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HUSSERL, LONERGAN, AND PARADOXES OF MEASUREMENT

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Best wishes to Phil McShane on his 70th! His range of interests and expertise in both the natural sciences and in the work of Bernard Lonergan provide a special link between us – not to mention, of course, Joyce and the ancient Celtic myths that underlie our cognitional method, whether or not Lonergan has a prime numbering for these! As for implementation, let’s see!

My scientific field is theoretical physics.[1] My philosophical orientation is phenomenology, especially hermeneutical phenomenology, as modified and extended under the influence of Bernard Lonergan’s cognitional theory.[2] In fact, I was al-

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[1] During my post-doc at Princeton, I came under the influence of Eugene Wigner who always referred to himself as a chemical engineer. He was the founder of the group theoretic formulation of the quantum theory. Among my publications, those that are most relevant to the philosophy of chemistry, as I understand this from my very limited reading of this new field, deal with (1) quantum logic (Heelan 1974, 1979, 1983a/1987), (2) the group-theoretic structures of observational data (Heelan 1988, 1989a) and thus, (3) the praxis-ladenness rather then the theory-ladenness of scientific data (Heelan 1989b, 1997, 1998, 2002b, 2002c, 2002d). I find myself now in critical dialogue mostly with the work of Hans Primas (Primas 1983) and Harald Atmanspacher (Atmanspacher and Primas 1997). I have great admiration for the views of Primas, tempered, however, with criticism; admiration for his long-term strategy of not excluding the subjective dimension from his analysis of natural science and criticism that he did not pursue this topic further than he did and with philosophical resources, such as the work of Husserl, that were surely available to him. I want especially to thank Jaap van Brakel whose book raised my awareness of the differences between physics and chemistry (Van Brakel 2000).

[2] Phenomenology is a tradition of thinking that has scarcely been applied to the philosophy of natural science, for historical and cultural reasons

ready deeply under the influence of Bernard Lonergan's work before I went to Louvain/Leuven to study phenomenology as a propaedeutic to my preparation in the philosophy of science. The specific topic of this paper is one close to the center of Philip's interest, namely, to articulate the right balance among theory, experiment, and what Husserl called '*die Sache selbst*' or the 'givenness' of scientific objects as experienced and understood. The method I shall adopt is that of Husserl's phenomenology of perception, as modified by Lonergan's method of 'self-appropriation.' I will be concerned then with the 'constitution' of experimental data in science – any science.[3]

How data are 'given' in scientific inquiry was much in dispute in the 1950's and 60's when the positivism of the Vienna Circle was challenged by a new generation of philosophers, such as W. Sellars, who showed that the observational 'givenness,' even of a 'pink ice cube,' no less than a scientific 'datum,' is 'laden' with 'theoretical concepts.' The

connected with the aftermath of World War II. Lonergan's acquaintance with *phenomenology* came from a meeting he attended of phenomenologists at Louvain, Belgium, in 1951. This meeting stressed the existentialist side of phenomenology, supported at that time by Louvain. Lonergan did not on that account become familiar with Husserl's interest in the natural science which was not on display at that meeting – see *CWL 5*, 41. The dominant school of the philosophy of science after WW II was led by logical positivism, then by logical empiricism. The source of this influence was principally the Marburg School of Neokantian philosophy, to which Carnap, Cassirer, Felix Cohen, and others belonged (Cf. Primas, 1983, also Friedman, 2000). Presently, logical empiricism – and with it the philosophy of science – is in great disarray, so there is an urgent need to broaden the philosophical understanding of natural science.

[3] The term 'constitution' is a technical term with Husserl. An object 'constituted in perception' means that it is structured by the perceiving subject 'intentionally,' that is, for the purpose of presenting to the perceiver a named (or nameable) object of perception different from and over against the perceiving subject. Note: scientific and functional orderings can be incompatible with one another, consequently there is only a contingent connection between the scientific and the functional orderings; for instance, a hammer, even though it may have the geometrical and other technical specifications of a hammer, is a hammer essentially and eidetically only because it actually serves the purposes of a hammer (see Husserl 1960, 1983, 1989).

notion of physics was also changing at that time from a predominantly positive experimental science to a predominantly theoretical science led by Platonic ideas under the leadership of Einstein, Heisenberg, Pauli, and other followers of the University of Göttingen on the mathematizing of physics.[4] Since the 1960's there has been a consensus among philosophers of science on the 'theory-ladenness' of data. I will show in this analysis that, not one, but two theories are involved in the constitution of a datum. The two theories are isomorphic and can be expressed group theoretically. One applies to the *observer as a noetic* agent, that is, as a perceptual knower; the other applies to the observed as a *noematic* object, that is, as an experimental datum. Of these theories, the one familiar to the philosopher of science is the theory of the scientific object. The other theory is a theory of the scientific observer's essential contribution to the phenomenological constitution of data. This study will show that neither theory in fact plays a definitive role in the constitution of data. These are instead praxis-laden. Such a conclusion would also coincide with that of Primas and Atmanspacher (see references).

