to complement the above considerations from 'inside' quantum mechanics, let us take an example 'outside', from everyday life, that allows the phenomena to be seen without theoretical constructions obscuring the view. This is

necessary because examples from physics are construed from the outset within the mathematical theoretical terms through which physics attempts to calculably grasp the phenomena of movement. Suppose, mundanely enough, I am in the kitchen chopping an onion on the chopping board for the evening meal. Both I and the onion are in movement, not merely in motion. I am chopping the onion to put it in the frying pan that has been heated on the hotplate of the electric stove. I have also got some other vegetables, such as carrots, potatoes and mushrooms, around the chopping board which similarly will be used to make the evening meal. The onion in its movement has come from the onion basket in the pantry, and will continue its movement into the frying pan once it has been chopped. The chopping itself is a kind of movement that changes the onion and does not simply shift its place, as in the case of motion, but its form — into chopped onion. Although the potatoes are presently at rest on the kitchen table, this state of rest is part of a movement from where the potatoes have been in the potato basket in the pantry to their likewise being peeled and chopped and ending up in the frying pan, or in a saucepan to boil and later to be mashed. As the cook, I know where the onion and the potatoes have come from, and I also know where they are going, even though I may not yet have decided whether to sauté or boil the potatoes; they could also be grated and turned into a crisp, fried potato pancake. The future movement of the potatoes is therefore to this extent indeterminate, or open, with a finite spectrum of potential, depending as it does on me, the cook, as mover, and on the ends I set. Therefore, in my cooking activity I have past, present and future together implicitly in view, for otherwise it would be impossible for me to engage in this activity, this everyday movement.

Now suppose that I have finished chopping one half of the onion and have put it in the frying pan when the phone rings, and, after turning the hotplate down to low, I go out of the kitchen to answer it. The other half of the onion is left lying on the chopping board, and I leave the light on in the kitchen. While I am on the phone, my wife comes looking for me in the kitchen, for that is the place where I usually am at this time of day. What she sees is the half onion lying on the chopping board, the other vegetables on the table around the chopping board, the already chopped

onion frying on the stove at a low heat. My wife does not merely see a present state at an instant of time, but sees the movement of cooking, even though it is presently at rest. Without knowing the details, she sees where the onion has come from, namely, from its usual place in the pantry, and she sees where it is headed, namely, either into the frying pan or into the fridge to be used tomorrow. She also sees the movement of the potatoes, carrots and mushrooms, whence they came and whither they are going, although it is indeterminate what future awaits them from a finite spectrum of possibilities. She doesn't know whether the potatoes will be peeled, chopped and added to the onion in the frying pan, whether they will be peeled and then boiled in a saucepan and finally mashed, or whether they will be peeled, grated and fried separately. A description of future possibilites in terms of real space-time co-ordinates, which are of their nature uncountably infinite, would be an instance of exact-scientific overkill.

She also sees my absence. My absence is present to her. But not only that. She sees where I have been a short time ago and she sees where I will be coming back to in a short time, namely, the kitchen. So she sees, in the present, but as an absence, both my past and future movement. She also sees where I am at present, albeit indeterminately, namely, somewhere else in the flat, probably in my office or in the bathroom. All this she sees 3D-temporally by viewing the situation of movement at rest in the kitchen, with the onions simmering at low heat on the stove, the other vegetables ready for being prepared for cooking, and so on. She takes this situation in at a glance and understands it without having to make explicit her perceptions and draw syllogistic conclusions from them. The situation she understands is one of movement involving me, onions, potatoes, carrots, mushrooms, the stove, etc. The presence, past and future of the movements in the situation are understood, albeit indeterminately, but within the three temporal ecstacies that are taken for granted by understanding. She sees at a glance that the chopped onion is on its way to its future in which it will be part of an evening meal, and she sees that I will soon be coming back to the kitchen, i.e. that that is the future destination of my movement in the short term, and that soon the evening meal will be on the table. A stranger to our flat, such as a

burglar, would also understand the situation of the empty kitchen as one of various movements associated with cooking and also that the cook will soon be coming back to the kitchen, but the burglar's understanding of the past and future movements of cooking ingredients and the cook would be more indeterminate than my wife's because he is not familiar with the particularities of our household world.

My wife needs no laws of physics to predict and precalculate either my movements or the onion's. Such laws of physical motion are not only superfluous, but also useless for understanding the movements comprised by the situation. If applied, such laws of physical motion, especially laws of quantum mechanics, would only obfuscate through a theoretical construction laid over the phenomena. The situation and its movements are understood already, and with a certain indeterminacy, before any scientific physical view of it could ever be formulated by reducing its everyday context and meaning to get an entirely artificial situation involving entities conceived of as extended in some fashion and subject to various force-fields amenable to mathematical formulation. In other words, the scientific physical description of the situation can only make us dumber than we are as beings at home in a world which we always already understand and to which we are attuned. To treat the situation in the vacant kitchen as a physical system in a certain classical or quantum state to which certain dynamical variables apply would indeed generate a mathematical problem in physics, which may or may not be soluble, determinately or otherwise, but the imposition of the mathematical physical problem would obliterate the situation itself and make it not only altogether incomprehensible but also entirely invisible. The situation itself, involving movements in the timespace of our shared household world, would have dropped out of sight. That is indeed the danger of the modern scientific mode of access to the world, that it bamboozles us with ideas bearing the hallmark of scientific seriousness and backed up by powerful institutions of learning premised upon scientific method as self-evident.

A physicist might object by asking whether we are to be content with the mere description of a banal situation as given above as all we can hope for, as opposed to digging deeper into the phenomenal situation to

uncover its fundamental, underlying laws of motion. Surely, he would say, we can do better than merely reiterate a trivial description of a banal situation. The response to this objection is that the above is not merely description, but lays bare (an aspect of) the inconspicuous temporal structure of the world we human beings inhabit and which we simply take for granted. Expressly noticing how and that we perceive movement itself as stretched out into three temporal dimensions in a logic-defying unity must be a cause for wonderment and the starting-point for an explicit phenomenological ontology. How is it possible that in a situation of rest we can see movement? And yet we do without thinking twice about it. Any movement taking place takes place in both space and three-dimensional time. The determinacy or indeterminacy of movement is a phenomenon that can only occur within this time-space in the transition from the present to the future, from here-and-now to there-and-then, or from the past to the present. Moveover, the future there-and-then is present as an absence in the present situation, a perplexing circumstance. What is as yet withheld from the here-and-now is nevertheless present, albeit to a greater or lesser degree of indeterminacy.

Once this is seen, it would be folly to assume as a matter of principle that there are laws of movement, whether known or as yet unknown, governing this transition in every case and for every kind of movement. And yet, modern physics believes that, in principle, it has within reach the ultimate truth about movement and change for *all* that is, encapsulated in fundamental, mathematical physical laws of motion. It has been digging itself into this hole since the seventeenth century. By contrast, on the basis of a phenomenological insight, we should not be surprised that in the attempt to formulate mathematical laws of motion, modern physics strikes upon an indeterminacy that challenges the universal validity of a rigorous principle of efficient causality.

There is a reluctance among today’s scientists and analytic philosophers to seriously and radically pose the question concerning time, even though it is clearly on the agenda. Nevertheless, philosophically it is time for dissidents to raise their voices against the

regime of modern science that has been in power for well over three hundred years.

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