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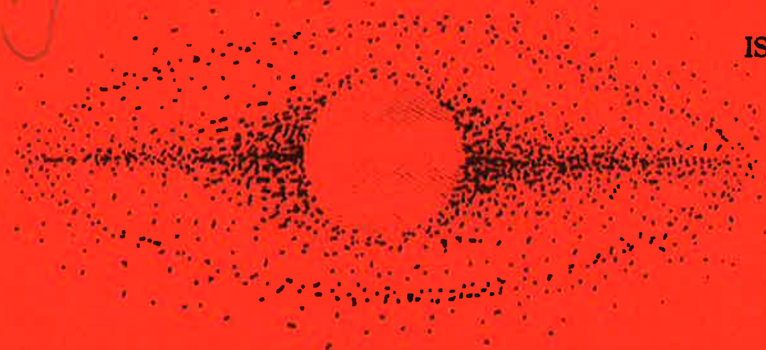
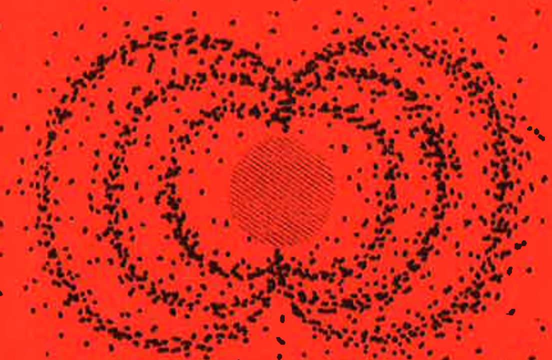
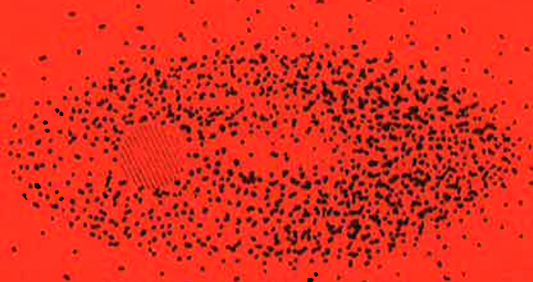


Be STAR NEWSLETTER



NUMBER 16

September 1987



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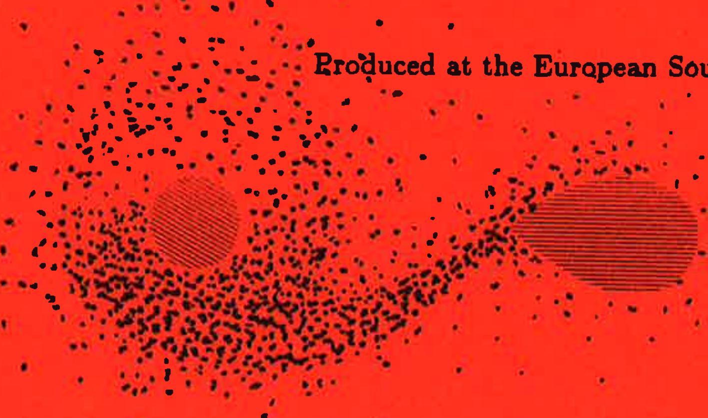

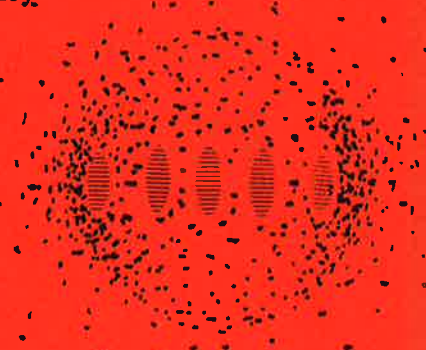

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The Be Star Newsletter is open to all contributions related to matters concerning Be stars. Please send manuscripts and all correspondence to the editor's address given on the front page. In the case of very urgent late contributions directly contact the technical editor via one of the fast links listed below. The Newsletter is distributed free of charge to all astronomical institutions which request it. If you wish that the Newsletter is also received at your institute, write to the technical editor:

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Normally only one copy per institute will be mailed. By default, it will be sent to the institute's library; please name a contact person if this is not desirable.

Acknowledgements: The Be Star Newsletter is produced at and financially supported by ESO and the ST-ECF. Britt Sjöberg and Harry Neumann are thanked for their active help in administrative and technical matters. The graphic on the front page is by Christa Jauch.

EDITORIAL

* * * * *

It is a pleasure to send you the sixteenth issue of the *Be Star Newsletter*. I hope that your summer has been enjoyable and scientifically productive and that your favorite Be star did not decide to go into quiescence just as you were about to wage a major observing campaign on it! The format for this issue is similar to the previous one and includes Contributions, What's Active/Inactive?, Observations ... Theoretical Support...Wanted/Available (and this time, an instrument which is available), Preprints Received, Bibliography, and Meetings. I thank all who sent contributions and I am grateful for the comments on the last issue. I appreciate the feedback as this is the only way we can make the *Newsletter* more valuable to the Be star community. Again I wholeheartedly thank those who helped compile the bibliography, and if we missed any of your papers, just let me know and we will mention them in the next issue.

New observations continue to reveal the remarkable variability in Be stars and many new results appear in this issue. These range from UV activity in 66 Oph and HR 2855 to ground-based observations of 59 Cyg, ζ Tau, and χ Oph. In addition, short comments on photometric and spectroscopic variability in several other objects are included. Early indications are that our new "classified advertisement" section will prove to be successful and I hope to see more scientists taking advantage of it to further their programs.

The Proceedings of I.A.U. Colloquium No. 92 on "The Physics of Be Stars" (edited by Arne Slettebak and Ted Snow) has just been published by Cambridge University Press and contains a wealth of information on activity in Be stars. New technology and especially multifrequency observations continue to make our field of research prolific. Additional information on the "Physics of Be Stars" can be found at the end of this newsletter.

I plan to continue publishing, without editorial comment, compressed versions of the abstracts of preprints which you send to me (unless you request otherwise). We still request that all contriubtions be submitted in a "camera ready" condition (cf. Issue No. 14 for instructions). But a consequence of such a method of distribution is that contributing authors are solely responsible for the accuracy, completeness, etc. of their material. It has been suggested that we adopt a practice of soft-refereeing contributions, but I am currently opposed to this as it will inevitably delay the publication of newsworthy items. Let me know your thoughts on this issue!

Please send me your comments on this issue and ideas for new sections. Since biannual publication appears to be popular, we will continue it. Please send contributions and preprints for Issue No. 17 by:

January 31, 1988

I would like to thank Ms. Nancy Wu, USC Space Sciences Center, for typing part of this newsletter and the Space Telescope - European Coordinating Facility and the European Southern Observatory for their financial support. Hope to see some of you at the Trieste Workshop on "Pulsation and Mass Loss in Stars".

Gerrie Peters, Editor

Working group matters

In less than a year from now, 1988 August 2–11, the XXth IAU General Assembly will take place in Baltimore. As has been the case with previous General Assemblies, there should also be a meeting of the Be star working group. Jean-Pierre Swings, General Secretary of the IAU, just informed me that he will be collecting information on the needs for meeting rooms and other facilities around the turn of the year. In order to enable the organizing committee to prepare the meeting according to the interests of the participants, your suggestions to any of its members (Paul Barker, Vera Doazan, Mike Marlborough, Gerrie Peters, Arne Slettebak, Ted Snow and the undersigned) are very welcome (*e.g.* also concerning other events during the General Assembly whose times should be avoided by our meeting) but are needed *soon*.

In number 14 of the Newsletter, I had mentioned the possibility of having a full-scale workshop on Be stars on the periphery of the General Assembly. It is clear now that there will not be such a dedicated meeting. With the proceedings of the Boulder colloquium (thanks to the editorial work by Arne Slettebak and Ted Snow) just having appeared and most of us still being busy digesting it, I personally do not regret this too much, and I had the impression that this is not just my opinion. However, for 1989/90 one would certainly look at this question differently. Some American colleagues have already expressed their view that it is again Europe's turn to take the initiative. This does of course not necessarily have to be so, and there are also other regions than only North America and Europe. It would be nice if a more concrete proposal from the community would be available for discussion at Baltimore.

More and more astronomers now have access to one or several computer networks. Those who have tried these new communication facilities will readily agree that they are quite convenient. One problem, however, is that telex and regular mail addresses can be looked up much more easily. For the communication within the working group a centrally maintained list of computer addresses may therefore be desirable. I offer to compile such a list from all addresses that will be sent to me for that purpose. If applicable, please add also alternative addresses (on other networks). To be sure that at least one address is technically valid, only information that reaches me by electronic mail will be considered; my computer addresses can be found on page 2 of this Newsletter. The list could be distributed in November.

In future, that list could be maintained in a special captive account on the ESO computer system so that everybody with remote log-on capabilities could read it. Such an account could also serve as a general purpose mail box. Anybody wishing to quickly circulate a message among colleagues who take an active interest in Be stars could electronically mail it there while to be informed on recent developments would require to occasionally scan the mail directory of that account. Any information that is still relevant at the time when a new issue of the Newsletter is due could also be reproduced in printing. Outdated news would periodically be deleted. Please let me know if you consider such a facility to be of any use and if you would actively *contribute* to it.

Finally, G. Cayrel de Strobel, chair person of the scientific committee of IAU commission 29, asked me to prepare the section on B and Be stars for the commission's triennual report. Because of the short notice given, I could not place a request in the Newsletter to send me relevant re- and preprints as I would have done otherwise. But I hope that with the help of the bibliography kindly compiled by Drs. A.M. Hubert, J. Jugaku, P. Koubský, M. Ruusalepp and A. Slettebak for each issue of the Newsletter the incompleteness (which on just 2 1/2 pages is unavoidable) is not too unbalanced. Preprints are available on request.

Dietrich Baade

CONTRIBUTIONS

* * * * *

Wind Activity in 66 Oph (B2 IVe) from 1984-1987

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66 Oph (B2 IVe, v sin i=240 km/s; Slettebak 1982) has been one of the more heavily monitored Be stars since the launch of IUE. The existence of a strong and highly variable stellar wind in this star was reported by Peters (1982a,b,c). Barker and Marlborough (1985) presented data from 1981 and 1982. More recently Grady, et al. (1987) have analyzed data from 1982 to 1985 and found that the wind absorption in the resonance lines of C IV and other species is due to blended absorption from multiple shortward shifted discrete absorption components, without evidence for an invariant underlying P Cygni profile. They also found that the distribution and strength of the absorption was reproducible over the period 1982-1983.

