Bull. Astr. Soc. India (1999) **27**, 123-127

HR 3040 — on the Am track?

S. Sreedhar Rao, C. Raghavender Rao and G. C. Kilambi

Centre of Advanced Study in Astronomy, Osmania University, Hyderabad 500007, India

Abstract. HR 3040 (HD 63589) exhibits pseudo-luminosity effects similar to many a main-sequence Am star, especially a strong Sr II 4077 line indicating a higher luminosity class. Its K-line matches that of A3 V, violet and blue metallic line spectrum resembles F2 III-IV, whereas its Sr II 4077 is as strong as that in an F5 III standard. With respect to its observed spectral characteristics and estimated orbital parameters, the position of HR 3040 vis-à-vis similar Am systems on the HR diagram is discussed.

Keywords : MK Morphology, Pseudo-luminosity effects, HR 3040, radial velocities, HR diagram.

1. Introduction

HR 3040 (HD 63589), an A2 Vm star, was assigned A2, 3 type for its K-line, A7 for its Balmer lines and F0 for its metals by Curchod and Hauck (1979). It is a slow rotator with v sini=40 km/s (Palmer et al. 1968) while quite recently Abt and Morrell (1995) assigned 31 km/s for the same. Its photometric indices are V=6.03, B-V=+0.15, U-B=+0.13, V-R=+0.15 and R-I=+0.02 (Mendoza et al. 1978). This star was observed during 1983-88, in our Am star programme to detect any change in its radial velocity, since the majority of Am stars are slow rotators (<100 km/s) and yield orbits, being the members of the spectroscopic binaries (Abt, 1961, 1965).

2. Spectroscopic observations

The observations were made with the Meinel Spectrograph, at the Nasmyth focus of the 1.2m telescope of the Japal-Rangapur Observatory, at a linear reciprocal dispersion of 33 A/mm. A detailed description of this system is given by Raghavender Rao and Abhyankar (1991). The spectral resolution at this dispersion is 0.66 A or 50 km/s. 15 spectra were measured for radial velocities. It was also observed at classification dispersion of 66 A/mm for "MK Morphological Study" together with some MK standards. Kodak IIa-O emulsion was used throughout and the spectra were digitised on the Zeiss Microdensitometer at the Department of Astronomy, Osmania University.

3. MK morphology and the pseudo-luminosity effects

The Am stars are defined by their unique spectral characteristics, viz., Sp (K) <= Sp (H) <= Sp (ml) (Roman, Morgan, Eggen 1948). MK Morphological studies of Am stars revealed a pseudo-luminosity effect exhibited by this class in their spectra, viz., a brighter luminosity class in the violet region than the region around G-band. The methodology of deriving the spectral types for different regions of the spectra of the Am stars is described by Sreedhar Rao and Abhyankar (1991). Also, Sr II 4077 line exhibits a higher luminosity class and almost matches with that in Ap (Cr-Eu-Sr) stars in some extreme cases. This may indicate a probable spectral line variation.

Figure 1 shows the digital spectrum of HR 3040 in the region λλ 3850-4400 A (thick line) matched with the MK standard star spectra (thin line) in different regions. The MK morphology of this spectrum indicates a weak CA II K-line (λ3933 A) corresponding to the spectral type

