

ABUNDANCES OF HEAVY ELEMENTS IN SIRIUS ($Z > 72$)

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ABSTRACT. The abundances of eight heavy elements: Hf, Ta, W, Re, Os, Ir, Hg and Pb are found in the atmosphere of Sirius A. The Copernicus UV spectral atlas is used. The investigated elements show the overabundances with respect to the Solar system values in the range 0.7–2.7 dex.

Key words: Sirius – *r*-, *s*-process elements – stellar abundances.

In the last decade the abundances of heavy elements in the atmosphere of Sirius were investigated by Savanov (1987), Sadakane et al. (1987) and Sadakane (1991). The review of elemental abundances in the atmosphere of this Am star were made by Lyubimkov (1995). The present study is intended to determine the abundances of elements with atomic number $Z > 70$ in the atmosphere of Sirius A (Sirius B is white dwarf).

The Copernicus Ultraviolet spectral Atlas of Sirius (Rogerson, 1987) was used as an observational spectrum. The atlas covers the wavelength region from 1649 Å to 3170 Å, the spectral resolution is 0.1 Å, signal to noise ratio can reach 100. The comparison of this atlas with recent GHRS/HST spectra of Sirius show the excellent agreement - the width of rotation profile of Sirius ($v \sin i = 12$ km/s) exceed the width of instrumental profile of both spectrographs.

For investigation of abundances in the atmosphere of Sirius we used Kurucz (1995) atmosphere model with the following parameters: $T_{\text{eff}} = 10000$ K, $\lg g = 4.3$, $[M/H] = 0$, $v_{\text{turb}} = 2$ km/s. We calculated the synthetic spectra of Sirius in the wavelength region covered by observed spectrum using Tsymbal (1996) program. Careful comparison of calculated and observed spectra permit us to identify the lines of iron group elements and heavy elements.

We made an attempt to check the abundances of iron group elements and adopted the abundances of these elements derived by Savanov (1987). It should be noted that the large difference (up to 1.2 dex) exist between the abundances of iron group elements derived by Savanov (1987) and Sadakane & Ueta (1989).

Abundances of selected heavy elements were derived using our software for automatic spectrum synthesis. The main part of it is SYNTH code (Kurucz, 1995).

Table 1: Lines of heavy elements in the spectrum of Sirius

Z	Ion	λ (Å)	$\log N$	$\log gf$	ref.
72	Hf II	2393.362	2.76	-0.70	CB
		2496.993	3.28	-0.30	CB
73	Ta II	2272.600	2.31:	0.48	CB
		2285.276	2.26	0.36	CB
		2400.637	1.63:	-0.26	CB
74	W II	2026.091	3.87	-0.98	CB'
		2030.001	3.78	-0.62	CB'
75	Re II	2504.563	2.31	1.00	CB
		2608.497	2.08	1.35	CB
76	Os II	2067.230	2.25	1.20	CB
		2194.403	1.88:	0.72	CB
		2580.024	2.31	1.62	CB
		2596.047	2.27:	2.14	CB
77	Ir II	2242.631	3.15:	2.14	MC'
80	Hg II	1942.313	2.49	-0.14	MIG
82	Pb II	1642.127	4.13	-0.56	MIG'
		2203.534	4.03	-0.10	MIG'

References:

- CB – Corliss & Bozman, 1962a
- CB' – Corliss & Bozman, 1962b
- MC' – Meggers et al., 1975
- MIC – Migdalek, 1976a
- MIC' – Migdalek, 1976b

In each case synthesis was performed taking into account all possible blending by atomic lines with measured wavelengths and oscillator strengths from Kurucz (1995) database (CD-ROMs 1,18,23). Synthetic spectra were broadened by rotation and instrumental profile.

The used lines are listed in Table 1: the charge of nuclei (Z), identification of ion, wavelength, abundance in the scale $\log N(\text{H}) = 12.00$, oscillator strength ($\log gf$) and reference for $\log gf$.

The mean values of abundance of investigated elements are shown in Table 2: the charge of nuclei, identification of element, number of used lines, abundance in the atmosphere of Sirius, solar or meteoritic abundance according to Grevesse & Noels (1993), relative

Table 2: Abundances of heavy elements in the atmosphere of Sirius

Z	N	$\log N$	$\log N_{\odot}$	$\Delta \log N$	
72	Hf	2	3.02	0.88	+1.88
73	Ta	3	2.06	0.13	+2.28
74	W	2	3.82	1.11	+2.71
75	Re	2	2.20	0.27	+1.93
76	Os	4	2.18	1.45	+0.73
77	Ir	1	3.15	1.35	+1.80
80	Hg	1	2.49	1.09	+1.40
82	Pb	2	4.08	1.85	+2.23

abundance of the element in the Sirius atmosphere with respect to the solar system one.

We must to mention that Sadakane et al. (1987) determined the value of abundance of Hg in the atmosphere of Sirius very close to this study. Sadakane (1991) investigated the abundances of Mo, Cd, W and Pb in Sirius. Our results for W and Pb agree with Sadakane (1991) after correction of oscillator strengths.

All elements, investigated in this study show the large overabundances with respect to the solar system abundances. The abundances of two of them - Ta and Re are not known even for the Sun.

New measurements of oscillator strengths are desired to obtain a more precise result.

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