OPEN ACCESS

Evolutionary Status of Selected Post-AGB Single and Binary Stars in Gaia DR3

M. Parthasarathy[1,2], Marina Kounkel[2], and Keivan G. Stassun[2]

Published August 2022 •

Research Notes of the AAS, Volume 6, Number 8

Citation M. Parthasarathy *et al* 2022 *Res. Notes AAS* **6** 171

keivan.stassun@vanderbilt.edu

[1] Indian Institute of Astrophysics, Bangalore 560034, India

[2] Vanderbilt University, Department of Physics & Astronomy, Nashville, TN 37235, USA; keivan.stassun@vanderbilt.edu

M. Parthasarathy https://orcid.org/0000-0002-8361-431X

Marina Kounkel https://orcid.org/0000-0002-5365-1267

Keivan G. Stassun https://orcid.org/0000-0002-3481-9052

1. Received August 2022
2. Revised August 2022
3. Accepted August 2022
4. Published August 2022

https://doi.org/10.3847/2515-5172/ac8c46

Post-asymptotic giant branch stars; Binary stars; Stellar distance; Stellar evolution

Abstract

Gaia data is helping to further understand the evolutionary status of post-AGB and related stars. In this paper we present an analysis of Gaia DR3 data of post-AGB stars and post-AGB binaries with accurate parallaxes. Gaia DR3 data of 44 post-AGB candidates are analyzed, including 16 post-AGB binary candidates. Of these, 19 stars have RUWE values >1.4. For several stars, the calculated absolute luminosities confirm that they are indeed in post-AGB evolutionary stage. We find that 12 stars have relatively lower luminosities; some of them may be post-RGB stars and some may be post-HB stars. We find that IRAS 01427+4633 (BD+46 442), IRAS 16230–3410, and IRAS 19199+3950 (HP Lyr) are evolved high velocity stars.

1. Selection of Stars

Stars are selected from Vickers et al. (2015) based on their Gaia data having not yet been analyzed and they have accurate parallaxes. This resulted in 52 stars including some post-AGB binaries and several stars with RUWE >1.4 (Stassun & Torres 2021). Details and methods of analysis are given in our previous paper (see Parthasarathy et al. 2022). For context, Figure 1 shows the stars in the $\log T_{\rm eff}$ versus $\log L_{\rm bol}$ plane and in the RUWE versus $\log L_{\rm bol}$ plane.

