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THE HEGELIAN ‘QUANTUM’: A META/PHYSICAL EXPLORATION

Abstract: Quantum Physics (QP) in its explanatory framework deploys an idea of mutual ontological dependence of occurring states as irreducible to *independent* structures. Independent structures, often described in terms of a common ground of physical reality, are not quite compatible with mutually dependent states of either ‘ground states’ or ‘excited states.’² The paper presents a reading of Hegel’s notion of the Quantum in his *Science of Logic* in order to tease out the ontological dependence between ‘quanta’ and ‘magnitudes,’ which makes possible a quantified description of physical states irreducible to a unified and common physical reality. The specific relation of ontological dependence arises between ‘quanta’ and ‘magnitudes’ in terms of a phenomenologically salient dependence between the physical reality and its magnitudes on the one hand, and a transformation of this quantified physical reality into what Hegel terms the ‘quantum intrinsically affected by a beyond’ on the other.³ This is close to what QP terms ‘action at a distance’ or ‘non-locality.’ The ‘beyond’ of a superposed physical state in QP, the magnitude of which gets transformed from a ‘possible value’ to an ‘actual value,’ resembles the Hegelian description of being affected by a beyond. In this paper, an attempt is made to read how, for Hegel, the quantified physical reality alters itself following its internal limiting property of magnitudes only to sublimate its altered state into a qualitative notion of reality.

Key words: Quantum Physics, Hegel, *Science of Logic*, the Hegelian ‘quantum’

The paper unpacks Hegel’s *Science of Logic* to show how quantities transform themselves into quality in our very processes of quantization of any physical phenomenon, the import of which

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² C. Wüthrich, “Challenging the space-time structuralist,” *Philosophy of Science*, 76, 1039-1051.

³ Georg Wilhelm Friedrich Hegel, *The Science of Logic*, ed. George Di Giovanni, (Cambridge: Cambridge University Press, 2010), 207. Henceforth *Logic*.

could be to show how quantum superposition in QP gives rise to a large number of superposed states and then collapses in what Hegel terms the ‘being-for-itself,’ which is essential to a qualitative determination of a physical process. Physical processes and the relations between quantized elements of those processes assume, for Hegel, a hermeneutical combination between quantity and quality, process and its sublation. In a field of calculation and observation, such a combination between quantity and quality has been theorized by quantum physics using the language of mathematics. This echoes the Hegelian idea that Quantum is a being determined for itself and not outside of itself. Being inside itself, the quantum physical reality is manifested in the properties of fundamental particles. The paper explores several hermeneutical convergences between the Hegelian expressions and the language of QP, which not only establishes a compatibility between the metaphysical insights, but also tells us how the Hegelian ideas of ‘relations’ and ‘comparison of relations’⁴ fit into QP’s description of relations between superposed states and their beyond, and vice-versa.

What is even more interesting in these hermeneutical comparisons is a Hegelian cue about the ‘consummation of substance’ into ‘concept’ and ‘subject,’ reflected in an act of ‘appearing in reference to an other,’ which is a metaphysical or fictional appearance. That the substance appears as a consummated ‘fictional’ other is a Hegelian insight that comes close to QP’s idea of the unbounded swarms of fundamental particles that always remain to be discovered in nature depending upon how the subject constructs the quantum thresholds for the purposes of investigation. There are fictional others, as named by James Joyce in *Finnegans Wake* (1939), such as “kraals of slitsuckedmarrogbones. (Cave!)”⁵; or in terms of fundamental particles, such as ‘three quarks for Muster Murk.’⁶ The mix of the ‘actual world’ in the text and the non-factual worlds acts as a fictional dream experience disconnected from the waking world in Joyce. Hegel’s notion of the Quantum as a substance that is posited and consummated through appearances creates a re-centering of the quantum physics framework through the metaphysical moves of alteration and sublation of the physical quanta. Hegel narrates such metaphysical moves as a ‘fictional’ story using notions such as ‘relations.’ In quantum physics, the emergence of particles that are more ‘fundamental’ than others establishes those kinds of

⁴ *Logic*, 216.

⁵ James Joyce, *Finnegans Wake* (London: Faber and Faber, 1939).

⁶ Physicist Muray Gell-Mann, while choosing the name ‘quark’ for the fundamental constituent of nucleon referred to James Joyce’s *Finnegans Wake* (Book 2, Episode 4, page 383):
Three quarks for Muster Mark! / Sure he hasn't got much of a bark / And sure any he has it's all beside the mark. / But O, Wreaneagle Almighty, wouldn't un be a sky of a lark (...)

‘connections’ that Joyce’s fictional narrative of *Finnegans Wake* makes possible. Joyce’s quarks and particles are ‘emerging’ and ‘annihilating.’

