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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, which assumes energy exchange between dark matter and dark energy through a diffusion mechanism. After we solve the background expansion history for the late-time Universe, the full set of linear perturbation equations is driven using the $1+3$-covariant approach. We take into account the recent measurements of Baryon Acoustic Oscillations (BAO) from the Dark Energy Spectroscopic Instrument (\textit{DESI BAO DR2}), cosmic chronometers (\text{CC}), and the compilations SNIa distance moduli namely: \textit{Pantheon plus + SH0ES} (\textit{PPS}), \textit{DESY5}, \textit{Union3}, together with the redshift space distortion (\textit{RSD}) and growth rate f from VIPERS and SDSS collaborations for statistical analysis of the work. We then seek to constrain the cosmological parameters: H_0 in km/s/Mpc, Ω_m, r_d, M, σ_8, $_8$, and the interaction term Q_m through the MCMC simulations. As a result, a comparison of the H_0 and S_8 values predicted by ΛCDM and diffusive models with the cosmological surveys from late- and early-time measurements. To evaluate the viability of the dark-fluid model in describing cosmic dynamics, the numerical results of background cosmological quantities are presented. These results show that the dark fluid behaves like the 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 density contrast, $\delta(z)$, growth rate, $f(z)$, and redshift space distortion, $f\sigma_8(z)$ are presented, demonstrating the impact of energy diffusion between dark matter and dark energy for the cosmic structure growth. Using the AIC and BIC Bayesian methods, a detailed statistical analysis has been performed.

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