Why Galaxies Care About AGB Stars:
A Continuing Challenge through Cosmic Time
Proceedings IAU Symposium No. 343, 2019
F. Kerschbaum, M. Groenewegen & H. Olofsson, eds.

doi:10.1017/S1743921319002291

Observational Properties of Miras in the KELT Survey

R. A. Arnold[1], M. Virginia McSwain[1], Joshua Pepper[1], Keivan G. Stassun[2] and the KELT Collaboration

[1]Dept. of Physics, Lehigh University, 16 Memorial Drive East, Bethlehem, PA 18015
emails: raa314@lehigh.edu, mcswain@lehigh.edu, joshua.pepper@lehigh.edu

[2]Dept. of Physics and Astronomy, Vanderbilt University,
2301 Vanderbilt Place, Nashville, TN 37235
email: keivan.stassun@vanderbilt.edu

Abstract. We present a catalog of the observed properties of Mira-type variable stars detected with the Kilodegree Extremely Little Telescope (KELT). Asymptotic giant branch (AGB) candidates were identified in KELT using a combination of photometric data from KELT and 2MASS colors. Of the 4 million objects with KELT photometry, 3332 Mira-like variables were identified. Here, we present their observed periods and luminosities which will place important constraints on future theoretical work on the effect convection has on pulsation periods and mode stability.

Keywords. stars: AGB and post-AGB, stars: variables: other, techniques: photometric

1. Introduction

Miras are large amplitude, long period, luminous variables near the tip of the asymptotic giant branch (AGB). They have the potential to serve as distance indicators as they follow a period-luminosity (PL) relation (Whitelock *et al.* 2008 and references therein). A catalog of galactic Miras may serve as an important tool in calibrating this PL relation and improving our understanding of the properties of Miras.

Our study uses photometric data from the Kilodegree Extremely Little Telescope (KELT), which is a robotic single-band photometric survey designed to detect exoplanet transits around stars with magnitudes of $8 < V < 13$. It has high photometric precision and cadence, and a long time baseline with the earliest observations dating from 2005.

2. Discussion

To find Miras we selected candidate AGB stars using $H - K_s$ and $J - H$ colors from 2MASS. Color criteria for selecting candidate AGBs were chosen using 2MASS colors of Miras from the GCVS and AAVSO catalogs. We tested light curves of candidate AGBs for coherent variability using the Stetson L (Stetson 1996) and the alarm variability statistic A (Tamuz *et al.* 2006). We adopted the criteria of $L > 1$ and $A > 50$ to select variable AGB candidates. For the selected stars, we then calculated the periodicity of the KELT light curves using the Lomb Scargle (LS) algorithm (Zechmeister & Kurster 2009; Press *et al.* 1992). We searched for periodic signals between 10 and 1000 days with a frequency step size of $\Delta f = 0.1/T$, where T is the length of observations. The period associated with the highest LS power was selected.

We selected Miras using their amplitudes and the strength of the periodic signal in light curves measured by the LS power. Miras are conventionally defined to have amplitudes of $\Delta V > 2.5$ mag, but at longer wavelengths such as those measured by KELT's R-band

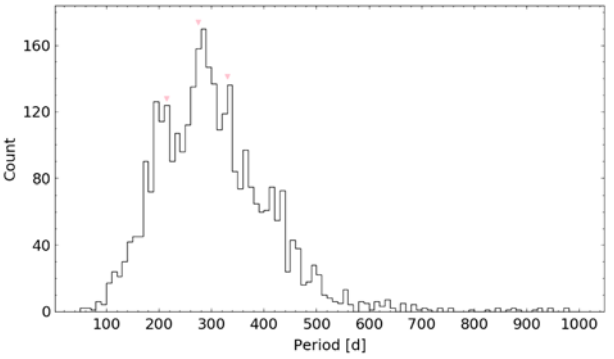

Figure 1. Period distribution of our Miras. The three red triangles mark period peaks found by Vogt *et al.* (2016)

filter their amplitudes decrease. We adopt the following criteria for identifying Miras: a LS power > 0.7, and a measured light curve amplitude > 1.5 mag.

We found 3332 Mira-like objects in the KELT survey. Of these, 258 Mira-like objects have not been included in previously published literature. The distribution of periods is shown in Fig. 1. For those stars also found by Vogt *et al.* (2016), we found good agreement between our periods and theirs. Of the 2875 Vogt *et al.* (2016) objects, 1415 were observed by KELT, and we identified 752 of them in our Mira-like catalog. Most of the failed matches were at the faint end of our magnitude range, but we recover 73% of the Vogt *et al.* (2016) targets with $V < 10$ mag.

We calculated absolute magnitudes of our Miras using 2MASS K_s magnitudes and preliminary distances derived from Gaia DR2 by Bailer-Jones *et al.* 2018. The absolute magnitudes were transformed to luminosities using color-dependent bolometric corrections from Houdashelt *et al.* (2000) and Kerschbaum *et al.* (2010). The typical error of the luminosities is a factor of 2 due to the imprecision of the Gaia DR2 parallaxes. This is mostly the result of their variability and their angular diameters being comparable to their parallaxes. In the future, we hope to compare the PL relation of our sample with theoretical results from MESA and GYRE. As this PL relation is better understood, Miras may serve as important extragalactic distance indicators in the future. We also plan to investigate the effects of convection on the theoretical PL relation through implementing turbulent convection in the open-source GYRE pulsation code, which can be used in conjunction with the MESA stellar evolution code.

References

Bailer-Jones, C. A. L., Rybizki, J., Fouesneau, M., *et al.* 2018, *AJ*, 156, 58
Green, G. M. *et al.* 2018, *MNRAS*, 478, 651
Houdashelt, M. L., Bell, R. A., Sweigart, A. V., & Wing, R. F. 2000, *AJ*, 119, 1424
Kerschbaum, F., Lebzelter, T. & Mekul, L. 2010, *A&A*, 524, 87
Paxton, B., *et al.* 2011, *ApJS*, 192, 3
Press, W.H., Teukolsky, S.A., Vetterling, W.T. & Flannery, B.P. 1992, Numerical Recipes in C, 2nd ed. (New York: Cambridge University Press)
Stetson, P. B. 1996, *PASP*, 108, 851
Tamuz, O., Mazeh T. & North P. 2006, *MNRAS*, 367, 1521
Townsend, R. H. D. & Teitler, S. A. 2013, *MNRAS* 435, 3406
Vogt, N., Contreras-Quijada, A., Fuentes, Morales, I., *et al.* 2016, *ApJS*, 227, 6
Whitelock, P. A. 2012, *Ap&SS*, 341, 123
Whitelock, P. A., Feast, M. W., & Van Leeuwen, F 2008, *MNRAS*, 386, 313
Zechmeister, M. & Kürster, M. 2009, *A&A*, 496, 577

https://doi.org/10.1017/S1743921319002291 Published online by Cambridge University Press