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Galactic Bulge Hypervelocity (HVS) RR Lyrae variable stars and one high galactic latitude HVS HB star

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Abstract

Six Galactic Bulge Hypervelocity (HVS) RR Lyrae stars and one high galactic latitude HVS Horizontal Branch (HB) star found from the ongoing search for HVS in the Gaia DR3 and SIMBAD data are presented. Some of these stars may be unbound and may be leaving the Galaxy. The source of the hyper velocities acquired by these stars may be the influence of the massive black hole at the center of our Milky Way Galaxy or other processes such as the dynamical interaction with other stars in the densely populated Galactic bulge.

Keywords : Hypervelocity stars - Galactic Bulge - RR Lyrae stars - Horizontal-Branch stars

1. Introduction

RR Lyrae type pulsating variables are core-helium burning Horizontal – Branch (HB) stars. They are low mass metal-poor population II stars. Numerous such stars have been found in the Galactic Bulge by the OGLE (Optical Gravitational Lensing Experiment) survey. (Soszynski et al. 2019 (references therein), Pietrukowicz et al. 2020 (references therein)). RR Lyraes are one of the best standard candles for accurate distance estimates using their period-luminosity relation. The average absolute magnitude of a RR Lyrae star is about 0.75. They are 40 to 50 times brighter than the Sun.

RR Lyraes have also been detected in the Local Group of galaxies and they have been extensively used as astrophysical tracer objects within the Local Group of galaxies. The detection of HVS among various types of stars is important to further understand the HVS phenomena (Brown 2015, Brown et al. 2005, Hills 1988).

2. Search for HVS

I have searched the GAIA DR3 and SIMBAD data for HVS with Gaia G magnitudes less than 17.0 and radial velocities more than + 400.0 km/sec. Regarding the choice of +400 km/sec as the lower limit is to select stars with very high radial velocities (true HVS) and not to confuse with high velocity stars and also it is based on the review paper of Brown (2015). (see Parthasarathy 2023). All the selected stars have RUWE (Renormalized Unit Weight Error (Lindegren2021)) values less than 1.4. In this paper I present six hypervelocity (HVS) Galactic Bulge RR Lyrae stars and one high galactic latitude Horizontal Branch (HB) HVS star that I found from the ongoing search for HVS (Parthasarathy 2023) using the Gaia DR3 (Gaia Collaboration 2021, 2022a,b) and SIMBAD astronomical database (Strasbourg, France).

3. OGLE Galactic Bulge RR Lyrae HVS

In Table 1 the data of seven stars extracted from the Gaia DR3 and SIMBAD is given. The radial velocities (RV) given in Table 1 are from SIMBAD data base (see Jonsson et al. 2020, (APOGEE data and spectral analysis from SDSS data release 16: seven years of observations including first results from APOGEE-SOUTH). These radial velocities were derived by Jonsson et al. (2020) from an analysis of high resolution spectra. Typical errors in radial velocities are of the order one km/sec. They have derived the radial velocities and chemical composition for large number of stars. Jonsson et al. compared their radial velocities with the radial velocities from Gaia DR3 and have concluded that the radial velocities given in their catalogue (Jonsson et al. 2020) are in good agreement with the Gaia DR3 radial velocities. Jonsson et al. (2020) have not identified and discussed HVS in their catalogue. The distances (d) of seven stars given in Table 1 are from Bailer-Jones et al. (2021).The radial velocities of these seven stars given in Table 1 clearly suggest they are HVS. Their U, V, W velocities and tangential velocities (Vtan) also clearly indicate they are HVS. The U, V, W. and Vtan values are not given in this research note because of space limitations. Anyone interested in these values can calculate them from the data given in Table 1. All the RR Lyrae stars discussed in this note (Table 1.) have their recent light curves in the Gaia DR 3 part 4 variabilty (Gaia Collaboration 2022ab).

Table 1. Galactic Bulge HVS RR Lyraes and one hig galactic latitude HB HVS

Star name	l (deg)	b (deg)	mu (mas/yr)	Gmag	RV (km/sec)	d(pc)
OGLE BLG-RRLYR-12295	359.73	-4.75	6.429	16.12	1123	6676
OGLE BLG-RRLYR-14278	1.34	-4.96	4.381	16.70	840	8423

OGLE BLG-RRLYR-17332	0.04	6.05	9.397	16.29	769	4654
OGLE BLG-RRLYR-17478	356.61	3.49	13.403	16.98	803	7603
OGLE BLG-RRLYR-25798	3.89	3.60	7.265	16.91	873	6100
OGLE BLG-RRLYR-33247	0.1	-3.82	6.235	15.93	-997	6022
SDSS J101233.03+262548.0	204.77	54.68	2.912	16.48	1412	6397

4. Discussion and Conclusions

OGLE BLG-RRLYR-12295

IT is RRc type RR Lyrae. Its pulsation period is 0.293228 days.

OGLE BLG-RRLYR-14278.

It is RRab type RR Lyrae. Its pulsation period is 0.451353 days. SIMBAD data indicates high rotational velocity. It may be a close-binary star. Further study of this star is needed.

OGLE BLG-RRLYR-17332

It is also RRab type RR Lyrae . Its pulsation period is 0.646795 days. In the Gaia DR3 data its Teff is 6357 K, log g = 4.1137, and [Fe/H] = -1.4266 or -2.6959. It seems to be very metal-poor. High resolution spectroscopic analysis of this metal-poor star is needed.

OGLE BLG-RRLYR-17478

It is also RRab type RR Lyrae. Its pulsation period is 0.856471 days. In Gaia DR3 data its Teff is 6300K, log g =4.3738 and [Fe/H] = -1.6665.

OGLE BLG-RRLYR-25798

It is RRab type RR Lyrae. Its pulsation period is 0.520771 days. Teff = 5671K, log g = 4.3704, and [Fe/H] = -3.7274. It is very metal-poor. Further high resolution spectroscopic analysis of this star is very important.

OGLE BLG-RRLYR-33247

It is RRc type RRLyrae. Its pulsation period is 0.265370 days. It is having very high negative radial velocity (Table 1.).

SDSS J101233.03+262548.0

It is a very high galactic latitude star (Table 1.). Chen et al. (2010) found it to be metal-poor ([Fe/H]) = -1.27. Gaia DR3 data gives Teff = 5182K, log g = 4.3297, and [Fe/H] = -1.3862. This star may be a galactic halo red-HB star. Its radial velocity (Table 1.) indicates it is unbound and leaving the Galaxy.

All the seven stars (Table 1) mentioned above are hypervelocity stars. The influence of black hole situated at the galactic center or the other processes described by Brown (2015) may be responsible for these stars to acquire hyper velocities.

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