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The universe as a hierarchically leveled whole in action

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Summary

Basically I am in search of a novel realistic model, a world-view which would apt to solve the conceptual problems related to quantum mechanics. Here I specifically try to clarify and reconcile Bohr's and Einstein's divergent views on the nature of reality when illuminated by two wide-ranging holistic theories which are recently put forward in Finland. Dr T. Suntola has presented a lucid cosmological model which is compatible with relativity and quantum phenomena and Dr. A. Annila starts from the statistical mechanics of open systems and explains diverse interrelated phenomena by using the concept of action. Even if the two theories start from different perspectives they might be depicting one and same underlying reality. Nature is seen as a holistic, hierarchically leveled structure whose intricacy allows the existence of humans as causally active participants who nevertheless always remain subordinate to the balanced action of the whole.

Introduction

It is evident that we are living in the middle of a great change of paradigm. A new conception of reality is in formation because quantum phenomena cannot be understood within the particle-mechanistic framework which took its shape at the beginning of modern era. The idea that the world would be an clockwork whose deterministic laws could be discerned by humans as external observers does not suffice any more. I expect that the most fundamental metaphysical assumptions like the relation between the parts and the whole and the nature of the basic substance and the properties as well as the role and locus of the humans have to be reconsidered to arrive at accurate conception of reality. It is obvious that humans should be included into the system but not as senseless automata – we should be seen as responsible participants in an evolving process.

Niels Bohr understood the depth of the change in need. Especially he managed to embed the humans into the world not only as spectators but also as actors who aim at describing their experiences in an unambiguous way. However, he gave up the task to construct a proper picture of the quantum reality. Maybe heedfulness was reasonable at that time even if Einstein did not accept Bphr's view. Einstein never abandoned the realist ontology of classical physics and assumed that Bohr's theory contained, at best, only a part of the whole truth. Their famous debate went on unsolved for decades. A solution to metaphysical matters could not be reached on the basis of quantum mechanics. Even a most detailed study of the theory does not provide answers to the question of how to understand it. The theory just opened up a new realm and showed the problems related to the classical paradigm of science, the traditional particle mechanistic approach. A more comprehensive theory remains to be found to discern the profound metaphysical issues at stage.

Appropriately two profound and wide-ranging theories have recently been put forward here in Finland. Dr. T. Suntola has presented a lucid cosmological model which is compatible with relativity and quantum phenomena and Dr. A. Annila starts from the statistical mechanics of open systems and explains diverse interrelated phenomena by using the concept of action. The two formulations appear at first to have quite a different approach to reality. One of them is based on zero-energy principle, and the other to the principle of maximal dispersion of energy (i.e. least action). Yet I like to think that they might actually describe one and same underlying reality from different perspectives using different languages. In my view both of them seem to be apt for resolving the conceptual problems related to quantum mechanics. They enlighten Bohr's and Einstein's dispute and suffice in creating a better conception of reality, which

quantum physics as such is not able to do. Yet the quantum phenomena and paradoxes are most important in providing a test; any new model which seeks to make reality understandable must solve or surpass the conceptual problems encountered in quantum physics.

The two formulations of reality have many similarities. They are both holistic and hierarchic (recursive, self-similar, having systems within systems). The concept of energy is important in both. When highlighting the role of energy they transcend the classical materialistic bias related to physics. Yet nature remains strictly lawful even if not minutely predetermined. But there are differences also. One takes the universe to be closed, for the other it is open to expand forever. One regards mass to be a kind of invariant substance behind everything, a medium which is needed for the energy to manifest whereas the other takes mass as a measure for a bound form of energy which can be converted to energy in radiation according to $E = mc^2$. One uses universal coordinates: the time runs from past to future and the space contains four metric dimensions. The other claims to generate also the coordinate quantities, position and time out of the closed and open actions; it certainly manages to make a definite distinction between stable (i.e. stationary) and evolving structures which is a prerequisite for any real change or irreversible evolution to take place in universe. In brief these wide-ranging theories are dealing with most profound metaphysical questions. They seem to provide a reasonable, self-consistent and above all physically coherent entrance to totally different kind of conception of reality compared to the ideas related to clockwork reality.