What follows is a convergence of reading of quantum physics, Hegel’s Quantum, and their fictional connections, exploring the language of quantum descriptions. The descriptions of reality such as ‘quantum superposition,’ as the states of entangled particles at a distance that sustain themselves in such superposition through ‘fluctuations’ and ‘scatters,’ do not easily fit within the causal structure of the universe. Rather, the superposed states violate the physical laws of mass-energy conservation as they are influenced by an external cosmic microwave background radiation (CMBR) that can establish superposition between the particles that are separated through a very large distance. Appropriately placed detectors can observe the unhindered movement of photons through long distances that is sustained by the CMBR. The nature of CMBR is such that scientific measurement can never account for the uncertainty in its time and energy. It is innately quantum as CMBR prevents a collapse into a black hole and creates what could be called the ‘quantum bounce.’ In other words, bouncing quantum states that emit energy waves are sustained by the large superpositions between the particles in space. Such large superpositions ontologically depend on the very states of superposition, which do not remain stationary and continuously emerge into ‘new states.’⁷ This is theorized in physics in terms of the ‘repulsive gravitational forces’ that prevent the newly emergent states of superposition from collapsing into ‘mosaic states,’ as such a collapse would also have prevented the very creation of gravitational fields in space that sustain the large system of superpositions⁸ in the first place.⁹ So one needs to theoretically bridge the ontologically dependent states of superposition with the emergent states of superposition by way of quantization of the ‘spacetime’ in relation to the emergent property of non-locality, which physicists understand consider to be a ‘vanishing act.’ The vanishing impact of the repulsive gravitational force affecting large superpositions could be understood as the Hegelian ‘vanishing divisibles.’ Hegel’s description of a vanishing divisible is that it ‘transcends’ itself in general and in the form of ratio, it transcends itself into its otherness.¹⁰ It is a quantity that approaches a limit value because of its divisor that acts as a limiting concept just as the particles in superposition approach a limit value in a particular state. Hegel conceived of such mathematically vanishing

⁷ Stephen Hawking, *Brief Answers to the Big Questions* (London: Hachette, 2018), 108-9.

⁸ Roger Penrose, “On the gravitization of quantum mechanics 1: Quantum state reduction,” In *Foundations of Physics*, no. 44 (2014): 557.

⁹ Albert Einstein, “Ist die Trägheit eines Körpers von seinem Energieinhalt abhängig?,” in *Ann. Of Phys.*, vol. 18, no. 323 (1905): 639–641.

¹⁰ *Logic*, 153.

divisible as ‘quantum,’ which is a relation of dependence or ratio between the quantity and its divisor that ‘represents’ the limit value of the divisible. The limit value of a divisible alters and vanishes. In Hegel’s terms a ‘vanishing quantum’ is a divisible magnitude in such a way that,

(...) Magnitudes are understood in their vanishing, that is, as such magnitudes which are no longer quanta; (...) but the *limits of the ratio*. The quanta taken for themselves, the sides of the ratio, as well as the ratio itself in so far as it would be a quantum, are supposed to have vanished; the limit of the quantitative ratio is where the ratio is and is not; more precisely, where the quantum has vanished and, consequently, the ratio is preserved only as a qualitative moments of quantity.¹¹

The phenomenon of vanishing quantum and its limits corresponds to the states of quantum superpositions and their character of non-locality. Non-locality, expressed as a limit of the ratio between position and momentum, assumes its limit in terms of a probable outcome when they are measured by an observer, i.e., as ‘qualitative moments’ of quantity.

It seems that Hegel’s method of counter-positing the elements of an unresolvable contradiction as “ontological” disrupts the identity between the quantum states as neither the same nor different by reciprocally calling one another into “alteration,”¹² which is a principle of the quantum:

A Quantum, according to its quality, is therefore in absolute continuity with its externality, with its otherness. Consequently, not only *can* every determinateness of magnitude be transcended, not only *can* it be altered: that it *must* alter is now *posited*.¹³

This metaphysical principle of quantum guides Hegel into positing the states of alteration as ‘otherness’ that only has a ‘negation of itself’ as an ‘ontological difference’ between its self-reference as determined by another to move towards ‘any other existing thing.’ This ontological difference is unresolvable in any determinate form of existence, it is like a search for an absolute

¹¹ *Logic*, 218-9.

¹² Hegel, op.cit. 196-7.

