Asian Journal of Chemistry *Vol.21, No.10 (2009), S180-183*

Variation at Hα Emission Line in a Unique Be Star γ Cassiopeiae

B.S. SALARIA*, P.S. GORAYA*, NARDEEP KUMAR* and H.S. GHUMMAN †
**Department of Physics, Punjabi University, Patiala, INDIA*
E-mail: bsslaria52@yahoo.com

The well known Be star γ Cassiopeiae (γ Cas) is being observed spectroscopically and photometrically for the last nearly one and half century. This star is a prototypical "classical" Be star which resulted in many new discoveries in Be phenomena. This was first B star with Balmer line emission, thus opening a new class of B stars called Be stars. Due to its unique and fascinating nature we plan to include this object in our regular observing program. In the present communication we report the Hα observations of this object. The spectrophotometric spectral scans of this star covering the Hα region in the wavelength range 6100 - 6900 Å are presented to explore the variations of Hα emission strength and shape of the line. The star displayed unusual behaviour at Hα emission line during the period of observations. Reversal of asymmetry from V>R to V<R along with the transformation from double-peaked emission to a single -peaked emission at Hα emission line has been explored on time-scales of about weeks. High time resolution observations show possible ultra-rapid variations in Hα emission strength and shape on time-scale of minutes to seconds.

Key Words: Be star, Emission line, Variation, Circumstellar envelope

INTRODUCTION

The well known Be star γ Cas (HR 264; HD 5394; m_v=2.47; Sp.T. B0.5IVe) is being observed spectroscopically and photometrically for the last nearly one and half century. γ Cas is a prototypical "classical" Be star. It is first B star with Balmer line emission which gave rise to a new category of stars known as "Be Stars"[1]. The Be star γ Cas has exhibited brightness and spectral variations on various time scales. Detailed discussion on its pronounced long-term brightness and spectral variations has been made by Doazan *et al.*[2],and Telting and Kaper[3]. The star had undergone two consecutive shell phases during 1935-36 and 1939-40. These phases were followed by a relatively short phase of normal B-type star and γ Cas again entered in the Be phase with typical characteristics of a

† G.G.S. Khalsa College, Sarhali; Distict Tarantaran, INDIA

"classical" Be star. One of the most important characteristics of Be stars is the variability of Balmer emission lines on various time-scales. The variability of emission lines on time scales of decades, years and months has been well established in some Be stars[4] .But there are many opinions about the rapid variability of emission lines on time-scales of hours and minutes. However, Slettebak and Snow[5] have reported the presence of rapid variations in γ Cas. It has been realised that high time resolution observations of Be stars may provide important information about the reality of rapid variations. In the present communication we report the results of high time resolution spectral observations of γ Cas.

OBSERVATIONS

The star was observed during three nights 1982, September 8, 20 and November 2, by using the 104-cm reflector of Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital, India. The scanner was mounted at the Cassegranian focus (f/13) of the reflector. Continuous spectral scans of γ Cas were taken with the Hilger and Watts spectrum scanner in the wavelength range of 6100-6900 Å. High time resolution observations were secured. The scanner consists of a grating with 600 lines/mm giving dispersion of 70 Å/mm. The scanner was used in the first order with an exit slit of 25 Å pass band. An EMI 9658B photomultiplier cooled to -20^0C was used with the standard d.c. techniques for recording the signal on the Hewlett Packard (HP) strip chart recorder. Along with γ Cas, the standard star ξ^2 Cet was also observed covering the same wavelength range as γ Cas. The original high time resolution observational records of spectral scans are displayed in Fig.1 and 2.

RESULTS AND DISCUSSION

In Fig.1a we reproduced the original spectral scans of γ Cas covering Hα region. The total scanning time for these observations was ~13 minutes. The time resolution between the individual scan was ~1-3 minutes. It is seen that during these observations on 1982 September 8 the Be star γ Cas exhibited strong emission with broad double peak at Hα line. Both the V and R components of the emission peak are easily visible in these tracings. The strength of V-component of emission was greater than the R-component (i.e. V>R).In Fig.1b the total scanning time covering Hα scans was ~9 minutes and the time resolution between the individual scans was ~1-3 minutes. The Hα strength of γ Cas in this case was still reasonably strong during these observations on 1982 September 20, but the emission strength of Hα was much less than that during 1982 September 8. In these scans again the emission peak was broad and divided into two components (V and R). Again the V-component was stronger than the R-

component (i.e. V>R).In Fig.2 we have displayed the original tracings of Hα line recorded on 1982 November 2 for γ Cas and standard star ξ^2 Cet for comparison.

It is interesting to see that the Be star γ Cas exhibited almost a sharp single peaked strong emission at Hα line. Fig.2 shows a steep rise in the emission strength of Hα line beginning from the longer wavelength wing side of the line in almost all the scans. The total scanning time of γ Cas in Fig.2 was ~12 minutes. The time resolution between individual scans in Fig.2a was ~1-3 minutes. The time resolution in Fig.2b,c was further increased to ~22-40 seconds to search ultra-rapid variations. It is obvious from Fig.2a that Hα emission shows a strong single-peaked sharp line with almost the same emission strength, in all scans. But the scans displayed in Fig.2b,c obtained at increased time resolution, show gradual increase in the emission strength of Hα line. These tracings also show gradual development of the weak V-component on the left wing of the line. These tracings give some indications about the ultra-rapid variations of the emission strength and shape of the Hα line on time-scales of seconds to few minutes.

