1990Ap&SS.165..225R

SPECTRUM VARIABILITY OF 25 SEXTANTIS

R. RAJAMOHAN, ARVIND PARANJPYE, and T. P. SAJEEV*
Indian Institute of Astrophysics, Bangalore, India

(Received 28 August, 1989)

Abstract. The identification of moderately strong spectral lines at a dispersion of 30 Å per millimeter is given for the peculiar star 25 Sextantis. The observed variability of some of the lines are briefly described. It is found that lines of Fe I and Fe II are highly variable.

1. Introduction

The bright B9p Si Cr Sr star 25 Sextantis (HR 4082) was discovered to be a 4.37 daylight variable by Manfroid and Renson (1980) with an amplitude of 0.06 in the *u* filter. Adelman's (1983) spectrophotometric observations indicate that the Balmer jump in this star is highly variable. 25 Sextantis is called a spectrum-variable in the remarks column of *The Bright Star Catalogue* (Hoffleit and Jaschek, 1982). All chemically peculiar (CP) stars that show spectrum variations also light and magnetic field variables (Preston, 1970; Hack, 1975). These variations are generally interpreted in terms of a rigid rotator model proposed by Stibbs (1950) and Deutsch (1958). We have begun a systematic search for spectrum variability amongst bright chemically peculiar (CP) stars on the Main Sequence which are also known to be light variables. In this paper we describe the variability of some of the spectral lines observed in this star.

2. Observations

Our experience indicated that in order to find weak variability of spectral lines, a moderate dispersion of about 30 Å per millimeter is needed. Hence, we replaced the standard 651 lines per millimeter grating of the Zeiss Universal Grating Spectrograph (UAGS) with a Bausch and Lomb 1800 lines per millimeter grating. This gave a dispersion of 30 Å mm^{-1} when used with the 175 mm focal length Schmidt camera. We obtained five good spectra of 25 Sextantis with the 1-m telescope of the Vainu Bappu Observatory at Kavalur. All spectra were obtained on IIa-O plates and digitzed with the PDS microdensitometer. Details of 5 plates taken are given in Table I.

3. Result and Discussion

The analysis of the spectra were carried out with programs writen for an IBM PC/AT compatible. The PDS output on tapes were first transferred to diskettes. The PC is used as a measuring machine. The position of the comparison lines were displayed and with

* Visiting student, Cochin University, Kerala, India.

Astrophysics and Space Science **165**: 225–230, 1990.
© 1990 *Kluwer Academic Publishers. Printed in Belgium.*

© Kluwer Academic Publishers • Provided by the NASA Astrophysics Data System

1990Ap&SS.165..225R

TABLE I

List of plates taken

Plate No.	Date of observation	Mid UT h m
1888	23 Dec., 1988	22 45
1890	24 Dec., 1988	20 42
1897	25 Dec., 1988	23 24
1942	27 Jan., 1989	22 09
1979	3 Mar., 1989	15 21

