Open Journal of Philosophy
2013. Vol.3, No.4, 451-454
Published Online November 2013 in SciRes (http://www.scirp.org/journal/ojpp)

Scientific Research
http://dx.doi.org/10.4236/ojpp.2013.34066

Triple-Aspect Monism and the Ontology of Quantum Particles

Gilbert B. Côté*
Sudbury, Ontario, Canada
Email: gbcote@gmail.com

Received August 22nd, 2013; revised September 22nd, 2013; accepted October 1st, 2013

An analysis of the physical implications of abstractness reveals the reality of three interconnected modes of existence: abstract, virtual and concrete. This triple-aspect monism clarifies the ontological status of subatomic quantum particles. It also provides a non-spooky solution to the weirdness of quantum physics and a new outlook for the mind-body problem. The ontological implications are profound for both physics and philosophy.

Keywords: Triple-Aspect Monism; Abstractness; Virtual; Timelessness; Non-Locality; Entanglement; Quantum Particles; Ontology

Introduction

A recent analysis of the properties of infinity (Côté, 2013) led to the conclusions that 1) infinity is abstract and real, 2) concrete space-time is finite, 3) mathematical Platonism is a logical necessity, and 4) quantum particles lie at the interface between the abstract and concrete aspects of reality.

I now intend to expand these conclusions with an analysis of the properties of abstractness. This should help clarify the ontological status of subatomic quantum particles and shed some light on the closely related mind-body duality problem.

Properties of Abstractness

On the premise of mathematical Platonism we affirm that infinity and mathematical statements constitute an abstract part of reality and exist independently of rational observers. This implies the reality of abstractness as a mode of existence distinct from space-time, i.e. without any embodiment, in sharp contrast to concrete reality. By definition, the existence of abstractness apart from space-time not only means that it occupies no space (and is therefore non-local), but also indicates that it is timeless.

Timelessness, or atemporality, is defined here as the absence of time and should not be confused with eternity (endless time, infinite time) or paused duration. In turn, the absence of time entails the total absence of change (because change can only be measured along a time scale). Abstract infinity, its mathematical arrangements and its infinite amount of information are thus unchangeable, immutable, fixed, permanent and unalterable. From the point of view of timelessness, past, present and future all exist together as one entity.

In abstractness and timelessness, abstract space is infinite and continuous, contrary to concrete space-time which is finite and discontinuous (Côté, 2013). Accordingly, in quantum field theory, the answers to calculations of the density energy of the vacuum have infinite values while astronomical measurements of supposedly the same density in large expanses of curved space-time yield small positive values close to zero (Rugh & Zinkernagel, 2002; Baez, 2011). This huge discrepancy—a long-standing unsolved problem in physics—is due to the fundamental difference between the properties of the continuous, abstract space of quantum theory, and those of the curved space-time of relativity. It is therefore important to examine the physical implications of abstractness in greater details.

Virtual Particles

We already know that quantum particles lie at the interface between the abstract and concrete aspects of reality (Côté, 2013). Virtual particles, in particular, have a very elusive nature. They are called virtual because they pop in and out of the vacuum so quickly that they do not even last long enough to be directly observed and hardly seem to exist at all. However, their existence has consequences that are physically measurable. One example is the Lamb-Retherford shift of energy levels within atoms of hydrogen (Lamb & Retherford, 1947) due to the interaction between virtual particles and the hydrogen atom's single electron. Another example is the Casimir effect between two metal plates (Casimir, 1948) due to the difference between the restricted number of virtual particles that can pop into the small space between the two plates and the larger number of particles that freely pop up outside, thus resulting in a net pressure on the plates. The physical reality of virtual particles more recently received additional support when a dynamic Casimir effect was used to extract real photons out of empty space (Wilson et al., 2001).

In quantum field theory, virtual particles are viewed as transient fluctuations, perturbations, excitations or vibrations in various quantum fields (e.g. photons in the electromagnetic field). The fields themselves can also be understood in terms of hybrid, virtual entities at the interface between abstractness and concrete space-time: their mathematical formulation is abstract but includes space-time variables. They appear to be neither

*Retired.

fully abstract, nor completely concrete.

From our point of view in concrete space-time, one of the basic characteristics of a real photon (as opposed to a virtual one) is the significant amount of time spent between its emission and detection (from less than a second to more than 13 billion years). However, both types of photons are discrete packets of pure energy without concrete substrate, both lie at the interface between the abstract and concrete aspects of reality, and both are interpreted as excitations in the underlying electromagnetic field. This prompts us to expand the notion of virtuality and consider both types of photons as virtual (i.e. neither abstract nor concrete) until they either 1) get annihilated with their antiparticles and return to abstractness, or 2) get detected and integrate concrete space-time. Once annihilated or detected, they no longer exist as separate, virtual entities.

