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Testing $f(T)$ Gravity with Cosmological Observations: Confronting the Hubble Tension and Implications for the Late-Time Universe

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Abstract. In recent years, modifications to General Relativity (GR) have been explored to address cosmological observations, particularly in the context of late-time cosmic acceleration. Among these, modifications based on the Teleparallel Equivalent of General Relativity (TEGR), particularly $f(T)$ gravity, have gained significant attention. In this work, we investigate the scalar perturbations in $f(T)$ gravity, focusing on how these perturbations modify the Poisson and lensing equations and how they impact cosmological observables. By incorporating observational data from cosmic chromatometers, Big Bang nucleosynthesis, the DESI BAO survey, and Type Ia Supernovae (SNe Ia), we derive constraints on the parameters of the $f(T)$ power-law model. Our results suggest that $f(T)$ gravity can effectively alleviate some of the tensions observed in the standard Λ CDM model, including the Hubble constant (H_0) discrepancy. Furthermore, the evolution of the supernova luminosity and its dependence on the gravitational constant are considered to refine the measurement of cosmological parameters. The model's ability to address the H_0 tension is critically examined, and we find that $f(T)$ gravity offers a viable alternative to the standard model. The work concludes by comparing the fits of the $f(T)$ gravity model to the Λ CDM model using various information criteria, revealing key insights into the viability of modified gravity in contemporary cosmology.

Keyword: modified gravity, cosmological observables, Hubble tension