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A 1% calibration of the Galactic Cepheid Luminosity scale based on cluster Cepheids strengthens the Hubble tension

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I present our recent 1% calibration of the Galactic Leavitt Law (period-luminosity calibration) based on Gaia astrometry of Cepheid-hosting open star clusters as well as individual Cepheids (Cruz Reyes, Anderson et al. in prep.). We identified host clusters in the vicinity of Cepheids using our own clustering method to identify clusters whose average parallax can be safely used in lieu of Cepheid parallaxes for Leavitt law calibration. This method provides average cluster parallaxes with typical uncertainties of ~ 6 micro arcsec for clusters, including angular covariance terms and improving by a factor of ~2.8 on the typical uncertainty of Cepheid parallaxes used for Leavitt law calibration. Using the LMC for comparison, we show that cluster parallaxes are accurately corrected for known Gaia parallax systematics by applying the Lindegren et al. (2021) based on quasars. Hence, additional (beyond Lindegren et al.'s) corrections for parallax offsets that are required for individual Cepheids are not required for average cluster parallaxes. This allows us to calibrate the Milky Way Leavitt law to unprecedented accuracy in a variety of photometric bands and reddening-free Wesenheit magnitudes while simultaneously solving for the residual individual Cepheid parallax offset. Using two photometrically independent sets of Wesenheit magnitudes, we measure the most precise value for the Cepheid parallax offset to date with a significance of 6 sigma. At the same time, we determine the absolute magnitude of Solar metallicity Cepheids of 10 day period to an accuracy as good as 1%, exclusively relying on data of Milky Way Cepheids without a need for data from other galaxies or the distance ladder. Importantly for the Hubble tension, we find a Cepheid luminosity scale in 0.9 sigma agreement with the same number determined by the SH0ES team (Riess et al. 2022) based on an extragalactic distance ladder fit as used to determine the Hubble constant. Our methodology is maximally different from the SH0ES distance ladder, yet obtains results consistent to within 1 sigma and at an accuracy of 1%. This lends strong support to the veracity of the Hubble tension and shows that Gaia astrometry can deliver on its potential to calibrate the Cepheid luminosity scale to better than 1% in future data releases.

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