¹³ *Ibid.*, 189.

immediate existent that all quanta are bound to posit as a self-referring negation, ‘repulsion of itself from itself.’¹⁴ Hegel puts it succinctly:

(...) quantum sends itself beyond itself; this other which it becomes is at first itself a quantum, but a quantum which is not a static limit but one that impels itself beyond itself. The limit which arises as this beyond is therefore only one that again sublates itself and sends itself to a further limit, *and so on to infinity*.¹⁵

The principle of sublation works in Nature through a quantitative infinite progress, but the infinite is a quantitative non-being of the quantum, which arises through sublation of the magnitudes of quantum to its own vanishing point in a field of infinite progress. How can natural scientists and physicists negotiate this field of infinite progress, which is an irreducible relation between one quantum and another in their otherness relation with the very field in which they occur or leave their impelling vanishing effect? That physical objects exist together and not as discrete establishes the ontological difference, as well as the dependence determining both the manifest and hidden properties, which mostly change in the metaphysical otherness relation in the course of emergence. What is sublated is the apparent, the discrete and the phenomenal into a realm of otherness that pervades the relational ‘hanging together’ of entities in the multiverse of the physical order.

One needs to then carefully understand how the Hegelian principle of contradiction remains an unresolvable visualization of spacetime or wavelike fields in abstract matrices that sublates the bounded space, circumscribing the electrons to adjust them into too many transitions and new formations, as Hegelian alterations that must be posited in small regions of being or space and will never be equal to Schrodinger’s determinate values.

Hegel’s early prognosis about the physical world was a philosophical speculation about the immeasurable multitudes of stars in an immeasurable space-time as ‘beyond,’ ‘sublime’ or unresolvable vanishing points of an ever-widening gyros, which he turned into a conformist calculus of the law of derivatives as a mathematical resolution for the physical world of large ontologically dependent objects, the mutual dependence of which can never allow them to be independent. Within these limits, Hegel’s textual excursion into the Quantum, seen from the perspective of more recent quantum physics aligns itself more easily with the concepts of alteration, beyond and otherness than with the conventional Newtonian calculus, of which

¹⁴ Ibid.

¹⁵ Ibid., 189-90.

Hegel thought to be the limit posited by Nature. It seems that Hegel took a credible stance by subjecting to the laws of Nature the metaphysical potential of Quantum, which in its call for the beyond and the infinite assumes a qualitative form that cannot be reduced to any quantity, as Hegel thought influenced by Newton. Additionally, the textual exploration of Hegel in the “Quantum” fragment generates a similar curiosity like James Joyce’s quarks in *Finnegans Wake*.¹⁶ It is as if one stands on the shoulders of a metaphysical giant to see the long ropes of Natural Sciences trying to tie it down to a determinate physical universe, while the Giant with the mind of the God never discloses how they will play the dice to all the progenies of Science.

The Vanishing- Jumping “Quantum”

It is therefore effective to read the “Quantum” fragment through a Joycean lens yet embedded in Hegel’s science of logic, which drives one to the ends of metaphysics and unfolds a new science by making the magnitudes vanish at their limits and by bringing forth quanta through quality. The textual drive towards quantum as an emergent quantity-quality summons some sleepwalking moments of the early modern mathematicians Newton and Lagrange. The “Quantum” fragment takes one on a Joycean sleepwalking journey into the Hegelian world of determinations, as Hegel further turns the category into an ontological fiction of vanishing and jumping away from itself, into ‘affirmative determinations of the category of infinitesimals’.¹⁷ Infinitesimals as the emergent properties of incommensurable entities, determining each of the entity in terms of their separate property, leave open the possibility of thinking ‘elements’ that constitute the entity and its property. Such an idea finds its geometric representation in figures, while the concepts lie in a zone of indetermination, e.g. point, space or plane. Hegel encountered the impossibility of reduction of an arc to a straight line for the sake of measurement (which apparently had an Archimedean Euclidean solution) and opened it up to the problem of determination of the finite in the infinite space. Hegel names this a ‘superfluity of sensible existence,’¹⁸ thereby opening up towards the idea of being ‘parallel.’ The idea of the parallel had been a way of overcoming what the mathematicians of Hegel’s time faced as a stumbling block in the external spatial limits, which Hegel took as a way of understanding the specific nature of limitedness that his dialectical method is aimed at. Hegel wanted to fill in the gap between the thought of limited being and the incommensurable nature of being outside thought. Such a

¹⁶ James Joyce, *Finnegans Wake* (London: Faber and Faber, 1939), 597, lines 1-2.

¹⁷ Hegel, *op.cit.*, 269.

¹⁸ *Ibid.*, 267.

being outside thought, that is spread all over the space without limit, allowed for a localization of the objects of thought, while thought itself encountered its own limits in the vast space of infinity to experience the limitations of the categories of thought. This is how Hegel builds up an internal critique of the structures of thought that is compatible with his critical overcoming of the limits of entities in Nature.

