Lost in the Stars: Chemical Tagging of the Magellanic Clouds and Accreted Populations

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The internal kinematics of massive red supergiant branch (RGB) and oxygen-rich and carbon-rich asymptotic giant branch (AGB) stars in the Magellanic Clouds have been modeled to examine the tidal evolution of the Magellanic Clouds. The Large Magellanic Cloud (LMC) and the Small Magellanic Cloud (SMC) initial evolutions can be traced by identifying kinematically distinct stellar populations accreted in the LMC. To address the distinct populations in the SMC and the LMC, a neural network (NN) is trained to chemically identify tracers using SDSS-IV APOGEE DR17 chemical abundances. The NN achieves a classification accuracy of approximately 87% and a false positive rate of 9%, identifying distinct metallicities around [Fe/H] = -1.0. Further analysis in the [Ce/Fe] abundance space yields the very first evidence that AGB populations in the Magellanic Clouds will undergo a post-AGB in situ evolutionary third dredge-up phase without Li production. After accounting for asymmetric drift in the AGB population, a LMC rotation curve is derived based on a robust Markov Chain Monte Carlo method. Finding the amplitude of the rotation curve as 56 km/s ± 10 km/s beyond a radius 2.4 kpc ± 0.2 kpc with a systemic velocity at 269 km/s ± 9 km/s, outliers from the fits are taken and a kinematically unique population of >4% in the LMC is found. This coincides with the HI arms kinematically associated with disk being pulled into the LMC. The fraction of unique tracers drops at [Fe/H] = -0.92, providing strong evidence that the kinematically unique population originated in the SMC. This work reinforces evidence that Galactic substructures resulted from collisions between the Magellanic Clouds and demonstrates that the stretching of the Magellanic Bridge is not kinematically unique.

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