We have continued to monitor this star with the IUE in order to determine whether changes in the wind strength, as inferred from the resonance profile equivalent widths, are correlated with polarization episodes, and with variations in the far UV continuum (Peters and Polidan 1987). Figure 1 shows the C IV equivalent widths for 1984 through 1987 May 3. The 1985 data show the wind absorption weaker than or comparable to the absorption strengths observed in 1984. The wind maximum, which had been observed in September for 1982, 1983, and 1984 was not detected in 1985. the 1986 monitoring, which began in 1986 June and continued through 1986 early October, resulted in observations of only moderate to strong wind absorption. The early 1987 data indicate that the wind strength is close to minimum, and similar to the range observed in 1985. A more recent observation obtained on July 27 1987 showed a C IV equivalent width of 1.12 A. Monitoring of this star will continue until early October 1987, at which time the star is too close to the Sun for IUE to observe, and will resume by 1988 March.

The available IUE data suggest that the duration of strong wind episodes in this star is not constant. The 1981-1982 strong wind episode lasted only approximately 6 months. The 1985-1987 episode appears to have lasted for approximately 2 years. Continued monitoring will be needed in order to determine whether the regularity of the wind episodes observed from 1982-1985 is atypical.

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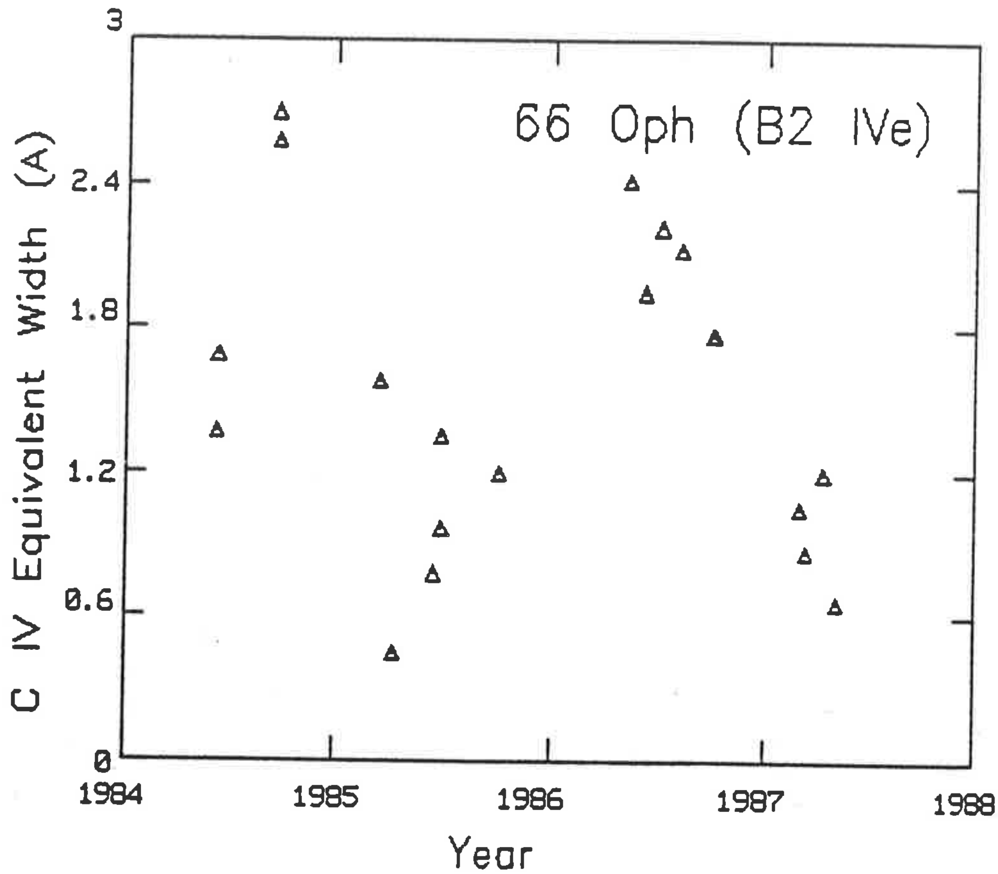

RADIAL VELOCITY VARIATIONS OF ZETA TAU IN 1978--1986

GUO Yulian GAO Weishi

Beijing Astronomical Observatory - Academia sinica

We have been monitoring zeta Tau with the grating spectrograph attached to the 60/90 cm Schmidt telescope of the Beijing Observatory since the end of 1978 . A lot of spectrograms were obtained at 17,50 and 86 Å/mm . We selected some high-quality spectrograms from different observing runs and determined the radial velocities for the stronger shell lines (e.g. the Balmer and CaII k lines). The mean errors in velocity values are ±3.2km/s for the 17Å/mm, ±3.7km/s for the 50Å/mm and ±4.9km/s for the 86Å/mm respectively.

Our results show that:1. The radial velocities of the shell lines in zeta Tau were variable throughout our observing runs. There are longer term fluctuations besides the short-period variations arising from the binary motion. Figure 1 shows the variation of the mean velocity values of the H_γ,H_δ,H_ϵ shell lines with the time . 2. The radial velocities of the CaII k line vary in the same way as those of the H_γ,H_δ,H_ϵ lines(see fig1) 3. The radial velocity variations of the V component of the H_β emission line are simillar to the above-mentioned variations(see fig. 2). In addition, the V/R ratio of the H_α and H_β emission lines underwent long-term variations during 1978-1986 which were closely related with those of the radial velocities.

Our measured radial velocities agree well with those of Hubert-Delplace et al.(1983) from the end of 1978 to 1979 (see fig. 1). However, our results for 1978-1986 showed some significant difference as compared with those published by Delplace and Chambon (1976) for the period 1960-1975. The pseudo-periods of the radial velocity variation and the amplitudes obtained by us diminished distinctly. It may indicate that the present cycle of activity of the stellar envelope which started the mid-1950s is on the decline.

References

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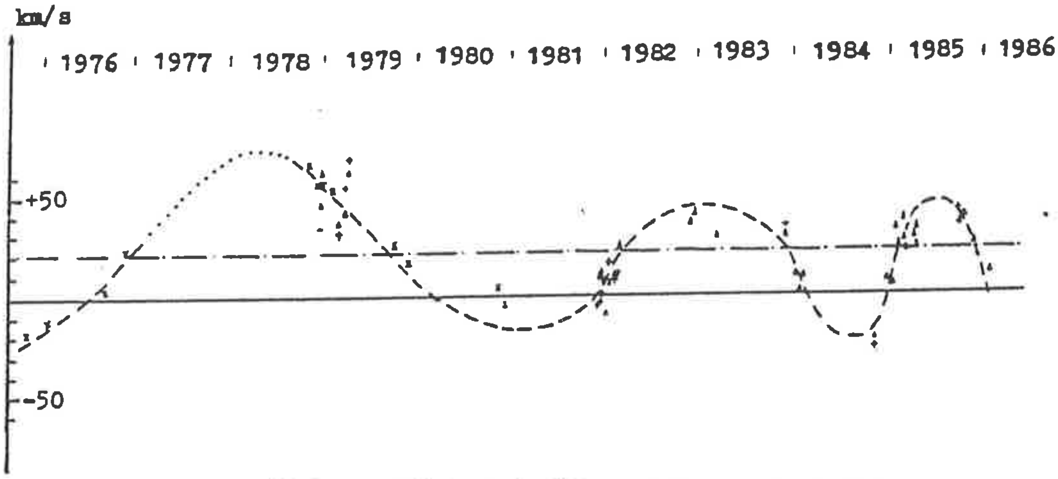

Fig.1 Radial velocity variations of the shell lines of zeta Tau in 1976-1986; ▲ $H\gamma$ $H\delta$ $H\varepsilon$; + Ca II k; X Hubert-Delplace el al.data(1983).

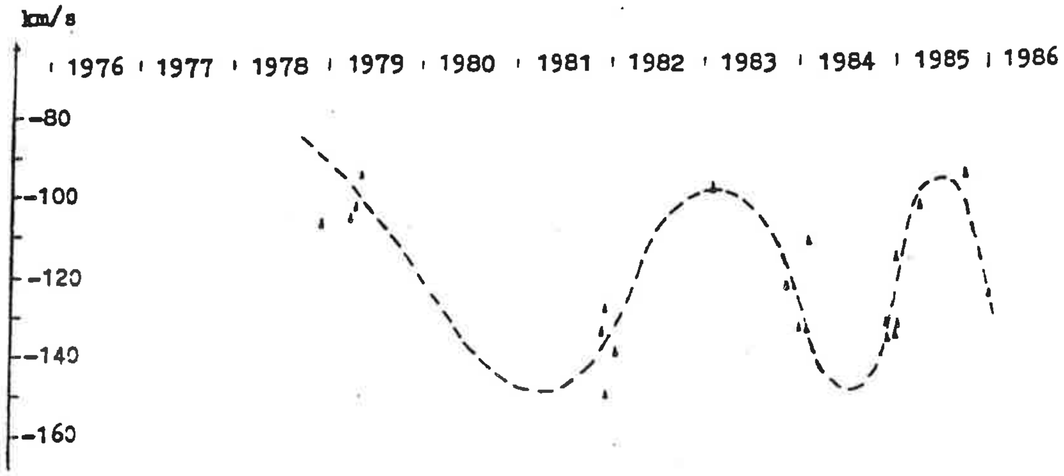

Fig.2 Radial velocity variation of the V component of H emission line

THE UNSTABLE SHELL OF ζ TAURI

GAO Weishi, GUO Yulian

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The envelope of ζ Tau shows the interesting feature in the variation of the radial velocities of the shell lines. Some excellent studies of radial velocities for the shell motion of ζ Tau have been performed. Our work is motivated by the question of whether new observations in the visible region could give us a better understanding about the shell activity and the accompanying radial velocity variations in this Be binary.