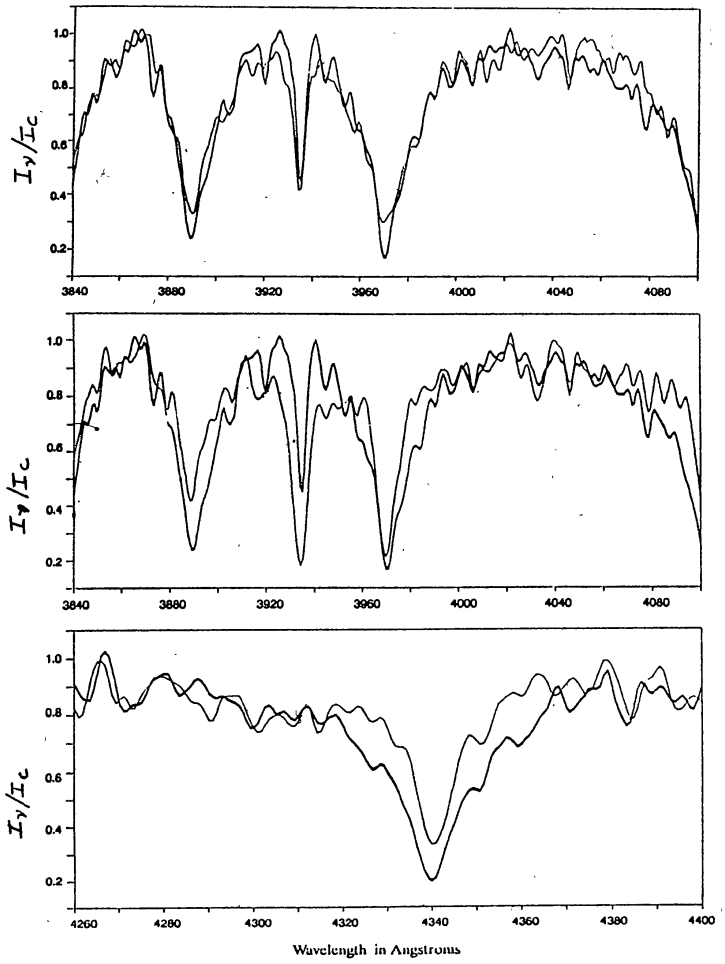

Figure 1. K-line (top), m39 (middle) and m43 (bottom) regions ofthe spectrum of HR 3040 (HD 63549) matched with MK Spectral standards (see text). Thick line is HR 3040.

A3 V (top) and the metals in its violet (middle) (λλ3840-4100 A) and the blue region (bottom) (λλ4260-4400 A) closely resembles that of F2 III - IV spectrum. The Sr II 4077 line, however, closely matches with F5 III, a higher luminosity class than its violet region indicates.

The strength of Sr II 4077 in HR 3040 encourages a similar study of its spectra obtained over a period of time which might reveal spectral line variation, if any, as in the case of 41 Sex A, a prototype of a *transitional object* between the Ap and the Am classes (Sreedhar Rao, Abhyankar, Nagar 1990).

4. Radial velocities and the orbit

Palmer et al. (1968) gave 11 radial velocity measurements which vary from +26 to –28 km/s, and our 15 spectra measured for radial velocity show a variation in the range –10 to –53 km/s which indicates that it would yield period and hence an orbit. However, our observations are also scattered like those of Palmer et al.

The period finding analysis is in progress and a preliminary period of 41 days is also well within the range of the orbital period 2.5 to 100 days for the binaries with main sequence primaries exhibiting peculiar metallic line spectra (Abt, Beidelman 1969). A detailed paper will be submitted elsewhere.

5. Colours and position in the HR Diagram

The colours of Am stars are in the range B-V = +0.15 and +0.30. For HR 3040, it is +0.15 and U-B = +0.13 (Osawa 1958 & 1959; Mendoza et al. 1978).

Beidelman (1956) and Osawa (1958) have first studied the problem of Am stars in the colour- colour diagram. These stars fall below the line for normal dwarfs although their colours correspond to those for normal stars of spectral types in the range A5-F0, indicating an UV deficiency of about 0.7 mag. The position of Am stars, with respect to their absolute visual magnitudes in the colour-magnitude diagram was reviewed by Jaschek and Jaschek (1957). According to them the Am stars seem to cluster around a restricted regions, 0.5 mag above the observed main sequence to the red side of late A type main sequence stars (see Fig. 5.7 Abhyankar 1992). As members of clusters, their ages are in the range 2-10 × 10^8 years and they are not extremely young objects since they are not found in binarity with B type stars.

We have chosen a random sample of Am stars for which the log T_e and M_v have been taken from the literature. Figure 2 shows the plot of these on the HR diagram which are clustered around the region between 4 and 3.8 log T_e.

- From the diagram it is apparent that the cooler Am stars (> A5 Vm) are systematically falling above the main sequence (dashed line) than the hotter ones.
- Majority of the Am spectroscopic binaries with orbits and those with variable radial velocities are concentrated below the main sequence. HR 3040 falls close to this region. It is already a known variable radial velocity object and it might therefore show duplicity.

