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LINE IDENTIFICATION OF SCHNEIDER'S STAR (BD +24°3675) AROUND H_β

REINHOLD KROLL
Institut für Astronomie und Astrophysik, Am Hubland, D-8700 Würzburg

ABSTRACT The line spectrum of BD +24°3675 is investigated from 4730 to 4990 Å. I discuss the presence of individual elements, including Rare Earths. The equivalent widths of all strong lines are given. Estimates of T_{eff} and $logg$ indicate that the star might be evolved with a low surface gravity. Indications for spectral line variability have been found.

INTRODUCTION

From objective prism plates, Bidelman (1983) classified this 10^{th} magnitude field star as a CP2 star of the hot silicon type. Little attention has been paid to it until Schneider (1986) measured Strömgren colors and Δa values. He noticed a period of 7.52 days in all Strömgren colors. Further, this star showed the largest Δa value ever measured, a = $0\overset{m}{.}101$ at mean, which also strongly varied with an amplitude of $0\overset{m}{.}062$.
The Δa photometry was invented by Maitzen (1976) to detect CP2 stars photometrically. It measures the strength of the continuum flux depression at 5200 Å, which is commonly found in these stars, with one filter (g2) centered on the depression and two filters (g1 and Strömgren v) at either side. Although this system has proven very handy to catch CP2 stars, for instance in clusters, it is not understood, what process causes the continuum flux depression.
It has been suggested that strontium or silicon are the main constituents or that it is just a chance cumulation of magnetically enhanced lines.
BD +24°3675 is certainly a good candidate to study the nature of the $\lambda = 5200 Å$ depression, since it is sharp lined and shows Δa variation.

OBSERVATIONS

BD +24°3675 was observed during a study aimed at Balmer line variability by the author with the 2.2m telescope at Calar Alto. The Coudé spectrograph was used with a dispersion of 17Å/mm to feed a CCD camera. The spectral range covered was about 4730 to 4990 Å, one pixel corresponds to roughly 0.25 Å. Three spectra have been recorded at $JD = 2\,447\,042.47948$, $2\,447\,044.47436$ and $2\,447\,045.48234$, corresponding to phases 0.43, 0.56 and 0.83 with the ephemeris given by Schneider (1986). For the purpose of line identification, all three spectra have been co-added.

LINE IDENTIFICATION

The result of the line identification work is summarized in Tab. I. It lists the laboratory wavelength of the identified lines (the observed wavelength, if no certain identification could be made), the element and its ionization stage, the multiplet number and intensity values as given in Moore (1959), if such values were available, and the measured equivalent width.

TABLE I The line spectrum of BD +24°3675 from 4730 to 4990 Å

λ	Elem.	Mult.	Int	Eqw.
4730.361	MN 2	5		12
4731.439	FE 2	43	3	160
4734.750	C 2	48	2D	38
4735.670	HF 2	25	20	30
4735.750	HF 2	59	10	
4736.99	??			96
4738.290	MN 2	5		17
4739.800	LA 2	64	15	
4740.270	LA 2	8	120	238
4740.400	CL 2	51	150	
4742.000	GE 2	2	(50)	42
4746.115	CO 1?	182	(1)	63
4749.930	FE 1	120	(1)	26
4755.728	MN 2	5	0N	79
4759.49	??			180
4761.420	CR 2	176	1	88
4762.410	C 1	6	2x4	62
4764.700	MN 2	5		115
4767.142	CO 1?	182	(2)	54
4768.680	CL 2	40	150	28
4769.60	??			77
4771.090	CL 2	40	40	63
4771.720	C 1	6	4	7
4774.27	??			88
4775.870	C 1	6	3	42
4777.780	CR 2	25		55
4778.930	CL 2	40	45	101
4779.110	S 2	8	2	
4779.986	TI 2	92	1	44
4781.320	CL 2	40	75	26
4788.39	??			70
4794.540	CL 2	1	250	57
4796.670	LA 2	63	25	138
4798.535	TI 2	17	(2)	44
4799.97	??			136
4801.800	O 1	15	(2)	
4802.200	O 1	15	(3)	50
4802.530	FE 1	120	SUN	
4803.000	O 1	15	(4)	
4805.105	TI 2	92	2	166
4805.180	CR 2	25		
480686	Mn 2			43
4810.060	CL 2	1	225	140
4810.760	FE 2	169	0	
4812.350	CR 2	30	25	170
4814.800	GE 2?	2	(200)	70
4817.330	C 1	5	1	88
4819.460	CL 2	1	200	70
4819.740	SI 3?	9	3N	
4821.010	??			100
4824.130	CR 2	30	75	180
4824.970	CR 2	25		-
4826.730	C 1	5	1	118
4829.230	K 2	1	30	75
4836.220	CR 2	30	25	217
4843.340	FE 1	4		35
4844.95	??			145
4848.240	CR 2	30	60	184
4850.83	??			108
4856.190	CR 2	30	20	109
4861.33	H_β			9300
4864.320	CR 2	30	50	58
4871.323	FE 1	318	25	35
4874.025	TI 2	114	TR	27
4876.410	CR 2	30	50	237
4876.480	CR 2	30		

