General Relativity and Quantum Cosmology

A consistent first-order model for relativistic heat flow

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This paper revisits the problem of heat conduction in relativistic fluids, associated with issues concerning both stability and causality. It has long been known that the problem requires information involving second order deviations from thermal equilibrium. Basically, any consistent first-order theory needs to remain cognizant of its higher-order origins. We demonstrate this by carrying out the required first-order reduction of a recent variational model. We provide an analysis of the dynamics of the system, obtaining the conditions that must be satisfied in order to avoid instabilities and acausal signal propagation. The results demonstrate, beyond any reasonable doubt, that the model has all the features one would expect of a real physical system. In particular, we highlight the presence of a second sound for heat in the appropriate limit. We also make contact with previous work on the problem by showing how the various constraints on our system agree with previously established results.

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