ζ Tauri has been observed at the Beijing Observatory for nine years(from 1978 to 1986). The behaviour of the hydrogen emission lines and the radial-velocity (RV) variation were illustrated in another paper (Gao W. et al. 1986). It is very interesting that the pseudo-periods of RV variations for shell should reappear in this observing interval. The RV variations arise from two causes: the orbital motion with a fixed relatively short period and the long-term movement of the outer layers of the envelope. After allowing for the effect of binary motion, the RV variation of the shell exhibited two pseudo-periods from 1976 to 1985. The first period seemed to be something like 6 years and the second was about 3 years. These cyclic variations are quite similar to those found by Delplace (1970), Delplace and Chambon(1976), but the values of the pseudo-periods are somewhat different. It seems that the pseudo-periods have changed and are probably decreasing.

Table I shows the RV values for the Balmer series, HeI and MgII, FeII4923.92,SiII4128.05 and the CaII K line. Here we would like to continue giving some results. For different groups of Balmer lines the averages of the radial velocities are different. We attempted to examine the variations of the radial velocities along the Balmer series. In Fig.1 it follows that there is no clear evidence for the existence of a Balmer progression. The differences between the radial velocities of $H\gamma$,$H\delta$,$H\epsilon$ and other lines are plotted in Fig.2. On the whole a similar tendency of RV variations for groups of H8, H9, H10 and H18, H19, H20 even HeI and MgII was found. At each velocity phase the amplitudes of RV variation for three groups are larger than the group of $H\gamma$,$H\delta$,$H\epsilon$. No pronounced tendency has been found in the RV variations of the metallic lines(FeII, SiII) which are formed in the cooler equatorial disk.

ζ Tau consists of a hot(B1Ve or B4IIIpe) primary and a cool(G8III?) secondary(Malanushenko et al. 1979). The envelope around the primary may perhaps be formed and is being constantly replenished by the gas stream from the secondary component. The structure of the envelope varies with the time. A model of elongated disk may give a reasonable explanation for the unstability of outer layers of the shell. But the motion of the inner layers of the envelope is probably much more complex and needs further studies.

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Gao, W. et al.: 1986, Proceedings of the Second Japan-China Workshop(Department of Astronomy, University of Kyoto), 13.

Malanushenko, V.P. et al.: 1979, Bull. of the Crimean Astrophys. Obs. 60,29.

Table I Radial velocities of the strongest shell lines (km/sec)

JD	Cycle (132.91d)	Balmer lines $H_\gamma, H_\delta, H_\varepsilon$	Balmer lines H_8, H_9, H_{10}	Balmer lines H_{18}, H_{19}, H_{20}	HeI, MgII	CaII K 3933.66	FeII 4923.92	SiII 4128.05
2443 918.111	211.904	+34.420	+35.533	+35.810	+34.287	+29.263	+20.360	+12.330
950.060	212.144	+41.253	+65.626	+64.546	+39.593	+55.689	+48.602	+24.798
967.042	212.272	+48.575	+61.887		+56.218	+68.921	+78.671	+64.360
4 953.133	219.691	+ 9.200	+12.228	+ 6.606	+11.575	- 5.799	+13.802	
986.026	219.938	+ 6.274	- 5.359	- 1.257		+13.128		
5 011.108	220.126	+22.902	+12.360	+19.888		+15.386		
683.153	225.184	+30.840	+30.605	+41.333	+54.854	+33.268	+36.914	
716.099	225.432	+11.370	+ 6.715	+12.269	+16.480	-15.655		
749.146	225.680	+10.637	+ 0.117	- 1.448	- 0.559			+25.583
769.125	225.830	+19.721	+18.466		+27.711	+30.317	+34.466	
6 011.282	227.652	-15.663	-25.410	-33.738	-36.082	-27.034		
064.139	228.050	+ 4.918			+16.847	-19.792		
090.073	228.245	+21.560	+27.763	+40.139	+21.150	- 2.210		
106.152	228.366	+26.511	+25.949	+36.315	+30.571			

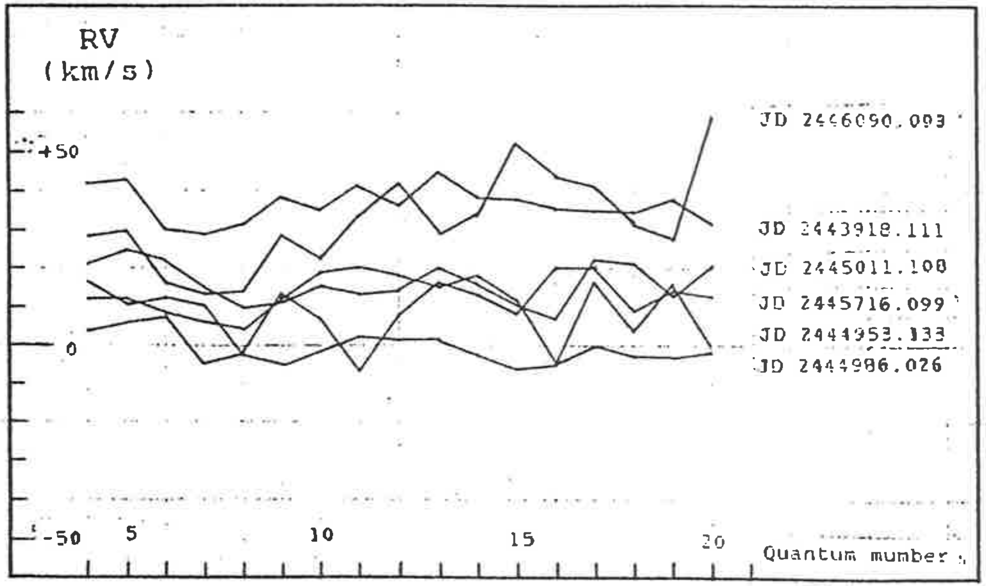

Fig.1 Radiale velocities of Balmer lines vs quautum number

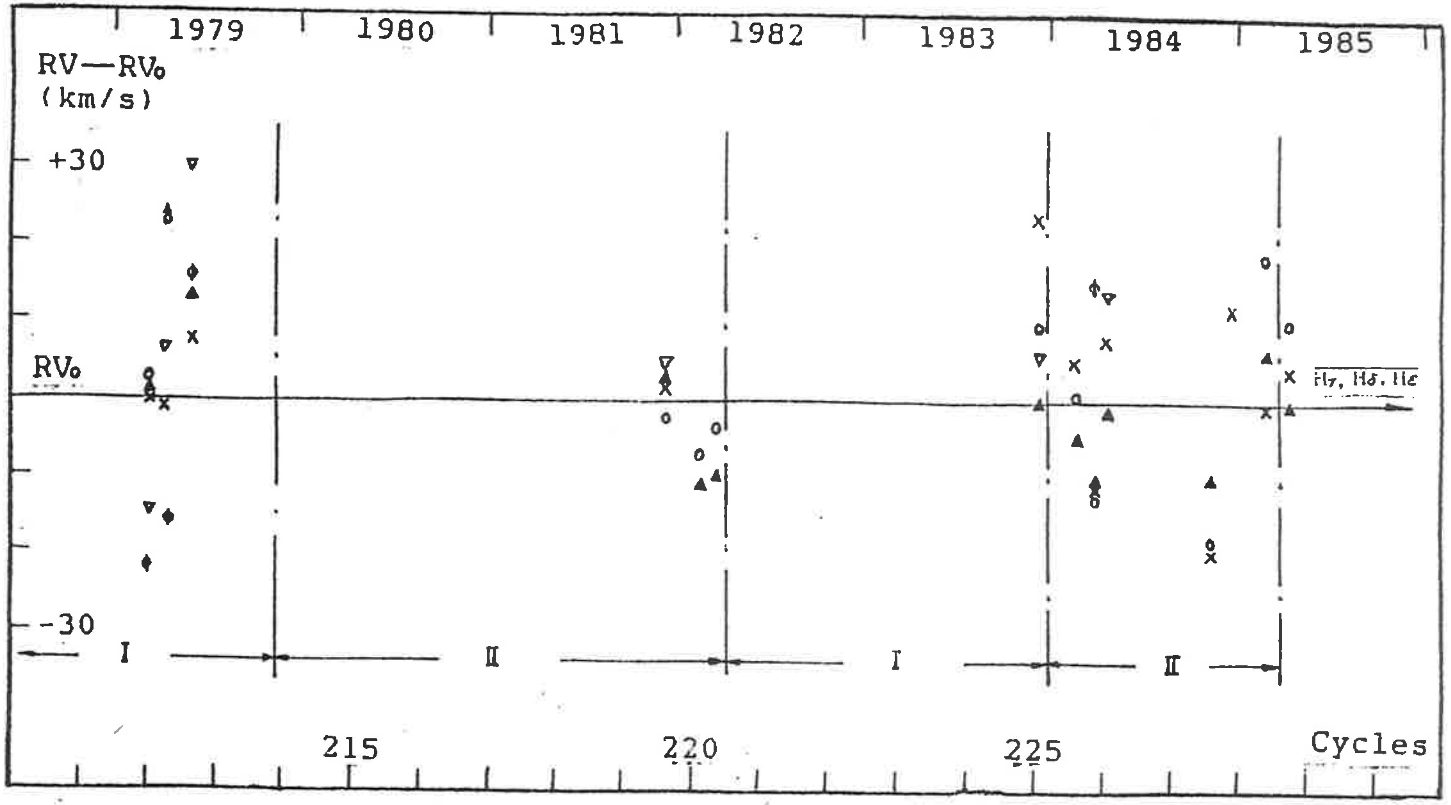

Fig.2 Relative radial velocities for the following lines:

▲ $\overline{H_8, H_9, H_{10}}$ - $\overline{H_\gamma, H_\delta, H_\epsilon}$; o $\overline{H_{18}, H_{19}, H_{20}}$ - $\overline{H_\gamma, H_\delta, H_\epsilon}$

× $\overline{\text{HeI, MgII}}$ - $\overline{H_\gamma, H_\delta, H_\epsilon}$;

▽ $\overline{\text{FeII 4923.96}}$ -$\overline{H_\gamma, H_\delta, H_\epsilon}$; ϕ $\overline{\text{SiII 4128.05}}$ - $\overline{H_\gamma, H_\delta, H_\epsilon}$

The positive velocity phases (I) and negative phases (II) Of $\overline{H_\gamma, H_\delta, H_\epsilon}$ are indicated.

W H A T ' S   A C T I V E / I N A C T I V E ?

