Gravity from Entropy

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Gravity is derived from the Gravity from Entropy (GfE) action coupling matter fields with geometry. The fundamental idea is to relate the metric of Lorentzian spacetime to a quantum operator, playing the role of an renormalizable effective density matrix and to describe the matter fields topologically, according to a Dirac-Kähler formalism, as the direct sum of a 0-form, a 1-form and a 2-form. While the geometry of spacetime is defined by its metric, the matter fields can be used to define an alternative metric, the metric induced by the matter fields, which geometrically describes the interplay between spacetime and matter. The proposed GfE Lagrangian is the Geometric Quantum Relative Entropy (GQRE) between the metric of spacetime expressing the information stored in the true metric that can be codified by the metric induced by the matter fields and curvature. The modified Einstein equations obtained from this action reduce to the Einstein equations with zero cosmological constant in the regime of low coupling. By introducing the G-field, which acts as a set of Lagrangian multipliers, the proposed entropic action reduces to a dressed Einstein-Hilbert action with an emergent small and positive cosmological constant only dependent on the G-field. The obtained equations of modified gravity remain second order in the metric and in the G-field. A canonical quantization of this field theory could bring new insights into quantum gravity while further research might clarify the role that the G-field could have for dark energy and dark matter.