An Investigation of a Dark Sector Interaction Model to Solve the Hubble Tension

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A major topic in modern cosmology is the disagreement between datasets when interpreted using the status-quo Lambda cold dark matter (Lambda-CDM) model. Lambda-CDM assumes that baryons, radiation, and cold dark matter (CDM) evolve independently from each other and from a constant dark energy density (the cosmological constant Lambda). Most prominently, there is a four standard deviation discrepancy between the direct measurement of the Hubble constant by the Supernova H0 for the Equation of State (SH0ES) collaboration using Cepheid variables and the model-dependent determination obtained by fitting Lambda-CDM to cosmic microwave background (CMB) measurements. Given that the nature of both CDM and dark energy are currently unknown, the Hubble tension may be a hint of physics beyond the scope of Lambda-CDM. In this project, a novel model, called the Interacting Dark Sector (IDS) model, was proposed to attempt to reduce the Hubble tension. IDS encodes decay-type interactions between CDM and dark energy. This decay is proportional to the CDM density but is restricted at early, CDM-dense times to preserve the excellent fit between Lambda-CDM and CMB data. A Markov Chain Monte Carlo sampling algorithm was used to fit IDS to dataset combinations, both containing and not containing SH0ES data, to determine probability distributions and best-fit values for model parameters. IDS increases the predicted Hubble rate by an average of 1.2 km/s/Mpc when SH0ES data is included, reducing the Hubble tension from four to three standard deviations. Although results suggest that IDS is unlikely to solve the Hubble tension, current cosmological data is generally consistent with the possibility of dark matter-dark energy interaction, motivating further exploration of dark sector interactions.