COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS
Number 4124

Konkoly Observatory
Budapest
13 December 1994

HU ISSN 0374 – 0676

GENEVA PHOTOMETRY OF THE ECLIPSING BINARY TV Nor

The eclipsing binary HD 143654 = TV Nor has been brought to the attention of spectroscopists by Renson (1990) because it has been classified Ap EuCrSr by Houk (1978). Indeed, there is as yet no clear-cut case of an Ap star of the Si or SrCrEu type belonging to an eclipsing system. This is probably because of the lack of short period binaries among this kind of peculiar stars (see e.g. Gerbaldi et al. 1985). However, such a system would be most interesting, because it is known that the abundance anomalies are not evenly distributed on the surface of the star, but are concentrated into patches following the large-scale magnetic structure. Many Ap stars are therefore spectrum variables simply because their rotation brings these patches into view and away from it; the art of "Doppler imaging" exploits the resulting line variations to map the abundance anomalies on the surface of the star. Such maps, however, present ambiguities, especially regarding the latitudes of the patches. Observing an Ap star undergoing an eclipse by a normal, constant companion would help to remove the ambiguities, and even to build an independant map of the eclipsed hemisphere for the corresponding rotational phase (Piskunov & Rice, 1993; Vincent et al., 1993).

In the hope that HD 143654 could be such a rare system, we monitored it with Geneva photometry in order to obtain a good quality lightcurve. All measurements have been made from the European Southern Observatory, La Silla, Chile, with the double-beam "P7" photometer attached to the 0.7m Swiss telescope. The first three, routine measurements were made as early as 1982, 1983 and 1984 respectively, and 5 additional measurements were made in April 1989 by the late Dr. Zdenek Kviz. Systematic monitoring began essentially in June 1990, stimulated by Renson's IBVS note, and continued each following season until July 1994.

We expected that this well-detached system would present periodic variations outside the eclipses, due to the intrinsic variations of the Ap component. The result is, however, disappointing from this point of view, as shown in Figure 1 which displays the [U-B], [B-V] and V curves. Outside the eclipses, the r.m.s. standard deviations are respectively 0.0090, 0.0049 and 0.0047, which can be entirely attributed to measurement uncertainties. Thus, neither the primary nor the secondary is photometrically variable in a significant way, making any spectral variation rather improbable.

It is interesting to notice that the minima have different depths in V and vary in opposite ways in [B-V], while [U-B] remains constant. This means that the components have significantly different effective temperatures and spectral types. The primary is probably an early or mid- A dwarf while the secondary may be an A8 or F0 giant. This fact is probably significant regarding the Ap classification: the spectrum appears composite, and was very likely misinterpreted as that of a single Ap EuCrSr star.