Hegel opens up the category of thought to its three physical dimensions, to map the discrete onto the qualitative moment of parallels, which cannot be determined by the physical entities like lines, etc. That the lines require a conception into planes, and planes into space, and space into the beyond all limits is both an affirmative determination of the Infinite space and a negativity of the quantum as only a correlation between thought and objects. He exemplified it as ‘dx,’ ‘dy,’ etc., projected unto the objects as derived functions, but such a reductionist account for Hegel can never grasp the ‘indeterminate expression of the negativity of the quantum.’¹⁹ The increments and the rate of change in a series for Hegel is not a real movement of thought, but an application of certain categories or thought constructs, following Lagrange’s or Newton’s methods. The relations that constitute various functions and their operations like multiplication are an abstract negation of the concrete relations of matter. There is an ontological gap between a geometrical grasp of these relations in space and time and the emerging shapes of abstract output, which acts as limitations internal to the workings of scientific understanding. This difference between appearance and essence is manifest in the difference between geometry and arithmetic, where the former is limited by spatial relations, while the latter has an affirmative determination of the infinite in its calculus.

Hegel then poses the problem in a scientific vein by asking how to ground the apparent reality into an epistemically coherent nature of existence.²⁰ In other words, Hegel shakes off the appearances to arrive at a deeper terrain of reality that the ‘completed determinateness’ of quantum possesses, but he opens this up into a ‘qualitative determinateness of quantity’ and a ‘qualitative determinateness found in the relation to powers.’²¹ Hegel thus creates a separate realm of mathematical objects that fits into the superfluity of senses. The quantum remains a source of setting up determinate relations between the mathematical objects and a qualitative presence of a possible scientific picture of the realm of objects.²² In exploring such a picture,

¹⁹ Hegel, *op.cit.*, 259.

²⁰ *Ibid.*, 73.

²¹ *Ibid.*, 258.

²² *Ibid.*, 254.

Hegel agrees to the fact that a gap between the finite and the infinite could be filled in by sublating the difference through differential equations. The process of sublation cannot be avoided as mathematical expressions can only sublimate in a semblance of physical propositions, but such semblance itself is very limited. One can relate the Popperian verisimilitude between mathematical laws and natural phenomena to the Hegelian sublation of the mathematical in the natural that turns nature inside out. Hegel shows that manipulation of a mathematical equation, by raising its powers or by altering degrees of a differential equation, alters the equation between the thing's phenomenal properties and their appearances with the thing itself in such a way that the thing becomes 'epiphenomenal.'²³ This epiphenomenal character of the thing internalizes the negation of the thing itself in abstract mathematical formulations of the relational terms in which the thing exists. Hegel maintained that the quantum is meant to differentiate between the thing itself and the epiphenomenal thing composed of its properties and sublated in mathematical equations, which can further sublimate the difference to an 'infinitely small difference,' for example, by using differential equations.²⁴ In other words, summing up, analyzing, juxtaposing internal processes of differentiation over a defined space is to regulate the differences to sublimate themselves into their internal elements, which are atoms and quanta, i.e., the Joycean poeisis²⁵ of particulars into emergent fractions, divisible and other quanta that vanish at the limits and alter themselves to epiphenomenal entities. These are like the Joycean dream elements that collectively produce a contrived and self-implicated picture of guilt for the physical world wherein the terms of metaphysics and physics hang heavily together as in some 'collective guilt' of humanity.

Could this Hegelian-Joycean journey from the phenomenal to the epiphenomenal be complete without sublation as an embedded procedure within abstract formalism as well as in the very core of Nature itself? Hegel figures sublation as splitting the being itself in the middle to negotiate the relationality between the appearing phenomenal and the emergent epiphenomenal, and this split sublates both the phenomenal and the epiphenomenal into a process of quantum differences that further assumes mathematical, geometrical and physical forms in a movement of dialectical differences:

²³ Adrian Johnston, *Zizek's Ontology: A Transcendental Materialist Theory of Subjectivity* (Evanston: Northwestern University Press, 2008), 141.

²⁴ Hegel, *op.cit.*, 251.

²⁵ Joycean 'poeisis' lies in Joyce's look at human history, as "HCE has, so deep in his sleep, sunk to a level of dreaming in which he has become a collective being rehearsing the collective guilt of man." In *A Shorter Finnegans Wake*, ed. Anthony Burgess (London: Faber and Faber, 1969), 8.

