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Observational constraints of diffusive dark-fluid cosmology

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In this manuscript, the background and perturbed cosmic dynamics have been investigated using an interacting dark-fluid model by assuming energy exchange between dark matter and dark energy through a diffusion mechanism. We solve the background expansion history for the late-time Universe and derive the full set of the evolution equations of the matter density contrast, $\delta(z)$ and redshift space distortion, $f\sigma_8(z)$, using the $1+3$-covariant formalism. We then seek to constrain the best-fit cosmological parameters: h, Ω_m, r_d, M, σ_8, and the interaction term Q_m through the MCMC simulations with cosmological datasets. Using the joint datasets of the Hubble parameter measurements from cosmic chronometers (CC), Baryon Acoustic Oscillations (BAO) from the Dark Energy Spectroscopic Instrument (DESI), and SNIa distance moduli from Pantheon+ SH0ES, redshift space distortion (RSD) from large-scale galaxy surveys, a detailed statistical analysis of the work is made. To evaluate the dark-fluid model's viability in describing late-time cosmic dynamics, the numerical results of background cosmological parameters are presented. The results show that the dark-fluid behaves like Chaplygin gas (CG) that drives cosmic acceleration when Q_m is negative, while for positive Q_m, it exhibits characteristics of a quintessence-like phase. From the perturbation evolution equations, the numerical results of $\delta(z)$ and $f\sigma_8(z)$ were used to explore structure growth. A comparison of the H_0 and S_8 values has been made of the ΛCDM and diffusive models across recent cosmological surveys to show the possibility of alleviating the cosmological tensions, though the detailed analysis is beyond the scope of the current study.

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