Joint CQSE and CASTS Seminar

Weekly Seminar
Mar. 23, 2012 (Friday)

TIME Mar. 23, 14:30 ~ 15:30
TITLE General Relativity without paradigm of space-time covariance: sensible quantum gravity and resolution of the ``problem of time"
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Abstract

Covariance of space and time in Einstein's theory of General Relativity (GR) entails a number of technical and conceptual difficulties. Remarkably, these can be resolved by a paradigm shift from full 4-dimensional general coordinate invariance to invariance only with respect to spatial diffeomorphisms. The framework for a theory of gravity with this paradigm shift, from quantum to classical regimes, is presented; GR is contained as a special case. Appositely formulated as a master constraint, the Hamiltonian constraint now determines only dynamics; and is relieved of its dual role of generating symmetry transformations, and the consequent baggage of unphysical multi-fingered evolution with arbitrary lapse functions is no longer present. The Dirac algebra, in which 4-dimensional diffeomorphism symmetry of GR is only realized on-shell, is replaced by the master constraint algebra which possesses only spatial diffeomorphism gauge symmetry, both on- and off-shell. Decomposition of the spatial metric into unimodular and determinant, q, factors results in mutually commuting pairs of canonical variables. The classical content of GR can be captured with a Hamiltonian constraint linear in the trace of the momentum π. This fortuity, and the fact that π is precisely conjugate to $\qt$, imply a theory of quantum gravity can be described by a Schrodinger equation first order in intrinsic time $\qt$ accompanied by positive semi-definite probability density.

The corresponding semi-classical Hamilton-Jacobi equation is also first order in intrinsic time, with the implication of being complete; and gauge-invariant physical observables can be constructed from integration constants of its complete integral solution. Classical space-time, with direct correlation of its proper times and intrinsic time intervals, emerges from constructive interference; and the physical content of GR

can be regained from a theory with a true Hamiltonian generating intrinsic time translations, but with only spatial diffeomorphism symmetry. The framework also prompts natural extensions and improvements towards a well-behaved quantum theory of gravity.