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GAMMA LUPI DOES *NOT* APPEAR TO BE A Be STAR*

Ghosh *et al.* (1987) recently reported the discovery of the bright B2 IV star γ Lupi (= HR 5776 = HD 138690) as a new Be star. This bright (V = 2.8 mag) star has not previously been seen to display emission lines, and the detection of a non-emission line B star that suddenly becomes a Be star would be very important indeed as Ghosh *et al.* (1987) point out.

Even more important is, however, that such inferences are based on reliable observational facts (*cf., e.g.*, the similar case of HD 91948 as discussed by Bolton and Lyons 1984). My inspection of nearly 70 references kindly supplied by the Centre de Donnees Stellaires, Strasbourg, for γ Lup and the period 1950 to 1987 did not uncover any indication of circumstellar material in excess of what can be expected for non-emission line B stars. Jaschek *et al.* (1964) did not find the Hα emission looked for, nor did any other spectral classification work (*e.g.*, de Vaucouleurs 1957, Slettebak 1968, Hiltner *et al.* 1969) discover bright spectral lines. Oegerle and Polidan (1982) searched *Copernicus* scans for circumstellar OI λ 1304 Å without detecting it at the 5 mÅ level. Likewise, Snow *et al.* (1979) only detected the two very strongest of the numerous FeIII lines often seen in Be stars. Therefore, there was probably no significant amount of circumstellar matter along the line of sight. The intrinsic linear polarization as measured by Serkowski (1970) is consistent with there also being no circumstellar matter in a nonspherical configuration. Barker *et al.* (1985) measured a longitudinal magnetic field strength of 45 $\pm$ 74 Gauss, *i.e.* the star may as well have no magnetic field.

Ghosh *et al.* mention 320 km/s as the v sin i of γ Lupi. This appears to be the value given by Huang (1953). On the revised scale, Slettebak *et al.* (1975) derive only 210 km/s. Also, Slettebak's (1968) spectral classification is B2 IV, not B2 IVn, so that γ Lupi at least is not an extreme Bn star. The star is known to be a close visual binary consisting of two components of nearly equal brightness with an angular separation of

*Based on observations obtained at the European Southern Observatory, La Silla, Chile.

less than 1 arcsec and an orbital period of about 150 years (Heintz 1956). Van Albada and Sher (1968) measured radial velocity variations with a full range of about 80 km/s and suggest that one of the two visual components is a spectroscopic binary with a possible period of 2.8 $\pm$ 0.1 day. My re-analysis of their data and the more recent radial velocities by Levato *et al.* (1987) does not contradict this conclusion. However, van Albada and Sher's measurement of April 25.019, 1966 is rather discrepant. This problem is somewhat alleviated, but not completely removed, with a period near 0.739 day which is a 1 c/d alias and also roughly one-quarter of the period found by van Albada and Sher so that the radial velocity variations may also be non-orbital in origin. With this period, the radial velocity curve is very non-sinusoidal. A new series of multiple observations per night seems necessary for the conclusive resolution of this ambiguity. Independent of the result, it is almost certain already that γ Lupi does contain an intrinsically variable star as is suggested by the two HeI λ 6678 Å line profiles of Fig. 1 which were observed on two consecutive nights and display the typical signature of intermediate-order ($m \approx$ 8-10) nonradial pulsation. On the other hand, in a search for new β Cephei stars, γ Lupi was tested by Jakate (1979) for rapid variability, but no variations were detected at the 0.01 mag level.

Snow (1981) found a slight asymmetry in the UV resonance lines from which he deduced a mass loss rate of $9.65 \cdot 10^{-11}$ $M_{\odot}$/yr. He states that of the 22 stars in his sample only three are non-emission line stars (this statement was also carried over to Snow 1982), but γ Lupi is not among the three exceptions mentioned. Since no other evidence of the star being a Be star is given and Snow *et al.* (1979) explicitly say that emission lines are not known from this star, γ Lupi probably was just accidentally not included among the pure B stars in Snow (1981). All available evidence therefore suggests that γ Lupi in fact did not so far harbour a Be star.

The evidence that Ghosh *et al.* offer for γ Lupi recently having turned into a Be star is based on four photographic spectra with a reciprocal dispersion of 16 Å/mm (unfortunately the widening of the spectra is not given). The Hα tracings each show two or three faint (Ghosh *et al.* do not provide a flux scale but it can indirectly be deduced with the help of Fig. 2 discussed below) spikes which however vary in position and strength. None of these features exceeds the amplitude of the noise in the adjacent continuum as is to be expected if they, too, are just typical spikes in the noise. At this level the discrimination between Be and B stars clearly becomes doubtful, and ultimately the latter category may even vanish. The reality of these features is also for another reason doubtful since general experience (*e.g.*, Dachs *et al.* 1986) shows that the separation of the Hα emission peaks in Be stars is the larger the weaker the emission is (see Dachs *et al.* 1986 for the explanation in the framework of the standard equatorial disk model). By comparison, the features of Ghosh *et al.* appear too closely spaced.

Purely by coincidence I have obtained a single Hα spectrum of γ Lupi with the Coudé Echelle Spectrometer (CES) plus Reticon detector of the European Southern Observatory at La Silla on April 12, 1987, i.e. just 18-21 days after Ghosh *et al.* (1987). The characteristics of this spectrum and the reduction procedure applied to it are the same as described in Baade *et al.* (1988) except for possible low-amplitude large-scale distortions which have not been attempted to correct. The profile is reproduced in Fig.

