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Challenging ΛCDM with scalar-tensor f(R,T) gravity and thermodynamics of irreversible matter creation

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We investigate the possibility of gravitationally generated particle production via the mechanism of non-minimal curvature-matter coupling. An intriguing feature of this theory is that the divergence of the matter energy-momentum tensor does not vanish identically. We explore the physical and cosmological implications of the non-conservation of the energy-momentum tensor by using the formalism of irreversible thermodynamics of open systems in the presence of matter creation/annihilation. The particle creation rates, pressure, temperature evolution and the expression of the comoving entropy are obtained in a covariant formulation and discussed in detail. Applied together with the gravitational field equations, the thermodynamics of open systems lead to a generalization of the standard ΛCDM cosmological paradigm, in which the particle creation rates and pressures are effectively considered as components of the cosmological fluid energy-momentum tensor. We also consider specific models, and we compare the cosmology with a curvature-matter coupling with the ΛCDM scenario, and if it additionally gives rise to particle creation rates, creation pressures, and entropy generation through gravitational matter production in both low and high redshift limits.

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