Why Galaxies Care About AGB Stars:
A Continuing Challenge through Cosmic Time
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Updates on the Ultraviolet Emission from Asymptotic Giant Branch Stars

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Abstract. A comprehensive study of UV emission from asymptotic giant branch (AGB) stars with the Galaxy Evolution Explorer (GALEX) revealed that out of the 316 observed AGB stars, 57% were detected in the near-UV (NUV) bandpass and 12% were detected in the far-UV (FUV) bandpass (Montez *et al.* 2017). A cross-match between our sample and Gaia DR2 results in parallax estimates for 90% of the sample of AGB stars, compared to only 30% from Hipparcos. This increase allowed us to further probe trends and conclusions of our initial study. Specifically, that the detection of UV emission from AGB stars is subject to proximity and favorable lines of sight in our Galaxy. These improved results support the notion that some of the GALEX-detected UV emission is intrinsic to AGB stars, likely due to a combination of photospheric and chromospheric emission.

Keywords. stars: AGB and post-AGB, ultraviolet: stars, stars: evolution

Asymptotic Giant Branch (AGB) stars are luminous sources from optical to radio wavelengths, however, their ultraviolet (UV) emission is poorly-characterized. In Montez *et al.* 2017), we presented a comprehensive study of the UV emission in the near and far UV emission (NUV and FUV, respectively) based on observations of 316 AGB stars by the Galaxy Evolution Explorer (GALEX). The sample included carbon, M-type, and S-type AGB stars and both photometric and spectroscopic observations. 179 of the AGB stars were detected and 137 were not detected. We reported that the NUV emission from AGB stars is correlated with the optical to the near-infrared emission and is often found to vary in phase with phased visible light curves. Our study also found evidence for anti-correlation between the circumstellar envelope density and the NUV – and possibly FUV – emission. Including Hipparcos parallax estimates, we found that the detections and non-detections indicated higher detection fractions from the closest AGB stars, as well as the influence of galactic extinction on the detectability of UV emission from AGB stars.

We cross-correlated our GALEX AGB catalog with the 2nd Data Release of Gaia (Gaia DR2; Gaia Collaboration 2016, 2017) using a search radius of 6″. The resulting sample increases the number of AGB stars with parallax estimates compared to the Hipparcos-based results. However, given the variability and projected sizes of the nearest AGB stars, the Gaia DR2 parallax estimates for the closest AGB stars have lower precision due to potential brightness variations on their surfaces that can lead to photocenter shifts (e.g., Chiavassa *et al.* 2018). Indeed, this problem is evident in the Gaia DR2 Astrometric

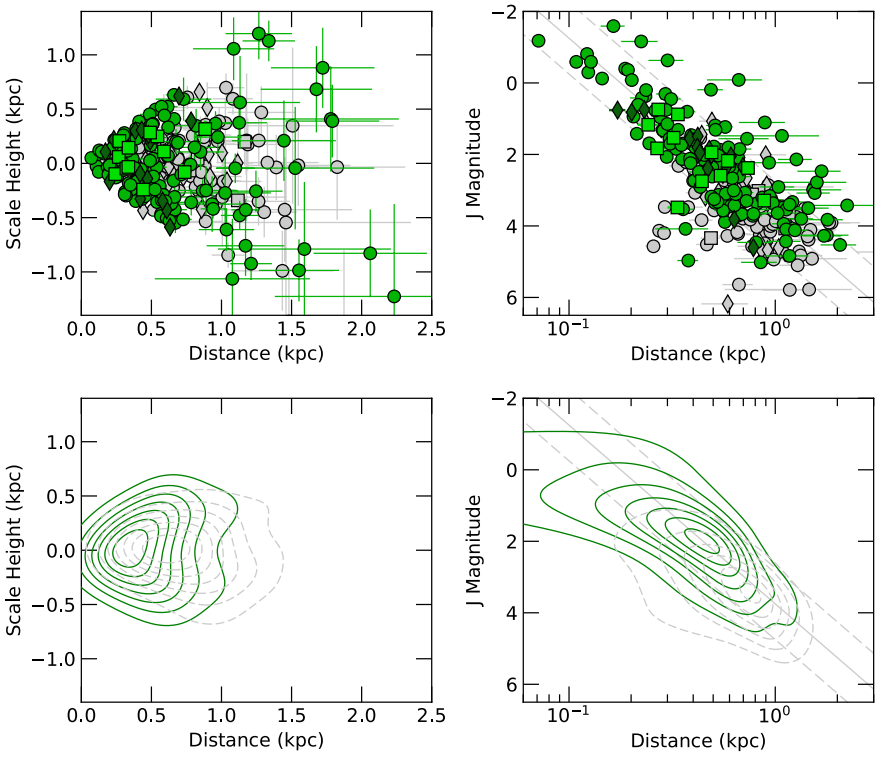

Figure 1. Top panels: UV detections (green symbols) and non-detections (gray symbols) of the AGB star sample with Gaia parallax measurements and their scale heights (left) and 2MASS J band magnitudes (right). Bottom panels show the same data after applying a kernel density estimator to better represent the detection and non-detection distributions. Symbols shapes represent the various types of AGB stars (circles for M-type, diamonds for carbon, and squares for S-type).

Goodness of Fit in the Along-Scan direction (`GOF AL`) metric for the sample. The `GOF AL` values are worse for the brightest/closest AGB stars and flattens to acceptable values for the fainter/farther AGB stars. As a result, reported parallax estimates for nearby ($J < 2$ mag) individual AGB stars are suspect, but when treated as a population, as done here, the influence of the potential photocenter shifts is reduced.

The trends determined from Hipparcos parallax estimates for our AGB sample are further strengthened by the Gaia parallax estimates. We more readily detect UV emission from the brighter and closer AGB stars and can detect AGB stars farther away when they are at higher galactic scale heights. These trends further support the notions that UV emission is an inherent (and hence most likely intrinsic) characteristic of AGB stars, and that galactic extinction hampers UV detection of AGB stars.

References

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