Whenever the difference of the moment on which the magnitude to be compared depends is a difference of power; since this difference comes down (...), then is to be represented as a fraction (...). Precisely for this reason the demonstration of the greater smallness has nothing to do with something infinitely small (...).²⁶

Sublation to the smallest or greater smallness as a phenomenal property emerges as an effect of dialectical progress of thing, of the movement of nature or thing itself towards its internal quantum differences, towards the epiphenomenal reality of the very thing. Sublation of the phenomenal to the epiphenomenal thus arises as a return to the mathematical, geometrical and other positing of a set of relations and equations that can capture the process of making fragments.

One might then surmise that Hegel tended to discover grounds by lowering the higher order natural phenomena through physical sublation to return to a metaphysically rich epiphenomenal reality of the Quantum kind, which is superposed and presents a mathematically embedded shape of relationality between objects, entities and beings. Hegel conceptualized his position by stating:

The qualitative determinateness of quantity is first exhibited in the quantitative relation as such: however, (...) it was anticipated that it would be in the *relation of powers* (...) that number, by the equating moments of its concept (unity and amount), is posited as having turned back into itself, and that, as such, it would receive the element of infinity, of being-for-itself, that is, of being determined through itself.²⁷

Hence Hegel is able to see the relation of powers between quantities as completely qualitative and the procedure is a sublation of the quantitative at the limits of their respective powers as a quality of themselves, as being-for-itself and not just as an in-itself. The notion of Quantum arises from this entire qualitative sublation of quantities, which again is part of the epiphenomenal emergence from a physical event occurring over time and space as it is presented through differential quantities. Hegel's notion of infinity in being-for-itself finds its exteriority in an in-itself, the actual occurring event, which then needs to be sublated by an interior for-itself. These two moments of emergence of in-itself from for-itself and return to for-itself is a grasp on the external and internal fragments of consciousness, for Hegel. The change

²⁶ Ibid., 248.

²⁷ Ibid., 236.

from the internal to the external and vice-versa assumes limits, opposition, return and ongoing relationality without dissolving the process of determination of one moment by the other and yet measuring its own quantity of change in the qualitative return to itself, to be again split and then to sublimate the split in an act of measurement, with each moment of difference and positioning that changes the very nature of an initial being-for-itself. There is a primacy of consciousness in this entire operation that pervades through the physical-causal world and returns back to itself as an infinitely repetitive and self-enhancing procedure. Hegel explained this interior-exterior movement of being-for-itself in the following way:

In this determination, it is an *excluding* [exteriorizing]; the one repels from itself the many not generated by it, the ones not posited by it.

(...) Plurality is not at first posited otherness; limit is the only void, only that in which the ones *are not*. But in the limit they also *are*, they are in the void (...).²⁸

We can note that this void remains and holds the poles of the interior and the exterior by not allowing to be closed at its limits as it would have been the case empirically. Understandably, Hegel sees in the split between the interior and the exterior a possibility of sublation by/of consciousness, which then opens up the moment of return with an infinite possibility of self-awareness and awareness of the posits from the world that repel each other as a physical process from within the very metaphysical moves of consciousness. A being-for-itself then carries within the quantum of consciousness that interacts with all the external quantities to turn back to itself as sublated in a qualitative determination of the very for-itself. The question then is, is it compatible with the objects of physics, especially with the superposed states of the world that release energy?

The Constitution of the ‘Thing’ as Quantum

Hegel understood things of the physical universe as ‘abstract magnitudes’ that are constructed through the moves of consciousness, as discussed in the previous section. The idea of Quantum is compatible with the mathematical model of the phenomena of Nature, which again has both a phenomenology and its interpretative possibilities. The interpretative possibilities begin from Hegel’s idea of the relations between magnitudes as relations between

²⁸ Ibid., 236.

physical terms, which again entirely follows a metaphysically rich explanatory framework developed in the textual fragment on the Quantum.

What is the nature of thing then, for Hegel? Newton’s mathematical model for Hegel opens up a new horizon of understanding that can show the qualitative nature of each quantum as magnitudes that change into measurable qualities, which phenomenologically amounts to an emergence of phenomenon into an epiphenomenon of a conscious process. This is how Hegel develops a new understanding of the laws of nature that is conditioned by the phenomenological properties of quantum, which, for Hegel, assumes the form of opposition between the elements of a whole. Such an opposition assumes a quantitative magnitude, which transforms itself into a qualitative possibility of infinite smaller forms. Hegel contended,

With this identity, the *qualitative something* comes on the scene; for the identity is the unity that refers back to itself through the *negation of its distinct terms*; these terms, however, make up the determinateness of the existent magnitude. That something is a quantum, but its qualitative existence is now posited as indifferent to it as it is in itself. One can speak of quantum, number as such, etc. without any mention of a something as their substance. But the something, self-mediated by virtue of the negation of its determinations, now confronts these as existing for itself, and, since, it has a quantum, (...) but the positing of it in these differences as extensive and intensive quantum is the return into this unity, which as negative, is the something posited as indifferent to them.²⁹