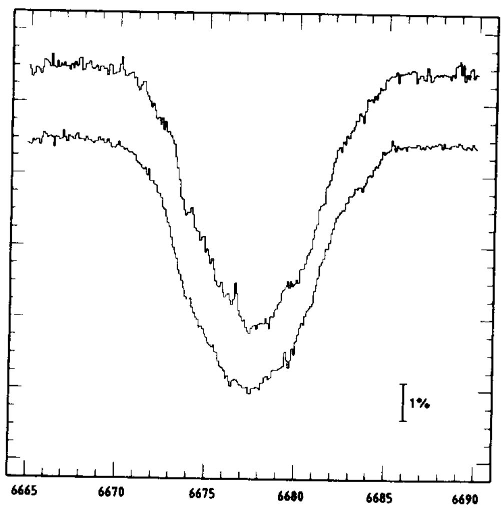

Figure 1: Two HeI λ 6678 Å profiles of γ Lupi obtained on January 22 (top) and 23 (bottom), 1985. Note the wiggles which are probably indicative of intermediate order ($m \approx$ 8-10) nonradial oscillations. The flux scale is provided by the vertical bar; the offset between the two spectra corresponds to 2% of the adjacent continuum flux.

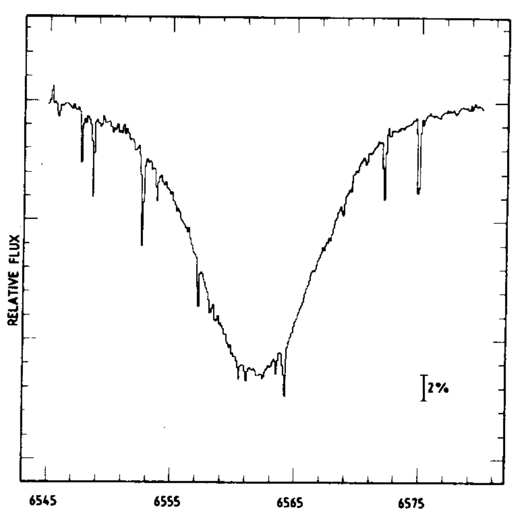

Figure 2: Hα profile of γ Lupi observed on April 14, 1987. The vertical bar gives the flux scale (in units of the adjacent continuum); it also indicates the order of magnitude of the fainter of the features reported by Ghosh *et al.* (1987). The numerous sharp absorption features are of telluric origin. The profile is not perfectly symmetric because low spatial frequency distortions due to flatfielding, *etc.* have not specifically been corrected for (*cf.* also Smith *et al.* 1987 and Baade *et al.* 1988). There is no indication whatever of an emission component.

2; at a S/N of better than 600 there is no trace of an emission component.

Observations by Baade *et al.* (1988) have shown that Be stars may undergo small outbursts which produce faint Hα line emission that fades on a timescale comparable to the time elapsed between the observations by Ghosh *et al.* and the one in Fig. 2. In so far the new data do not prove that γ Lupi has *never* been a Be star, especially not because the occurrence of emission may also depend on the phase of the short-term variability. But the assumption that γ Lupi is not a Be star still seems well justified.

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References:

Baade, D., Dachs, J., van de Weygaert, R., Steeman, F.: 1988, *Astron. Astrophys.*, in press (= *ESO Scient. Prepr.* No. 550)
Barker, P.K., Landstreet, J.D., Marlborough, J.M., Thompson, I.B.: 1985, *Astrophys. J.* **288**, 741
Bolton, C.T., Lyons, R.W.: 1984, *Inf. Bull. Var. Stars*, No. 2580
Dachs, J., Hanuschik, R., Kaiser, D., Rohe, D.: 1986, *Astron. Astrophys.* **159**, 276
de Vaucouleurs, A.: 1957, *Mon. Not. R. astron. Soc.* **117**, 449
Ghosh, K.K., Kuppuswamy, K., Jaykumar, K., Rosario, M.J., Velu, C.: 1987, *Inf. Bull. Var. Stars*, No. 3057
Heintz, W.D.: 1956, *Astron. Nachr.* **283**, 145
Hiltner, W.A., Garrison, R.F., Schild, R.E.: 1969, *Astrophys. J.* **157**, 313
Huang, S.-S..: 1953, *Astrophys. J.* **118**, 285
Jakate, S.M.: 1979, *Astronom. J.*, 84, 552
Jaschek, C., Jaschek, M., Kucewicz, B.: 1964, *Zeitschr. Astrophys.* **59**, 108
Levato, H., Malaroda, S., Morrell, N., Solivella, G.: 1987, *Astrophys. J. Suppl. Ser.* **64**, 487
Oegerle, W.R., Polidan, R.S.: 1982, *Publ. Astron. Soc. Pacific*, **94**, 997
Serkowski, K.: 1970, *Astrophys. J.* **160**, 1083
Slettebak, A.: 1968, *Astrophys. J.* **151**, 1043
Slettebak, A., Collins, G.W., Boyce, P.B., White, N.M., Parkinson, T.D.: 1975, *Astrophys. J. Suppl. Ser.* **29**, 137
Smith, M.A., Graves, J.E., Jaksha, D.B., Plymate, C.L., Ramsey, L.W.: 1987, *Publ. Astr. Soc. Pacific* **99**, 654
Snow, T.P.: 1981, *Astrophys. J.* **251**, 139
Snow, T.P.: 1982, *Astrophys. J. (Letters)* **253**, L39
Snow, T.P., Peters, G.J., Mathieu, R.D.: 1979, *Astrophys. J. Suppl. Ser.* **38**, 227
van Albada, T.S., Sher, D.: 1968, *Bull. Astron. Inst. Netherlands* **20**, 204