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Riemannian Geometry and General Relativity Reframed as a Generalized Lie Algebra JOSEPH JOHNSON, Univ of South Carolina — Quantum Theory (QT) and the Standard Model (SM) are expressible in Lie algebra frameworks while General Relativity (GR) is framed in the non-linear differential equations of Riemannian Geometry (RG), a very different framework that makes their union difficult. We show that RG can be reframed as a NonCommutative Algebra (NCA) that is a generalization of a Lie algebra (LA) where "structure functions" of position (X) generalize the LA structure constants. Such a NCA becomes an (approximate) LA in small regions of space-time. We begin with an Abelian algebra of n Hermitian operators X^μ ($\mu = 0, 1, .. n-1$) with representations on a Hilbert space whose eigenvalues represent independent variables such as space-time. We define operators D^μ that by definition translate the corresponding eigenvalues of X^μ each by a distance ds as $dX^\lambda(ds) = \exp(a\ ds\ \eta_\mu D^\mu)\ X^\lambda \exp(-a\ ds\ \eta_\nu D^\nu) - X^\lambda = ds\ \eta_\mu [\ D^\mu, X^\lambda]/a$ + ho where a is a constant and η_μ is a unit vector for the translation. We define the functions $g^{\mu\nu}(X) = [D^\mu, X^\nu]/a$ and show that $ds^2 = g_{\mu\nu}(X)\ dX^\mu dX^\nu$ proving that $g_{\mu\nu}(X)$ is the metric for the space taken in the position diagonal representation where $D^\mu = a\ g^{\mu\upsilon}(y)\ (\partial/\partial y^\nu) + A^\mu\ (y)$ thereby defining $[D^\mu, D^\nu]$. Integration with QT gives a = i. Details and predictions are discussed.

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