* * * * *

OBSERVATIONS AT THE CORRALITOS OBSERVATORY II.

In Be STAR NEWSLETTER No. 15, a list of the most photometrically active Be stars under observation at the Corralitos Observatory was given. In the additional half year since its publication, the number of variables has increased slightly. Thusfar, from an increased sample size of 259 stars, 29.7% have been found to be definitely variable (average residuals from mean magnitude greater than 0.03), 12% slightly variable (0.02 - 0.03), and 58.3% nonvariable. These changes reflect the results of observations through April, 1987.

Two lists are now given. The first represents additions to the category of definite variables since the last newsletter, and the second that of the nonvariables which have remained inactive for the previous two years of observation. There have been some demotions of stars in the interim from the category of definite variability to that of slight which accounts in part for the variation in the percentage totals from last time.

Full details will be published at the close of the photometric survey in June, 1988.

RECENT ADDITIONS TO THE CATEGORY OF DEFINITE VARIABLES

HD 13661	HD 49888	HD 65875	HD 203699
13669	49977	81357	205618
15450	50064	163848	223036
19243	50091	167311	223044
20340	54464	169805	225095
34921	55538	171754	228104
36376	59094	174705	242750
40978	62729	195907	BD+43 3913
49699	64109	197434	+39 1135

THE NONVARIABLE STARS

HD 7636	HD 26775	HD 37352	HD 47359
9709	27845	37541	48282
12856	29332	37657	49787
13429	29373	38191	49992
13758	30280	38708	50083
13831	32190	39018	50138
13867	33051	39340	50737
13890	33461	39478	51193
15238	33988	42406	51354
18877	34257	42529	51452
20017	35345	42908	53367
20097	36012	43703	53416
22298	36665	44637	54086
23800	37149	44674	54575
26398	37318	46658	55135

HD 55394
55806
56039
57386
58127
60260
60307
62532
71072
76868
89884
91120
118246
127617
134458
135485
141569
158319
162428
165783
167722
168135
168957

HD 171263
173219
173817
174775
176159
177015
178515
179218
180398
181308
181709
185175
187350
189689
190073
190150
190944
191495
192445
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193238
195407
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HD 198931
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RECENT Hα OBSERVATIONS AT KITT PEAK NATIONAL OBSERVATORY

I continued to observe Be stars at Hα and He I 6678 with the Coude Feed Telescope + TI3 CCD detector at KPNO during 1987 April 16 - 20, May 2 - 6, and August 23 - 26. A description of the instrumentation and the setup that I used can be found in Peters (1986; Ap. J., 301, L61). Here are some results on several Be stars of widespread interest:

γ Cas - Observations were made on May 5 and August 23 - 26. Hα continued to display a triangular profile with a peak intensity of 4.0 I_c on May 5 and 4.5 ± 0.2 I_c during August. Further analysis of the data from my last run is required before I can comment on whether the apparent daily variations are real. He I 6678 was a double emission feature during both observing runs with V > R. V was 1.04 I_c on May 5, but showed a slight increase in strength to 1.06 ± 0.02 in August. The S/N for these and other observations described below was 100 - 200 averaged over twenty pixels.

HR 2855 (FY CMa) - Spectacular changes were observed in He I 6678 and Hα between April 20 and May 2. These are described in a separate section below.

λ Eri - This nonradial pulsator was observed on April 20 and on several occasions during August. There is evidence for weak emission at Hα during April. The intensity of the emission was below the continuum (telluric H_2O confused the observation). Hα emission was definitely present during the August observations. It was double (V = R) with a strength of 1.02 I_c. No He I emission was seen during April, but weak double emission was observed in August. During the August 23 observation R > V, but on August 25, 26 V > R. No change was seen in 30 min. on three spectra taken on August 25. Variations in the absorption profile, indicative of ongoing nonradial pulsations, were seen in the August observations.

χ Oph - The Hα emission feature in this star displayed a simple triangular profile (with some weak redward absorption) with a peak intensity of 9.0 I_c on May 4. The emission strength had definitely declined by August 26 when a peak intensity of 7.75 I_c was observed. During the latter observation a weak core was seen in Hα.

66 Oph - The intensity of Hα in this star, which displays a highly variable wind (cf. Grady, et al., this Newsletter), has been secularly increasing since the 1970s. Between 1982 June and 1984 June, the strength of Hα increased from 6.3 I_c to 7.0 I_c. The rate of increase has recently slowed. In April, I_p/I_c was 7.3; during the May observations it was 7.6. Throughout the August observing run, the peak intensity of Hα was 7.5 I_c. During August weak double emission was seen in He I 6678 (R > V ≅ 1.01 I_c). Variable absorption suggestive of mass outflow was observed.

π Aqr - Several observations from May 2 - 6 reveal that Hα increased in strength (I_p/I_c = 4.2) from its value in 1986 November (I_p/I_c = 3.7). The trend is apparently continuing as it was observed to be 4.5 I_c during August. The profile is symmetrical with very weak absorption cores flanking the central emission line. He I 6678 remains an inverse P Cygni feature. During May V/I_c was 1.1, but the emission became less prominent by August (V/I_c = 1.05).

59 Cyg - Some interesting variations have recently been observed in He I 6678 and Hα. Observations on April 18, May 2, and May 6 are shown in Figures 1 - 3. On April 18, Hα was a symmetrical emission feature with a weak central core and a peak intensity of 1.65 I_c. He I 6678 was a weak double emission line with V $\gtrsim$ R; the emission just filled the absorption feature. An observation on May 2 revealed

that Hα had increased slightly to 1.70 I_c and that the core had vanished. Weak fine structure was apparent in this line. The He I line appeared generally the same as it did fourteen days earlier, but a very weak, narrow emission component which was marginally detectable with the CCD was seen. By May 6, Hα had again developed a core, V > R, and the peak intensity had further increased to 1.75 I_c. Perhaps the most interesting change was that the He I emission had increased to a value above the continuum level. V exceeded R and V was 1.02 I_c. Observations on August 24, 25, and 26 reveal very little change since the May 6 spectrum. Hα and the He I line still display the same profiles, but He I 6678 has grown slightly to 1.06 I_c and the V lobe still dominates. There is no redward emission above the continuum. I find it remarkable that it took but four days to produce a quasi-permanent change in the circumstellar envelope.

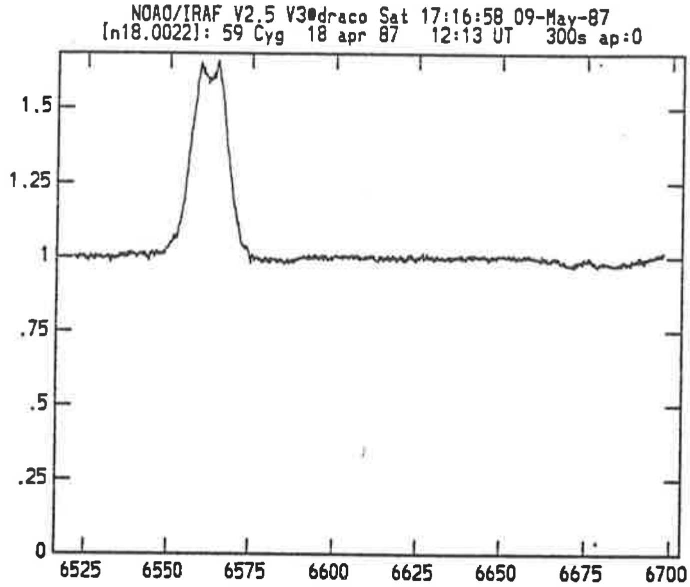


Fig. 1

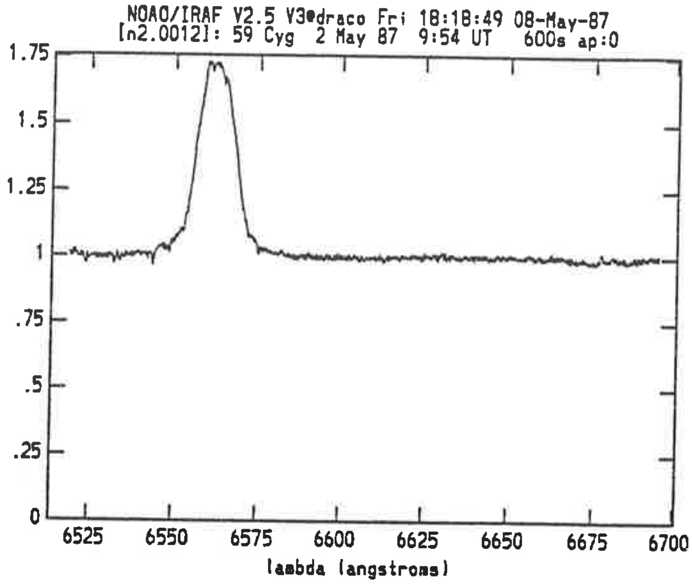


Fig. 2

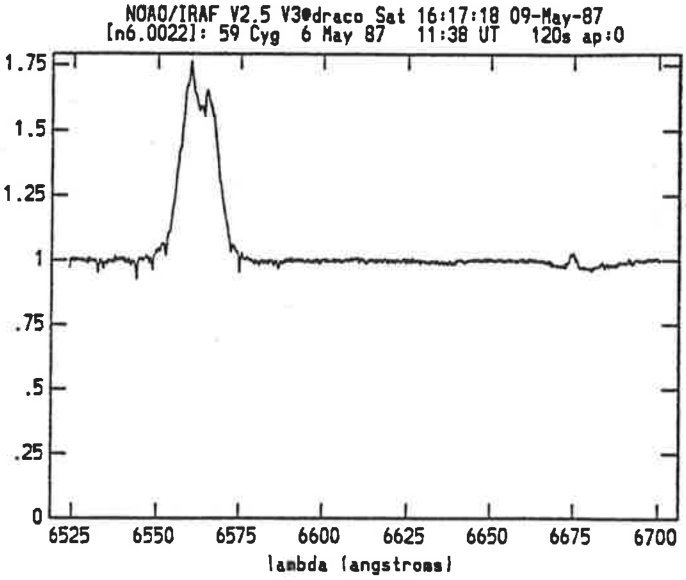


Fig. 3

G. J. Peters, Space Sciences Center, USC, Los Angeles, CA 90089- 1341; USA.

RECENT SPECTACULAR ACTIVITY IN THE Be STAR HR 2855 (FY CMa)