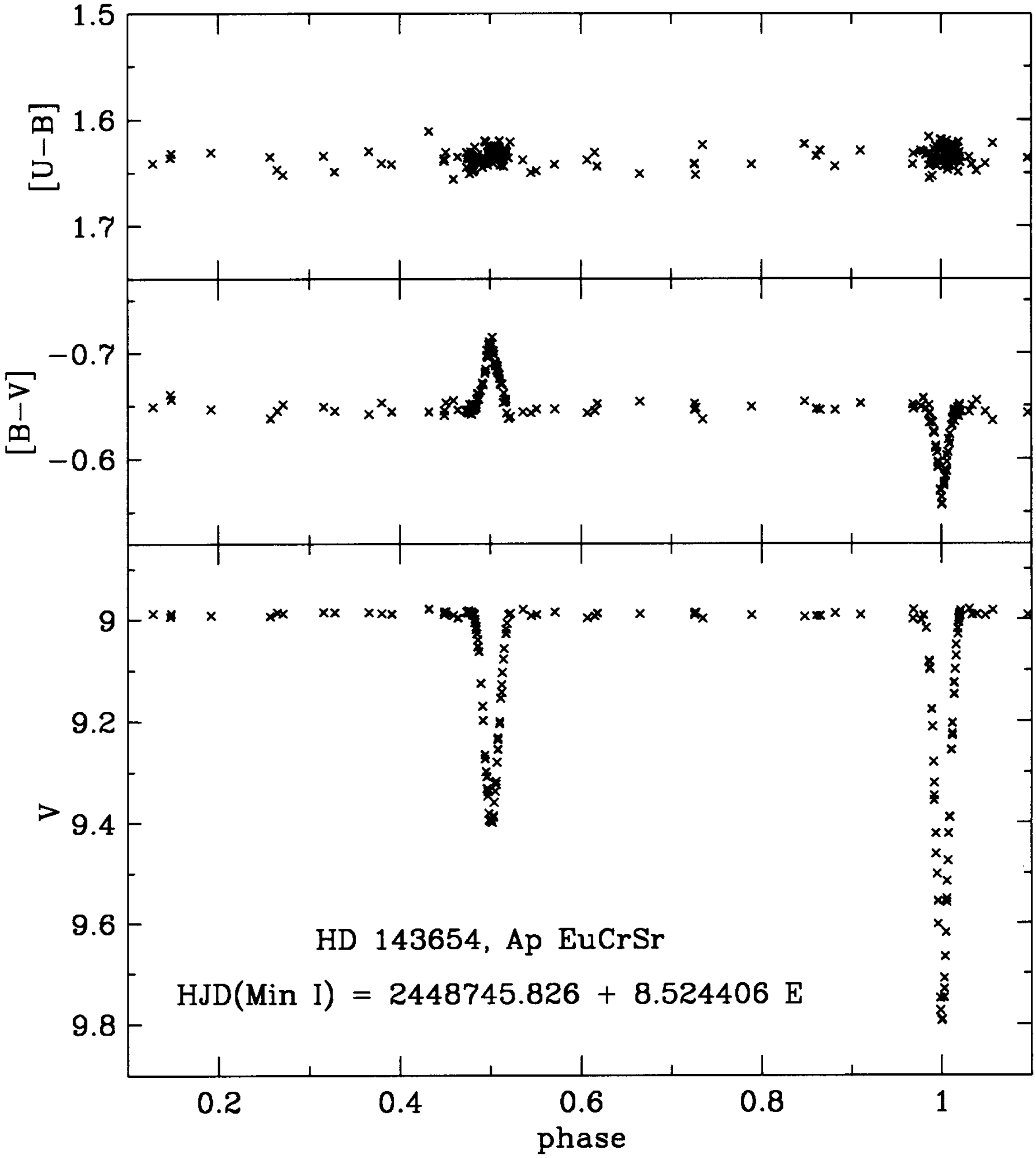

Figure 1. Geneva [U-B], [B-V] and V lightcurves of the eclipsing binary TV Nor, folded according to the period of Hertzsprung (1937). Notice the lack of variability between the eclipses.

This is confirmed by the behaviour of the peculiarity parameter $\Delta(V1-G)$ as a function of phase: while this parameter is generally positive for Ap stars (see e.g. Hauck & North 1982), it remains here at the constant value

$$\Delta(V1-G) = -0.006$$

with an r.m.s. residual scatter of only 0.0055 magnitudes. There is no significant variation at all during the eclipses. Therefore, the $\Delta(V1-G)$ value of not only the whole system, but also of each component of TV Nor is quite typical of normal stars.

Furthermore, one of us (PN) has taken a spectrum of this system with the 1.4m CAT telescope of the European Southern Observatory, equipped with the CES spectrograph, the Long Camera and the FA 2048 CCD detector (ESO CCD # 30). The resolving power was R = 60000. The spectrum was taken in the H_α region on the night of May 16-17, 1994 at HJD = 2449489.607, i.e. at phase $\phi = 0.2531$ according to the ephemeris given in Figure 1. This is practically at a quadrature and allows us to estimate the total mass of the system from the relative velocity at that phase and from the Kepler's third law. Fitting a gaussian to the core of the H_α line of each component, we obtain $\lambda_p = 6560.984$Å and $\lambda_s = 6564.447$Å, implying a relative velocity $\Delta V_r = 158.2$ km s^{-1}. If the orbit is circular, which is very probably the case since the eclipses have the same duration and are separated by exactly half a period, and if the inclination i of the orbital plane is close to 90° as the very existence of deep eclipses suggests, then we obtain for the semi-major axis

