ABUNDANCE ANALYSIS OF THREE Ap STARS: HD2453, HD8441, AND HD192913

T. A. Ryabchikova and D. A. Ptitsyn
The Astronomical Council
of the U.S.S.R. Academy of Sciences
Pyatnitskaya Str. 48, Moscow
109017 U.S.S.R.

ABSTRACT. Using 9 Å/mm-dispersion spectra of two Ap stars (HD2453 and HD8441) from the list by Adelman (1973) and the SiCr star HD192913 the abundances of 19 elements are obtained by the model atmosphere technique. The curve-of-growth method is used to estimate the surface magnetic field from Fe, Cr, and Ti lines.

One of the most extensive study of chemical composition of Ap stars was carried out by Adelman (1973). Now, more than 10 years later, the improved oscillator strengths and more refined methods of analysis of model atmosphere parameters are available, that makes it desirable to reinvestigate abundances of elements in these stars. Recently Adelman (1984) has redetermined the chemical composition of HD8441 and obtained quite different results. In this paper we present results of chemical analysis of two stars from the Adelman's list (HD2453 and HD8441) and the SiCr-type star HD192913.

For each star several 9 Å/mm-dispersion spectra were taken with the 2-m telescope of the National Astronomical Observatory of the Bulgarian Academy of Sciences and the 2-m telescope of the Ondrejov Astronomical Observatory of the Czechoslovakian Academy of Sciences. Observations were carried out in the frames of the Multilateral cooperation of Academies of Sciences of Socialist Countries. The spectra were traced with the microdensitometer 3CS Joyce Loebl and processed using the programme described by Piskunov et al. (1984). As far as possible unblended lines of 19 elements were chosen and their averaged equivalent widths were used to obtain abundances of elements by the model atmosphere technique.

Line intensities were calculated by means of the computer programme written by N.E.Piskunov at the Astronomical

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Council of the USSR Academy of Sciences. The model atmospheres were taken from Kurucz et al. (1974). Europium abundances were corrected for hyperfine structure according to the paper by Landi Degl'Innocenti (1975).

The effective temperature T_e was determined from photoelectric photometry data. The final value of T_e was adopted taking into account available estimations of T_e based on continuum energy distribution. The surface gravity log g was obtained using $H\beta$ and $H\gamma$ profiles. The theoretical curves of growth for Fe, Cr, and Ti were fitted to the observed ones by the least-mean-square method with 3 free parameters: microturbulent velocity ξ_t, abundance of the element log N, and surface magnetic field H_s. The broadening due to H_s was treated the same way as the Doppler broadening (Ryabchikova and Piskunov, 1984). The final mean values of T_e, log g, ξ_t, and H_s are given in Table I.

Derived logarithmic abundances are presented in Table II and in Fig.1. The scale corresponds to log N = 12 for hydrogen. The figures in parentheses indicate the number of

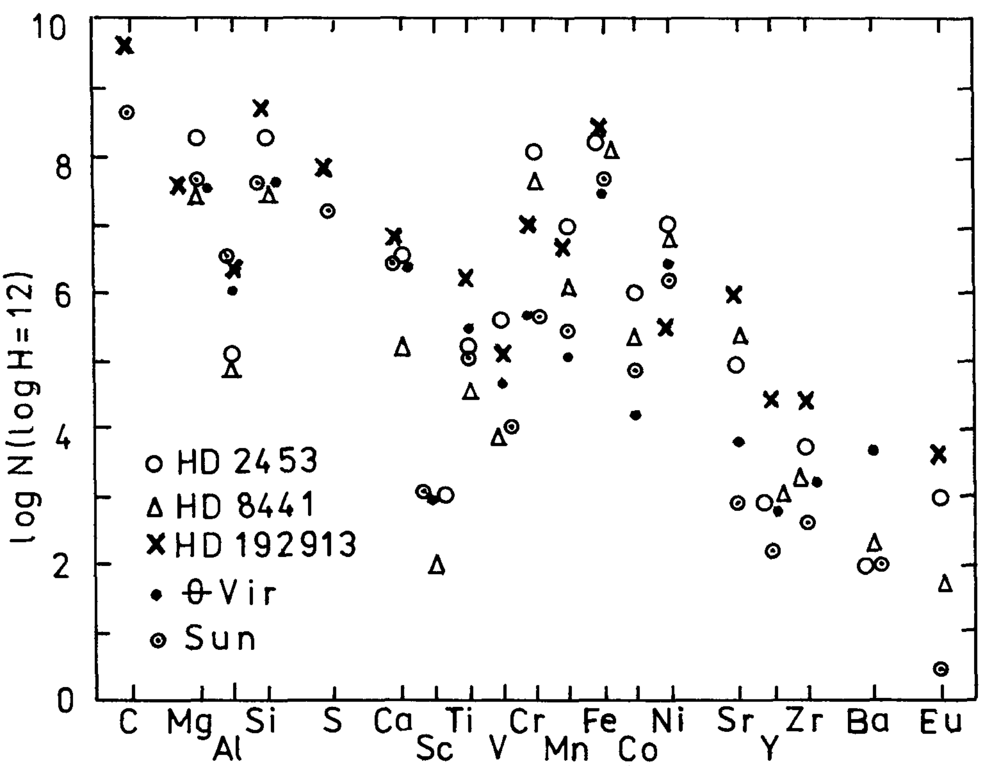

Fig.1. Elemental abundances of three Ap stars, normal star θ Vir, and the Sun.

