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# THE EUV SOURCE HD 52452: DISCOVERY OF A LIKELY TRIPLE SYSTEM

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HD 52452 (BD +26°1435 = SAO 78998, $V = 7.96$) has been identified by Mason et al. (1995) as the optical counterpart of the EUV bright source RE J70222+255054 detected in the Wide Field Camera all-sky survey by ROSAT (Pounds et al. 1993). It is reported in the Tycho Catalogue (TYC 1899 688 1) as a suspected variable with a parallax of $17.0 \pm 6.4$ mas (Perryman et al. 1997) and it is classified as a G5 star in the SIMBAD database. HD 52452 has been included since late 1994 in a program of spectroscopic and photometric observations aimed at the classification of EUV stellar sources detected by EXOSAT and ROSAT (Cutispoto et al. 1999, 2000). In this paper we report on the discovery of the optical variability of HD 52452 and on its inferred spectral classification.

The $UBV$ photoelectric photometry presented here were collected from 16 November 1994 to 23 February 1995 by the 80-cm Automated Photometric Telescope (APT-80) at the *M. G. Fracastoro* station of Catania Astrophysical Observatory on Mt. Etna (1725 m *a.s.l.*). The APT-80 feeds a single channel charge-integration photometer equipped with an uncooled Hamamatzu R1414 SbCs photomultiplier and Johnson's standard $UBV$ filters. The differential photometry of HD 52452 (**v**) was made using HD 52071 (K2III; $V = 7.12$; $B - V = 1.26$, $U - B = 1.27$) as comparison star (**c**), and HD 51530 (F7V; $V = 6.21$; $B - V = 0.51$, $U - B = -0.01$) and HD 50692 (G0V; $V = 5.77$; $B - V = 0.60$, $U - B = 0.05$) as check stars ($\mathbf{ck}_1$ and $\mathbf{ck}_2$, respectively). Ten seconds integrations in the $U$, $B$ and $V$ filters and an observing sequence $\mathbf{ck}_2$–**c**–$\mathbf{ck}_1$–**c**–**v**–**v**–**v**–**c**–**v**–**v**–**v**–**c** were adopted. After sky background subtraction, the measurements were corrected for atmospheric extinction. Normal points were computed by averaging each sequence of six $\mathbf{v} - \mathbf{c}$ differential values and transformed into the $UBV$ Johnson standard system (Table 1). The typical standard deviations of the normal points are of the order of $0\overset{\mathrm{m}}{.}01$ in $V$ and $B$ filters and $0\overset{\mathrm{m}}{.}015$ in the $U$ filter. No significant light variations were detected from the differential measurements of the comparison and check stars. During the whole observing period these stars were constant within about $\pm 0\overset{\mathrm{m}}{.}015$ in the $V$-band.

From the present data HD 52452 resulted to be variable with a peak-to-peak amplitude of $\Delta V \simeq 0\overset{\mathrm{m}}{.}16$. The set of photometric data was analysed using a Scargle–Press period search routine (Scargle 1982, Horne & Baliunas 1986) and a photometric period $P = 0.42304 \pm 0.00015$ day, with a *false-alarm-probability* FAP = 8.1%, was found. Fig. 1 shows the $V$-band, $B - V$, and $U - B$ light curves for the mean epochs 1994.92 (open

Table 1: Heliocentric Julian day, rotational phase, $V$ magnitude, $B-V$ and $U-B$ colours of HD52452. Phases are reckoned from the photometric ephemeris HJD = $2449672.0 + 0^{\rm d}.42304 \times E$

| HJD | Phase | $V$ | $B-V$ | $U-B$ |
|---|---|---|---|---|
| 2449672.6213 | 0.468 | 8.005 | 0.691 | 0.221 |
| 2449682.6683 | 0.215 | 7.959 | 0.706 | 0.206 |
| 2449683.6579 | 0.554 | 7.986 | 0.720 | 0.221 |
| 2449699.6492 | 0.351 | 8.001 | 0.702 | 0.218 |
| 2449700.6261 | 0.660 | 8.042 | 0.702 | 0.227 |
| 2449701.4792 | 0.676 | 8.040 | 0.690 | 0.218 |
| 2449703.5877 | 0.660 | 8.032 | 0.698 | 0.234 |
| 2449752.5680 | 0.428 | 7.986 | 0.724 | 0.228 |
| 2449754.4465 | 0.868 | 8.125 | 0.718 | 0.213 |
| 2449756.4505 | 0.604 | 8.008 | 0.699 | 0.221 |
| 2449757.4588 | 0.987 | 8.070 | 0.723 | 0.238 |
| 2449761.4301 | 0.374 | 7.996 | 0.697 | 0.196 |
| 2449766.4177 | 0.162 | 7.957 | 0.705 | 0.223 |
| 2449768.4409 | 0.944 | 8.116 | 0.714 | 0.229 |
| 2449771.4734 | 0.112 | 7.972 | 0.690 | 0.214 |
| 2449772.4665 | 0.459 | 7.975 | 0.699 | 0.200 |

triangles) and 1995.12 (filled circles). Phases are reckoned using the ephemeris HJD = $2449672.0 + 0^{\rm d}.42304 \times E$. The $V$-band light curve is double peaked and shows no evidence of eclipses. Both $B-V$ and $U-B$ colours are constant within the photometric precision.