This hermeneutical interpretation of the magnitude of the quantum fits with the wave-particle duality of nature, as revealed in QP. This duality resembles the intensive and extensive magnitudes, which are bound by an ontological dependence relation of negation. The magnitudes vanish before and after measurement, which is similar to behaving in a Quantum fashion, as in measuring the quantum states with the non-quantum measures in Schrodinger’s equations. Hegel hermeneutically posited this non-quantum classical state as ‘extensive,’ an apparatus independent reality that ultimately has to come to terms with how the measuring apparatus itself is affected by the entanglement between the waves and/or particles. One of the interpreters of such an effect on the apparatus puts it succinctly,

²⁹ Ibid., 185-6.

It is not the apparatus that measures the particles; it is the particle (and waves) that measures the particles (and waves); the results have to be magnified in order to be seen as waves, specks, particles, spots, lines, etc., i.e., we see the results of interactions.³⁰

The qualitative existence of wave-particle duality is posited as indifferent to their ‘substance’ or the ‘in itself.’ The qualitative existence, as stated in Hegel’s hermeneutical assertion, is not independent of the apparatus, which itself is qualitatively altered and self-mediated by the virtue of negation of its prior determinations in a field of observed properties. As such the entire Quantum description of the apparatus dependent reality and its impact on the very apparatus turns out ‘to be a cloud of indeterminate waves,’ which are a combination of waves and particles.³¹ These combinations assume interesting ontological relations, such as the strange quantum numbers possessed by quarks in terms of their spinning along an axis that combines ‘up,’ ‘down’ and ‘strange’ quarks as triplets. This assigned directionality is not just a physical relation, but a hermeneutical combination in terms of which various positions could be mutually set up in a calculable and observed field that has been theorized by physicists.³² In the world of fundamental particles, there is a multiplicity of Hegelian negations and positings such as conversion of a down quark in a neutron into an up one by emission of negatively charged weak bosons.³³ What sounds so very close to a Hegelian insight is how the zero mass bosons can cancel each other out to leave the field with finite mass bosons,³⁴ something akin to the extensive magnitudes cancelled out by the intensive ones through sublation, leaving us with the concept of Quantum. In Hegel’s words,

If we now first look at this progress in its abstract determinations as they are displayed before us, what we find in it is *the sublating quantum, but no less also of its beyond; what we find, therefore, is the negation of quantum as well as the negation of this but negation.*³⁵

The sublating quantum arises in various massless bosons cancelling each other out, leaving only massive particles, which lies at the beyond of the massless bosons to allow weak and negatively charged ones to pick up masses from the vacuum, which is a negation of the massless bosons, but

³⁰ Rajimwale, op.cit., 180.

³¹ Ibid., 181.

³² Jim Baggott, *The Quantum Story: A History in 40 Moments* (Oxford: Oxford University Press, 2011), 222-3.

³³ Ibid., 223.

³⁴ Ibid., 229.

³⁵ Ibid., 202.

in a weak sense of acquiring ‘masses.’ So the mass stands in an ontological relation of negation to energy, while the relation gets weakened by sublating the massless energy into masses, which breaks the symmetry of the field by vanishing masses at the weak field interactions.³⁶

To understand this further, Hegel’s assertion that the sublated Quantum is a quality that surpasses itself and is a negation³⁷ of itself could be understood as a collapse of a superposed state into unmeasurable infinite state of quantum, in which, like its own negation, measurement itself is affected to the extent that it leaves out every emitted particle as unaccountable in a state of collapse and polarization. The number of the pairs of particles detected as smaller than the number of particles generated after the collapse resembles the Hegelian ‘greater smallness,’ which is also a kind of repelling from itself, as polarized particles combine only to affect ‘action at a distance’ that is not an in-itself. That reality at the Quantum level is determinately non-local, opening up the Hegelian possibility of sublation, which is how the ‘action at a distance’ happens by moving from the polarized states. In the field of quantum electrodynamics, which looks at the interaction of electromagnetic forces with a variety of particles, Richard Feynman draws various kinds of lines to represent various interactions between the particles, and forms an idea of ‘action at a distance’ by drawing two kinds of lines: straight and wavy. The straight lines are Fermions that include all combinations of composite particles, and are akin to what Hegel termed as ‘quantum determined according to its concept,’ while the wavy lines in Feynman’s diagrams represent multiple wave-fronts created out of the interactions after the photons are released or absorbed. This is again close to the Hegelian notion of sublated determination of Quantum, as the waves of interaction between the particles that follow the laws of conservation of mass energy, charge and momentum, could be considered as those properties that are the Hegelian “being-outside-itself”³⁸ of particles. The process of sublation is like the assumption of probable charges that keep the particles together in superposed states, which are ‘polarization combinations’ that determine various other properties of these particles, just as the sublated quality of Quantum in Hegel is a negation. In the case of atom amplification using laser beams, the momentum gathered by the atoms interferes with the laser photons and in turn the excited laser photons force the atoms to move in random momentum states. Such a state of radiance creates matter waves like shown in Feynman’s diagrams, as if they were Hegelian infinite quanta that surpass themselves in those random momentums. The same phenomenological moves could be found also in the quantum chromodynamics (QCD) of holding together the proton and the