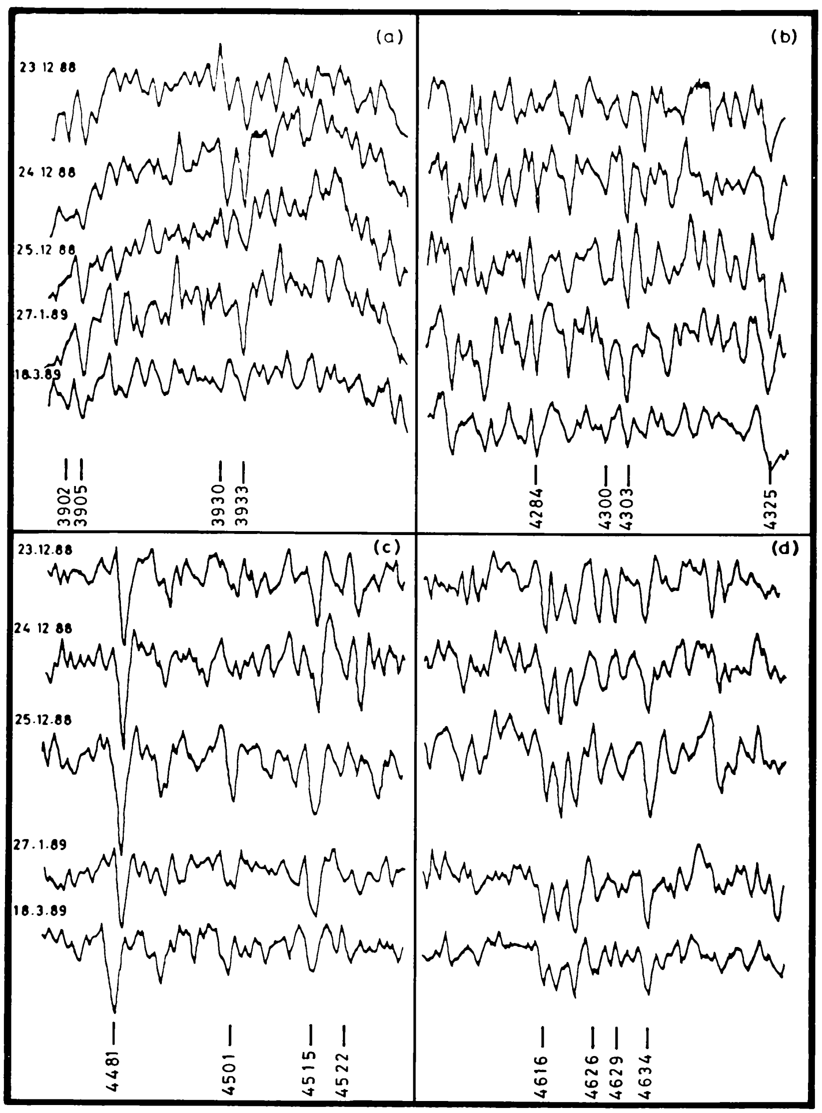

Fig. 1. Intensity tracings of few typical regions illustrating the variability of some of the lines listed in Table I. Note the strong variation of λ3930 in (a), Ti II 4300 and Fe II 4303 in (b), Ti II 4501 and Fe II 4522 in (c) and λλ4626 and 4629 in (d).

© Kluwer Academic Publishers • Provided by the NASA Astrophysics Data System

1990Ap&SS.165..225R

TABLE II

25 Sextantis (HR 4082) line list

λ (rest)	Itensity	Identification	Remarks
3849.81	2.0	49.97 Fe I–20	Variable
3853.79	2.0	53.66 Si II–1	–
3855.84	4.0	56.02 Si II – 1	–
3862.68	2.0	62.59 Si II–1	–
3865.97	2.0	65.59 Cr II – 167, 66.54, 66.01 Cr II–130	Variable
3874.66	1.0	–	Variable
3878.77	2.0	78.02 Fe I–20, 78.58 Fe I–4	–
3903.20	1.0	02.95 Fe I–45	Variable
3905.82	3.0	05.64 Cr II–167, 06.04 Fe II–173, 05.53 Si I–3	–
3911.66	1.0	11.32 Cr II–129	–
3930.64	1.5	–	Variable
3933.72	2.5	33.66 Ca II–1	–
3939.13	2.0	38.97 Fe II–190	Variable?
3948.72	1.0	–	Variable?
3956.37	2.0	–	Variable?
3976.40	2.5	–	–
3979.35	2.5	79.51 Cr II–183	–
3991.	1.5	–	Blend
4002.98	2.0	02.48 Cr II – 166, 03.33 Cr II – 194, 02.55 Fe II – 29	–
4012.72	1.5	12.50 Cr II – 183, 12.47 Fe II, 12.37 Ti II–11	–
4016.24	1.5	–	Variable
4017.91	1.5	17.96 Cr II – 166	Variable?
4025.18	1.0	25.14 Ti II–11, 24.55 Fe II – 127	–
4030.68	2.0	–	–
4045.71	1.0	45.82 Fe I–43	Variable
4049.18	2.0	49.14 Cr II – 193	–
4052.10	1.0	51.97 Cr II – 19	Variable
4054.00	1.5	54.11 Cr II, 53.81 Ti II – 87	
4063.77	1.0	63.59 Fe I – 43, 64.35 Ti II – 106	–
4075.85	2.0	75.45 Si II – 3, + ?	–
			–
4077.65	3.0	77.71 Sr II – 1	–
4082.20	1.0	82.30 Cr II – 165	Variable?
4110.99	2.5	11.01 Cr II – 18, 26	–
4128.16	4.5	28.05 Si II – 3	–
4131.04	3.5	30.88 Si II–3	–
4132.41	3.0	32.41 Cr II–26, 32.06 Fe I–43	–
4146.25	2.0	–	–
4151.25	1.5	51.00 Cr II–163, 51.60 Fe II–149	–
4161.46	1.5	61.52 Ti II–21, 61.80 Sr II–3, 61.05 Cr II – 162	–
4172.26	2.5	71.90 Ti II–105, 72.60 Cr II–18	Variable
4179.36	2.0	79.43 Cr II – 26	–
4187.39	2.5	87.04 Fe I – 152, 87.80 Fe I–152	Variable
4198.33	2.0	98.31 Fe I–152, 98.17 Si II – 7, 26	Variable
4206.22	2.0	05.48 Fe II – 22, 06.37 Mn II – 7	Variable
4215.80	2.5	15.52 Sr II–1	–