HD 52452 was observed spectroscopically with the McMath telescope (Kitt Peak, AZ) in October 12, 14 and 17, 1994. The 12 and 14 October high resolution spectra were collected in the Li I 6708 Å region (Fig. 2). These spectra show the existence of two components: a rather fast ($v \sin i = 14 \pm 2$ km s$^{-1}$) and a very fast rotating star ($v \sin i \geq 60$ km s$^{-1}$). The Li I line was not detectable (EW $< 4$ mÅ). The 17 October spectrum was collected in the H$\alpha$ region (Fig. 3): only the very fast rotating component is visible and the H$\alpha$ is partially filled-in. The procedures of spectroscopic observation, reduction and analysis are given in Cutispoto et al. (1999, 2000).

The lack of Li, implying that the star is not young, and the very high rotation of one of the two visible components strongly suggest that the very fast rotating star is an SB1 close binary system, whose high rotation rate is attributable to tidal coupling. Assuming for this SB1 component an inclination of the orbital plane $i < 50$ degrees (which is an upper limit for the SB1 to be non eclipsing), and by using the method described by Cutispoto et al. (1999, 2000), we infer that HD 52452 is a triple system consisting of a G4V + late-G very fast rotating SB1 and a G5:V slower rotating companion. This spectral classification ($M_V \simeq 3.8$, $D \simeq 68$ pc) is in fairly good agreement with the absolute magnitude of HD 52452 derived from the distance listed in the Tycho catalogue ($D = 59^{+35}_{-16}$ pc).

In order to compute the X-ray luminosity of HD 52452 we converted into flux the Count Rate (CR) and Hardness Ratio (HR) values from RASS–BSC (Rosat All Sky Survey–Bright Source Catalogue) using as conversion factor ECF = $(8.31 + 5.30\mathrm{HR}) \times 10^{-12}$ erg cm$^{-2}$ given by Fleming et al. (1995). By adopting a distance of 68 pc, the X-ray luminosity, in the 0.2–2.5 keV energy band, turns out to be $L_{\rm X} = 5.0 \times 10^{30}$ erg sec$^{-1}$.

On the basis of the currently available data, we are confident that HD 52452 is a triple system consisting of a tidally coupled G4V + late-G SB1, which rotates with a period

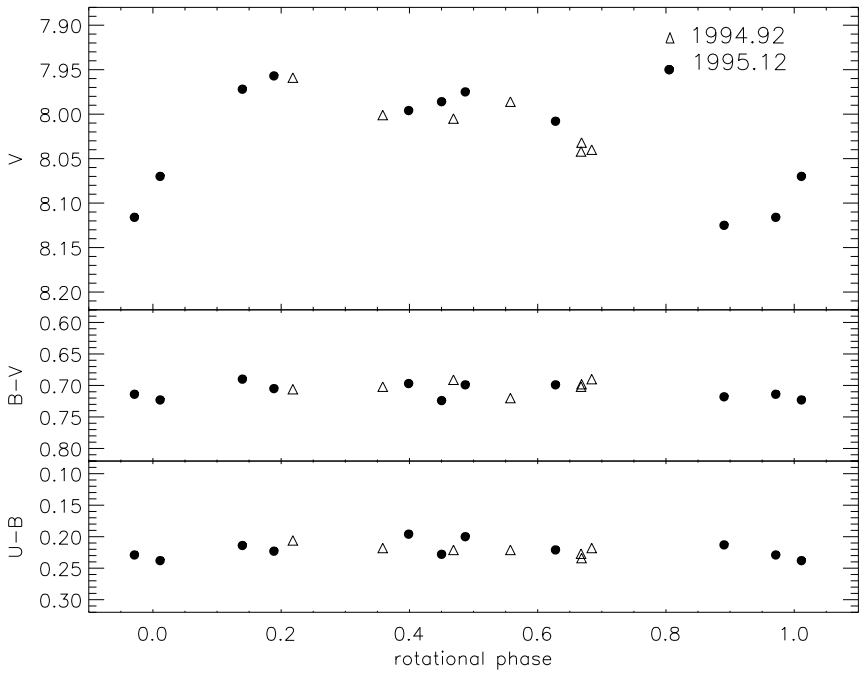


**Figure 1.** The $V$-band, $B-V$, and $U-B$ light curves for the mean epochs 1994.92 (open triangles) and 1995.12 (filled circles). Phases are reckoned using the ephemeris HJD $= 2449672.0 + 0^{\rm d}.42304 \times E$