In this paper and with respect to terms, by 'object' I mean principally a scientific datum. This is an event occurring usually in the laboratory that manifests to an experimenter the local presence and measure of a named element belonging to a scientific explanatory account, that is, of a datum as distinct from, say, just experimental noise. Other terms for this are a 'scientific phenomenon,' or a 'measurement event'; all are local, particular, observed, described in scientific terms, and recorded by an experimenter. However, 'object' may also at times be used to refer to an abstract conceptual object such as a term of a theoretical model; the context of the discourse will tell where this is so.

The starting point for my reflection is an application of Husserl's eidetic phenomenology of perception to measurement in physics.[5] From this I go on to the analysis of data

[4] See Sellars (1963), "Philosophy and the Scientific Image of Man," 1-41. For 'observational givenness' in physics, see Primas and Atmanspacher on 'intuition'; Atmanspacher and Primus (1997); Primas (1984), p. 32.

[5] I have listed in the references some relevant titles from my published

constitution, and thence, to establish two theses to be stated below. These theses are basic then to cognitive science. They are also philosophical theses applicable, I claim, to any science based on the theoretical understanding of data.

Thesis I: In classical physics, there are, contrary to its mainline tradition, basic 'uncertainty principles' for scientific data or phenomena that are analogous to those of quantum physics. These are due to the overlooked 'entanglement' of the observer and the observed in the phenomenological constitution of a scientific datum using measuring instruments, and possible 'complementarities' in the dynamic interplay of *noesis* and *noema* in relation of observation in the process of measurement.

Thesis II: A quantum object exists and functions as ontologically prior to and independently of the constitution of everyday or classically scientific perceptual space-time(s).

Understanding Measurement

Husserlean phenomenology is both a phenomenological psychology and a philosophy of what is 'given' in perception. It claims to be both a 'science' and a 'scientific philosophy' (cf. Husserl, 1960). I argue that by the term 'scientific' Husserl meant scientific by the standards and models of the mathematical physicists who were his contemporaries and colleagues in the Faculty of Philosophy at Göttingen in the early decades of the 20th century. These were the leaders who helped to transform the conception of physics in Germany and later in the larger world during the first half of the twentieth century from that of a principally experimental science in the 'Baconian empirical' tradition to that of a principally mathematical-theoretical science in the 'Newtonian rationalist' tradition. This transformation involved a change in the perspective from which scientific data were understood. Data once interpreted as positive facts came to be re-interpreted as theoretically-based facts. In this transposition, the influence of the Göttingen school of mathematical physics was paramount. This school of

papers. A complete list will be found on the web site, www.georgetown.edu/heelan. Heelan (1983a/1987) is an early attempt to deal with these problems on the broadest scale; see also Heelan (2002a).

natural science stemmed from Gauss in the 19th century. Through the geometry of Riemann and the algebra of Lie it came to see physics as a set of mathematical models. 'Physics,' said David Hilbert in 1901, 'was too difficult for physicists, they needed the help of mathematicians.' Besides philosophers, the Faculty of Philosophy in Göttingen at that time also housed natural philosophers who were mathematicians and physicists. Among them were David Hilbert, Felix Klein, Richard Courant, and Emmy Noether (see Heelan 1988, 1989a, Petitot 1999). These were all distinguished leaders of this movement. They were later joined by Einstein and Heisenberg, the two currently most identified with the transformation of physics – and by analogy, the very notion of science – into a branch of mathematics.

Husserl was trained in mathematics as well as in philosophy. He taught philosophy at the University of Göttingen from 1901 to 1916. The new notion of science as tied to mathematical models gave a special privilege, first, to geometry where group theoretic invariance and covariance reigned and, secondly, to the algebra of Lie groups. Influenced by the intellectual and scientific environment, Husserl set about trying to cure the positivistic crisis in the philosophy and psychology of his time by re-doing psychology and philosophy on the model of Göttingen science. Following his earlier works, *Logical Investigations* (orig. pub. 1900 and revised in 1913), and *Ideas I* (orig. pub. 1913) and *Ideas II* (orig. draft. 1913), there came the mature works, *The Crisis of European Sciences* (orig. draft 1936) and his *Cartesian Meditations* (orig. 1929) in which he claimed that phenomenology was to be a 'scientific philosophy.' I believe one must read his project as attempting to marry the new definition of science as mathematical and group theoretic with the notion that science had to be essentially about phenomena, i.e., data as perceptual objects.[6] His clue probably came, I think, from the phenomenological solution of a simple question: how can an extended body 'given' in perception be modelled as a covariant spatial structure of the perceptual space-time group? Such a theory would preserve the

[6] I realise that the use of group-theoretic considerations is also taken to be an important step by chemists and chemical engineers.

form invariance (covariance) of the object-(as-imagined-or-perceived)-in-space-and-time under the space-time transformation group of motions in (imagined-or-perceived-space-time). Assuming that there was an evident isomorphism between the objective ('real') world of things in public space and time and the normative 'given' intuitions of the embodied self (the observer) and phenomena (the observed) as stable and independent 'things' covariant relative to a common and shared perceptual spatial and temporal environment. This gave birth then to phenomenological psychology and to phenomenological philosophy.