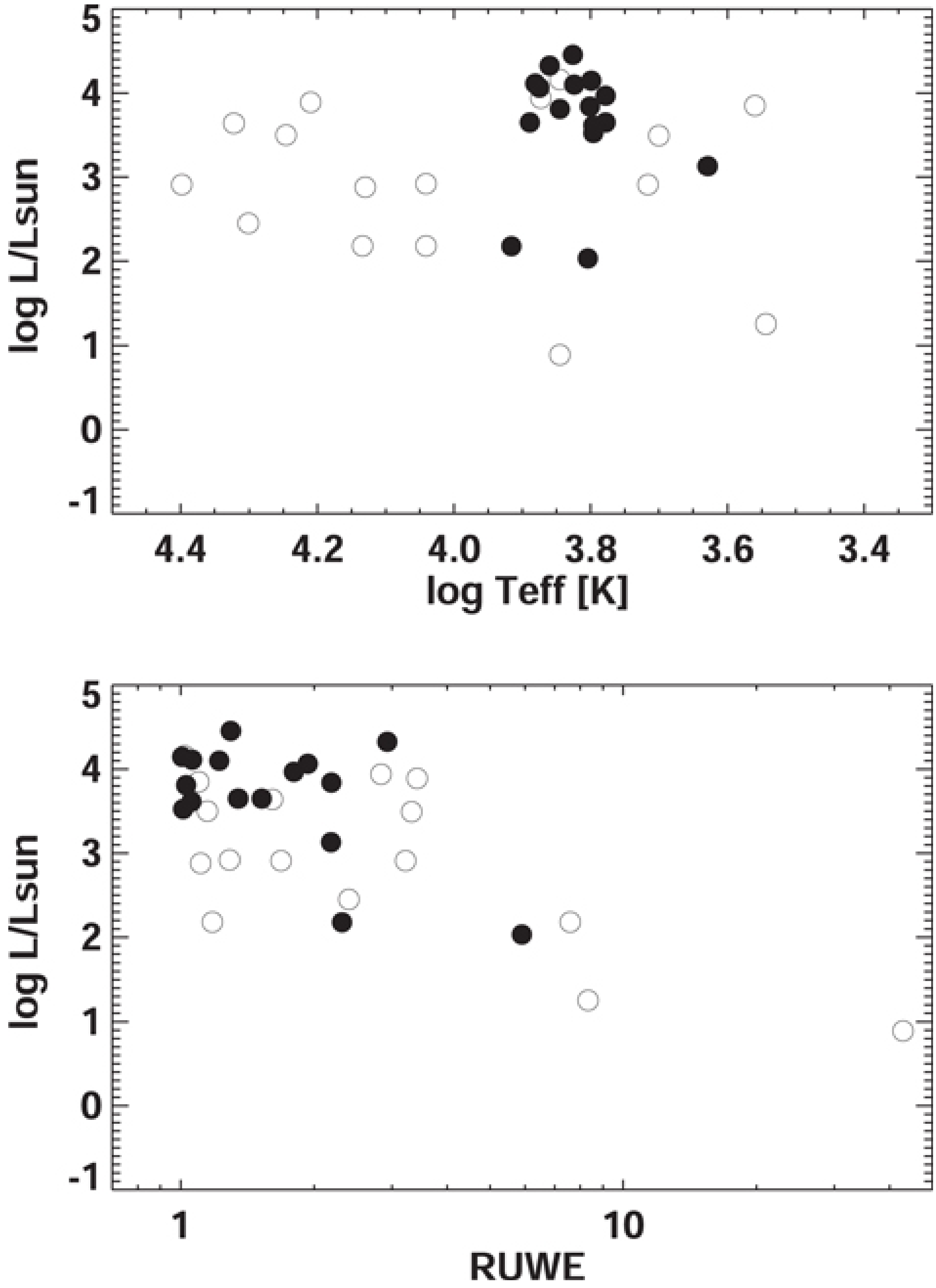

Figure 1. (top) HR Diagram positions of the sample stars, and (bottom) RUWE values vs. $\log L_{\rm bol}$. Post-AGB stars are shown with open symbols, post-AGB binary stars are shown with filled symbols.

2. Results

2.1. Post-AGB Stars

2.1.1. CPD −61 455

This is a high galactic latitude star. Hambly et al. (1996) from an analysis of its spectrum conclude it is a post-AGB binary with a K-type companion. The derived luminosity and $T_{\rm eff}$ indicates it may be a hot post-HB star.

2.1.2. IRAS 07131−0147

This star is a highly polarized bipolar point symmetric reflection nebula (Scarrott et al. 1990). Alves & Hoard (1996) also conclude it is a late-type post-AGB binary. The central star may be obscured by a dusty disk. The derived luminosity is only $\sim 18\,L_\odot$, which may be due to obscuration by a dust disk. It may be a post-RGB star.

2.1.3. IRAS 07253−2001

There is no detailed study of this star. Reddy & Parthasarathy (1996) made *BVRI* photometric observations and obtained spectral type of the star from low resolution spectrum. The derived luminosity is too low, indicating it is not a post-AGB star.

2.1.4. IRAS 12419−5414 (Boomerang Nebula)

This star is also known as Centaurus bipolar nebula. Sahai & Patel (2015) have detected cold outflows from this bipolar proto-planetary nebula with a dusty disk.

2.1.5. IRAS 12584−4837

Gauba & Parthasarathy (2003) analyzed the IUE spectrum of this star, derived $T_{\rm eff}$, and found evidence for hot stellar wind and mass-loss. The derived luminosity indicates it is not a post-AGB star, but a hot post-HB star.

2.2. Post-AGB Binaries and Related Stars

2.2.1. IRAS 01427+4633 (BD+46 442, SAO 37487)

This is a high galactic latitude star. It is considered a post-AGB binary with orbital period of 140.8 days and systemic radial velocity of -98.13 km s^{-1} (Gorlova et al. 2012; Ooman et al. 2018). From the luminosity we conclude it is a high velocity star in post-AGB stage of evolution. Its RUWE is <1.4. Kluska et al. (2022) derive $T_{\rm eff} = 6250$ K, $\log g = 1.5$ and [Fe/H] = −0.7. They find that no depletion of refractory elements unlike other post-AGB binaries. It may not be a binary, the velocity variations may be due to pulsation.

2.2.2. IRAS 05208−2035 (AY Lep)

This is a high galactic latitude star. Steinmetz et al. (2020) derived $T_{\rm eff} = 4255$ K, $\log g = 2.46$, and [Fe/H] = −0.15. The luminosity is lower than that of a post-AGB star. Its RUWE is >1.4. It may be a post-RGB star.

