Investigating the flow of energy within the Dark Sector

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Abstract

We investigate the exchange of energy between dark matter and dark energy in a coupled quintessence model, where a scalar field ϕ with potential $V(\phi)$ interacts with pressureless dark matter through a coupling β. Working in a spatially flat FLRW background, we derive the field equation and the continuity equations for each component. The interaction appears as an energy transfer term $Q = \beta\phi\dot{\rho}_{dm}$, which enters the two continuity equations with opposite signs, so the total energy density remains conserved and the Friedmann equations stay consistent. The direction of the flow is set by the sign of $\beta\phi$. We then rewrite the Friedmann constraint in dimensionless variables and reduce the background evolution to a two-dimensional autonomous system.