

Spacetime and the Philosophical Challenge of Quantum Gravity

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Abstract

We survey some philosophical aspects of the search for a quantum theory of gravity, emphasising how quantum gravity throws into doubt the treatment of spacetime common to the two 'ingredient theories' (quantum theory and general relativity), as a 4-dimensional manifold equipped with a Lorentzian metric. After an introduction (Section 1), we briefly review the conceptual problems of the ingredient theories (Section 2) and introduce the enterprise of quantum gravity (Section 3). We then describe how three main research programmes in quantum gravity treat four topics of particular importance: the scope of standard quantum theory; the nature of spacetime; spacetime diffeomorphisms, and the so-called 'problem of time' (Section 4). These programmes are the old particle-physics approach, superstring theory, and canonical quantum gravity. By and large, these programmes accept most of the ingredient theories' treatment of spacetime, albeit with a metric with some type of quantum nature; but they also suggest that the treatment has fundamental limitations. This prompts the idea of going further: either by quantizing structures other than the metric, such as the topology; or by regarding such structures as phenomenological. We discuss this in Section 5.

Keywords: quantum gravity; conceptual problems of quantum theory and general relativity; spacetime as emergent

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