

# Dark Matter and Stars: Multi-Messenger Probes of Dark Matter and Modified Gravity

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## Mapping the landscape of gravity theories

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Both Einstein's equations and the field equations of a modified theory of gravity can be derived as equations of state from purely thermodynamical considerations, leading to the identification of GR with an equilibrium state of gravity and modified gravity with a non-equilibrium one. This breakthrough made the relationship between gravity and thermodynamics even more intriguing. I will present a new approach to the thermodynamics of modified gravity which is inspired by these results, but follows a starkly different path. A precise description of the approach to equilibrium naturally emerges from using Eckart's first-order irreversible thermodynamics on the effective imperfect fluid describing scalar-tensor gravity. Applications of this framework to cosmology, extensions to different classes of modified theories, and the formulation of two complementary descriptions based on the notions of temperature and chemical potential all contribute to a new and unifying picture of the landscape of gravity theories GR is embedded in.

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