What is perceived in science are data. So phenomenology can claim to be a scientific philosophy of scientific data. I will be concerned with the phenomenology of measured data. While this may seem to narrow the notion of experimentation and to fall short of giving recognition to other traditional modes, say, of chemical or biological experimentation based more on the observation of quality-changes than of quantity-changes, the argument to follow holds for quality-changes too.

The theoretical model, of course, purports to 'represent' the real individual perceptual object. This is an empirical, not an abstract, object; it is an intuited sensible particular object, an observed datum seen locally in and against the background of that part of the lived perceptual world that is the laboratory. The perceptual object or datum and its theoretical model are then two different objects; one is something presented to the experimenter in the perceptual world of the laboratory, the other is a mathematical model that purports to reflect accurately the bare objective structure of the former in abstract non-intuitable terms. We ask: with what justification or within what limits do we 'equate' – if that is what we do! – the scientific model with the scientific phenomenon? The question may sound odd to scientific ears because scientists by their training orient their thinking and reasoning objectively, as it were, within just one perspective, that of a universal impersonal viewpoint that privileges theory. In keeping with this perspective, they use the same scientific term for the particular phenomenon and for its theoretical model almost as if these were the same entity. This practice is disturbing because, to use possibly an extreme example, it risks confusing, say, Number 10 Downing Street with the number, here 10, within the numbered system used to number the houses on Downing Street which may tell you nothing about what it is that is most important to know, namely, that it is the British Prime Minister's official residence. These two numberings belong to different categories. Clearly, some kind of explanation is necessary of how we observers use measurement to link mathematical models with given practical scientific objects, such as data. Going to Husserl, we find an answer in his analysis of perceptual objects in a series of his works, notably in the *Cartesian Meditations*, and a parallel one for scientific objects in his posthumously published work, *The Crisis of European Sciences and Transcendental Philosophy* (Husserl 1976). Let me briefly summarize what here is essential to our inquiry.[7]

Husserl asks: what is involved essentially in perception? When we see, hear, feel, smell, etc., something; that something manifests itself as a stable something by and through a multiplicity of potential appearances or (what he calls) '*Abschattungen*'.[8] We usually translate this German term either as 'appearances (of something)' or 'profiles (of something).' Literally, *Abschattungen* means 'a shadowing forth (of something).' We recall Plato and the Myth of the Cave! We never see a perceptual object as a simple unity, but as a unity distributed over an indefinite multiplicity of ways of appearing in typical situations. The ancient Greek philosophers were puzzled by sensible objects because their appearances changed dynamically all the time while nevertheless being recognised as manifesting one stable and unchanging object. Husserl was the first to note that sets of appearances constituted continuously connected sequences that could be sampled and controlled by the perceiver's movements or actions in relation

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[7] See Petitot (1999) or Heelan (1983a/1987, 1989a) for a more technical account.

[8] In this paper the term 'appearance' will have the sense of Husserl's term '*Abschattung*' which implies a 'shadowing forth' of some to-be-found perceptual object. This process may or may not be successful; when successful it will be an '*Erscheinung*.' There are terms in English to express this difference in connotation. Other terms more or less synonymous with 'appearance' are 'perspective' and 'profile.'

to the perceived object, and that there could be an infinite variety of such sequences. He noted conversely that the object could independently manifest different sequences of appearances to a perceiver as it was moved in relation to the perceiver. He concluded that the relative movements of observer and observed were connected in perceptual space and time in a way analogous to the inhomogeneous Galilean transformation group of the space and time that perceiver and perceived shared.[9] His essential point was that the same identical space-time transformation group governs (1) the possible movements and acts of the subject whereby the object is constituted in the subject's perceptual space and time and (2) of the object as constituted within the common worldly space and time that they both inhabit as bodies. Whether the subject moves independently of the object in perceptual space and time or the object moves independently of the subject in their common worldly space and time, both in accordance with the same group, the same identical object shows itself to the observer in the observer's perceptual space and time, and is located in the common worldly space and time that their respective bodies inhabit. Husserl was thus able to claim that perception was made possible because the perceiving subject and the perceived object were linked by an essential condition, namely, the exis-

