“On Integrating General Relativity with Quantum Theory by Reframing Riemannian Geometry as a Generalized Heisenberg Lie Algebra”

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Abstract:
For over 100 years, the dominant problem in theoretical physics has been the lack of integration of the theory of general relativity (GR) with quantum theory (QT) and the standard model (SM). QT and the SM are built upon a non-commuting operator (Lie) algebra of fundamental observables for position, momentum, energy, angular momentum, charge, strangeness and other observables for describing atomic and nuclear level phenomena. This algebra expresses the interference in the order of fundamental measurements. But GR is framed as nonlinear differential equations for the curved metric of space-time in a Riemannian Geometry (RG) without an operator algebra for its fundamental observables of space-time and of the metric.

It will be shown that the Einstein equations for GR as well as the underlying RG and can be reformulated as a generalized Lie algebra with a single assumption that generalizes the space-time metric to be a function of the position operators from quantum theory. Since the metric is now an operator, this approach generalizes the framework of the underlying Heisenberg Lie algebra and consequently the Lorentz and Poincare algebras when gravitation is dominant. The proposed integrated algebraic system is shown to give exactly the Einstein equations with large masses and dominant gravity (small h) and likewise to exactly give traditional QT and the SM frameworks when gravity is negligible. Possible observable tests of this proposed integration and new results are discussed. This approach also admits extensions to extra dimensions as with string theories. However, some of the core problems of such an integration (renormalization, covariant GR gauge transformations and their merger with the SM Yang Mills theory) are not yet solved. The presentation will end with a purely mathematical derivation of the foundations of RG based upon a generalized Lie algebra.