³⁶ Ibid., 202.

³⁷ Ibid., 203.

³⁸ Ibid., .202.

neutron by strong interaction forces over a distance and forming colour properties over the weaker interaction in which there is a direct Hegelian shape of things experienced.

QCD proposes that all quarks carry one of the six colour charges, and that they combine in trios, or quark-antiquark pairs, which appear colour-neutral or white from the outside. This is like Hegel's split into the intensive and extensive magnitudes held together by the being-for-itself or consciousness in which the opposites find a neutral medium like whiteness in the quark combinations. This justifies Hegelian proposition,

Quantum no longer has Infinity, the being determined-for-itself, outside it, but in it.³⁹

QCD colours show the property of triplets being determined for itself that can infinitely form combinations at various energy levels emitting elementary particles that can mediate weak interactions. Such weak interactions are an 'in it' version of interactions, creating intensive magnitudes of charges that could be mediated by bosons, while neutrinos scatter matter with qualitatively less radiation in, for example, an ultra cold medium. Such positing of reduced momentum and falling charges of particles is an outcome that Hegel would call "the abstract non-being of Quantum," which shows the fundamental characteristics of nature that there is no way to beat the uncertainty principle. That the combinations of particles display both wave and particle character in both string and weak interactions brings in the Hegelian vantage on uncertainty, which is,

(...) the non-being of Quantum, the infinity, is thus limited [limited by famous 'conservation principle'], that is, the beyond is sublated [which way the particle is moving], is itself determined as a quantum [interference pattern formed by emitted particles] which, consequently, is its negation with itself [non local behavior].⁴⁰

In other words, nature does not allow a simultaneous observation of a particle and its action at a distance (momentum), and Hegel goes a step further in drawing up the metaphysical principle of sublation that allows for a determination of quantum as a 'negation with itself,' as the particle loses its identity in interference patterns that emerge in nature. The critical point in the Hegelian hermeneutical rendering of the principle of Quantum is the principle of 'beyond' that is

³⁹ Ibid., 203.

⁴⁰ Ibid., 202.

determined by what Hegel calls the “Quantum’s own moment.”⁴¹ Such moments are experienced when a large quantity of pairs of electrons condenses into macroscopic quantum states extending over large distances, which are the Quantum’s own moments. Similarly, when micropotentials are formed by the interference of two or more polarized beams of particles, they tend to decohere themselves at quick time periods to pass information, as in the Quantum computation that is its own moment of passage of information. The current procedure of transmission of high dimensional Quantum information through the encoded states of superposition resembles the Hegelian “being in simple unity with itself”⁴² in the elements like qubits, qudits etc. that can have any dimension within the Quantum system. Such qudits, for Hegel, are like a quantum key that high dimensional states can attain, which, for Hegel, is attained “from the negation of the negation.”⁴³ In terms of the Quantum information processing, the ‘negation of negation’ in the quantum system passes information of a higher order, when the initial information carrying qubits get negated into received information keys that can be further carried through high dimensional qudits. Hegel would say,

(...) the empty meaning of a non-being, of an unattained but sought beyond, is in fact nothing other than *quality*.⁴⁴

The qualitative states arise from a computationally stable state that arises from an efficient decoherence of entangled states, which is itself a qualitative phenomenon of transitions, not controlled externally, but by localizations, which Hegel would call an “ought” moment in receiving information. From decoherence to localization, the information is transmitted, Hegel would state,

(...) the qualitative moment, which, however, is only an ought. Its indifference towards the limit, and hence its lack of a determinateness which is an existent-for-itself, its surpassing itself, is that which makes the quantum what it is.⁴⁵

The ‘ought’ moment of quality as ‘information’ combines the physical substrate with the computational, although such a combination is an outcome of a ‘decoherence-based localization’ that provides for quantum packets and threads that, in turn, become a source of computational and qualitative transmission of data.

⁴¹ Ibid., 203.

⁴² Ibid., 203.

⁴³ Ibid., 203.