I think that the most important reason why the both theories are able to clarify and make sense of quantum phenomena is that they are not atomistic approaches but holistic portrayals which essentially use wave description. Problems like wave-particle dualism (exhibited in double-slit experiment) do not actually exist as particles are secondary entities created in certain circumstances. – Nonlocal or entangled phenomena can be addressed because of the hierarchical structure of the whole; reality incorporates closed structures which regulate the behavior of their parts; behavior of the minor structures depends on the bigger whole (frame, state, (object)). The context may always have a natural immediate effect on its parts if you do not start by assuming that explaining phenomena means that everything is reduced to the separate independent parts. In these theories the whole – the overall energy density or a parent frame – has its role to play in the scheme of things. The interactions become more intricate as there are not just external relations but also an inner immediate connection, partnership related to a given context. In this kind of framework it is much easier to locate humans (and their measurements) to the whole. A hierarchically leveled (kind of organic) whole leaves room for causally active humans who nevertheless always remain subordinate to the balanced action of the whole.

Evolution based on open actions

I will start with Dr. Annila's approach as it is close to standard physics, (that is the formalism of closed systems), and perhaps easier to grasp in a short presentation. It discloses the problems related to traditional physical method which was concentrating on the study of closed predictable structures, thus omitting the context where something is happening. It is evident that we do not live in a closed predictable structure, the clockwork, imagined by classical physics but in reality the context i.e. the surrounding environment affects any system. Anyone who is dealing with quantum phenomena knows how difficult it is to isolate a system, sooner or later the coherency is lost. (Which is of course most fortunate, without this there would be no place for a real change or evolution to take place.).

Arto Annila has formulated the statistical mechanics of open systems as well as made extensive use of the notion of action. He goes back to the original notion of Maupertuis' principle of least action which includes open and path-dependent natural processes. In this way all entities in the world can be pictured in terms of energy densities. Energy is everywhere, the photons, electrons and even the voids of the Universe are saturated with it. Things evolve as the diverse systems interact with their surrounding systems when taking part in an overall energy dispersal process. Energy naturally disperses from higher densities to lower ones

by using the steepest available paths. Everything is pictured to be built out of most elementary actions, preons which are closed or open actions (composed of one or multiples $\hbar$.) Closed actions exist when at equilibrium with their surrounding conditions. They are spatially localized energy densities, stationary systems whose behavior (motion, phase etc) is predictable (computable). However, these steady structures do not last forever when surrounding energy densities, i.e., other actions changes. Then the closed high-density confinements break by discarding (acquiring) open actions carry to others of lower (higher) densities. The mutual energy density differences are the driving forces of changes of state. The flows of energy will naturally select from the available variation the least-time paths of dispersal, known also as geodesics. Everything happens lawfully towards a given end but the detailed course of events is impossible to predict as the driving forces do change when the density differences diminish in the open process which uses all the possible paths. (The equation of motion is intractable by integration).

In this kind of context quantum paradoxes tend to disappear. The phenomena simply look natural, they fit into the context. Even the basic unobservable the abstract and elusive wave function $\Psi(x,t)$ gets an clear interpretation in terms of energy density. Wave function is a fitting formalism, (via its mutually orthogonal spatial and temporal variables), to describe the flow of energy density from one site of energy density to another. When the flows level off the density differences, the wave functions will change and eventually the natural process will attain the state where the energy landscape has no curvature. Then the system has arrived at a thermodynamic steady state $d_tP = 0$ where the opposite circulations of energy densities Ψ and Ψ^*, as familiar from Kirchhoff's law, are equally abundant.

