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High-resolution spectroscopic observations of two chemically peculiar metal-poor stars: HD 10613 & BD+04°2466

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Abstract. We determined the atmospheric parameters and abundance pattern of two chemically peculiar metal-poor stars: HD 10613 and BD+04°2466 and discuss the nature of these two objects.

Keywords. stars: fundamental parameters; stars: Population II; stars: chemically peculiar

1. Introduction

Barium and CH stars belong to a class of chemically peculiar stars where binarity is an essential requirement to explain their overabundance of carbon and the elements heavier than iron. Regarding the stellar population type, CH stars are clearly members of the halo population, they have high radial velocities and are metal-poor objects. CH stars have been regarded as population II counterparts of the barium stars. Population studies done for barium stars show that they differ from the CH stars with respect to their distribution in the Galaxy. Barium stars are found in the disk and in the halo of the Galaxy (Gómez *et al.* 1987). This study shows that barium stars can also be divided into groups according to their luminosities, kinematic and spatial parameters. It was also shown that barium stars in the halo are very rare, only 6% of the total sample. Here we continue our investigation on "metal-deficient barium stars candidates" searching for possible candidates in the literature. In a previous search we identified and analyzed HD 206983 (Junqueira & Pereira 2001, Drake & Pereira 2008). We now analyze one star that was suspected to be a metal-poor barium star by Catchpole *et al.* (1977) and also classified as a member of the halo population by Gómez *et al.* (1987), HD 10613. In addition we analyze BD+04°2466 which belongs to this small sample of "metal-deficient barium stars" of Luck & Bond (1991).

2. Analysis & results

The atmospheric parameters were determined using the local thermodynamic equilibrium (LTE) atmosphere models of Kurucz (1993) and the current version of the spectral analysis code MOOG (Sneden 1973). HD 10613 and BD+04°2466 have respectively the following atmospheric parameters and radial velocities ($T_{\rm eff}$/log g/[Fe/H]/$\xi_{\rm m}$/$V_{\rm rad}$): 5 100 K/2.8/-0.82/1.6 km s^{-1}/89.3 km s^{-1} and 5 100 K/1.8/-1.92/1.6 km s^{-1}/38.5 km s^{-1}. The abundance pattern for HD 10613 & BD+04°2466 is given in Table 1.

Table 1. Abundance in the log ε(H) = 12.0 scale and in the notation [X/Fe].

	HD 10613				BD+04°2466			
Species	n	log ε	[X/H]	[X/Fe]	n	log ε	[X/H]	[X/Fe]
C I	2	8.25±0.06	-0.27	+0.55	2	7.77±0.15	-0.75	+1.17
N I	1	7.43±0.22	-0.49	+0.33	1	7.10±0.25	-0.82	+1.10
O I	1	8.53±0.04	-0.30	+0.52	1	7.21±0.07	-1.62	+0.30
Na I	2	5.35	-0.98	-0.16	2	4.53	-1.80	+0.02
Mg I	2	7.03	-0.55	+0.27	–	—	—	—
Si I	6	6.93±0.11	-0.62	+0.20	2	6.24	-1.31	+0.61
Ca I	7	5.75±0.12	-0.61	+0.21	11	4.97±0.20	-1.39	+0.53
Sc II	6	2.45±0.26	-0.72	+0.10	5	1.25±0.12	-1.92	0.00
Ti I	8	4.42±0.12	-0.60	+0.22	2	3.27	-1.75	+0.17
Cr I	6	4.97±0.12	-0.70	+0.12	4	3.63±0.06	-2.04	-0.12
Mn I	2	4.29	-1.10	-0.28	1	3.09	-2.30	-0.38
Ni I	10	5.43±0.08	-0.82	0.00	3	4.13±0.18	-2.12	-0.20
Cu I	1	3.51	-0.70	+0.12	–	—	—	—
Zn I	1	3.72	-0.88	-0.06	2	2.92	-1.68	+0.24
Y II	7	2.20±0.20	-0.04	+0.78	6	0.79±0.13	-1.45	+0.47
Zr I	3	2.71±0.05	+0.11	+0.93	–	—	—	—
Zr II	2	2.61±0.43	0.00	+0.82	4	1.47±0.19	-1.13	+0.79
Ba II	1	2.75	+0.62	+1.44	1	1.91	-0.22	+1.70
La II	6	1.67±0.23	+0.50	+1.32	4	0.45±0.05	-0.72	+1.20
Ce II	6	1.91±0.20	+0.33	+1.15	5	0.73±0.15	-0.85	+1.07
Nd II	16	2.23±0.21	+0.73	+1.55	12	0.93±0.12	-0.57	+1.35
Eu II	1	0.41	-0.10	+0.72	–	—	—	—
Pb I	1	2.48	+0.48	+1.30	1	2.00	0.00	+1.92

3. Conclusions

Our analysis of the chemical abudances of these stars showed that:

(*a*) HD 10613 is another metal-poor barium star, not already shown as a binary system. However, its luminosity and abundance ratios give support to the interpretation that the observed overabundances of carbon and *s*-process elements in the photosphere of this star are due to mass transfer from a companion, formerly a TP-AGB star.

(*b*) BD+04°2466 is a CH star since its carbon-to-oxygen ratio is larger than unity (C/O = 3.63). In fact, BD+04°2466 displays the main characteristics of the mass-transfer paradigm, i.e. presents overabundances of the elements created by the slow neutron capture reactions and carbon as well and has already been proved to be a member of a binary system (Jorissen *et al.* 2005). We also shown that BD+04°2466 is another 'lead star', since its [Pb/Ce] ratio closely follows the theoretical predictions for a star at such metallicity.

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