Table I. Atmospheric parameters

HD number	T_e,K	log g	ξ_t,km/s	H_s,kGauss
2453	9000	3.75	2	2.54
8441	9200	3.50	0	0.56
192913	11000	3.50	1	1.80

Table II. Derived abundances

Element	HD2453	HD192913	HD8441	HD8441*	θ Vir	Sun
CII	...	9.72(2)	...	8.22	...	8.69
MgI	8.67(1)	...	7.43(2)	7.22	7.46(2)	7.58
MgII	7.95(1)	7.50(4)	7.29(4)	7.00	7.45(3)	
AlI	5.09(1)	6.37(1)	4.92(1)	...	6.02(2)	6.47
SiII	8.31(2)	8.66(8)	7.48(2)	7.02	7.58(5)	7.55
SII	...	7.78(2):	...	...	...	7.21
CaI	6.60(3)	6.90(1):	5.18(1)	5.63	6.45(3)	6.36
CaII	...	6.68(1)	...	4.70	...	
ScII	3.13(3)	...	2.12(1)	2.18	2.98(6)	3.1
TiII	5.24(11)	6.16(16)	4.59(15)	4.47	5.48(32)	5.02
VII	5.62(2)	5.13(5)	3.90(2)	3.74	4.70(12)	4.0
CrI	8.72(16)	6.94(2)	7.97(15)	7.60	5.43(3)	5.67
CrII	7.42(24)	6.97(14)	7.47(29)	7.69	5.91(18)	
MnI	6.89(6)	6.88(2)	5.90(3)	6.04:	5.13(2)	5.45
MnII	7.01(7)	6.60(9)	6.37(8)	6.20	5.02(2)	
FeI	8.28(14)	8.32(10)	8.00(16)	8.18	7.43(36)	7.67
FeII	8.31(13)	8.57(20)	8.22(15)	8.19	7.56(25)	
CoI	5.95(2)	...	5.45(1):	5.31:	4.18(1)	4.92
NiI	6.93(1)	...	...	5.87:	6.40(1)	6.25
NiII	7.26(4)	5.47(2)	6.80(4)	...	6.49(5)	
SrII	4.98(3)	5.98(3)	5.39(3)	4.66	3.84(4)	2.9
YII	3.00(3)	4.52(3)	3.13(3)	2.71	2.79(2)	2.24
ZrII	3.78(6)	4.50(2)	3.33(3)	...	3.15(3)	2.56
BaII	2.13(1)	...	2.30(1)	...	3.72(1)	2.13
EuII	3.12(5)	3.73(4)	1.76(3)	2.68	...	0.51

*from Adelman (1984)

lines used in the abundance analysis. For comparison are also given the chemical composition of normal star θ Vir (T_e=9300 K, log g=3.5, ξ_t=0 km/s) obtained by T.A.Ryabchikova and the solar abundances according to Grevesse (1984).

Conclusions that can be made from Table II and Fig.1 are as follows. For HD8441 our results are in a good accord with those obtained by Adelman (1984). In the stars under study the abundances of practically all elements except Al (and light iron-peak elements in HD8441) are greater than

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or in some cases close to normal values. The overall patterns of relative abundances in all three peculiar stars are quite similar. There is a similarity in odd-even effect and in mean relative abundances of different groups of elements. The abundances of heavy elements (Sr, Y, Zr, and possibly Ba) in the standart star θ Vir appear to exceed solar values by 0.5 - 1 dex. Among the stars under study the highest content of metals (with the exception of some iron-group elements) is observed in the hottest star, HD192913, and the lowest one in the star with the weakest (practically negligible) magnetic field, HD8441. Cr, Mn, and Eu reveal the largest excesses (up to ~2 dex). It is worthwhile to note that the abundance of Eu corrected for the hyperfine structure turns out to be not so high for Ap stars as it is often believed: the excesses over the solar values are 1 - 3 dex. The variations of iron content in peculiar stars is remarkably small (of the order of the errors of analysis) as compared to other elements. The iron excess relative to standart abundance amounts to ~0.6 dex in all stars. Overdeficiency of some odd elements, Al and Y in particular, is observed. Their abundance ratio to neighbouring even elements for peculiar star is higher than in standart distribution.

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REFERENCES

Adelman,S.J. 1973, Ap.J. Suppl., 26, 1.
Adelman,S.J. 1984, Astr. Ap., 141, 362.
Grevesse,N. 1984, Phys. Scripta, T8, 49.
Kurucz,R.L., Peytremann,E., and Avrett,E.H. 1974, Blanketed Model Atmospheres for Early-Type Stars (Washington: Smithsonian Inst.).
Landi Degl'Innocenti,E. 1975, Astr. Ap., 45, 269.
Piskunov,N.E., Ptitsyn,D.A., Ryabchikova,T.A., and Khokhlova,V.L. 1984, Nauchnye Informatsii, Astr. Sovet Akademii Nauk SSSR, 54, 45.
Ryabchikova,T.A., and Piskunov,N.E. 1984, in: Magnetic Stars, Proc. Conf. held in Riga, April 10-12, 1984, ed. V.Khokhlova, D.Ptitsyn, and O.Lielausis (Salaspils: Latvian Phys. Inst.), p.59.