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Analysis of Gaia DR3 data of selected high galactic latitude H-alpha emission stars

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Abstract

Gaia DR3 data of 52 high galactic latitude H-alpha emission stars selected from the paper of Stephenson (1986) are analyzed. Ten new variable stars and eight new high velocity stars have been found. Details of six post-AGB stars and several other interesting stars are discussed. Many of the stars presented in this paper have Gaia DR3 light curves and spectra. A detailed study of these 52 stars is needed to derive their chemical composition and to further understand their binarity, circumstellar matter and evolutionary status. The astrophysical parameters from the Gaia DR3 data reveal several hot (OBA) and several F and G-type stars in this sample. Some of them are metal-poor stars.

Keywords: High-galactic latitude stars – H-alpha emission stars

1. Introduction

Earlier studies of high galactic latitude H-alpha emission stars listed in the paper of Stephenson (1986) revealed that some of them are in post-AGB phase of evolution (Vijapurkar et al. 1998, Parthasarathy et al. 2000, Fujii et al. 2002, Gauba et al. 2003). Downes and Keyes (1988) made spectroscopic observations of 111 high latitude H-alpha emission stars from the paper of Stephenson (1986) and found six symbiotic stars, three cataclysmic variables, several Be stars and T-Tauri stars. They conclude that 47 stars failed to show H-alpha emission lines even though Stephenson (1986) lists them as high galactic latitude H-alpha emission stars. Maheswar et al. (2003) observed 52 stars from the paper of Stephenson and found H-alpha emission in the spectra of 11stars. Emprechtinger et al. (2005) studied 11 stars and found several Be stars. With this background in my mind, I decided to analyze Gaia DR3 data of 52 high galactic latitude H-alpha emission stars selected from the paper of Stephenson (1986). I have excluded T-Tau stars and stars that failed to show H-alpha emission line (Downes and Keyes 1988, Maheswar et al. 2003). The Stephenson list includes many Me dwarf stars and I have also excluded them. His list also includes many weak H-alpha emission stars and have also excluded them. Binary and multiple stars are also excluded. Stephenson (1986) lists 206 stars, however many of these stars do not have UBV photometry data and MK spectral types. Finally, I have selected 52 stars from the longer list that remain after those exclusions and extracted their Gaia DR3 data (Gaia Collaboration 2022) and related data from the SIMBAD database and given in Table 1 and column one gives StHA (Stephenson 1986) number (SIMBAD database).

Table 1. Selected high galactic-latitude H-alpha emission stars

StHA No.	l deg	b deg	V	B-V	G mag	Sp.	RV km/sec	mu mas/yr	d pc	Mv	Teff, log g, [Fe/H]
5	125.53	-26.28	8.56	0.200	8.59	A3		16.542	358	0.4	
13	134.70	-9.99	10.12	0.08	10.11	Be		1.074	1590	-1.6	12487K, 3.42, 0.16
14	148.53	-43.79	10.20	0.53	10.91	Bep	34	25.577	249	0.81	
15	133.08	10.47	13.5		13.12	A5		99.464	63		low luminosity
22	174.11	-32.63	11.71	0.26	11.89	B3V		2.605	2763	-2.1	15746K, 3.63, -0.57
32	197.49	-30.04	13.5		12.29	C1	325	6.695	10.2kpc		4400K, 1.36, -0.04
50	206.68	-17.32	11.30	-0.04	11.21	B6e	-489	0.780	1565	-0.04	14950K, 2.02
51	147.70	17.84	11.37	0.22	11.57	B3		1.568	3058	-2.44	18117K, 3.69, -0.4
52	206.85	-16.54	7.83	0.11	7.76	B3 IV	46	0.116	399	-1.3	13379K, 3.75, -0.03
58	192.40	13.78	9.39	0.45	9.31	F2	13	9.246	425	0.92	6671K, 3.61, -0.25
59	173.50	22.13	11.23	0.41	10.93		46	1.933	514	2.67	6456K, 3.79, -0.1
62	199.47	14.37	12.80	-0.06	12.79	B0Ie		1.166	8225		24521K, 4.47, -1.0
65	209.88	22.53	9.29	0.50	9.19	F8	90	108.265	137	3.61	6065K, 4.02, -0.6
75	217.25	35.81	12.5		12.16	A7	19.2	13.635	492		5652K, 4.18, -015
84	266.63	61.17	8.58	0.30	8.53	F0V		36.542	149	2.72	7104K, 4.10, -0.51
89	136.6	69.19	12.5		12.15	F7	20.2	30.8	446		5712K, 4.20, -0.49
97	116.94	54.2	11.84	0.52	11.97			4.627	823		6480K, 3.78, -0.66
98	107.85	63.89	8.93	0.41	8.87	F8	-19.7	46.021	187	2.57	6662K, 3.96, -0.3
100	96.88	63.68	14.2		12.56		-36.9	4.667	578		5796K, 4.21, 0.01
101	85.04	68.34	13.5		12.3		-16.9	18.310	224		5331K, 4.56, 0.06
109	87.93	56.78	13.0		12.16	F7	-14.8	10.627	653		5856K, 4.12, -0.14
132	29.71	36.88	12.44	0.64	12.07		-37.8	16.574	302		5879K, 4.35, -0.44
133	112.63	33.14	9.36	-0.08	9.51	B5		4.249	2754	-3.14	10000K, 2.22, -1.9
134	51.81	40.92	9.44	0.18	9.43	F0		6.621	296	2.09	
139	29.82	31.69	9.84	0.3	9.78	A2	-35.6	16.249	309	1.56	
143	54.47	33.38	12.02	-0.36	11.70	Be		11.399	4470		
145	47.93	24.03	10.19	0.066	9.95	A1	-16.	6.417	739	0.56	
147	50.67	19.79	11.39	0.02	11.82	B1IIIe		11.993	4462	-2.82	29206K, 3.4, 0.01
150	77.50	25.28	11.19	-0.12	10.96	Be		7.273	8277	-3.32	37492K, 4.18, -1.0
152	45.6	9.2	11.3	0.2	11.1	B3 IIIn		9.313	2052	-1.49	19972K, 3.96, 0.45
153	106.5	27.32	13.5		11.74		-70.6	7.341	2766		
160	19.9	-11.8	11.87	-0.19	11.59	Be		4.205	5322	-1.93	13370K, 3.79, -0.61
161	67.57	9.51	11.54	-0.05	11.31			6.863	10.3kpc		19210K, 3.67, 0.014
166	75.41	10.61	11.76		11.72	B2Ve	-56	5.021	7824		19924K, 4.19, 0.15