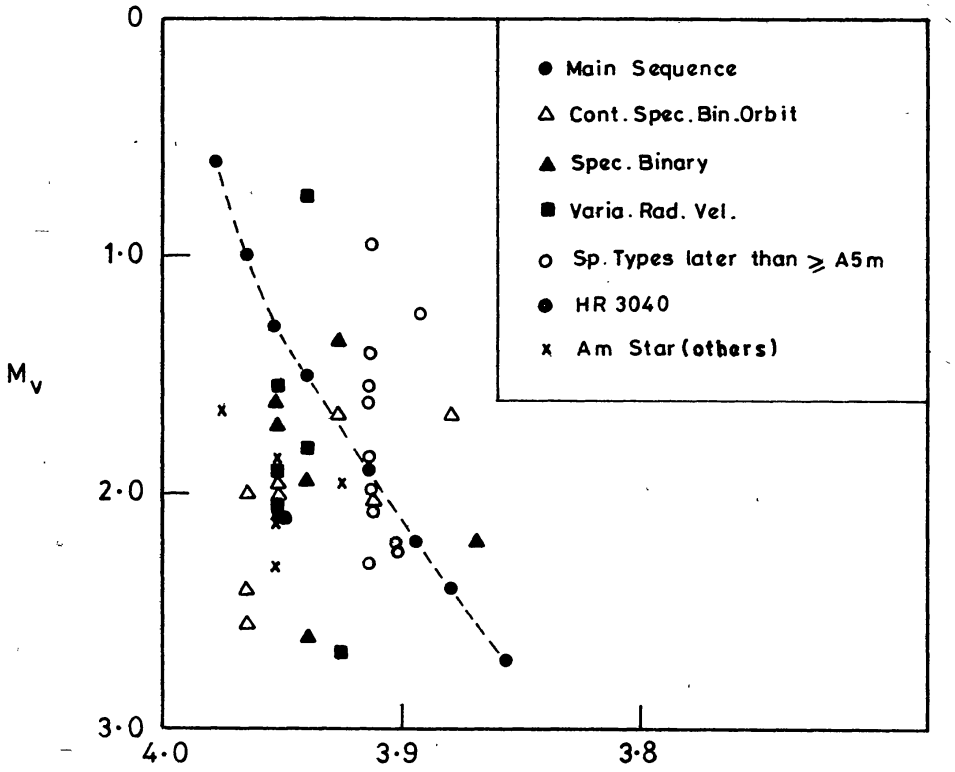

Figure 2. Plot of a sample of Am stars on the H-R Diagram (see text)

Abnormal metallicities associated with these stars resulting in excessive line blanketing may be the explanation for their unusual positions in the HR diagram.

When their continuous energy distributions are corrected for the presence of metallic lines, they seem to fall among the normal dwarfs of the same hydrogen-line type (Van t'Veer-Menneret 1963). Also, in any two Am stars with the same (B-V), the one with greater metallicity is the brighter (Sargent 1964). This further supports the contention that Am stars are normal population I A type dwarfs in which some mechanism like diffusion, which is not completely understood, gears up the metallic line intensity, thus causing excessive line-blanketing and weak Ca II K line.

Our sample shows that there is no clear cut Am Track on the HR diagram. However, this aspect requires further study with a larger sample, corrected for line-blanketing to understand their evolutionary nature.

SSR gratefully acknowledges the travel from ASI and SAP, CASA, O.U., and thank the organisers for excellent local hospitality.

References

Abhyankar K. D., 1992, Astrophysics, Stars and Galaxies, p. 75, Tata McGraw Hill, New Delhi, India.

Abt H. A., 1961, ApJ, Suppl. 6, 37.

Abt H. A., 1965, ibid 11, 429.

Abt H. A., Morrell N. I., 1995, ApJ, Suppl. 99, 135 A.

Abt H. A., 1969, ApJ, 158, 1091.

Bidelman W.. P., 1956, PASP, 68, 318.

Curchod A., Hauck B., 1979, A&A Suppl. 38, 449.

Jaschek M., Jaschek C., 1959, Z. Astr. 47, 29.

Jaschek M., Jaschek C., 1957, AJ, 62, 343.

Mendoza E. E. V., Gomez T., Gonzalez S., 1978, AJ, 83, 606.

Osawa K., 1959, ApJ, 130, 1590.

Osawa K., 1958, PASJ, 10, 102.

Palmer D. R., Walker E. N., Jones D. H. P., Wallis R. E., 1968, RGOB, 138.

Raghavender Rao C., Abhyankar K. D., 1991, Contr. Niz. & J-R Obs, No. 26.

Roman G., Morgan W. W., Eggen O. J., 1948, ApJ, 107, 107.

Sargent L. W., 1964 ARA&A, 2, p. 297.

Sreedhar Rao S. Abhyankar K. D., Praveen Nagar, 1990, ApJ, 365; 336.

Sreedhar Rao S., Abhyankar K. D., 1991, J.A.A., 12, 133.

Van t' Veer-Menneret C., 1963, ARA&A, 2, p. 289.