There are other evidences of rapid spectral changes of γ Cas in the form of line-asymmetry on the time scale of 0.7 days[6]. Another types of rapid spectral changes in the form of travelling sub-features repeating every ~0.8 days have also been reported[7-10].

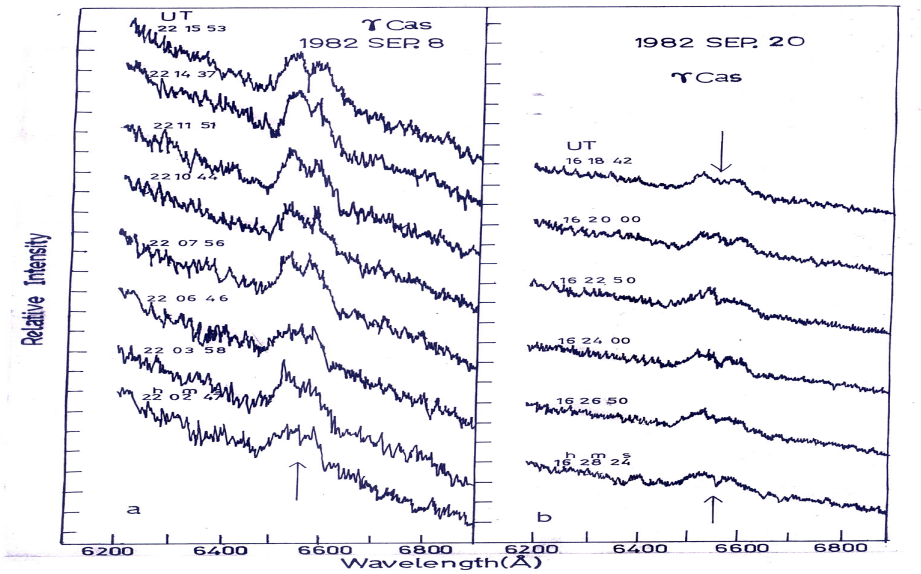

Fig.1 Original high time resolution spectral scans of γ Cas.

Conclusions

The present study indicates that the shape and emission strength of Hα line has shown large changes on time-scale of weeks. The inversion of asymmetry from

V>R (during September 8 and 20) to R>V (during November 2) has clearly taken place. In addition, during September 8 and 20 the Hα emission strength of γ Cas

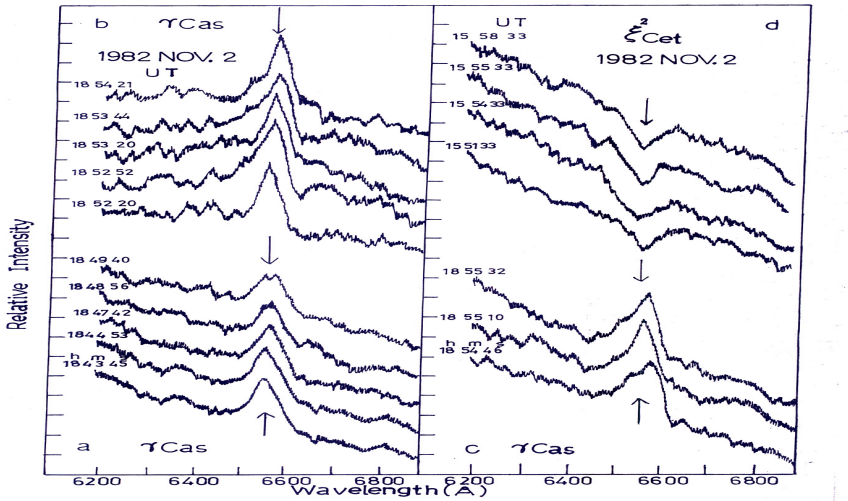

Fig.2 Original high time resolution spectral scans of γ Cas and ξ^2 Cet.

was double-peaked which transferred to single-peaked sharp emission during November 2. It is also important to note that during November 2, the Be star γ Cas exhibited ultra-rapid variations in Hα emission strength on time scales of seconds to few minutes.

ACKNOWLGEMENTS

This work has been done under the research project sanctioned by the Department of Science and Technology (DST), Delhi. The authors are thankful to DST, Delhi for providing financial assistance.

REFERENCES

1. A.Secchi, *Astron. Nachr.,* **68**, 63(1867).
2. V.Doazan,M.Franco,L.Rusconi, G.Sedmak and R.Stalio , *Astron. Astrophys.,* **128**, 171(1983).
3. J.H.Telting and L. Kaper, *Astron. Astrophys*., **284**, 515(1994).
4. A.Underhill and V. Doazan, 'Be Stars With and Without Emission Lines,' NASA SP-456(1982).
5. A.Slettebak and T.P.Snow, *Ap.J(Letters*)., **224**,L127(1978).
6 J.B.Hutchings, *Monthly Notices Roy. Astron. Soc*., **150**, 55(1970).
7. Z.Ninkov, S.Yang and G.A.H.Walker, *Hvar Obs. Bull.,* **7**, 167(1983).
8. S.Yang, Z. Ninkov and G.A.H.Walker, *Publ. Astron. Soc. Pacific.,* **100**, 233(1988).
9. T.Horaguchi, T.Kogure, R.Hirata, N.Kawai, M.Maysuoka and T.Murakami .,*Publ. Astron.Soc. Japan* ., **46,** 9(1994).
10. M.A. Smith, *Astrophys. J*., **442**, 812(1995).