Modern canonical quantum general relativity

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Abstract (arXiv)
This is an introduction to the by now fifteen years old research field of canonical quantum general relativity, sometimes called "loop quantum gravity". The term "modern" in the title refers to the fact that the quantum theory is based on formulating classical general relativity as a theory of connections rather than metrics as compared to in original version due to Arnowitt, Deser and Misner. Canonical quantum general relativity is an attempt to define a mathematically rigorous, non-perturbative, background independent theory of Lorentzian quantum gravity in four spacetime dimensions in the continuum. The approach is minimal in that one simply analyzes the logical consequences of combining the principles of general relativity with the principles of quantum mechanics. The requirement to preserve background independence has lead to new, fascinating mathematical structures which one does not see in perturbative approaches, e.g. a fundamental discreteness of spacetime seems to be a prediction of the theory providing a first substantial evidence for a theory in which the gravitational field acts as a natural UV cut-off. An effort has been made to provide a self-contained exposition of a restricted amount of material at the appropriate level of rigour which at the same time is accessible to graduate students with only basic knowledge of general relativity and quantum field theory on Minkowski space.


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Cambridge Core - Theoretical Physics and Mathematical Physics - Modern Canonical Quantum General Relativity - by Thomas Thiemann. Modern physics rests on two fundamental building blocks: general relativity and quantum theory. General relativity is a geometric interpretation of gravity while quantum theory governs the microscopic behaviour of matter. Since matter is described by quantum theory which in turn couples to geometry, we need a quantum theory of gravity. In order to construct quantum gravity one must reformulate quantum theory on a background independent way. Modern Canonical Quantum General Relativity provides a complete treatise of the canonical quantisation of general relativity.