This expanded notion has significant philosophical implications, as illustrated below with Thomas Young's (1804) famous double-slit experiment.

Timelessness and Non-Locality

As it is performed today, Young's double-slit experiment starts with the emission of one or more real photons in the direction of a screen where two parallel slits have been cut. The well-known wave function of the electromagnetic field describes photonic interference along all possible light paths before and after the slits, as well as different probabilities of photon detection at various discrete points on a second screen positioned behind the first screen. Whether photons are emitted singly or in large groups, the predicted and observed distributions of detected particles on the second screen show a pattern due to wave interference. Photons therefore seem to be waves as well as particles, a conclusion that stands as a flagrant contradiction. This paradoxical state of affairs has now been baffling scientists for more than a century (Gilder, 2008). However, the calculations of quantum physics are so accurate that physicists learn to use them without asking too many philosophical questions. This may be technologically sufficient, but it is philosophically and scientifically unsatisfactory.

If we use the expanded notion of virtuality (as presented above) to analyse these results, we view each photon as a virtual excitation in a virtual field. Essentially, each photon becomes a set of possible solutions to a wave function, and as such, it does not physically travel in space-time during the experiment. The eventual detection of a quantum of light on the second screen corresponds to the random selection of a particular solution to the wave function at the moment the experiment ends. The photon then—and only then—integrates space-time and loses its separate, virtual existence. Between emission and detection, the set of possible solutions (i.e. the photon) remains timeless and non-local (i.e. it stays out of space-time) in accordance to its virtual existence. This interpretation retains the wave functions as they stand today in physics textbooks, but it enhances the philosophical status of mathematics. Physicists need not worry, and mathematicians may cheer.

By recognising the distinct reality of abstractness and virtuality, we avoid the historical paradoxes and weirdness of quantum physics. We do not have to wonder how a single photon can travel through both slits at once because it does not travel. We do not have to be puzzled by its being both a wave and a particle because it is neither. We are dealing instead with a wave function that describes how a quantum of energy changes locations timelessly, from its location at emission to its location at detection, without any intermediate location. The double-slit experiment is no longer mysterious and the wave-particle duality no longer puzzling. This solution is a welcome consequence of the logical necessity of mathematical Platonism.

Virtual Entanglement

Once subatomic particles are interpreted in terms of virtual entities, it is easy to solve further quantum paradoxes. The next example is that of the mysterious entanglement of elementary particles, imagined by Einstein, Podolsky and Rosen (1935) to claim the incompleteness of quantum theory, and derided by Einstein as a "spooky action at a distance". Their paradoxical prediction was later confirmed by Aspect et al. (1982) as well as several other groups: experimental results on pairs of entangled particles emitted with opposite properties (such as polarisation, spin or electric charge) show that the detection of one member of the pair immediately fixes the indeterminate properties of both members, even when they are separated from each other by any distance. In terms of space-time, the consequences of entanglement can only be explained if information travels at least 10,000 times faster than the speed of light between the two members of the pair (Salart et al., 2008). However, such a speed is impossible according to the theory of relativity.

Results explained strictly in terms of space-time become even more mysterious for delayed-choice experiments where the decision on how and what to measure is chosen after the particles have taken a particular path along the experimental set-up. In such cases, the measurement seems to show a retroactive adjustment of the particles' behaviour in the past (Peruzzo et al, 2012; Kaiser et al., 2012).

If we include the reality of abstractness, timelessness, and the virtual nature of entangled particles in our interpretation, we see again that the probability function that describes the system is only solved (for all particles involved) at the time a measurement finally takes place. The solution is then applied to all entangled particles together, not only faster than the speed of light, but in no time at all, i.e. timelessly (with no speed involved). Until the measurement is made, the quanta under investigation exist virtually (i.e. timelessly and non-locally) and do not physically travel through concrete space-time. According to this interpretation, there is no longer any need for a "spooky" explanation that endorses a speed faster than the speed of light, no need for a backwards time influence or backwards causation (Garisto, 2002), and not even a need for a backward correlation or an Everettian many-worlds hypothesis (Gaasbeek, 2010). In addition, the proposed interpretation is non-local, it preserves causal order, and it holds whether the detection is made at random or on purpose, by an instrument or a conscious observer, whether it involves a single pair of particles or any number of fields or particles. Einstein was right on at least one point in this debate: spookiness is unnecessary.

