Invited Speaker

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Title: Covariant formulation of non-equilibrium thermodynamics in General Relativity: Cosmic Acceleration from First Principles

Abstract: We construct a generally-covariant formulation of non-equilibrium thermodynamics in General Relativity. We find covariant entropic forces arising from gradients of the entropy density, and a corresponding non-conservation of the energy momentum tensor in terms of these forces. We also provide a Hamiltonian formulation of General Relativity in the context of non-equilibrium phenomena and write the Raychaudhuri equations for a congruence of geodesics. We find that a fluid satisfying the strong energy condition could avoid collapse for a positive and sufficiently large entropic-force contribution. We then study the forces arising from gradients of the bulk entropy of hydrodynamical matter, as well as the entropy of boundary terms in the action, like those of black hole horizons. We apply the covariant formulation of non-equilibrium thermodynamics to the expanding universe and obtain the modified Friedmann equations, with an extra term corresponding to an entropic force satisfying the second law of thermodynamics. General relativistic entropic acceleration theory may explain the present cosmic acceleration from first principles without the need of introducing a cosmological constant. Following the covariant formulation of non-equilibrium phenomena in the context of a homogeneous and isotropic Friedmann-Lemaitre-Robertson-Walker (FLRW) metric, we find that the growth of entropy associated with the causal horizon of our universe (inside a finite bubble in eternal inflation) induces an acceleration that is essentially indistinguishable from that of ΛCDM, except for a slightly larger present rate of expansion compared to what would be expected from the CMB in ΛCDM, possibly solving the so-called H0 tension. The matter content of the universe is unchanged and the coincidence problem is resolved since it is the growth of the causal horizon of matter that introduces this new relativistic entropic force. The cosmological constant is made unnecessary and the future hypersurface is Minkowsky rather than de Sitter.