[9] Physics recognises three different physical space-time transformation groups: the Galilean group characteristic of Euclidean geometry (assumed by classical mechanics), the Lorentz group (assumed by Maxwell's Equations and Special Relativity), and the Continuous Group (assumed by Gravitation and General Relativity). While it is generally assumed that Euclidean scientific space-time is the unique idealisation of perceptual space-time, Heelan (1983a/1987) has criticised this assumption claiming that perception and pictorial space, unassisted by physical techniques of measurement, is better described by the family of hyperbolic Riemannian geometries. These are incommensurable and incompatible spatial orderings. Although Euclidean geometry is taken to be the normative model for perceptual/scientific objects such as crystals, plants, colours, etc, it is often (mistakenly) taken to be essentially (or eidetically) normative for such objects. Two dubious assumptions tend to lead to this conclusion: (1) that classical (measurement dependent) objects are simple idealisations of perceptual objects, and (2) that Euclidean space-time (based on rigid rods and standard clock measurement) is a unique idealisation of perceptual space-time. See Husserl (1960).

tence of a space-time transformation group common to both subject and object as covariant perceiver and as covariant perceived in the space and time both of the perceiver and of the public shared scientific world.

So far, so good! What the explanation so far given lacks is the capacity to explain the fact that the observer constitutes a single perceptual object – a datum – as out there spatially in the public world and as other than and independent of the act of constitution whereby the individual observer-subject posits the observed object in perceptual space and time. This capacity of human observers to constitute stable perceptual objects that are constituted by the act of observation while being presented as public fact is a primitive, given, ontological, human capacity. According to Husserl, it is the capacity for 'objectification,' also called 'intentionality,' that is a universal condition of possibility of all human inquiry into the world. An object so objectified is said to be present to the perceiver by its perceptual '*eidos*' or 'essence.' Such '*eidoi*' are retained by the subject as concepts and used habitually for recognition, description, and categorisation. Their existence supposes the possession, construction, and retention of these '*eidoi*'; they seem to play the role that 'schemata' play in Kant's philosophy, mediating between concepts and sensible intuition. Husserl called the subject's constitutive activity in perception '*noesis*.' This probes the environment for objects and gives meaning to group-theoretic invariants of sets of possible appearances according to an implicit dynamic plan or 'schema' structured by the space and time transformation group of the perceived world. Husserl called the object's self-manifestation in the world according to its eidetic form, the '*noema*,' or the 'object normed by its proper set of ways of appearing.' To what extent the activities of *noesis* and the discovery and constitution of *noemata* are historical, developmental, and potentially creative is a question to which Husserl and Heidegger gave different answers: Husserl chose fixed transcendental a priori norms for both *noesis* and *noemata*; Heidegger chose to take the historical and developmental view (cf. Petitot 1999).

Data: Are they theory-laden or praxis-laden? By abstraction or interpretation?

It is a truism in the philosophy of science that 'all scientific data are theory-laden'.[10] This phrase was originally coined in the 1950's by N.R. Hanson (Hanson 1958) to refute the then widespread view that data, qua perceptually given, were intuited facts, free of interpretation; these then were only subsequently networked by a theory. He showed that scientific data made no sense antecedent to theoretical relationships that mutually define their theoretical scientific essence. As far as the logical analysis goes, so far, so good! But what about a phenomenological analysis of data? How do practical data fulfil this logical analysis? How are thought and perception put together? One answer is that the logical analysis is an 'abstraction' from what is already there displayed in the practical data and achieved by eliminating the merely irrelevant from consideration. But the elements of most scientific explanations are not displayed in the original 'given' to be then separated out by analysis; they are produced with the aid of elaborate technologies in a special laboratory environment that is designed by theory. Data are what are 'given,' not at the beginning, but at the end of a piece of basic research; they are understood as phenomena only when the research is completed. Hence, philosophical reflection begins only at the end when the phenomenon can finally be presented to the philosophical inquirer for his/her reflection. Its aim is to understand the phenomenon in terms of how it is constituted as an object of human scientific knowledge. This is what Husserl means by phenomenology as being a science.

But is the phenomenon first given in the form of a rich chaotic background from which data are then 'abstracted' by disregarding what is already present in the background but

[10] In the practice of science, the term 'theory' usually implies a model insofar as it is related to the world, and one needs to be reminded that within the model the relationships are mathematical while within the world, and between the model and the world, the relationships are just factual. There is much confusion in scientific and philosophical literature about this, particularly where science is viewed from a Pragmatist perspective (see Heelan with Schulkin, 2002c). See also Heelan, especially Heelan (1997, 1998, 2002c), on the praxis-ladenness of scientific phenomena.

irrelevant to the inquiry? Or is it something new, produced by human theory, practice, and objectification? And if the latter, is it just an artefact of human invention, perhaps, a whim? Or does it present itself as something discovered in the world as there but hidden prior to human science, an object long concealed and now revealed for human acceptance, contemplation, and cultural use? It is this last. It is an object in the world long concealed as to its possibility and now revealed in human culture for human acceptance, contemplation, and cultural use, not by 'abstraction' but by 'interpretation.'