The measurement problem can also be treated in terms of energy transduction process. Measurement, like any interaction will always move the objects from their initial states to different final states which are either down or up in energy depending on the circumstances. The systems (the detector and object) are open during the process and thus their normal predictable course (their state depending on the energy content) will change (as also Niels Bohr was arguing). The indeterminacy $\Delta 2K\Delta t \geq h$ is naturally inherent in the detection as no state can be determined without a change of the state at least by h.

In this kind of context the EPR paradox does not cause any problems. As long as the observation (the observing system) does not perturb neither one of the two photons, the two-photon state, which resulted from a given decay, its particular polarization (i.e. its state; the inner connections which determine the predictable course of any closed structure) relative to each other will survive. Yet it remains indetermined with respect to the observer until the detection relates the system (one or the other of the two correlated particles) to the observer's frame. Thus in measurement (the energy rearranges and) the polarization of a photon is established in a new frame, a frame relative to the observer. I think the observers frame is philosophically a very interesting concept as allows a kind of midway position between realism and idealism (phenomenalism). We are dealing with real systems but nevertheless confined to our own worlds whose states are defined by our own experiences. The properties we observe are relative to us. Even if definite polarizations and spins may exist all the time in all the states available in the world, only after a measurements/interaction do we know how they (/what there) exist for us, how they are related to our (previous) states. The world includes us and it changes also because of our actions.

When we define everything in terms of energy densities, also the inseparability of wave and particle natures of light and other forms of energy is elucidated. (We are not fundamentally stuck with wave-particle dualism as Bohr stated.) For example when passing via two slits the flows of energy densities, such as a stream of photons or electrons from a high density source will disperse along the paths of least action. As long as the two slits are within the spread of an energy density perturbation, the flow of energy density through one slit depends on the flow through the other slit because both streams consume the common density difference. (When one slit is conducting, the density difference across the other slit will change and vice versa.) The flows via alternative paths depend on each other and inseparable interference effects will arise, when the coherent flows recombine after they have taken two or more paths to maximize the overall dispersal of energy in the least time. Moreover, any attempt to sniff, how the flows of energy density

distribute between to the two slits, will require, just as any measurement, some flow of energy, which in turn will obscure the interference pattern by contributing incoherently to the process of energy dispersal. Only when a single path is provided, i.e., when there are only two degrees of freedom, will the energy dispersal process be deterministic. So the message: Until now physics has unwarrantedly mostly focused upon these special cases of bound actions known as the Hamiltonian systems where the forces are separable from the flows and allow tracking of the motions by integration.

Annila's approach that comes from the statistical mechanics of open systems applies the universal law of maximal energy dispersal. It seems to fit quite well to the phenomena disclosed by quantum physics, (not to mention to the results related to nonlinear complex systems whose behavior cannot be explained simply on the basis of their parts.) It covers a wide range of phenomena (including evolution/possibility of a real change) which are shown in physical, biological and social systems (which are likely to be complex rather than simple, classical systems). I think that Annila' approach serves nicely as a background against which quantum interpretation discussions can be elucidated. Especially it makes Bohr's position understandable. In Bohr-Einstein EPR debate Bohr emphasized the role of context, the need to specify the whole measurement situation, where irreversible change took place. There is no need for any real physical force, push or pull acting at a distance if the measurement, as any physical interaction, is seen as an energy transfer process in which both the system studied and the observing system do chance. Given phases, the "nonlocal" correlations, pervade within any closed system or state as long as the energy is conserved. In interactions the energy density differences are leveling off and the phases do change as a result of an internal reorganization of the states. Bohr realized that it was time to give up the idea of stable immutable systems and configurations whose study of has traditionally been the main target of physics. They turned out to be transitory meaning that their internal characteristics do change whenever the energy changes in interactions. Yet, this does not mean that Bohr was right and Einstein wrong when demanding a more concrete formulation.