169	80.14	10.02	13.56	1.68	12.49	M2IIIe	-114	3.494	13.0kpc		3644K, 0.86, -0.67
175	56.67	-11.8	10.87	-0.14	10.88	B8		1.854	2660	-1.62	
176	22.65	-29.1	12.5		11.97		-18.5	8.743	10.4kpc		5162K, 1.77, -0.35
178	90.76	9.28	10.88	-0.05	10.69	Be		3.189	2177	-0.85	
179	63.4	-12.15			12.60	G6III	-95.	2.654	9869		4810K, 2.07, -0.22
180	40.88	-26.36	13.5		11.90		21	4.517	7714		
184	68.14	-12.52	11.01	0.10	11.09	A7		7.098	5007	-2.65	7900K, 2.321, -1.60
187	52.13	-27.98	7.73	-0.07	7.74	B9IV		18.747	351	-0.33	
189	82.77	-12.6	9.31	0.232	9.06	B8		5.680	697	-1.03	
190	58.42	-35.43	10.22	0.91	10.26	G5e	-1.0	5.593	1139	-0.82	5478K, 4.96
192	83.15	-16.81	8.44	-0.06	8.41	B8		3.235	684	-0.9	
193	70.72	-30.04	11.8	0.086	11.89			24.647	292		
196	56.78	-44.78	13.92	0.079	13.51			37.331	260		
197	109.59	10.22	9.52	0.4	9.42	F2	-18.4	14.280	257	2.22	7173K, 3.93, -0.41
198	114.75	16.65	10.54	0.38	10.47	Be		5.180	977	-1.09	12763K, 3.75, -0.49
202	78.58	-57.22	11.85	1.47	11.26	G9IIIe	-5.8	52.343	211	3.67	4978K, 3.40, -0.25
204	101.0	-44.47	8.65	-0.08	8.63	A0	-69.0	7.668	1319	-2.28	
205	112.09	-22.93	6.62	-0.04	6.60	B9		6.243	334	-1.23	

2. Analysis

Forty-four stars have RUWE values less than 1.4. Only eight stars have RUWE values more than 1.4. Thirty-seven stars are relatively nearby (distances of the order of few hundred pc) stars and have very accurate Gaia DR3 (Gaia Collaboration 2022) parallaxes (distances) and fifteen stars have parallaxes that are about three times more than the errors in their parallaxes and their distances given in Table 1 are from Bailer-Jones et al. (2021). The absolute visual magnitudes (Mv) are calculated using the Gaia DR 3 distances, V-magnitudes, observed B-V colour and spectral types. (B-V)0 values are from their spectral types (Cox 2000).