HR 2855, B0IVe, is currently one of the more active Be stars. In the optical spectral region emission is seen in the Balmer and He I lines, while in the UV mass loss via a wind is observed in the resonance lines of N V, C IV, Si IV, and Si III (terminal velocity $\sim$ -1500 km s^{-1}). The UV wind lines usually display discrete components. It is not unusual to observe variations in the optical emission lines and the UV wind features in spectra taken a few months apart. However, the variation which occurred between 1987 April 20 and May 2 was quite unusual, even for this star. Nightly observations at KPNO from April 16 - 20 revealed invariant Hα emission ($V/R = 1.2$, $V/I_c = 1.8$), while He I 6678 displayed a simple absorption profile with very weak double emission components. Twelve days later similar observations revealed the striking change in the He I line shown in Figure 1. He I 6678 developed a structured, inverse P Cygni profile with a V emission intensity of 1.2 I_c and a central core showing a velocity of -65 km s^{-1}. The weak red-shifted emission component which previously existed disappeared. Steady nightly variations in the He I line were seen through May 6. Between the April 20 observation and the one on May 6, Hα also changed. The V lobe increased in strength by 35%, but the R lobe showed only a slight increase. Minor variations were observed from May 2 - 6 during which the R lobe steadily decreased in strength to its earlier value. This star was again observed on August 25 and 26 (through 7 - 9 air masses just before the sun rose) and these new observations reveal only the slightest of changes. Hα displays the same strength and profile and the only difference in He I 6678 is that the core which had developed by May 6 has strengthened. As in the case of 59 Cyg, a quasi-permanent change in the circumstellar material occurred within a very short interval of time. *IUE* observations were obtained during March, before the recent activity, and on May 3. Compared with the pre-outburst observation, the latter revealed the appearance of sharp-components in N V (showing the velocity of the core in He I 6678) and S III 1200 A (with a velocity $\sim$ +100 km s^{-1}!). This remarkable event in HR 2855 will be discussed in more detail in a paper to be submitted to the *Ap.J.Letters*.

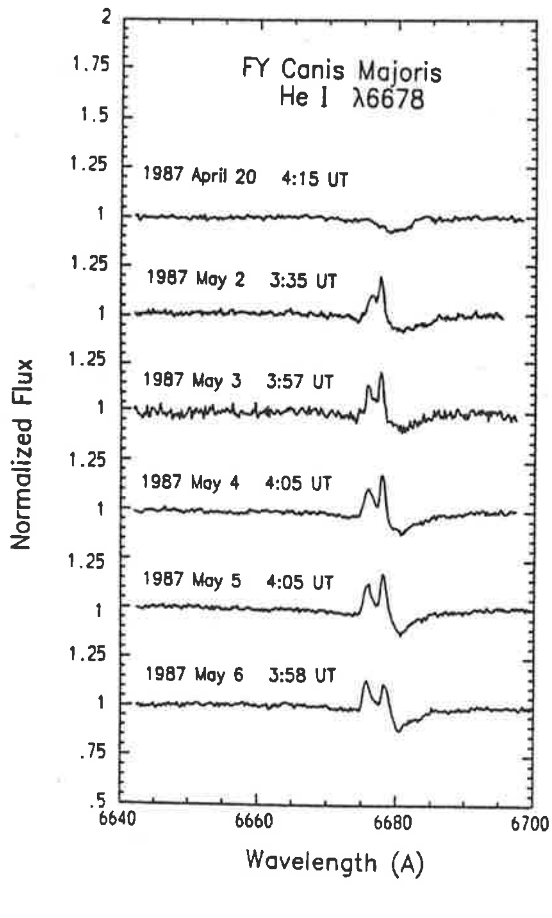


Fig 1 - CCD observations with the Coude Feed Telescope at Kitt Peak National Observatory reveal spectacular changes in He I 6678 in less than twelve days and further variations in the days that followed.

G. J. Peters, USC, Space Sciences Center, Los Angeles, CA 90089-1341; USA.

SUDDEN FLASHES/OUTBURSTS IN X OPH

K. K. Ghosh, K. Jayakumar and K. Kuppuswamy
Indian Institute of Astrophysics, Vainu Bappu Observatory
Kavalur, Alangayam, North Arcot, T . N ., 635701, India

Variability of Be stars with time scales of years, months and days is well known to the astronomical community. However, regarding rapid variations in the time scales of hours and minutes, there are different opinions by different authors. In addition to these variations, sudden brightening of the star with enhancement of the equivalent width emission of Balmer lines has also been observed for few Be stars. This type of sudden brightening has been attributed to as surface flashes or outbursts of the hot plasma from the interior of the star. However, not much of information is available about flashes or outbursts, for many Be stars. Here we shall present one such flash or outburst phenomena for X Oph.

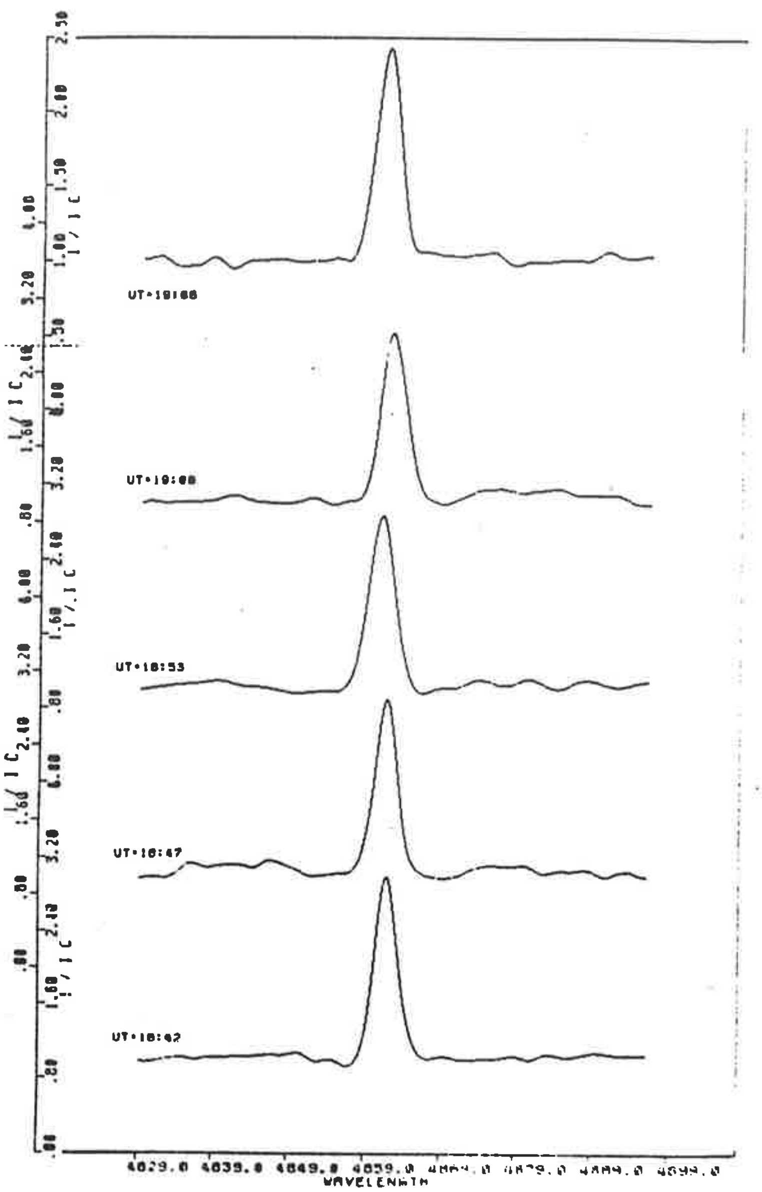
The time variability of Balmer (H_α and H_β) and Fe II emission lines of X Oph has been observed on several nights between 1985 – 1987 at the cassegrain focus of 102 cm reflector of Vainu Bappu Observatory, Kavalur, India, with a grating spectrograph giving the linear dispersion 82 A mm^{-1} . Observed spectra of X Oph obtained on 28/29 May 1986 for different observing time (from bottom to top with increasing UT) in the spectral region 4825 – 4895 , 5000 – 5400 and 6520 – 6610 Å are presented in Figs. 1–3 respectively. Spectra of X Oph which were observed before and after 28/29 May 1986 are not shown here.

Comparing the spectra of X Oph for different nights, we find that the emission strength of Balmer (H_α and H_β) and Fe II lines increased suddenly on 28/29 May 1986. Equivalent width of H_α emission line has also increased suddenly by a factor of 4 – 5 and for H_β and Fe II emission lines, enhancement was by a factor of 2 – 3.

This type of sudden brightening which is usually called as flashes or outbursts of the hot plasma from the interior of the star, may be due to the following reasons :

1. Radiative instability in the CORONA where $Te \sim (3 - 5) \times 10^5$ K.
2. Magnetic reconnections or some other instability (connected with magnetic field) on the surface of Be stars due to the surface hidden magnetic field.
3. Mass accretion onto the envelope of Be star from the companion in a binary system (which is still in hypothetical stage).

The above mentioned reasons are very speculative and the actual situation in the case of Be stars may not necessarily be any one of the three, but it may be a combined phenomena.



