

Calibrating Cepheid Star Luminosity to Increase Confidence to the Cosmic Distance Ladder

Chris Joseph

Abstract

The cosmic distance ladder is a culmination of objects and methods that astronomers use to map out our universe and discover distant phenomena. Each rung of this ladder progressively allows us to see further. The techniques on the higher rungs depend on the stability of the lower rungs. On the lower rungs of this ladder lie Cepheid stars, giving us the ability to see up to 300,000 lightyears. However, the intrinsic nature of Cepheids plagues the ladder. Cepheids, with their variable luminosity, generate a tremendous amount of uncertainty in the ladder. Previously, there were only a small amount of Cepheids identified with the Early Release Gaia Data. We extracted our data from the most recent Gaia Data Release 3 in the Gaia Archives. After heavy analysis and stringent cuts, we were able to utilize 419 well-measured Cepheids. By doing so, we believe that we can increase the overall accuracy of the cosmic distance ladder, which in turn will improve the accuracy of measurements made with the James Webb Space Telescope (JWST.) We did not incorporate the metallicity of stars into my analysis because these values were not well measured by Gaia. Its inclusion would enhance the precision of the Cepheid star rung in the cosmic distance ladder. Gaia only measures them in the green band (g-band) of the visible light spectrum, so stars not measured in this band were not accounted for. Interstellar extinction might have impeded the accuracy of the Cepheid star magnitudes. In our results, using more data did not necessarily translate to a more accurate period-luminosity relation. The slope uncertainty is too high to be reliable in these circumstances and did not lead to a better calibration of the Cosmic Distance Ladder. All in all, this could be an important contribution to the field of astronomy, as accurate distance measurements are essential for understanding the nature and evolution of the universe.