How does an observer come to recognise in the given outcome of a measurement the discovery and presentation of a new stable object in the lifeworld of the experimental laboratory? The answer seems to be that we *learn* to do this. Having learned to do this, a well skilled experimenter is capable of accepting a scientific datum unquestioningly, often on the occasion of just one measurement, that is, of one glimpse of what he/she then unhesitatingly pronounces to be there in the world. Such an observer experiences a 'given,' or what Husserl calls, '*die Sache selbst*,' and Primas calls, an 'intuition' of a scientific object. We have this experience ourselves every day with things familiar to us. For example, we glimpse a familiar face ahead of us, we recognise it, and immediately get ready, say, to greet the person in question. However, if a moment later the familiar face turns out to be just a life-size cardboard snapshot, we would quickly know that we were mistaken because the view turns out to be immobile and singularly flat. Now, one single measurement is no more than a single snapshot of something that could, like the life-size cardboard snapshot, turn out to be something quite other than what at first sight it appears to be. We can compare this situation with the duck/rabbit illusion. At the intersection of a particular set of duck images and a particular set of rabbit images there is a single image that coincidentally has the possibility of belonging to the two series of images and so can serve two purposes equally. This illusion illustrates the existence of underlying subjective cognitive structures operating in ordinary perception. A skilled experimenter has developed a similar subjective cognitive structure for the laboratory measurements with which he/she has acquired familiarity and skill. Such hidden structures of measurement exemplify a theory of that which in the measuring subject underlies the praxis of measurement, a cognitive structure that leads the skilled observer eventually to treat the outcome even of a single measurement as praxically a 'scientific datum.'

Husserl wanted to tie down philosophically and scientifically the theory of such intuitive givenness. While Husserl asked the question of everyday perception, I am asking it of measurement. Both experience the 'givenness' of perceptual objects, everyday in one case, scientific in the other. Both are given as stable objects revealed as present both in intuitive sensibility and in the public world only through infinite manifolds of possible appearances structured in such a way as to reveal the presence of a single stable object both in the space and time of the experimenter's sensible intuition and of the public world. It is through this multiplicity of quantitative and qualitative appearances that we come to recognise (what Husserl calls) the 'core meaning' of the kind of worldly being that is 'shadowed forth' in perception.

Revisiting for a moment the seeming truism that scientific data are 'theory-laden', and given now that there are two theories in question, one for the observer and the observer's perceptual space and time, the other for the observed datum in the public world, we can ask: to which does this truism refer? My answer is, to neither, for the recognition of a measured object always occurs in the lifeworld as a contingent empirical act dependent on experimental skill, the discernment of 'all things being equal' in environmental circumstances, and the assessment of the purpose of inquiry. Data then are primarily praxis-laden, based on measurement and on their circumstantial 'givenness' or 'intuitiveness,' that under doubtful circumstances is checkable with reference to the two theories just mentioned. I wish to point out that these conclusions belong to the genre of philosophy; not just sociology, history, psychology, anthropology, or empirical cognitive science. Similar views have been expressed by Hacking (Hacking 1983), Latour (Latour 1987), and some others, but not argued on ultimate philosophical grounds; argued, however, on social science or common sense grounds.

Before going on to discuss the paradoxes of measurement, let me summarise where we are with Husserl's scientific philosophy of the constitution of a phenomenon as reconstructed for the purposes of this inquiry: *A phenomenon is a perceptual object that is displayed in the dynamic world of perception by a multiplicity of continuously connected appearances which, where measurement is involved, are data. Data are stable appearances of stable scientific objects. The multiplicity of appearances or data is generated by a noetic-noematic intentionality-structure guided by a group-theoretic set of practices satisfying the empirical condition that the phenomenon is maintained in conscious awareness as of stable form under the dynamic variations produced by these practices. These practices follow and contingently fulfil an explanatory model in which the practices are taken to be group theoretic representations of the group of space-time transformations that constitutes the relevant model for the perceptual space-time in which the scientific phenomenon is presented in measurement to skilled scientific observers. The stability of the phenomenon given in perception is then explained as the object constituted by the group-theoretic set of transformations among the multiplicity of its appearances or data. This account also supposes that a phenomenon is always foregrounded against a wide range of backgrounds where 'all other things are equal.'*

Paradoxes of Measurement, Thesis I

Using this analysis of scientific phenomena and data, I will briefly summarise two fascinating but paradoxical philosophical principles about the natural sciences to which they lead. They are the 'Paradoxes of Measurement' mentioned in the title of this paper.

Thesis I. Classical Uncertainty Principles

The first thesis is about the existence of some basic similarities between classical phenomena in natural science and quantum phenomena, such as 'Uncertainty Principles,' 'entanglements,' and 'complementarity.'