2.2.3. IRAS 07008+1050 (HD 52961)

This star is an extremely metal-poor ([Fe/H] = −4.7) post-AGB binary (Kipper 2013; Ooman et al. 2018). Its RUWE is <1.4. The luminosity is in good agreement with that of a post-AGB star. It shows extreme depletion of refractory elements.

2.2.4. IRAS 07140−2321 (V421 CMa, SAO 173329)

This star is a post-AGB binary (Ooman et al. 2018). Its RUWE is <1.4 and the luminosity is in agreement with that of a post-AGB star. Its metallicity is [Fe/H] = −0.8 (Gielen et al. 2011). Its systemic radial velocity is 73.3 km s^{-1}; it may be a high velocity star.

2.2.5. IRAS 08005−2356 (V510 Pup)

This is a binary bipolar proto-planetary nebula with high velocity outflows (Manick et al. 2021). Iyengar & Parthasarathy (1997) obtained *BVRI* photometric observations. Its RUWE value is high (5.902). The luminosity is much lower than that of a post-AGB star, which may be due to obscuration by the dust disk.

2.2.6. IRAS 10158−2844 (HR 4049, HD 89353)

This is a high galactic latitude, extremely metal-poor post-AGB binary. Monier & Parthasarathy (1999) analyzed the IUE low resolution spectra and derived $T_{\mathrm{eff}} = 7500$ K and find significant variations in the UV flux. They also find a UV flux deficiency and variable circumstellar extinction which follows Lambda inverse law. Takeda et al. (2002) analyzed high resolution spectrum and derived [Fe/H] = −4.7, detected Zn lines, and find [Zn/H] = −1.3. All refractory elements are extremely depleted, which is due to dust grains formation. Its RUWE is >1.4 and its luminosity is in agreement with non-binary post-AGB stars.

2.2.7. IRAS 11000−6153 (HD 95767)

This star was classified as post-AGB by Pottasch & Parthasarathy (1988), and a post-AGB binary by Ooman et al. (2018). Its RUWE is < 1.4 and its luminosity is in agreement with that of a single post-AGB star.

2.2.8. IRAS 12222−4652 (HD 108015)

This was classified as a high galactic latitude post-AGB star by Pottasch & Parthasarathy (1988), and a post-AGB binary by Ooman et al. (2018). Its RUWE is 1.298 and its luminosity is a bit higher than that of typical post-AGB star.

2.2.9. IRAS 14524−6838 (HD 131356)

This star is a post-AGB binary (see Ooman et al. 2018). Its RUWE is >1.4 however its luminosity is in agreement with that of a typical post-AGB star.

2.2.10. IRAS 16230−3410 (V1330 Sco)

This is a high galactic latitude semi-regular variable star. Ooman et al. (2018) consider it a post-AGB binary with period of 649.8 days. Its radial velocity is -146.59 ± 3.02 km s^{-1}, indicating it is a high velocity star. Ooman et al. (2018) give its systemic velocity as -154.3 km s^{-1}. Its RUWE is <1.4 and the luminosity confirms it is a post-AGB star. The radial velocity variations may not be due to binarity, but pulsations.

2.2.11. IRAS 17534+2603 (89 Her, HD 163506)

This is a high galactic latitude post-AGB star (Parthasarathy & Pottasch 1986) and a binary with period of 289.1 days (Ooman et al. 2018). Its RUWE is <1.4 and its luminosity is in agreement with that of a post-AGB star.

2.2.12. IRAS 19199+3950 (HP Lyr)

This is a high galactic latitude variable star. Its radial velocity is -115.43 ± 2.45 km s^{-1}, indicating it is a high velocity star. There are significant variations (Graczyk et al. 2002) with pulsation period of 69 days. It is most likely a metal-poor ([Fe/H] = −1.0) A-type post-AGB supergiant (Graczyk et al. 2002; Manick et al. 2017). The radial velocity variations my be due to pulsation, not binarity. Its RUWE is <1.4 and its luminosity is in agreement with that of a post-AGB star.

2.2.13. IRAS 22327−1731 (HD 213985)

This is a very high galactic latitude metal-poor A-type binary (Gielen et al. 2011; Ooman et al. 2018). Its RUWE is >1.4 and the luminosity indicates it is a post-RGB star, not post-AGB.

2.2.14. BD+39 4926

Kodaira (1973) studied the chemical composition of this high galactic latitude A-type star, concluding it is a Pop-II metal-poor ([Fe/H = −2.52) star. It is not an IRAS source. It is a post-AGB spectroscopic binary with orbital period of 871.7 days (Ooman et al. 2018). Its RUWE is >1.4 and its luminosity confirms that it is a post-AGB star.