The Dynamic universe

There is also another model which gives perhaps an even more detailed picture concerning the structuring and hierarchy of universe. Dr. Tuomo Suntola has created a theory called Dynamic universe which actually seems to be a theory of everything. It is able to cover both relativistic physics and cosmology as well as quantum phenomena in the same framework. Suntola does not accept the equality of mass and energy (the idea that mass is converting into energy) and thus his approach discloses the hierarchy and connections between the closed systems in a different, more precise manner. In DU the totality of mass is the fundamental invariant which links everything together into a holistic composition. Mass as such is extremely abstract and inconceivable, devoid of dimensional extension or form. When excited by energy it takes the form of waves. The amount of mass exhibited by any local entity relates its behavior to the whole by telling exactly its share of the total resources, how much (internal and external) energy there is available for any separate entity.

At first sight Dr. Suntolas model may perhaps seem to be more like the classical kind of closed structure that we managed to get rid of when introducing evolution through open systems. It is a precise highly structured mathematical formalism with well established physical assumptions and strict predictions. While in Annila's model location and time are generated out of closed and open actions, DU takes a traditional look from the outside, using space and time as immutable coordinate quantities. Thus the theory re-establishes a universal frame of reference and gives a comprehensible model of the constitution and evolution of the universe. (Which as such is quite an astonishing achievement.) Like has happened in all big paradigm changes, the DU model once more successfully changes the perspective and reveals an unexpected link between mass, energy motion and space. (Since antiquity the growth in physical understanding of reality has characteristically been related to achieving a proper perspective and further

knowledge on the interrelations between these kinds of concepts.) In this new hierarchy the mass which is excited by energy determines the motion, volume and time development of space – the becoming of all physical structures and their interactions. The space appears as a closed 3-dimensional surface of a four sphere. (This is actually quite an old idea pondered in the 19th century e.g. by Bernhard Riemann and Ernst Mach. It was also Einstein's original cosmological view.) Space is a dynamic, structured whole which exhibits a hidden motion into the 4th dimension. Like in a pendulum the sum of the energies of motion and gravitation are equal throughout the cosmic expansion-contraction process and the total energy is conserved in all interactions in space. Surprisingly the approach also allows a sight into a kind of internal side, the internal immediate connections prevalent in the universe because of its finite resources and the characteristic structuring.

When starting from the overall mass and zero-energy balance, the multiplicity of the units is a result of the diversification of the whole. All the different parts of the universe are internally related to the whole via a system of nested energetic frames. The primary motion of mass with the expansion of space, balanced by global gravitation arising from the total mass in space, generates the ultimate frame, the homogenous space, whose evolution naturally gives rise to further relatively autonomous subsystems or frames, whose configuration always conserves the local as well as the overall energy balance. The frame provides both local and universal state of rest. It controls the behavior of its parts which may contain sub-frames behaving accordingly. Starting from the homogenous space, all the minor frames, which range from galaxy groups and solar systems to earth and all the individual material objects are formed at the cost of reduced local rest energy, which means a dent in space and reduced velocity of light.

In a way Suntola has done what Einstein was aiming for in his search for the unified field theory. As we know Einstein was against Bohr's abstract statistical approach related to quantum phenomena which was perhaps not wrong but incomplete. He believed that by unifying electromagnetism and general relativity one could create a new comprehensive theory which would yield quantum physics as a by-product. (Kumar) Suntola, who is an expert in electron physics started his search for the most fundamental principles in nature by scrutinizing and revising the postulates of theory of relativity. He does not need the equivalence principle or the Lorenz transformation. In addition to the precise geometry and the postulate of an overall zero energy principle, DU just needs to fix the total amount of mass to get a universe going. Suntola was surprised to notice how well his creation worked in cosmology (giving better predictions than the theory of relativity) He become a proficient cosmologist who knows exactly all the experiments and reasons why and where the theory of relativity goes wrong. In recent times he has moved into the quantum realm. The DU framework allows – starting from the Maxwell equations – to strip c from the Planck's constant and thus one gets a hold of "real" mass waves which are related to all entities. (see Suntola: Minimum dose of electromagnetic energy –presentation in SPIE conference (www.physicsfoundations.org)) Their use gives in details a correct description of the double-slit experiment as well as allows solving the energy states for the hydrogen atom. Notably the given connection between the mass and wave number works equally for the closed mass structures (particles) and for the electromagnetic radiation. (The only difference is that the closed mass structures possess a component in both real and internal (imaginary 4th dimension) momentum whereas radiation which propagates in space only posses a real component of momentum.) So, maybe Einstein's instinct of getting quantum physics as a by-product of a more comprehensive theory was not so wrong either.