Three Modes of Existence

To summarise so far, the detailed consideration of abstractness in quantum physics has led us to define three distinct modes of existence: abstract, virtual and concrete, each with its own characteristics. Abstractness is infinite and timeless; this implies that it does not change, does not evolve, plan, or make decisions, and it contains an infinite amount of information. Concrete space-time is finite and discontinuous; it is subject to gravity; it follows the rules of general relativity and evolves constantly. The hybrid realm of quantum physics forms a virtual bridge between the other two modes: it consists of abstract probability functions that include space-time variables.

There are relentless exchanges between the three modes of existence. We already saw above that abstractness contributes a constant flow of particles to the virtual mode of existence. (These particles can be interpreted as minute subsets of infinity. Since abstractness does not plan anything, their production is necessarily random and inevitable.) We also know that quantum particles combine to form concrete objects. Interestingly, the relation between the virtual and concrete modes of existence is not limited to the subatomic level. For instance, migrating birds seem to respond to the effects of the earth's magnetic field on the entangled electrons in molecules at the back of their eyes (Gauger et al., 2011), and quantum energy transfer is used in photosynthesis (Engel et al., 2007) at ambient temperature (Collini et al., 2010). Quantum particles return to abstractness when they get annihilated with their antiparticles; concrete stars produce astronomical amounts of quantum particles; abstract principles and the laws of physics determine the evolution of concrete entities (such as galaxies and living animals), and concrete people definitely have access to abstractness. In brief, there are bidirectional exchanges between all three modes of existence.

On the theoretical side, Hawking (1974) made the important suggestion that concrete black holes could gradually lose their mass and eventually vanish completely due to quantum effects near their event horizons. From the point of view of the three modes of existence, such black hole evaporation is a return of space-time to abstractness or, to use a different but equivalent wording, a return of concrete matter to abstract information. This interpretation is in keeping with the increasingly supported view in contemporary physics that the entire universe can be explained in terms of information, that information is never lost and is mathematically related to energy ($S = -\Sigma p_i \log p_i$) (Seife, 2006; Umpleby, 2007; Vedral, 2010; Gleick, 2011), just as energy is mathematically related to concrete space-time ($E = mc^2$). In other words, studying the inter-relationship between abstractness, virtuality and concrete space-time is just another way of looking at the known physical equivalence of information, energy and mass.

In conclusion, the three modes of existence can be academically studied by both philosophers and physicists, all three modes are real and interconnected, and all three are ontologically essential for the Universe to exist.

Triple-Aspect Monism

This world view has a direct impact on the famous mind-body problem. Having defined three interrelated modes of existence, we can no longer speak of two exclusive essences, like Plato and Descartes did. In fact, the concept of dualism has gradually lost most of its appeal among present-day philosophers, psychologists and neuroscientists who mainly support the idea of a dual-aspect monism (Pereira et al., 2010) and perceive mind and matter as two interdependent aspects of a single essence. Given the conclusions reached above in this article, we must further expand the notion of monism to include all three modes of existence into a triple-aspect monism.

This expanded framework has profound implications for physics and philosophy. For example, it enhances the reality of abstractness and timelessness, and will necessarily lead to the formulation of updated definitions of mind and body, with significant repercussions in science, philosophy, theology, religion and ethics.

Conclusion

The analysis of abstractness presented in this paper reveals the reality of three interconnected modes of existence: abstract, virtual and concrete. It clarifies the ontological status of subatomic quantum particles, it provides a non-spooky solution to the weirdness of quantum physics, and it presents a different outlook on existence and on the mind-body problem. It also sends a clear message of co-operation to physicists and philosophers who deal with ontological problems.

Acknowledgements

The constructive criticism and the encouragement of Prof. Lucien Pelletier of the Department of Philosophy, University of Sudbury (Ontario) are gratefully acknowledged.

REFERENCES

Aspect, A., Grangier, P., & Roger, G. (1982). Experimental realization of Einstein-Podolsky-Rosen-Bohm Gedankenexperiment: A new violation of Bell's inequalities. *Physical Review Letters, 49,* 91-94. http://dx.doi.org/10.1103/PhysRevLett.49.91

Baez, J. (2011). What's the energy density of the vacuum? http://math.ucr.edu/home/baez/vacuum.html

Casimir, H. B. G. (1948). On the attraction between two perfectly conducting plates. *Proceedings of the Koninklijke Nederlandse Akademie van Wentenschappen, B51,* 793-795.