⁴⁴ Ibid., 203.

⁴⁵ Ibid., 203.

Hegel’s Cues and their Phenomenological Prospects

In this final section, one could draw a larger picture by bringing together Hegel’s essentially phenomenological moves that cover the movement of the metaphysical Infinite and the mathematical Infinite. The metaphysical Infinite, for Hegel, is a hermeneutic progression of thought towards the immeasurably distant, which thought can measure up to, yet it rises up to the ‘immeasurable spaces and times’ in order to recognize the ‘relations of measure’ and the laws in order to constitute the rational finite. As opposed to the irrational infinite, the Subject, for Hegel, is capable of filling up the emptiness before it and also the fullness which is negated as the beyond of this thought.

What lies in the beyond of thought? QP brings out the states of superposition with opposite spin values that cannot be reduced to determinist either/or, rather the amplitudes of various states would make possible the same spin outcome in the joint measurements of such superposed systems. Macroscopic superposition works between the alive and dead states of Schrodinger’s famous cat, which are joint or mixed states that are attributed to the cat in identifying the evolving states of a system. In such joint or mixed states, which arise in relation to the measuring apparatus, the joint states progress to what Hegel called the ‘immeasurably distant’ as the macroscopic quantum entanglement constitutes relativistic quantum states. Such quantum states extend beyond the spin up or down to free particles of various spins. Such macroscopic states can accommodate massless particles as well. Each property of the particle is revealed before the measuring instrument, rather each of this property remains underdetermined until they are measured. In other words, the nature of interaction between the measuring device, i.e., an observer, and the particle determines the nature of the ‘property.’ This shows an ontological dependence between the measuring device and the property in which the instrument and the particle interact, which poses the question of how the observer becomes party to such an interaction. This is how qualitatively both the interaction as well as the idea of the particle is determined.

Hegel introduces here a theory of the mathematical infinite that is aimed at taking care of any state independent intrinsic property that such superposition brings about. For the properties of a boson particle, there is a field of bosonic interactions that gives rise to the independent properties of the boson. Without such a bosonic field of interactions, no one can say how boson assumes a particular property. Similarly no one can say what is ‘inside’ of a black hole from the ‘outside.’ This would mean that a lot of information contained in a black hole is

irrecoverable and to reconstruct it, one has to depend on the physical properties of the particles that the black hole emits. Such particles are again observer-dependent, and as much one can observe, so much is the information gathered from the black hole concerned. To examine the issue from the point of view of QP, the particles emitted by the black hole are the pairs of particle and anti-particle. The indirect effect of these paired particles, such as excited hydrogen atoms and the spectrum energy of light emitted from these particles, can be measured. Interestingly, as Stephen Hawking has shown, out of this paired particles, one might fall into the black hole, leaving the other to annihilate itself.⁴⁶ Another interesting problem is how black holes disappear as the particles escape them and information about the particles that fell into the black hole is lost and it needs to be reconstructed from the particles that escaped the black hole. Such a situation keeps QP in relation to the physical forces like the fundamental forces in and around the black holes create an infinite number of ‘conserved quantities’ such that from these conserved quantities, the overall charge, spin and electric charge could be found out after the particles are emitted outside the black hole.

This possibility of information loss and its partial reconstruction through spacetime like entities in various points in the vast universe, leaves us with a lot of imprecision as Hegel would have surmised. For Hegel, mathematical calculations raise huge contradictions as the terms meant for measuring the finite magnitudes are applied on an infinite phenomenon, which loses its quantum character at the level of the Infinite. Hegel contended,

We still are, therefore, at the contradiction contained in the magnitude, except that it is now distributed between the object and the subject: limitedness is assigned to the object, and the subject the capacity to transcend over and over again (...).⁴⁷

This capacity of the Subject to transcend over and over again historically brought in an expansive mathematical and instrumental capability to come to terms with phenomenologically ever expanding field of QP that keeps falling into various other interconnected physical forces such as Gravity, creating a renewed understanding of the Universe, known as the standard model that attempts to identify the many parameters of particles. In fact, such parameters are infinite, leaving us with the Hegelian Infinite that ‘can no longer be increased or diminished’.⁴⁸ Such an Infinite is dealt with the increasing dimensions of space and time that can

⁴⁶ Hawking, op.cit., 115.

⁴⁷ Hegel, op.cit., 207.

⁴⁸ Ibid., 206.

accommodate the contradictions and unresolved phenomena of four dimensional space of the Universe inhabited by us.

It can be concluded that Hegel's entire reading of Quantum is a hermeneutic opening to a large number of recent developments in QP that also exhibit phenomenological characteristics in terms of their subjective and objectively assigned roles.

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