ABSTRACTS

C2.8 Philosophy of the Physical Sciences

A PBR-like argument for psi-ontology in terms of protective measurements

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The ontological status of the wave function in quantum mechanics has been analyzed in the context of conventional projective measurements. These analyses are usually based on some nontrivial assumptions, e.g. a preparation independence assumption is needed to prove the PBR theorem. In this paper, we give a PBR-like argument for psi-ontology in terms of protective measurements, by which one can directly measure the expectation values of observables on a single quantum system. The proof does not resort to nontrivial assumptions such as preparation independence assumption.

Relationalism and Background Independence in Quantum Gravity

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The main problem faced by theories of quantum gravity is the problem of time, which is a direct result of incompatibility of our two main physical theories – General Relativity (GR) and Quantum Mechanics (QM). On the one hand, QM features Newtonian absolute time, a fixed background parameter. On the other hand, GR accounts for time as being a local dynamic parameter – a general spacetime coordinate. This stark contrast proves problematic for formulation of theory of Quantum Gravity, so much so that many physicists and philosophers begin to support the notion of Quantum Gravity without time. One way of approaching the problem of Quantum Gravity without time is Background Independence.

Background Independence is understood as freedom from absolute structures. The proposed presentation will focus on the notion of Background Independence and on its two criteria: temporal relationalism, and configurational relationalism. Analysis of temporal relationalism will focus on the understanding of time as proposed by Leibniz and Mach. Configurational relationalism will be analysed in light of internal space transformations of Gauge Theory.

Drawing on Barbour’s relationalism, and Rovelli’s relationalism, the main aim of the presentation is establishing whether temporal and configurational relationalism are sufficient conditions for achieving Background Independence, and what problems of time
Reconstruction of The Concept of Physical Quantity: An Epistemological Approach to Understand Weak Value

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The formulation of quantum mechanics is successful in probabilistic prediction of microscopic phenomena. The theory, however, brought us many philosophical problems, especially problems concerning physical reality. In fact, it has been thought that the theory never tells us what is going on in the quantum system which is in superposition. However, the situation has been changing. This is because we became able to measure quantum systems weakly without wave function collapse. The measurement, so-called weak measurement, was proposed by Aharonov and his colleagues in 1988. According to weak measurement, it seems that any quantum system has its own value which corresponds to the measurement outcome: weak value. Then some physicists regard weak values as elements of physical reality, because any physical quantity in classical physics has to be assigned its own value anywhere and anytime. The classical concept of physical quantity clearly supports naïve realism, because its value is determined independent of us, and this is why people believe that physical quantities are elements of physical reality. Actually, Einstein and his colleagues derived a sufficient condition for physical reality, which was written by using the concept of classical physical quantity. Of course, in quantum mechanics, the description of physical quantity is changed from the variable to the self-adjoint operator, but as before, it is believed that some basic physical quantities themselves correspond to intrinsic properties of physical objects even though they are not assigned values. However, does physical quantity correspond to physical reality? To give a negative answer, I reconstruct the concept of physical quantity through a mathematical procedure. Then I conclude that physical quantities are conceptual tools to describe physical phenomena and are not elements of physical reality. Moreover, based on the above conclusion, I propose an epistemological interpretation of weak value.

The Probability Problem in Everettian Quantum Mechanics Persists

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Everettian quantum mechanics (EQM) results in “multiple, emergent, branching quasi-classical realities.” (Wallace 2010b). The possible outcomes of measurement as per ‘orthodox’ quantum mechanics, are, in EQM, all instantiated. Given this metaphysics, Everettians face the ‘probability problem’ - how to make sense of probabilities and recover
the Born Rule. To solve the probability problem Wallace has derived a quantum representation theorem. I argue that Wallace’s solution to the probability problem is unsuccessful. My strategy is two-fold. First, I examine one of axioms of rationality used to derive the theorem, Branching Indifference (BI). I argue that Wallace is not successful in showing that BI is rational. Whilst I think it is correct to put the burden of proof on Wallace to motivate BI as an axiom of rationality, it does not follow from his failing to do so that BI is not rational. After all, one might think that there are other reasons ways to motivate BI. Thus, second, to exclude this possibility, I show that there is an alternative strategy for setting one’s credences in the face of branching which is rational and which violates BI. This is Branch Counting (BC). Wallace is aware of BC and has proffered various arguments against it. So the third task of the paper is to show that the arguments Wallace has produced against BC are unpersuasive. I conclude that indeed they are, and that therefore the probability problem in EQM persists.