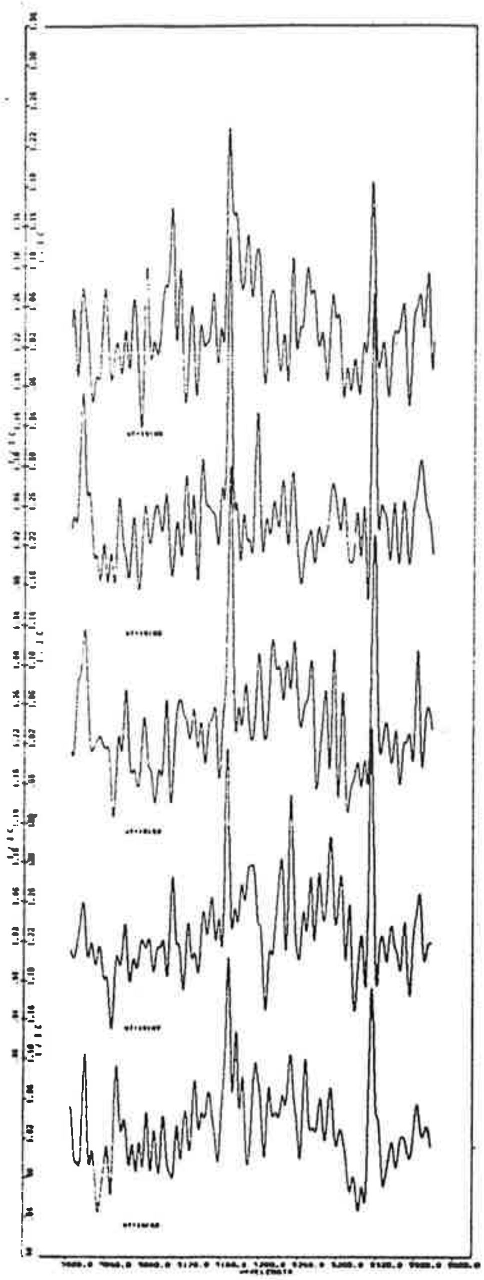


Fig. 1 Observed H_β profiles of X Oph. Mean time of observation has been given with each profile.

Fig. 2 Spectra of X Oph in the spectral region 5000 - 5400 Å. Strong Fe II emission lines are seen in the spectra.

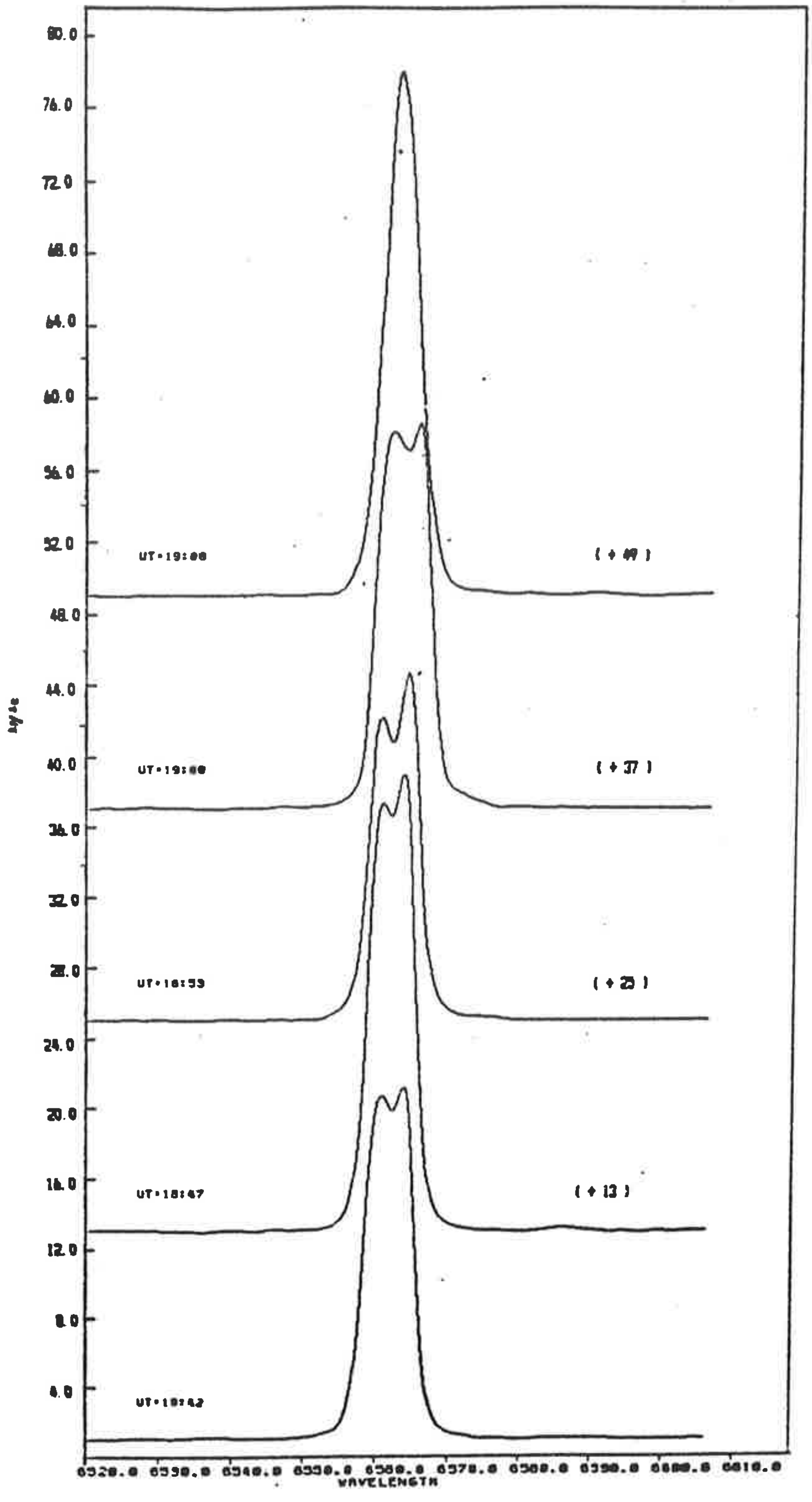


Fig. 3 Observed Hα profiles of X Oph. Continuum level intensities of four profiles have been shown in the figure.

* * * * *

UV Monitoring of Bright Be Stars

C.A. Grady and H.F. Henrichs

In conjunction with our co-investigators, we have been awarded 5 US2 and 1 ESA IUE shifts per year for the next two years to monitor stellar wind activity in a group of bright Be stars. The observations are split into 4 hour monitoring sessions per month. With this allocation we can expect to obtain 4 to 5 SWP high dispersion spectra (one per target) in each month. Our current target list includes γ Cas, δ Cen, ζ Oph, 2 Vul, o And, 59 Cyg, 66 Oph, 6 Cep, λ Eri, HR 2855, 25 Ori, ω Ori, 19 Mon, α Col, and ψ Per. We welcome suggestions from the astronomical community for additional targets to monitor, with the understanding that the star must be bright ($V<6$), and should ideally have a sufficiently large value of $v \sin i$ to exhibit a highly-ionized stellar wind at least some of the time. Due to our limited observing time, priority will be given to targets which are currently on multi-spectral observing campaigns, or which are showing signs of dramatic changes in their spectra (e.g. leaving a shell phase). To add targets, please contact Carol Grady at (301)286-3938 from 9 A.M. to 5 P.M. EST, or send letters to Carol at IUE Observatory, Code 684.9, NASA/GSFC Greenbelt MD 20771.

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CAMPAIGN ON FOUR RAPID VARIABLE Be STARS

G. J. Peters and J. R. Percy

The first part of our effort to investigate the cause for rapid photometric variability in Be stars was successfully carried through during August. Omicron Andromedae was observed with *IUE*, *Voyager*, and numerous ground-based telescopes and many of these multifrequency observations were obtained simultaneously. As a result of our announcement in the last *Be Star Newsletter*, many new observers joined our campaign. The second half of our program is scheduled for early November, during which ω Ori and λ Eri will be observed. In collaboration with Huib Henrichs, we will secure 40 continuous hours of repeated observations of these stars with *IUE* beginning at 3:00 UT on November 5. Observations will cover more than 85% of the light curve in ω Ori and over two cycles of the activity in λ Eri. Numerous ground-based observations will be made and *Voyager* observations will be obtained of ω Ori. If you are interested in participating in this project, please contact either G. Peters (spectroscopic observations) or J. Percy (photometric observations).

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KAPTEYN sterrenwacht

La Palma´s "Multi-Purpose Fotometer" and Be stars

J.Tinbergen

Kapteyn Observatory, Roden, Netherlands.

At the Observatorio del Roque de los Muchachos on the Canary Island of La Palma, we have installed a multi-purpose photometer (MPF from its Anglo-Dutch initials) which could be of interest to Be star observers. A short description follows; more details are in the Users´ Manual which may be obtained through Dr W.L.Martin, Royal Greenwich Observatory, Herstmonceux Castle, Hailsham, East Sussex BN27 1RP, England. Applications for observing time have to go through the British(-Dutch) or Spanish time allocation committees (enquire via Dr Martin); access is easiest for British, Dutch, Spanish and Irish observers, but others are not excluded per se. A mechanism for longer-term programmes exists.

MPF is a classical photon-counting instrument with filters and photomultipliers, but a number of useful techniques are united within this one instrument (see figure). The following excerpt from the Users´ Manual should be sufficient for deciding whether to ask for more detail. MPF is at present available only on the 1-metre Jacobus Kapteyn Telescope. It is controlled from a computer terminal by an efficient menu. The offline reduction programme is in Fortran 77 and can easily be adapted by the user for his own purposes.

Excerpt from Users´ Manual

Scientific goals

When MPF was conceived, a need was felt for an instrument that was capable of photometric precision, yet could be used flexibly for various spectral features and was also efficient in its use of the available light. Several approaches are possible; the one that was taken was to split the light with dichroic beamsplitters, to isolate certain wavelength ranges by filters and to use photomultiplier detectors.

Since dichroic beamsplitters are wavelength-dependent polarisers, the incoming light must be effectively depolarised if we are to avoid photometric errors with polarised objects. A time-averaging depolariser (rotating achromatic halfwave plate) was chosen for this. It was then an obvious step to include an optional polariser to allow (linear) polarimetry with half the light.

It was decided that efficient measurement of equivalent width of stellar absorption lines was a must. For this reason the photometric channels were to be in pairs, allowing "H-beta" photometry with each pair. The most significant scientific use of this could well be: calibration in terms of very bright stars of future massive CCD line-index photometry.

A further requirement was that dynamic range should extend from the faintest stars to the brightest on one and the same telescope (with reasonable assumptions of optical bandwidth). This led to the choice of pulse-counting electronics, combined with a 3000:1 range of "neutral-density" filters (in steps of 3).