From the Gaia DR3 light curves I found several new variable stars and they are: StHA 5, StHA 51, StHA 89, StHA 97, StHA 101, StHA 133, StHA 145, StHA 180, StHA 192, and StHA 205. Further analysis of the Gaia DR 3 light curves of these variable stars is needed to understand the causes, nature and type of their variability. Many of these variable stars have Gaia DR 3 spectra and an analysis of these spectra may yield their revised astrophysical parameters and chemical composition.

From the Gaia radial velocities, I found the following stars to be new high velocity stars: StHA 32, StHA 65, StHA 153, StHA 169, StHA 179 (LT Del). StHA 50, StHA 166, and StHA 204 may also be high velocity stars. For all the above-mentioned stars Gaia DR3 light curves and spectra are available and further analysis of this data is needed.

A symbiotic star is a binary system in which a red giant contains a hot white dwarf companion with an accretion disk. They are identified by their light curves and composite spectra.

StHA 32, StHA 169, StHA 179 (LT Del) are new high velocity symbiotic stars, StHA 180 is a symbiotic star having V-K and G-K colour 5.004 and 3.407 respectively, and StHA 190 is also a symbiotic star, and it is an IRAS source (IRAS 21392+0230). The Gaia DR 3 light curves and spectra of all the above-mentioned stars are available for analysis. Their astrophysical parameters from the Gaia DR3 data are given in Table 1. Some of these symbiotic star's spectra are given in the paper of Downes and Keyes (1988) and they are included in this study.

The cataclysmic variable stars are close-binary systems in which the hot white dwarf accretes mass from its companion star via an accretion disk. They are identified by their irregular increase in brightness by a large factor and by their outbursts.

StHA 14 (TT Ari), StHA 176 (LS Peg), StHA 193, and StHA 196 (UU Aqr) are cataclysmic variable stars. Their Gaia distances are given in Table 1. StHA 166 is a hot eruptive variable star. The Gaia DR 3 light curves and spectra of all the above-mentioned stars are available for analysis. The astrophysical parameters from the Gaia DR3 data are given in Table 1. The spectra of some of these stars are given in the paper of Downes and Keyes (1988) and they are included in this study.

StHA 62 (IRAS 07171+1823) (Vijapurkar et al. 1998), StHA 147 (IRAS 18062+2410) (Parthasarathy et al. 2000), and StHA 161 (IRAS 19200+3457) (Gauba et al. 2003) are hot post-AGB stars and they have circumstellar dust shells and low excitation planetary nebulae. Their distances and astrophysical parameters (Teff, log g, and [Fe/H]) from Gaia DR3 data are given in Table 1. The U-B value of StHA is -0.75 and it indicates that it may have a very hot companion. Based on the astrophysical parameters and Mv values (Table 1) StHA 133, and StHA150 may be hot post-AGB stars. The Gaia DR3 light curves and spectra of all the above-mentioned stars are available. Analysis of this data will be useful to further understand their post-AGB evolution. The astrophysical parameters and Mv value of StHA 202 (BP Psc) (IRAS 23198-0230) indicate that it may not be a post-AGB star. However, its RUWE value is 10.54 hence it may be a post-AGB binary with a dust disk. Stars with large RUWE values appear to be nearby based on their Gaia DR3 parallaxes. Stars with large RUWE values may be binaries (Stassun and Torres 2021). Further study of this star is needed.

StHA 15 is a nearby star. Its V-K colour is 3.82. Its Mv value and V-K colour indicates it is a nearby dwarf Me star. Analysis of Gaia DR3 spectrum of this star is important. StHA 52 is also a relatively nearby star. Its U-B = -0.62 indicates that it may have a very hot companion star. The B-V colour of StHA 143 is -0.36 indicates that it is a very hot star and or it may have a hot companion. Analysis of its Gaia DR3 spectrum is needed. StHA 50 may be a Blue Horizontal Branch (BHB) star. StHA 145 (IRAS 17449+2320) evolutionary status is not clear. Analysis its Gaia DR 3 light curves and spectra are important to further understand the evolutionary stage and the source for the circumstellar dust. Its V-K = 2.986 indicates that it may have hot circumstellar dust and or a late- type companion star. The V-K and G-K colour of StHA 153 are 5.097 and 3.336 respectively. It is a new high velocity star. Analysis of Gaia DR3 spectra of this star is very important. Analysis of Gaia DR3 spectra and light curves of StHA 184 (IRAS F20467+2331) and StHA 205 (IRAS F23574+3834) is important to understand their chemical composition, evolution and circumstellar matter.

3. Conclusions

Gaia DR3 data of 52 high galactic latitude H-alpha emissions stars selected from the paper of Stephenson (1986) are analyzed. Several interesting stars based on this analysis are discussed in the above section.

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