Collini, E., Wong, C. Y., Wilk, K. E., Curmi, P. M. G., Brumer, P., & Scholes, G. D. (2010). Coherently wired light-harvesting in photosynthetic marine algae at ambient temperature. *Nature, 463,* 644-647. http://dx.doi.org/10.1038/nature08811

Côté, G. B. (2013). Mathematical Platonism and the nature of infinity. *Open Journal of Philosophy, 3,* 372-375. http://dx.doi.org/10.4236/ojpp.2013.33056

Einstein, A., Podolsky, B., & Rosen, N. (1935). Can quantum-mechanical description of physical reality be considered complete? *Physical Review, 47,* 777-780. http://dx.doi.org/10.1103/PhysRev.47.777

Engel, G. S., Calhoun, T. R., Read, E. L., Ahn, T.-K., Mančal, T., Cheng, Y.-C., Blankenship, R. E., & Fleming, G. R. (2007). Evidence for wavelike energy transfer through quantum coherence in photosynthetic systems. *Nature, 446,* 782-786. http://dx.doi.org/10.1038/nature05678

Gaasbeek, B. (2010). Demystifying the delayed choice experiments. http://arxiv.org/abs/1007.3977

Garisto, R. (2002). What is the speed of quantum information? http://arxiv.org/abs/quant-ph/0212078

Gauger, E.M., Rieper, E., Morton, J.J.L., Benjamin, S.C., & Vedral, V. (2011). Quantum coherence and entanglement in the avian compass. *Physical Review Letters, 106,* 040503. http://dx.doi.org/10.1103/PhysRevLett.106.040503

Gilder, L. (2008). *The age of entanglement. When quantum physics was reborn*. New York: Knopf.

Gleick, J. (2011). *The information. A history, a theory, a flood*. New York: Vintage Books.

Hawking, S. W. (1974). Black hole explosions? *Nature, 248,* 30-31. http://dx.doi.org/10.1038/248030a0

Kaiser, F., Coudreau, T., Milman, P., Ostrowsky, D. B., & Tanzilli, S. (2012). Entanglement-enabled delayed-choice experiment. *Science, 338,* 637-640. http://dx.doi.org/10.1126/science.1226755

Lamb, W. E., & Retherford, R. C. (1947). Fine structure of the hydrogen atom by a microwave method. *Physical Review, 72,* 241-243. http://dx.doi.org/10.1103/PhysRev.72.241

Pereira Jr., A., Edwards, J. C. W., Lehmann, D., Nunn, C., Trehub, A., & Velmans, M. (2010). Understanding consciousness. A collaborative attempt to elucidate contemporary theories. *Journal of Consciousness, 17,* 213-219.

Peruzzo, A., Shadbolt, P., Brunner, N., Popescu, S., & O'Brien, J. (2012). A quantum delayed-choice experiment. *Science, 338,* 634-637. http://dx.doi.org/10.1126/science.1226719

Rugh, S. E., & Zinkernagel, H. (2002). The quantum vacuum and the cosmological constant problem. *Studies in History and Philosophy of Science, Part B: Studies in History and Philosophy of Modern Physics, 33,* 663-705. http://dx.doi.org/10.1016/S1355-2198(02)00033-3

Salart, D., Baas, A., Branciard, B., Gisin, N., & Zbinden, H. (2008). Testing the speed of "spooky action at a distance". *Nature, 454,* 861-864. http://dx.doi.org/10.1038/nature07121

Seife, C. (2006). *Decoding the universe. How the science of information is explaining everything in the cosmos, from our brains to black holes*. New York, Toronto, London: Penguin Group.

Umpleby, S. A. (2007). Physical relationships among matter, energy and information. *Systems Research and Behavioral Science, 24,* 369-372. http://dx.doi.org/10.1002/sres.761

Vedral, V. (2010). *Decoding reality. The universe as quantum information*. Oxford: Oxford University Press.

Wilson, C. M., Johansson, G., Pourkabirian, A., Simoen, M., Johansson, J. R., Duty, T., Nori, F., & Delsing, P. (2001). Observation of the dynamical Casimir effect in a superconducting circuit. *Nature, 479,* 376-379. http://dx.doi.org/10.1038/nature10561

Young, T. (1804). The Bakerian lecture. Experiments and calculations relative to physical optics. *Philosophical Transactions of the Royal Society of London, 94,* 1-16. http://dx.doi.org/10.1098/rstl.1804.0001