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TABLE I (continued)

λ	Elem.	Mult.	Int	Eqw.
4878.218	FE 1	318	12	17
4883.20	??			162
4884.570	CR 2	30	10	222
4895.68	??			87
4896.650	MN 2	5		40
4896.770	CL 2	17	200	
4899.920	LA 2	7	200	26
4901.650	CR 2	190	15	145
4903.317	FE 1	318	12	141
4906.82	??			130
4908.10	??			88
4911.664	ZN 2	3	25	103
4912.490	CR 2	190	12	228
4912.97	??			
4914.11	??			88
4920.509	FE 1	318	60	
4920.980	LA 2	7	300	332
4921.800	LA 2	7	300	
4921.929	HE 1	48	(4)	
4923.921	FE 2	42	12	285
4924.043	ZN 2	3	30	

λ	Elem.	Mult.	Int	Eqw.
4927.51	??			124
4932.74	??			56
4934.086	BA 2	1	700R	13
4937.13	??			40
4942.71	??			246
4948.13	??			244
4948.78	??			
4951.70	??			164
4952.780	CR 2		10	80
4953.79	??			49
4956.25	??			56
4957.603	FE 1	318	60	70
4958.788	GD 2	64	800	61
4971.31	??			89
4972.67	??			66
4974.24	??			44
4977.11	??			255
4977.87	??			
4984.53	??			156

Notes on individual ions

The most prominent lines in the range are that of Cr-2, especially those of multiplet 30. Also prominent is Fe, with can be found neutral and single ionized. Ti-2 is present with some weak lines, Zn-2 is very likely present, though one of only two lines is strongly blended with Fe-2. Mn-2 is weak, but definitely present with lines of multiplet 5 and the strong lines listed in Velasco et al. (1963).

C-1 shows several lines from multiplet 5 and 6, O-1 might be seen with three unresolved lines in the range 4801 - 4803 Å, N could not be found.

K-2 has one conspicuous line from the first multiplet in the range, the same is true for Ba-2, but this line is rather faint. Cl-1 is definitely present with several lines, including those from the first multiplet, however, most lines are blended. The blend at 4779 Å might be assigned to S-2, but that would be the only line of S-2, so its presence is doubtful.

Rare Earth elements might be present with lines of Gd-2 (one line), Ge-2 (two weak lines), Hf-2 (two weak lines), and La-2, which has several weak lines in the range, but to confirm its presence, as well as that of the other Rare Earth elements, the spectrum of BD +24°3675 must be studied at shorter wavelengths.

Very unlikely is the presence of Co-1, though two lines of multiplet 186 show wavelength coincidences, but stronger lines of Co-1 could not be found. He-1 and Si-3 might contribute to blended lines, but that can not be confirmed without further studies at different wavelengths.

ESTIMATES OF TEMPERATURE AND GRAVITY

For a rough estimate of T_{eff}, the calibration of Megessier (1988) is useful. With Schneiders photometric data $T_{eff} = 10500K$ is deduced. In a grid of H_β equivalent widths from model atmospheres with ten times solar metallicity, calculated with ATLAS8 by Kurucz and BALMER by Pyper, the 9.3 Å equivalent width of H_β in BD +24°3675 corresponds to $log g = 3.1$. This preliminary result indicates that BD +24°3675 is an evolved star.

SPECTRUM VARIABILITY

The spectra at $\varphi = 0.43$ and $\varphi = 0.56$ look very much the same, but in that at $\varphi = 0.83$ the metal lines are generally weaker. The metallicity index m_1 shows a minimum at $\varphi \approx 0.7$ in Schneider's photometric study, but the uncertainty in his period determination makes it impossible to compare phases from his and from this work. The case of spectrum variability of BD +24°3675 thus has to be clarified in the future.

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