To explain what this thesis means: consider two individual experimenters or observers in a suitable laboratory context. S_1

is a first-person observer, and S_3 is a third-person observer. They are looking at the same measurement process but from different perspectives. S_1 is the individual skilled experimenter who is observing the scientific datum, a datum of O; he takes a certain response of the measuring instrument M as manifesting the present of O under a certain quantity given by the measurement. S_1 makes a report, a report of a first-person witness to an event. S_3 is someone who is observing S_1's engagement with the physical process of measurement; S_3's is a scientific eye blind to S_1's interpretive perceptual act. S_3 sees only M, the measuring instrument in its physicality as a construction of metal, plastic, etc., wired as a physical process, and, of course, S_1 as a physical body. S_3 could be a engineer, a social scientist, a cognitive scientist, or even a skilled experimenter attending just to the experimental setup. S_3 makes a report, a report of a third-person witness to the physical process of measurement.

$$S_1 \quad M \quad O$$

$$S_3$$

Figure 1

Figure 1 just lists the two subjects, S_1 and S_3, and the two possible perceptual objects, M and O, each given through one of a set of its appearances without 'entanglements' deriving from perceptual relationships.

(S_1 + M) *observes* O (but M is NOT an object for S_1)

Figure 2

In figure 2, S_1 observes O, the measured datum; the measuring instrument M is in this case a functional part of the operating subject S_1 since it brings into play the measured datum through which O makes its appearance to S_1 in the laboratory.

S_3 *observes* M (but O is not an object for S_3)

Figure 3

In figure 3, S_3 observes M in one of its appearances, but O is not present to S_3 because the one appearance of M that could be taken as evidence of the measured datum O cannot be at the same time both an appearance of M and an appearance of O to the same observer S_3. The reason for this is the same as that given for the duck/rabbit illusion; the ambiguous image cannot be seen at the same time as an image of a duck and as an image of a rabbit because an object is perceived only if the entire range of its connected appearances is virtually present through the dynamic noetic-noematic schema in which objective information is virtually exchanged between the observer and the world. This relationship is a kind of dynamic hermeneutical 'entanglement' between the observer as a noetic agency and the observed as a noematic responder.

Analogy with Quantum Physics

The analogy between classical physics and quantum physics can be pursued further. Let the dynamic world of multiperspectival classical human perception be modelled by a Hilbert space Ψ where the states of the dynamic world of perception are represented by vectors in this space. Let S_1 and S_3 generate projection operators, $P(S_1) = P_1$ and $P(S_3) = P_3$ on the space Ψ. P_1 generates $P_1\Psi$, the subspace of Ψ that represents the dynamic world of S_1's perception, call this $\Psi(O)$. P_3 generates $P_3\Psi$, the subspace of Ψ that represents the dynamic world of S_3's perception, call this $\Psi(M)$. The subspaces, $\Psi(O)$ and $\Psi(M)$, are theoretical representations of the empirical scientific noetic-noematic perceptual horizons of S_1 and S_3 respectively in the Hilbert space representation of the dynamic world of multiperspectival human scientific perception. In the subspace $\Psi(O)$, O is represented as an object but not M; in the subspace $\Psi(M)$, M is represented as an object but not O. Thus, the subspace $P_1P_3\Psi = P_1\Psi(M) = \Psi(O)$ contains O but not M, while the subspace $P_3P_1\Psi = P_3\ \Psi(O) = 0$ contains neither M nor O. Forming the commutation operator $[P_1P_3 - P_3P_1]$, we find that the commutation operator

$$[P_1P_3 - P_3 P_1]\Psi(O) = \alpha\, \Psi(O)$$

where α is some scalar parameter. The commutation operator therefore is not zero. It preserves the form of $\Psi(O)$, and is the basis for a formal analogy between classical physics and quantum physics.

The formal analogy is between pairwise phenomena of classical physics and pairwise phenomena of quantum physics. This analogy becomes apparent only when it is understood that data recognition assumes an identical unconscious group theoretical structure in the viewing subject and in the datum. This common structure describes the 'entanglement' of S_1 with O and S_3 with M that preclude their separation. The reason is that S_1 and S_3 embody particular *noetic* orientations towards O and M respectively that shape and are shaped by O's and respectively M's *noematic* structures as perceptual objects known. Neither can exist apart from the virtual flow of information that establishes S_1 and O, and S_3 and M, as functioning unities of pairs of perceptual knowers and knowns. Each needs the other to establish its respective existence. On this Husserlean account of perception, the basis of the analogy between perception and quantum physics can be expressed in the following way: S_1 is dynamically *entangled* with O, and S_3 with M, in such a way that subject and object are dynamically inseparable; moreover, the respective horizons of S_1 and S_3 are *incommensurable* within the world of human perception in a way analogous to complementary observables in quantum physics, that is, they are constrained factually and hermeneutically by *Uncertainty Principles*.[11]

Who are First- and Third-party Observers, S_1 and S_3?

