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# Improving the distances of post-AGB objects in the Milky Way

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## Abstract.

Post-AGB (PAGB) stars are short-lived, low-intermediate mass objects transitioning from the asymptotic giant branch (AGB) to the white dwarf (WD) phase. These objects are characterised by a constant, core-mass dependent luminosity and a large infrared excess from the dusty envelope ejected at the top of the AGB. PAGB stars provide insights into the evolution of their direct descendants, planetary nebulae (PNe). Calculation of physical characteristics of PAGB are dependent on accurately determined distances scarcely available in the literature. Using the Torun catalogue for PAGB objects, supplemented with archival data, we have determined distances to the known population of Galactic PAGB stars. This is by modelling their spectral energy distributions (SED) with black bodies and numerically integrating over the entire wavelength range to determine the total integrated object flux. For most PAGB stars we assumed their luminosities are based on their positional characteristics and stellar evolution models. RV Tauri stars however are known to follow a period-luminosity relation (PLR) reminiscent of type-2 Cepheids. For these variable PAGB stars we determined their luminosities via the PLR and hence their distances. This allows us to overcome the biggest obstacle to characterising these poorly understood objects that play a vital part in Galactic chemical enrichment.

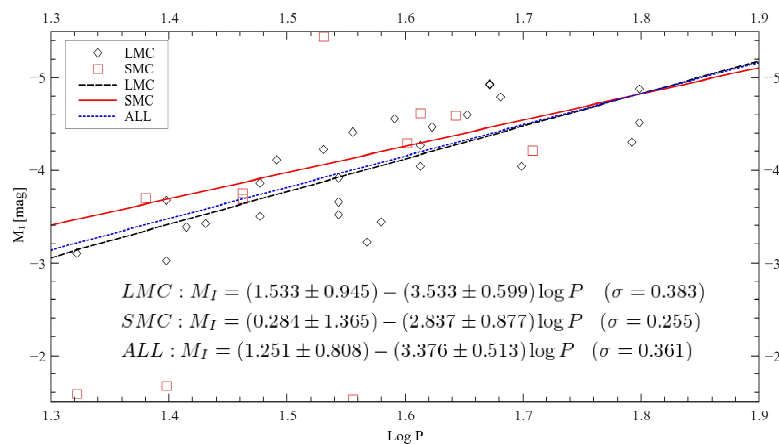
## 1. Introduction

Pre-planetary nebulae (PPNe) are a very brief phase in the late-stage evolution of mid-mass stars ( $\sim 1 - 8 M_{\odot}$ ) between the asymptotic giant branch (AGB) and the PN phase. The tenuous envelope ejection in the final superwind of AGB evolution reaches rates of  $10^{-4} M_{\odot} \text{ yr}^{-1}$ , and increases the effective temperature of the central star. The rate of increase is a strong function of core mass [1,2]. RV Tauri stars are F to K type variable stars with alternating deep and shallow minima and are believed to be luminous population II Cepheids that follow a period-luminosity relationship similar to type-2 Cepheids [3]. Understanding these objects depends on accurate distances that are not yet available for the more poorly-quantified objects. We aim to rectify this by determining accurate distances to the known Galactic PAGB star population [6].

## 2. Sample

We use the Toruń catalogue of PAGB and related objects [4,5] and flux data for known Galactic objects that includes 209 likely PPN, 112 RV Tauri, 72 R CrB/eHe/LTP and 87 possible PAGB





**Figure 1.** I-Band PLR for LMC and SMC RV Tauri variables taken from [7,8].

objects. We determine RV Tauri star distances via a newly defined period luminosity relation. These data are supplemented with publicly available data from other surveys from the optical to the sub-mm to build SEDs for all objects.

### 3. Method

We use the SED fitting method described in [6], with the luminosity calculation for RV Tauri stars described as follows. Using the data from [4,5] as well as publicly available photometry, we build an SED that is fit with a number of black body functions to calculate the total bolometric flux. This is used with the luminosity to determine the distance. Light curves and photometry from [7,8] are used to define a new period-luminosity relation for RV Tauri stars in both the LMC and the SMC to determine luminosities for their Galactic counterparts. Using these data we have defined a new period luminosity relations for RV Tauri stars in multiple wavebands the I-band PLR is shown in Figure 1.

### 4. Summary and future work

With a new catalogue of distances to the different PAGB objects we can work on determining the progenitors, amongst other physical parameters, for the different classes. With distances we can compare the z-heights for the different object classes, shining light on their progenitors. This will help uncover the shaping mechanisms responsible for the observed complex morphologies. This is the first ever distance catalogue for these objects.

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