General Relativity and Quantum Cosmology

Covariant Thermodynamics and Relativity

C S Lopez-Monsalvo

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This thesis deals with the dynamics of irreversible processes within the context of the general theory of relativity. In particular, we address the problem of the 'infinite' speed of propagation of thermal disturbances in a dissipative fluid. The present work builds on the multi-fluid variational approach to relativistic dissipation, pioneered by Carter, and provides a dynamical theory of heat conduction. The novel property of such approach is the thermodynamic interpretation associated with a two-fluid system whose constituents are matter and entropy. The dynamics of this model leads to a relativistic generalisation of the Cattaneo equation; the constitutive relation for causal heat transport. A comparison with the Israel and Stewart model is presented and its equivalence is shown. This discussion provides new insights into the not-well understood definition of a non-equilibrium temperature. The variational approach to heat conduction presented in this thesis constitutes a mathematically promising formalism to explore the relativistic evolution towards equilibrium of dissipative fluids in a dynamical manner and to get a deeper conceptual understanding of non-equilibrium thermodynamic quantities. Moreover, it might also be useful to explore the more fundamental issues of the irreversible dynamics of relativity and its connections with the time asymmetry of nature.

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