© Kluwer Academic Publishers • Provided by the NASA Astrophysics Data System

1990Ap&SS.165..225R

Table II (continued)

λ (rest)	Itensity	Identification	Remarks
4217.30	2.5	17.07 Cr II – 18, +	Variable
4224.82	2.0	24.85 Cr II–162, 24.09 Cr II–31	Variable?
4233.36	3.0	33.17 Fe II–27, 33.25 Cr II – 31, 33.61 Fe I – 152	–
4242.61	2.5	42.38 Cr II – 31, 42.33 Mn II – 1	–
4252.84	2.5	52.62 Cr II – 31	–
4254.44	2.0	54.35 Cr I–1	–
4262.03	2.5	61.92 Cr II–31, 61.80 Cr II–17	–
4269.27	2.0	69.28 Cr II–31	–
4270.54	2.0	–	–
4281.95	1.5	81.94 Mn II–1, 82.47 Mn II–1	Variable
4284.42	3.5	84.42 Mn II – 6, 84.21 Cr II–31	Variable
4290.03	4.0	90.22 Ti II–41, 89.72 Cr I–1	–
4296.63	2.5	96.57 Fe II–28	Variable
4300.24	3.0	00.05 Ti II–41, 00.20 Mn II–6	Variable
4303.40	3.0	03.17 Fe II–27,	Variable
4325.90	2.0	25.76 Fe I–42, 26.63 Mn II–6	–
4330.78	1.0	30.74 Ti II–41	–
4351.46	1.0	51.76 Fe II–27 +	–
4363.08	1.5	62.93 Cr II–179	–
4368.32	1.5	68.26 Fe II–	Variable?
4384.17	2.0	84.33 Fe II–32 +	Variable?
4385.30	1.5	85.38 Fe II–27	Variable?
4391.63	1.0	–	–
4395.24	1.5	94.06 Ti II–51, 95.03 Ti II–19, 95.85 Ti II–61	–
4405.06	1.5	04.75 Fe I–41, +	–
4417.16	1.5	16.82 Fe II–27, 17.72 Ti II–40	Variable
4436.47	1.0	–	–
4444.41	1.5	44.56 Fe II–20, 44.56 Ti II–31	–
4462.05	1.5	–	–
4481.35	3.5	81.23 Mg II–4	–
4489.08	2.0	89.18 Fe II–37	–
4495.55	1.0	–	Variable
4501.12	2.0	01.27 Ti II–31	Variable
4515.76	2.5	15.34 Fe II–37 +	–
4523.08	2.0	22.63 Fe II–38 +	Variable
4534.30	2.5	33.97 Ti II–50, 34.17 Fe II–37, +	–
4539.84	2.5	39.61 Cr II–39	–
4541.04	2.5	–	–
4549.70	3.5	49.62 Ti II–82	–
4555.38	3.0	55.02 Cr II–44, 55.89 Fe II–37	–
4558.73	4.0	58.66 Cr II–44	–
4564.23	2.0	64.27 Cr II–	–
4565.48	2.0	65.78 Cr II–39	–
4571.90	2.0	71.97 Ti II–82	–
4577.83	1.5	–	Variable

© Kluwer Academic Publishers • Provided by the NASA Astrophysics Data System

1990Ap&SS.165..225R

Table II (continued)