Returning to the real world: who in real life should be concerned with the results just obtained? Who are S_1 and S_3 and what roles do they play? Clearly S_1 is a scientific researcher in his/her native habitat, the 'enclosed garden' of the laboratory. S_3, however, could have several roles; for example,

[11] This is another way of saying that quantum logic is a non-distributive logic of contexts (see Heelan, 1974, 1979 and 1983a/1987 on this topic).

the following: (1) a scientist reflecting critically on the foundations of scientific thinking, or (2) an interdisciplinary scholar concerned to know how to evaluate cross disciplinary factual data, or (3) a philosopher reflecting on the hermeneutic paradoxes of scientific thinking, or (4) a cognitive scientist puzzling how to link the theory/practice methods of modern science to human consciousness. There are lessons that each can draw.

Regarding the foundations of scientific thinking, it seems that, contrary to the traditional expectations of scientists, the thesis that a universal objective space-time exists onto which all factual data can simultaneously be mapped from a single universal point of view that is human, theoretical, and practical proves not to be the case. It may, of course, turn out to be a useful fiction or postulate – Plato's 'likely story' – for certain purposes, for example, for the solution of classes of problems for which the models and practices of, say, classical mechanics are found to be *de facto* successful. However, the thesis stated above is true for any science that is based on the theoretical modelling of factual data. The root of the classical uncertainty is in measurement, where instrumental data are converted into scientific data, not by a textual hermeneutics (or reading) as, perhaps, in the Cartesian view, nor by deriving the higher from the lower by 'abstraction,' but by a human embodied object-constituting interpretative process that Husserl called, 'a noetic-noematic intentionality structure.' This is not just a scientific thesis but, according to Husserl, it is a transcendental philosophic thesis.

And what science is not so structured? We certainly know that the thesis is true of the quantum physics we presently have and it provides a specially interesting case that will be my second thesis.

Paradoxes of Measurement, Thesis II: Quantum Systems as Disembodied Physical Objects

If 'to be embodied' means 'to have a stable extension in some perceptual space-time,' quantum systems turn out not to be embodied beings or 'bodies.' Quantum systems then seem to exist and function as logically prior to and in some way independently of the constitution of perceptual space-time(s), everyday or scientific.

While objects disclosed by measurement would be displayed with the anticipation of a classical body, there is no such body in the quantum case; there is only the residue of a bodily presence in the potential set of isolated episodic appearances, its footprints, as it were, in the world when the quantum system is measured. Though these isolated appearances do not constitute a body that fulfils the Husserlean protocol, they are nevertheless more than just signs of an abstract or non-physical presence, they show a momentary local presence in the '*place*' where they appear. It is helpful here to use Aristotle's notion of an object's '*place*'; this is the smallest closed surface in the perceptual world of the subject that contains the object. A quantum system can be said by the subject to have occupied a place in the neighbourhood of any footprint whenever and wherever a measurement occurs which is in the laboratory. Quantum systems then are objects in the scientific perceptual world because they show their presence within the world even if only in specially prepared places such as the laboratory. They are not, however, classical bodies, though they are certainly physical and material. What relationships they have to the structured perceptual space-time of the laboratory they acquire only by measurement. These relationships are episodic because quantized, and isolated seemingly from the continuous dynamic ordering of perceptual space-time. On that account and despite their disembodied state, they can be said to be objects in a 'place' in perceptual space of the observer and, consequently, part of the furniture of the observer's world.

In quantum physics, a scientific object or datum is not just a conceptual object, but it is intuitively given in measurements by the footprint it leaves in the perceptual world of the experimenter. Though as an object, it can be represented locally by a measurement event in the classically modelled scientific world of the laboratory, it does not have an independent covariant extension or space-time environmental structure in that space. Though it is not then an 'embodied' object in its own right, it is physical and material since it can have a multiplicity of isolated footprints in the world– the record of a potential *sequence of individual measurements. A quantum object exists and functions ontologically prior to and in some way independently of the constitution of everyday and classically structured scientific perceptual space-time(s).*

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References

Atmanspacher, H. & Primas, H. "Representation of Facts in Physical Theory." *Time, Temporality, and Now*. H. Atmanspacher & E. Ruhnau, eds. Berlin: Springer. 1997. 241-263.

Friedman, M. *Parting of the Ways: Carnap, Cassirer, & Heidegger*. Chicago: Open Court Press, 2000.

Hanson, R.N. *Patterns of Discovery*. Cambridge: Cambridge UP, 1958.

Hacking, I. *Representing and Intervening.* Cambridge: Cambridge UP, 1983.

Heelan, P. "Afterword." *Hermeneutic Philosophy of Science, Van Gogh's Eyes, and God: Essays in Honor of Patrick A. Heelan, S.J.* B. E. Babich, ed. Dordrecht and Boston: Kluwer. 2002a. 445-459.

________"Phenomenology and the Philosophy of the Natural Sciences." *Phenomenology World-Wide*. A-T. Tymieniecka, ed. Dordrecht and Boston: Kluwer, 2002b. 631-641.

_______ (with Jay Schulkin). "Hermeneutical Philosophy and Pragmatism: A Philosophy of Science," *Philosophy of Technology, The Technological Condition: An Anthology*. Robert Scharff and Val Dusek, eds.. Oxford: Blackwell's, 2002c. (Same as *Synthese*, 115 [1998], 269-302).

