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Behavior of sulfur in extremely metal-poor stars

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Abstract. The LTE abundances of sulfur (S) were explored in the sample of 15 metal-poor stars with the metallicity range of $-4 <$[Fe/H]< -1.5, based on the equivalent widths of the S I(1) 9212 and 9237 Å lines measured on high-resolution spectra, which were observed by the Keck I HIRES. Combining our results and those of Takada-Hidai *et al.* (2005), we found that the behavior of [S/Fe] against [Fe/H] shows a nearly flat trend in the range of metallicity down to [Fe/H]~ -4.

Keywords. Stars: abundances, stars: Population II, stars: atmospheres

1. Introduction

The behavior of sulfur (S) in the metallicity range of [Fe/H]< -1 has been investigated by a pioneering work by François (1988), and the recent studies by Israelian & Rebolo (2001), Takada-Hidai *et al.* (2002), Nissen *et al.* (2004), Ryde & Lambert (2004), and Takada-Hidai *et al.* (2005).

Among these studies, Israelian & Rebolo (2001) and Takada-Hidai *et al.* (2002) suggested that [S/Fe] shows a linearly increasing trend with decreasing [Fe/H] in the range of $-3 <$[Fe/H]< 0. On the contrary, François (1988), Nissen *et al.* (2004), Ryde & Lambert (2004), and Takada-Hidai *et al.* (2005) argued that [S/Fe] shows a nearly flat trend in the range of $-3.2 <$[Fe/H]< -1. However, the behavior of [S/Fe] is almost unknown in the range of [Fe/H]< -3 due to few observations.

To explore the S behavior in the range of $-4 <$[Fe/H]< -1 and the validity of the nearly flat trend, we analyzed the S abundances, assuming LTE, in the sample of 15 metal-poor stars with the metallicity range of $-4 <$[Fe/H]< -1.5.

2. Observations and Analyses

Our sample stars are listed in Table 1 together with the atmospheric parameters and their references in column 9. The CCD echelle spectra were observed by the Keck I HIRES on 2004 May 9–10 in a wavelength range of 6910 – 9250 Å and a resolution of 45000. The equivalent widths of the S I(1) 9212 and 9237 Å lines were measured by the *splot* task of IRAF, and were analyzed to obtain the S abundances using WIDTH9 code and ATLAS9 atmospheric models (Kurucz 1993). Resulting abundances are given in column 7 of Table 1. Adopting the abundances of [Fe/H] from the references in column 9, which are shown in column 6, we estimated [S/Fe], which are given in column 8.

Table 1. Model Parameters and Abundances of Fe and S

Star	$T_{\rm eff}$ (K)	log g	[Fe/H]	ξ (km s^{-1})	[Fe/H][a]	[S/H][a]	[S/Fe]	Ref.[b]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
HD 88609	4570	0.75	−2.65	2.1	−2.77	−2.42	0.35	1
HD 115444	4720	1.5	−2.85	1.7	−2.79	−2.32	0.47	2
HD 122563	4650	1.36	−2.65	1.9	−2.47	−2.15	0.32	1
HD 126587	4960	2.10	−2.78	1.8	−2.72	−2.14	0.58	2
HD 140283	5830	3.67	−2.55	1.9	−2.36	−1.97	0.39	1
HD 165195	4190	0.96	−2.15	1.7	−1.82	−1.48	0.34	1
	4450	1.10	−2.00	1.9	−2.17	−1.73	0.44	3
BD +58°1218	5000	2.20	−3.00	1.0	−2.65	−2.31	0.34	3
BD +23°3130	5154	2.93	−2.66	1.3	−2.59	−1.89	0.70	4
BD −18°5550	4750	1.4	−3.0	1.8	−3.01	−2.32	0.69	5
G 64-012	6511	4.39	−3.17	1.5	−3.10	−2.76	0.34	6
BS 16084-160	4730	1.31	−2.95	2.0	−2.91	−2.45	0.46	7
BS 16085-050	4950	1.8	−2.91	1.8	−2.85	−2.06	0.79	2
BS 16467-062	5200	2.5	−4.0	1.6	−3.72	−2.99	0.73	5
CS 22885-096	5050	2.6	−4.0	1.8	−3.73	< −3.05	< 0.68	5
CS 30325-094	4950	2.0	−3.4	1.5	−3.25	−2.45	0.80	5

[a] Solar values of log S = 7.14 and log Fe = 7.45 are adopted from Asplund *et al.* (2005).
[b] 1=Takada-Hidai *et al.* (2005); 2= Honda *et al.* (2004); 3= Burris *et al.* (2000); 4= Israelian *et al.* (2004); 5= Cayrel *et al.* (2004); 6= Nissen *et al.* (2004); 7= this study + Schuster *et al.* (2004).

3. Results

Inspecting the behavior of [S/Fe] against [Fe/H] given in Table 1, we may suggest that [S/Fe] shows a nearly flat trend in the range of metallicity down to [Fe/H]∼ −4 with an average of [S/Fe]= +0.52 dex. If we combine our results of [S/Fe] with those of Takada-Hidai *et al.* (2005), we may confirm that the behavior of S inferred from the S I(1) lines follows a nearly flat trend in the range of −4 <[Fe/H]< −1.5.

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