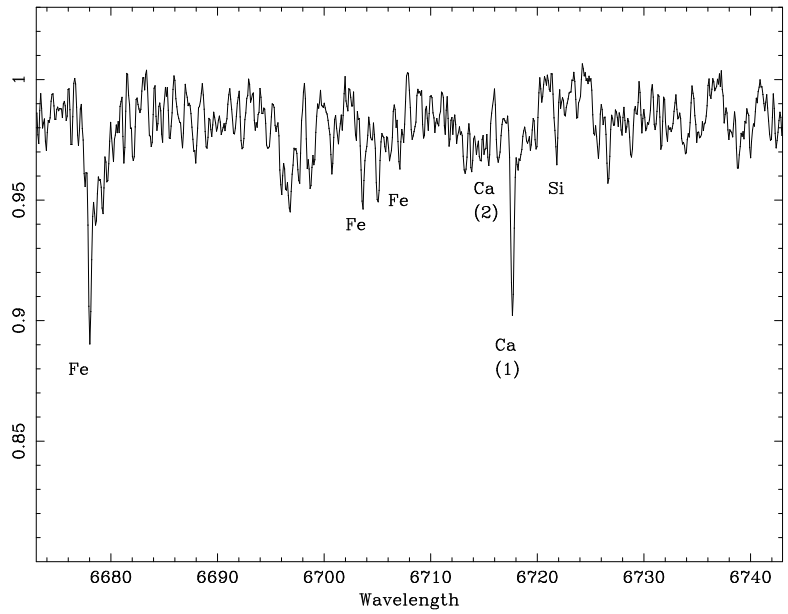


**Figure 2.** The October 12, 1994 spectrum of HD 52452 in the Li 6708 Å region. The rather fast ($v \sin i = 14 \pm 2$ km s$^{-1}$) and a very fast rotating star's components ($v \sin i \geq 60$ km s$^{-1}$) are visible

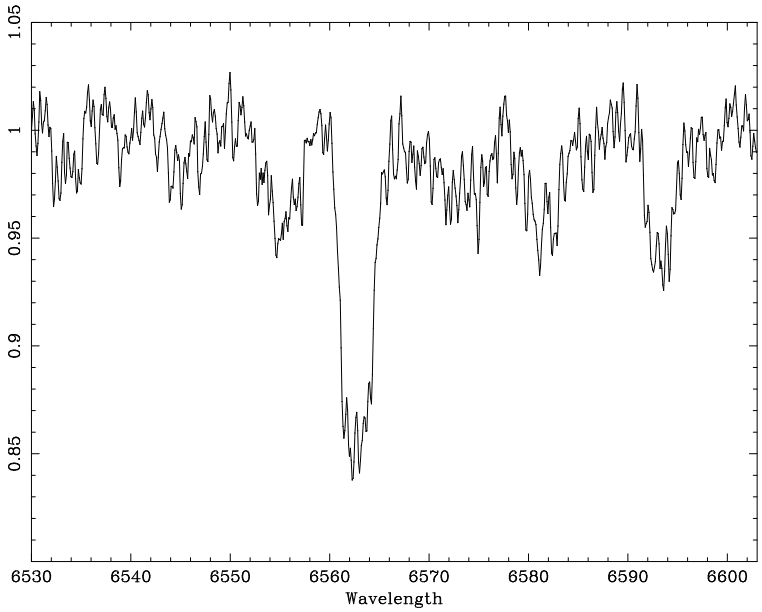


**Figure 3.** The October 17, 1994 spectrum of HD 52452 in the H$\alpha$ region. Only the very fast component is visible and the H$\alpha$ line is partially filled-in

of $P \simeq 0\overset{\mathrm{d}}{.}423$ and it is responsible for most of the observed optical variability, and a G5:V companion. The observed photometric variability is likely to be attributable to the presence of cool spots on the photospheres of both components of the SB1 system. However, a non negligible contribution to the observed optical variability, though not revealed by our periodogram analysis, may come from the G5V star, whose rotation, according to the above mentioned *vsini*, spectral classification and inclination of the orbital plane, is expected to be quite fast ($P \sim 2\overset{\mathrm{d}}{.}5$).

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