_______ "Lifeworld and Scientific Interpretation." *Handbook of Phenomenology and Medicine*. S. Kay Toombs, ed. Series in Philosophy and Medicine 68. Dordrecht and Boston: Kluwer, 2002d.

_______ "Scope of Hermeneutics in the Philosophy of Natural Science." *Studies in the History and Philosophy of Science* 29 (1998): 273-298.

_______ "Why a Hermeneutical Philosophy of Natural Science?" *Man and World* 30 (1997): 271-298.

_______ "Experiment as Fulfillment of Theory." *Phenomenology and Indian Philosophy*. D. P. Chattopadhyaya, Lester Embree, and J. N. Mohanty, eds. New Delhi: Council for Philosophical Research, 1992. 169-184.

_______ "Hermeneutic Phenomenology and the Philosophy of Science." *Gadamer and Hermeneutics: Science, Culture, and Literature*. Continental Philosophy, Vol. 4. H. Silverman, ed. New York: Routledge, 1991. 213-228.

_______ "Husserl's Philosophy of Science." *Husserl's Phenomenology: A Textbook*. J. Mohanty and W. McKenna, eds. Pittsburgh & Washington: CARP & University Press of America., 1989a. 387-428.

_______ "After Experiment: Research and Reality." *Amer. Philos. Qrtly.* 26 (1989b): 297-308.

_______ "Husserl, Hilbert and the Critique of Galilean Science." *Edmund Husserl and the Phenomenological Tradition*. R. Sokolowski, ed. Washington: Catholic U of America Press, 1988. 157-173.

_______ "The Epistemological Contribution of Ludwik Fleck." *Cognition and Fact*. R. Cohen and T. Schnelle, eds. Dordrecht and Boston: Reidel, 1985. 287-307.

________ *Space Perception and the Philosophy of Science*. Berkeley: U of California Press, 1983a (1987 pbk.)

_______ "Natural Science as a Hermeneutic of Instrumentation." *Philosophy of Science* 50 (1983b): 181-204.

_______ "Complementarity, Context-Dependence and Quantum Logic." *The Logico-Algebraic Approach to Quantum Mechanics*. C. Hooker, ed. Dordrecht: Reidel, 1979. 161-179.

_______ "Hermeneutics of Experimental Science in the Context of the Life-World." *Interdisciplinary Phenomenology*. D. Ihde & R. Zaner, eds. The Hague: Nijhoff, 1975. 7-50.

_______ "Quantum Logic and Classical Logic: Their Respective Roles." *Logical and Epistemological Studies in Contemporary Physics*. R. S. Cohen & M. Wartofsky, eds. Boston Studies in the Philosophy of Science Series, Vol. 13. The Hague: Reidel, 1974. 318-349.

_______ *Quantum Mechanics and Objectivity.* The Hague: Nijhoff, 1965.

Heisenberg, W. "Ueber quantentheoretische Umdeutung kinematischer u. mechanischer Beziehungen." *Zeit. f. Physik* 30 (1925): 879-893.

________ "Ueber den anschaulicken Inhalt der quantentheoretischen Kinematik u. Mechanik." *Zeit. f. Physik* 43 (1927): 172-198.

Husserl, E. *Cartesian Meditations*. Trans. D. Cairns. The Hague: Nijhoff, 1960.

________ *Crisis of European Sciences and Transcendental Philosophy*. Evanston, IL: Northwestern UP, 1976.

________ *Ideas: General Introduction to Pure Phenomenology* [*Ideas I*]. F. Kerstan, trans. Dordrecht and Boston: Kluwer, 1983.

________ *Ideas Pertaining to a Pure Phenomenology: Second Book* [*Ideas II*]. Dordrecht and Boston: Kluwer, 1989.

________ *The Shorter Logical Investigations.* J.N. Findlay, trans. & D. Moran, ed. New York: Routledge, 2001.

Latour, B. *Science in Action*. Philadelphia: Open University Press, 1987.

Petitot, J. 1999. "Morphological Eidetics for a Phenomenology of Perception." *Naturalizing Phenomenology: Issues in Contemporary Phenomenology and Cognitive Science*. Petitot, J., Varela, F.J., Pachoud, B., Roy, J-M., eds. Stanford: Stanford UP, 1999. 330-371.

Primas, H. *Chemistry, Quantum Mechanics, and Reductionism: Perspectives in Theoretical Chemistry*. Berlin: Springer, 1983.

Sellars, W. F. *Science, Perception, and Reality*. New York: Humanities Press, 1963.
Spiegelberg, H. *The Phenomenological Movement: A Historical Introduction, Vols. I & II*. The Hague and Boston: Nijhoff, 1982.
Van Brakel, J. *Philosophy of Chemistry*. Leuven: Leuven UP, 2000.

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