λ (rest)	Itensity	Identification	Remarks
4580.05	2.5	80.05 Fe II–26,	Variable
4582.21	2.5	–	Variable
4583.78	2.5	83.83 Fe II–38	Variable
4588.24	3.5	88.22 Cr II–44	–
4592.27	2.5	92.07 Cr II–44	–
4616.54	3.0	16.64 Cr II–44	–
4618.88	3.0	18.84 Cr II–44	–
4621.77	2.5	21.72 Si II–7	–
4626.29	2.5	–	Variable
4628.89	2.5	–	Variable
4634.33	2.5	34.10 Cr II–44	–
4646.73	2.0	–	Variable

a vertical cursor, their positions were accurately measured. High accuracy was achieved by magnifying each line before measurement. The same was repeated for the stellar lines. Probable errors of measurement was found to be $\pm$ 0.02 Å for the comparison lines and sharp stellar lines. Hydrogen line measurements are likely to be in error by about $\pm$ 0.06 Å.

Table II lists all the moderately strong stellar lines other than hydrogen. The rest wavelengths were determined using the radial velocity derived from H-lines, the K-lines of Ca II and Mg II 4481. The average rest wavelength determined from the 5 plates are given. These should be accurate to about $\pm$ 0.1 Å due to blending and all other combined errors due to the adopted procedure. The intensities indicated refer to the central depth of the line with a value of 10 for a completely dark line. The likely contribution at these wavelengths from various elements expected in this star is given in the third column. For these identification we were mostly guided by various line identification lists published in the literature for peculiar stars (e.g., Pyper, 1976; Adelman, 1974). These identifications are meant only as indicative of the major contributors to a given blend. The last column gives our comment on the observed variability of some of the lines. Only those lines that were definitely found to be variable are indicated. The plates were visually examined carefully for plate flaws before a line was called definitely variable.

Figure 1 illustrates the observed variability of some of these lines.

We find that, in general, only the Fe lines are strongly variable, while the variability of Si and Sr is not at all marked. Cr and Ti lines seem to vary to some extent. The Fe I and Fe II contributions to the blends and their variability is likely to be cause for the small variability observed for the other lines. Ca II 3933 and Mg II 4481 do not appear to be strongly variable. However, we find that in plate 1979, most of the lines are observed to be weak in comparison to their appearance in other plates. The strong variation of iron lines suggest the possibility of a relatively stable cool (magnetic) spots

© Kluwer Academic Publishers • Provided by the NASA Astrophysics Data System

1990Ap&SS.165..225R

in this star analogous to sunspots. High-dispersion work over a complete cycle of variations should lead to very interesting results for these type of objects.

4. Conclusions

We find that the spectrum of 25 Sextantis is dominated by Si, Cr, Sr, Ti, and Fe lines. The Si, Sr, and the K-line of calcium and Mg II 4481 do not show marked variability. Lines of Cr, Ti, and Fe are found to variable but the variability of Fe I and Fe II lines are much marked than that of the Cr II and Ti I lines.

Acknowledgement

We are thankful to Mr Ramrao S. Wagh of the Goa University for writing a subroutine to convert densities to intensities with an IMB PC/AT.

References

Adelman, S. J.: 1974, *Astrophys. J. Suppl.* **27**, 203.
Adelman, S. J.: 1983, *Astron. Astrophys. Suppl. Ser.* **51**, 511.
Deutsch, A. J.: 1958, *Handbuch Phys.* **51**, 689.
Hack, M.: 1975, in W. W. Weiss, H. Jenkner, and J. H. Wood (eds.), *Physics of Ap-Stars*, Universitäts Sternwarte, Wien, p. 255.
Hoffleit, D. and Jaschek, C.: 1982, *The Bright Star Catalogue,* 4th revised edition, Yale Univ. Obs., Connecticut, U.S.A.
Manfroid, J. and Renson, P.: 1980, *Inf. Bull. Var. Stars*, No. 1824.
Preston, G. W.: 1970, in A. Slettebak (ed.), *Stellar Rotation*, p. 254.
Pyper, D. M.: 1976, *Astrophys. J. Suppl.* **31**, 249.
Stibbs, D. W. N.: 1950, *Monthly Notices Roy. Astron. Soc.* **110**, 395.

© Kluwer Academic Publishers • Provided by the NASA Astrophysics Data System