Towards a new ontology

It is worth to study which one of the two models works better in explaining the quantum phenomena as this might provide guidelines for proper metaphysical choices. At the same time the explication also elucidates the Bohr Einstein debate as Annilas approach very much makes sense of Bohr's position and Suntola seems to fulfill Einstein's dream.

We have briefly discussed how Annila's statistical mechanics of open systems clarifies the issues related to the wave function, wave-particle-duality, non-locality and the measurement problem which appear paradoxical in the classical mechanical-deterministic context. Against what Bohr believed possible it also gives a picture of what might be going on in the quantum reality. There seems to be open and closed actions which take part in the process of leveling off the energy density differences in an overall energy dispersal process. At any case we learn that when using an abstract fundamental stuff which overcomes the closed boundaries of stationary systems, the conceptual problems related to classical paradigm can be solved.

We can say that Bohr got the things almost right but Einstein was not lead astray either. According to Thomas Kuhn a proper paradigm shift typically means a complete gestalt shift; a new paradigm is incompatible with the old one and assumes the world as being made of different kinds of entities. Kuhn also says that in a paradigm change the form of relevant questions may change as things are approached from different perspective. This is very much what is happening with the DU framework: many of the annoying features in present theories do no more exist. We do not need to worry about the incommensurability or puzzles of quantum and relativity theories as they do not contribute to the new description. An overall change, a totally new kind of framework (a new cosmological model based on abstract substance expressed in kilograms), is perhaps more than many people are ready to accept. In this sense the situation has not changed much. Einstein said when he was trying to explain what separated him and Schrödinger from most of their colleagues: 'Almost all the other fellows do not look from the facts to the theory but from the theory to the facts; they cannot extricate themselves from a once accepted conceptual net, but only flop about in it in a grotesque way.' (Kumar, 302)

Bohr and Einstein were unhappy as they could not convince each other. Had Bohr used the statistical mechanics for open systems the nature of quantum reality, the measurements and the role of humans might have been much easier to explain and communicate to others. On the other hand Einstein did not manage to find out his unified framework (which would include quantum mechanics in all details), as he was looking for one which would not violate locality or separability; he was not able to see how the whole has an effect on its parts – how the parts are not fundamentally separate but emerge from the diversification of the whole and how there is a kind of complementarity between the local and the global.

Now if the formalism used by Annila serves to make Bohr's position clear and Suntola fulfills Einstein's dream of a unified framework we are finally in position to tackle the real issues at stage concerning the nature of reality. We left with the task to choose between these two theories or to find out a way to put them together. Should we accept Bohr's or Einstein's tenet or is it possible to have them both? Perhaps, after all their positions were not so fundamentally different or incompatible, (omitting the mistakes, they were just concentrating on different things, different aspects of the whole.)
We might say that the actions and mass waves describe the same reality, but the action description (integrated energy) is a less accurate overview of the process of what is going on. For example it gives a basically right but a less accurate treatise of the double slit experiment. Some information is lost as mass and energy are not properly separated. One cannot differentiate all the various kinds of energy in details as occurs in DU which shows how the energy, in an ultimately balanced manner, triggers or forms the abstract indefinite mass thus giving rise to all extended detectable things: matter, radiation, electromagnetic phenomena, and all possible forms of closed vibrations exhibited in space.

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