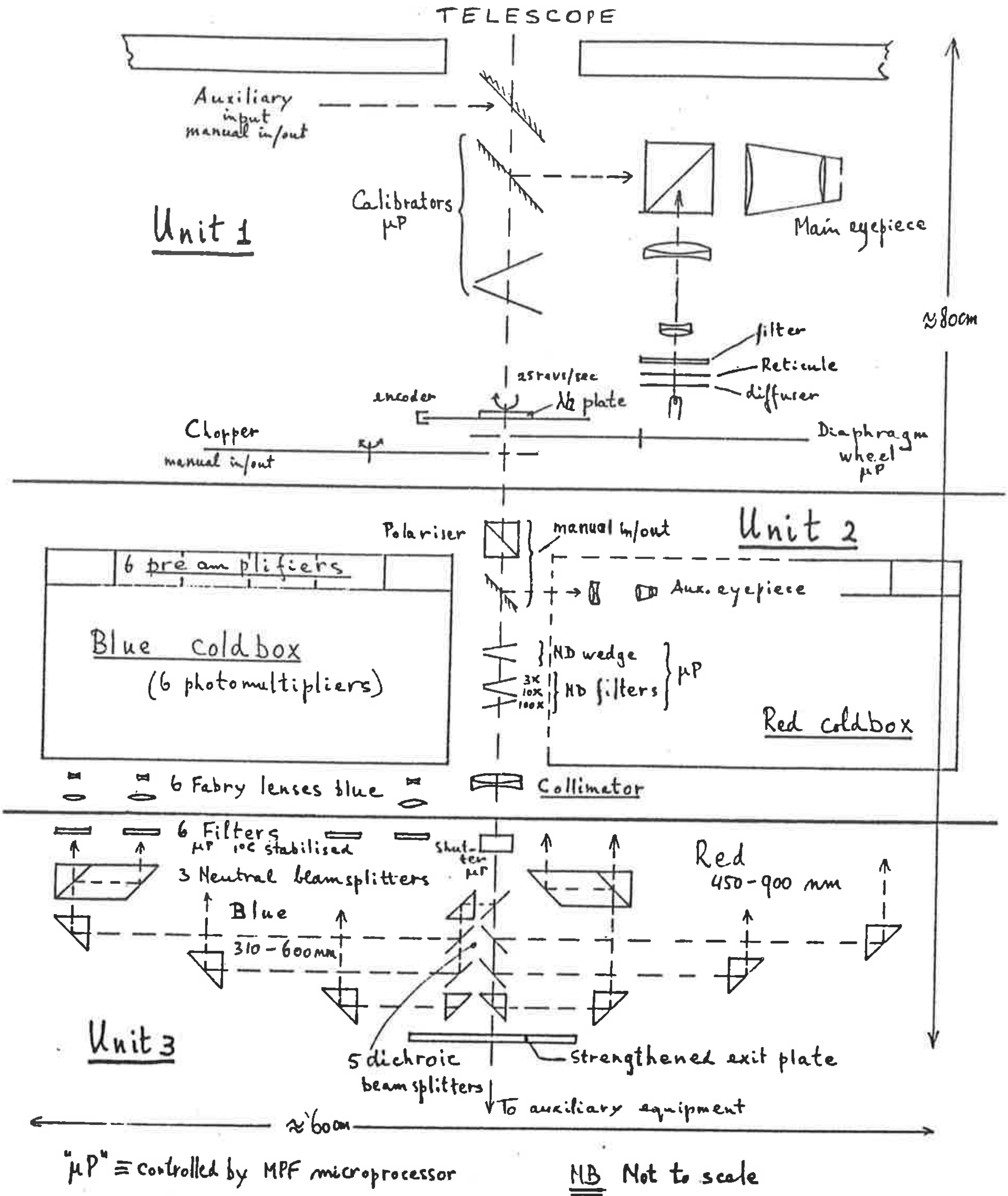
The fact that these filters are not strictly neutral means that UBV and similar broad-band photometry is more or less impossible. Strömgren photometry and similar medium-band photometry is feasible, though not first priority. Broad-band polarimetry can often be done, since polarisation is generally a slow function of wavelength.

The types of observing programme for which MPF is best suited are:

a) Quasi-simultaneous photometry and polarimetry.
b) Photometry of a few well-separated spectral features either in many stars or in a few stars but repeated many times.
c) Multi-colour photometry on bright objects (the major noise sources being scintillation or sky transparency variations, which MPF reduces considerably).
d) Broad-band polarimetry in 4 to 6 simultaneous passbands.
e) Multi-line-index photometry of high precision.
f) Sky-chopping photometry or polarimetry in 4 or more non-overlapping passbands. (CHOPPING MODE NOT FULLY OPERATIONAL AS YET)
g) Fast photometry in up to 12 simultaneous channels. (FAST MODE NOT YET OPERATIONAL)

Programmes that should NOT be attempted with MPF are:

a) Broad-band photometry (unless of low precision and mostly non-overlapping passbands). Reason: effective wavelength changes with neutral-density filters used.
b) Photon-limited photometry in only 1 or 2 channels or photon-limited polarimetry in less than 4 channels. Reason: inefficient use of photons; use a single-channel photometer.
c) Polarimetry of better precision than 0.00005 (degree of polarisation; PRESENT LIMIT about 0.0003). Reason: maximum count rate of 1 MHz leads to exorbitant integration times (present limitation at 0.0003 is due to polarisation zero point instability of as yet unknown origin).
d) Narrow-band observations of objects faint enough for the dark current to be the main source of noise. Use a low-dark-current single-channel photometer.



MPF schematic

MPF Specifications

Number of channels:	up to 6 (x2 by neutral splitter, x3 filters)
Modes:	1) H-beta type photometry in up to 6 lines 2) Multi-colour photometry (up to 6,12,36) 3) Linear polarimetry as in 2
Optical efficiency:	70% maximum, x 0.5 by neutral splitter, x 0.5 for polarimetry x filter transmission
Accuracy:	0.1% photometry, 0.03% polarimetry
Dynamic range:	Maximum count rate: 1 MHz Dark counts: 10 to 100 Hz Up to 9 mags calibrated ND filters
Wavelength range:	310 (at present 350) to 870 nm
Optical passbands:	0.5nm < B < 100nm
Telescopes:	F/15. At present 1-metre only
Diaphragms:	single: 0.4 to 8 mm (nominal) double: 0.2 to 3 mm (nominal; 5 mm apart; mode not fully implemented)
Time resolution:	0.7 second at full accuracy; fast mode down to 10 msec with some reservations about periodicities in the data (fast mode not yet implemented)
Eyepiece:	4 cm field; cross-wires or finding chart can be projected in (50 x 50 mm slides)
Passband monitoring:	-- Laboratory (position, polarisation, tilt) -- Effective inverse wavelength calibrator -- Monochromator entry port (monochromator not yet implemented)

If this has aroused your interest, then write to Dr Martin at RGO for a Users' Manual. I am myself too much involved in other instrumental projects to take any large share in observing programmes, but I am always ready to advise; the Users' Manual lists available modes of communication.

P R E P R I N T S   R E C E I V E D

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A survey of Be stars in the λλ 7500 - 8800 region
ANDRILLAT Y. - JASCHEK M. - JASCHEK C.; Laboratoire d'Astronomie USTL, Montpellier; CDS, Observatoire Astronomique Strasbourg; France.
To be published in: Astronomy and Astrophysics, Supplement Series
Preprints: from Y. Andrillat at first address

Abstract: This survey covers the spectra of over 97 Be stars observed at 50 and 230 A/mm plate factors with a Reticon in the λλ 7500 - 8800A region. Equivalent widths were measured for the strongest lines present in this region.

Calcium line emission from Be stars
APPARAO K.M.V. - TARAFDAR S.P.; Tata Institute of Fundamental Research, Homi Bhabha Road, Bombay 400005, India.
Preprints: K. Apparao at above address

Abstract: Calcium triplet line emission in the near infrared at λ8498, λ8542 and λ8662 from Be stars was observed earlier. We show that the emission arises in a region outside the H II region, produced in the gas envelope by the far ultraviolet radiation of the Be star. We call this the CII region, because the electrons for recombination are from ionization of carbon. In the case of late spectral type Be stars, the far ultraviolet photons from the star are not sufficient and additional ultraviolet photons probably from a corona-transition region are required, just as in the case of Balmer emission.

Time-resolved high-resolution spectroscopy of an Hα outburst of μ Cen (B2IV-Ve)
BAADE D. - DACHS J.; Space Telescope-European Coordinating Facility, European Southern Observatory, Karl-Schwarzschild-Str. 2, D-8046 Garching, W. Germany; and Astronomisches Institut, Ruhr-Universitat, Postfach 10 21 48, D-4630 Bochum 1, W. Germany.
To be published in: Astronomy and Astrophysics
Preprints: D. Baade at first address

Abstract: Following a phase of very weak but extremely V/R variable emission in early February, 1987, μ Cen developed a new highly symmetric doubly-peaked emission at Hα. The total equivalent width decreased by 1.5A within only two days. During the time of maximal growth of the feature an additional emission component with a full width of 800-900kms^{-1} partly filled in the underlying stellar absorption. If caused by Thompson electron scattering, the short duration of this phenomenon further strengthens the classification of the event as an outburst. The event at Hα was accompanied by conspicuous line profile variability of the CII λλ 6578, 6583A doublet which after the outburst also included dramatic V/R variations of emission components. The latter seem to have been detected for the first time in Be stars. After 17 and another 19 days, respectively, this first Hα outburst was followed by two comparable;

slightly fainter ones.
From the synopsis with the similar 1985 event reported by Peters (1986) for the same star, a first attempt is made to abstract the general pattern of such outbursts. Potential problems of elliptical ring and decelerated, balloon filling models are outlined. Processes governing the mass loss from Be stars and the evolution of their envelopes are briefly discussed. Apparently, Be stars do not undergo outbursts each time when their pulsation amplitude is large. E.g., in 1986 April, very weak but extremely strongly V/R variable Hα emission was observed in μ Cen while for at least 10 days there was no indication of enhanced mass loss. The, with respect to 1986 April, much stronger wings and the considerably shallower core of the Hα absorption are probably closely connected with (precede?) the emission event.

