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Title: Trace dynamics, octonions, and unification - *from quantum foundations to the $E_8 \times E_8$ octonionic theory of unification* –

Abstract:

In quantum theory, classical spacetime is an extrinsic concept, possible only when the universe is dominated by macroscopic, classical bodies. This makes quantum theory depend on its own limit, and a more general formulation will remove classical time from quantum theory. We develop such a generalized formalism in the following steps : (i) raise classical dynamical degrees to the status of matrices/operators [Trace Dynamics]; (ii) replace every spacetime point by the 16D split-octonion; (iii) use the Chamseddine-Connes spectral action principle to prescribe a trace dynamics Lagrangian for the theory; (iv) describe evolution by the so-called Connes time - unique to a non-commutative geometry and absent in Riemannian geometry; (v) prescribe a gauge symmetry group for the Lagrangian, which we choose to be $E_8 \times E_8$. This leads us to a pre-spacetime, pre-quantum theory of unification of the four fundamental forces. Spontaneous symmetry breaking at the electroweak scale leads to the emergence of the standard model and of general relativity. Quantum theory and general relativity are emergent phenomena, with classical spacetime emerging only when the universe becomes dominated by classical bodies. The formalism, based on the exceptional Jordan algebra of the octonions, permits us to derive mass ratios of quarks

and charged leptons from first principles.