Abstract

Spin-networks, as Real as Spacetime

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In the context of quantum theories of gravity—string theory, causal set theory, loop quantum gravity (LQG)—it is largely thought that spacetime disappears at the Planck-scale. With respect to LQG, it is claimed that spacetime is replaced at the Planck-scale by spin-networks which are something like a pre-geometric lattice of "geometrically" charged points and lines.

In the proposed talk, I will explain why spacetime is thought to disappear in LQG and explicate what might be the nature of spin-networks. However, I will argue that LQG neither requires spacetime to disappear nor that spin-networks be more than mathematical artifacts. In the course of this talk, I will provide a series of possible interpretations of LQG each of which differently describe the nature of LQG's fundamental structure. Some of these interpretations describe LQG as assuming a spatio-temporal structure, while some describe LQG as including spin-networks; interestingly, none of the interpretations which include spin-networks fail to include a substantival manifold.

In addition to spacetime disappearing fundamentally, it is also thought that spacetime emerges from spin-networks. For this claim to be true, spin-networks are required to be more than mathematical artifacts and must literally represent physical "spin-networks." However, given that mathematical spin-networks are built out of points and lines of the mathematical manifold, in order to interpret the networks literally, we must also interpret the background manifold literally. In short, I will argue that if we wish to interpret the spin-networks as physical structures, we will be forced to adopt a substantival interpretation of the background manifold of LQG.

As an alternative for understanding spacetime-emergence in LQG, I will argue that spacetime emerges from nothing other than quantum spacetime. Quantum spacetime is simply whatever structure is represented by the states of our Hilbert space and thereby exhibits the quantum geometric properties of the theory. The

position I will argue for is no different than the position one takes when claiming that at certain energy scales and with respect to certain properties, classical electrons "emerge" from quantum electrons. In the case of electrons, the classical structure emerges from its quantum variant and not some wholly distinct structure. In the same way, I will argue that spacetime emerges not from spin-networks but from its quantum variant. Contrary to the philosophic literature on the subject, in LQG there are not two things— emergent spacetime and fundamental spin-networks—but rather one thing: quantum spacetime, which sometimes happens to look classical. Emergence in LQG simply means that the quantum system exhibits stable properties which can be modeled with classical general relativity, or classical degrees of freedom. No new object comes into existence through this type of emergence, fundamental reality merely begins to look familiar.