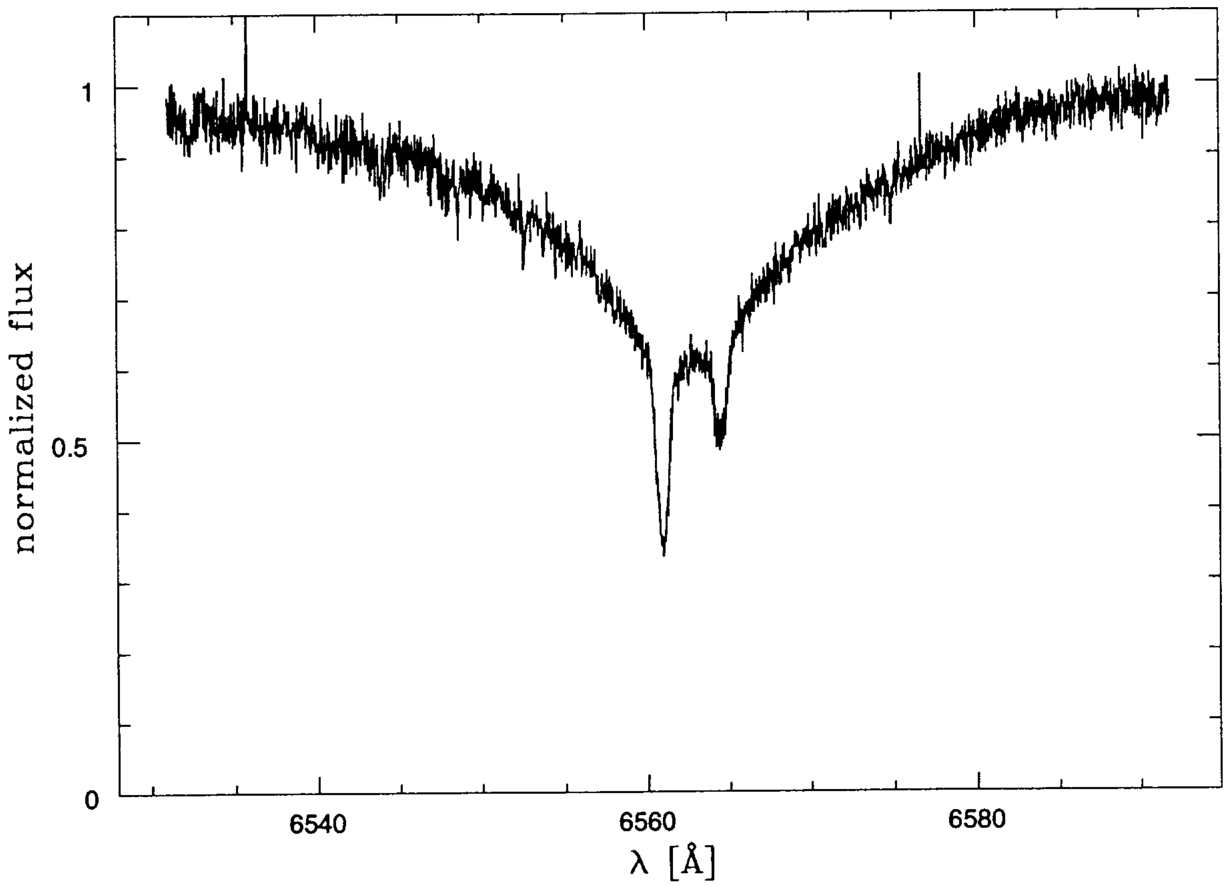

Figure 2. High-resolution spectrum of TV Nor taken at orbital phase 0.253, i.e. at quadrature, and showing the star as a double-lined system.

$$a = 0.124 \text{ AU}$$

and for the total mass

$$M_p + M_s = 3.50 M_\odot$$

which is quite consistent with the spectral types and luminosity classes proposed above for the two components.

This binary may well be spectroscopically normal, which would designate it as a very good candidate for precise mass and radius determination.

Acknowledgements: This work was supported in part by the Fonds National de la Recherche Scientifique. Drs. Z. Kviz, P. Lampens and Mrs. C. Nitschelm and F. Barblan contributed to the photometric observations, which were reduced by Mr. C. Richard.

P. NORTH
Institut d'Astronomie de l'Université
de Lausanne
CH-1290 Chavannes-des-Bois,
Switzerland

M. BURNET
Observatoire de Genève
CH-1290 Sauverny, Switzerland

References:

Gerbaldi, M., Floquet, M., Hauck, B., 1985, *A&A* **146**, 341

Hauck, B., North, P., 1982, *A&A* **114**, 23

Hertzsprung, E., 1937, *Bull. Astr. Netherlands* **8**, 168

Houk, N., 1978, *Michigan Catalogue of two-dimensional spectral Types for the HD Stars*, Vol. 2

Piskunov, N.E., Rice, J.B., 1993, *PASP* **105**, 1415

Renson, P., 1990, *IBVS*, No. 3452

Vincent, A., Piskunov, N.E., Tuominen, I., 1993, *A&A* **278**, 523