Hα echelle spectroscopy of Be stars: an atlas
BALLEREAU D. - ALVAREZ M. - CHAUVILLE J. - MICHEL R.; UA 337, Observatoire de Paris, 5 Place Jules Jansen, 92190 Meudon, France; Instituto de Astronomia, Universidad Nacional Autonoma de Mexico, Apartado Postal 877, 22830 Ensenada, Baja California, Mexico; and Escuela Superior de Ciencias. Universidad Autonoma de Baja California. Ensenada, B.C., Mexico.
To be published in: Revista Mexicana de Astronomia y Astrofisica
Preprints: D. Ballereau at first address

Abstract: From the analysis of 78 spectroscopic plates of the Hα emission line of 15 Be and shell stars, known to be variable from spectroscopic and photometric studies, we present an Atlas of the Hα line. We emphasize on the spectroscopic changes of the line to obtain criteria to further study the short-term variability of these interesting objects. As expected, we can easily detect the long-term variability when we compare our Hα line observations to previous work.
From this study, we found that all the stars observed show variability on a time scale from 2 to 14 days. On a shorter time scale, Hα line variability is present in HD 37202, HD 184279, HD 200120, HD 217050, HD 224559, HD 174638 and HD 183656.
A further simultaneous spectroscopic and photometric study is necessary to fully interpret their behaviour.
We include in this Atlas 3 spectra of the Hα absorption line of two β CMa stars observed during the campaign.

Implications of variable mass-outflow on modeling
DOAZAN V. - THOMAS R.N.; Observatoire de Paris, 61, Av. de l'Observatoire, F-75014 Paris, France; and Radiophysics Inc. 5475 Western Ave. Boulder, CO, 80309, U.S.A.
To be published in: "Mass-outflows from stars and Galactic Nuclei", held in Torino 4-8 May 1987, eds. L. Bianchi and R. Gilmozzi (Reidel)
Preprints: V. Doazan at first address

Abstract: It is now recognized that most early-type stars show mass-outflow variability. Using as example the Be stars, we discuss the effects of such variability on the structure of the stellar atmosphere and its implications on stellar modeling.

Empirical-theoretical modeling of Be variable mass-loss via variable: photospheric mass-outflow; coronal opacity; radiation-amplified wind-piston, driving pulsating cool-envelope

DOAZAN V. - THOMAS R.N.; Observatoire de Paris, 61 Ave de l'Observatoire, F-75014, France, and Radiophysics, Inc., 5475 Western Avenue, Boulder, CO 80309; USA.

To be published in: Stellar Pulsation, ed. A.N. Cox, W.M. Sparks, and S.G. Starrfield (Springer-Verlag)

Preprints: V. Doazan at above address.

Recent onset of an outburst in μ Cen, and Detection of a new Be star-γ Lup

GHOSH K.K. - VELU C. - KUPPUSWAMY K. - JAYAKUMAR K. - ROSARIO M.J.; Indian Institute of Astrophysics, Vainu Bappu Observatory, Kavalur, Alangayam, N.A., T.N., 635701, India.

To be published in: Information Bulletin on Variable Stars

Preprints: K. Ghosh at above address

Studies in Be-star variability, 2. Analysis of published radial velocities of six bright emission-line stars

HARMANEC P.; Ondrejov Observatory, Astronomical Institute of the Czechoslovak Academy of Sciences, 25165 Ondrejov, Czechoslovakia.

To be published in: Bull. Astron. Inst. Czechosl.

Preprints: P. Harmanec at above address

Abstract: Published radial velocities of six emission-line stars, o Cas, HR 1763, HR 2370, HR 2577, 7 Oph and HD 105056, are collected and analyzed. No satisfactory period could be found for the velocity variations of o Cas and it is concluded that the observed velocity changes probably arise from the superposition of long-term and rapid velocity variations. Tentative periods are suggested for the other five stars, and it is argued that all of them can be spectroscopic binaries. However, the evidence for real periodicity is not fully conclusive in either case and new series of observations are urgently needed.

IRAS excess radiation in Be stars and the behavior of the Ca II triplet

JASCHEK C. - ANDRILLAT Y. - JASCHEK M. - EGRET D.; CDS, Observatoire de Strasbourg; Laboratoire d'Astronomie USTL Montpellier; France.

To be published in: Astronomy and Astrophysics

Preprints: from C. Jaschek at first address

Abstract: We have examined a sample of 51 stars observed spectroscopically in the near infrared and by IRAS. We have found an interesting correlation between the Ca II triplet emission and IRAS excess: When the IRAS excess is large, Ca II is in emission; When the excess is small, no Ca II is present. This relation clarifies somewhat the erratic of the Ca II triplet in the Be stars.

A survey of Ae and A-type shell stars in the photographic region
JASCHEK M. - JASCHEK C. - ANDRILLAT Y.; CDS, Observatoire de Strasbourg; Laboratoire d'Astronomie, USTL Montpellier; France
To be published in: Astronomy and Astrophysics, Supplement Series
Preprints: from M. Jaschek at first address

Abstract: 28 northern Ae and A-type shell stars were observed in the photographic region. A regular pattern of line behavior with spectral type was found, which in part prolongates the behavior of Be stars toward cooler stars, although a discontinuity seems present around A0. A survey of other data concerning colors, rotation, variability etc. is also presented. Photometrically the stars simulate the behavior of higher luminosity objects. A large proportion of shells seem to be variable. The attempt to detect new shell stars among 13 stars known to be rapid rotators with normal spectra, failed however.

Is the Be star HR 9070 actually pulsating?
SAREYAN J.P. - ALVAREZ M. - CHAUVILLE J. - LE CONTEL J.M. - MICHEL R. - BALLEREAU D.; Observatoire de Nice, B.P. 139-F 06003 Nice Cedex, France, Instituto de Astronomia. UNAM, Apto-Postal 877, Ensenada, 22830, B.C., Mexico. Observatoire de Meudon - 92190 MEUDON PRINCIPAL, France, Escuela Superior de Ciencias, Univ. Aut. Baja California, Ensenada, B.C., Mexico.
To be published in: Astronomy and Astrophysics
Preprints: J.P. Sareyan at above address

Abstract: New photometric observations on this short period Be variable have been obtained by a cooperation program between Europe and Mexico in 1983-84-85. They show that the light maxima can be predicted by the following ephemeris: MAXIMA at H.J.D. = 2445618.6065 + 0.310037 E. Analysing our data - as well as all available data - by a 0.3 day period or by a double wave 0.6 day period curve brings about the same r.m.s. error, so that we get equivalent probabilities. Spectrography suggests large RV discontinuties in the components of Hα, superimposed on smooth variations possibly correlated with the shortest period.

Depending on the actual solution, pulsation or rotation may be involed. The shortest periodic Be stars show periods longer than the classical β CMa pulsating variables, so unusual pulsation modes should be considered.

Or, if rotation of a star with spots on its surface accounts for the variations, an exclusion mechanism between β CMa and Be phenomena must exist, probably as a function of rotation - line broadening.

IRAS observations of Be stars, II. Far-IR characteristics and mass loss rates
WATERS L.B.F.M. - COTE J. - LAMERS H.J.G.L.M.; SRON Laboratory for Space Research; Beneluxlaan 21; 3527 HS Utrecht, Netherlands; and Astronomical Observatory Sonnenborgh; Zonneburg 2, 3512 NT, Utrecht, Netherlands.
To be published in: Astronomy and Astrophysics
Preprints: L. Waters at first address

Abstract: IRAS observations of bright, classical Be stars detected at 12.25 and 60 μ are presented. The far-IR energy distribution of the Be stars is

studied in terms of the slope of the spectrum and the IR excess as a function of wavelength. The far-IR colours of Be stars indicate the presence of fully ionized circumstellar material, and no indication of dust. The IR excess as a function of wavelength is interpreted in terms of a simple equatorial disc model. The analysis yields information about the density structure of the circumstellar discs. Assuming mass continuity, in most stars a very gradual outward acceleration of matter in the disc is observed: $\rho(r) \propto r^{-n}$ with $2 < n < 3.5$. Adopting a velocity of 5 km/s at the photosphere, the mass loss rates are derived, and its dependence on luminosity is studied. It is found that the mass loss rates from the IR are much higher than the rates derived from asymmetric UV resonance lines, typically $\dot{M}_{IR} = 10^2 \dot{M}_{UV}$. The difference tends to decrease towards higher luminosities. $\dot{M}_{IR}$ depends only weakly on L, indicating that radiation pressure is not the only driving force, but another mechanism, called the Be mechanism, possibly related to rotation and non-radial pulsations, must be effective. It is suggested that very luminous stars with $L > 1\text{-}2\ 10^5 L_\odot$ cannot form discs due to the high radiation pressure that dominates the winds, and that mass loss due to the Be mechanism is negligible. At lower luminosities, the Be mechanism dominates the mass loss, resulting in enhanced equatorial mass loss.

B I B L I O G R A P H Y

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(Compiled by A.M. Hubert, J. Jugaku, P. Koubsky, M. Ruusalepp and A. Slettebak)

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Erratum in last Bibliography
WOO J.: Ac. Ap. S. 119, 61 (1986) should read WOO J.: ASS 119, 61 (1986)

Abbreviations used for publications

AA	Astronomy and Astrophysics
AA Suppl.	Astronomy and Astrophysics Supplement
Ac. Ap. S.	Acta Astrophysica Sinica
A. J.	Astronomical Journal
Ap. J.	Astrophysical Journal
Ap. J. Suppl.	Astrophysical Journal Supplement
ASS	Astrophysics and Space Science
BAAS	Bulletin of the American Astronomical Society
BAC	Bulletin of the Astronomical Institutes of Czechoslovakia
CRASP	Comptes Rendus de l'academie des Sciences de Paris
IAUC	IAU Circular
IBVS	Information Bulletin on Variable Stars
IKAO	Izvestia Krimskoj Astrofiziceskoj Observatorii
MNRAS	Monthly Notices of the Royal Astronomical Society
PASJ	Publications of the Astronomical Society of Japan
PASP	Publications of the Astronomical Society of the Pacific

Physics of Be Stars *

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Be stars are stars of the B spectral class with emission in their optical spectra. This book comprises the proceedings of the third Colloquium devoted by the International Astronomical Union to these complex and mysterious stellar bodies.

The 18 review papers and 63 contributed papers collected here span the full range of current research, with discussions of the five fundamentally different models that have been proposed to account for Be stellar phenomena, together with the observations and theory which both gave rise to the various models and provide the material for assessing their adequacy. Separate sections are devoted to the circumstellar gas associated with these stars and to their evolutionary status, and the volume concludes with a panel discussion of future research.

New observational techniques and technology has made the study of Be stars increasingly active in recent years. All astronomers who seek to keep pace with developments in this field will need to read this book.

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