LETTER

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Letter to the Editor

HD 30187 B and HD 39927 B: two suspected nearby hot subdwarfs in resolved binaries⋆

Valeri V. Makarov and Claus Fabricius

Copenhagen University Observatory, Juliane Maries Vej 30, DK-2100 Copenhagen Ø, Denmark

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Abstract. In doing a B_T, V_T photometric solution for close Hipparcos double stars, based on the observations with the Tycho instrument of the Hipparcos satellite, we discovered two very blue subluminous components of HD 30187 and HD 39927. The position of the components on an observational HR diagram implies their being sdO or sdB hot subdwarfs. The only previously known sdO component of a visual binary, HD 113001 B, is also confirmed by our photometric data. The two new candidate hot subdwarfs have parallaxes 8.25 and 10.17 mas, respectively, and with angular separations of about 0.35 arcsec, the orbital periods must be of the order of 100 years. This should make it possible to determine their masses from observation.

Key words: stars: individual: HD 30187 B – stars: individual: HD 39927 B – stars: white dwarfs – stars: binaries: visual

A massive re-processing of all Tycho observations, obtained with the Hipparcos satellite over 1989–1993, was undertaken recently in order to increase the number of astrometric and photometric reference stars (Høg 1998). As a major stage of this work, a data base of raw Tycho observations, i.e. photon counts, was established for the 2.5 million brightest stars. The Tycho instrument, in contrast to the Hipparcos main instrument, observed in two different passbands B_T and V_T, somewhat similar to the Johnson B and V (ESA, 1997). One of the possible applications of the data base was a two-colour photometric solution for close Hipparcos double stars with separations 0.1 to 2.5 arcsec, which generally only have one-colour photometry in the Hipparcos Catalogue. More than $5\,000$ double and triple systems were resolved photometrically. The method employed and the results will be given elsewhere (Fabricius & Makarov 1999).

The quality of the B_T and V_T magnitudes is characterized by their formal standard errors, being mostly in the range 0.01 to 0.1 mag depending on the brightness, and systematic errors depending on separation. The latter were estimated from a comparison of the V_T magnitudes with the Hipparcos H_p magnitudes and found to be within 0.15 mag for separations above 0.3 arcsec.

As many of these Hipparcos stars have statistically reliable trigonometric parallaxes in the Hipparcos Catalogue, an observational HR diagram, that is M_{V_T} against $(B_T - V_T)$ can be built up, where M_{V_T} is the absolute V_T magnitude. Such a diagram for some 2600 components of double and triple stars with separations 0.32 to 2.0 arcsec and π/σ_π greater than 5.0 is given in Fig. 1, left panel. The parallaxes π and their standard errors σ_π were taken from the Hipparcos Catalogue, Double and Multiple Systems Annex. The star HD 113001, marked with 3 in the right plot of Fig. 1 is also given, although π/σ_π is only 1.1. The Hipparcos parallax $\pi = 4.05$ mas for it appears to be accurate enough despite the unusually big formal error, as follows from its position in the HR diagram and from a new astrometric analysis of the Hipparcos observations.

While most of the photometrically resolved components belong to the main sequence and red giant branch, there is a conspicuous small group of four very blue subluminous stars. They are situated in the domain of hot subdwarfs, more specifically sdO to white dwarf DO stars. The hot subdwarfs are the immediate progenitors of the white dwarfs, and show a variety of properties, depending e.g. on the helium abundance (Saffer & Liebert 1994). The hot subdwarfs are numbered 1 to 4 in the right part of Fig. 1, and their primary components are shown with respect to a 'standard' HR diagram constructed from Hipparcos single stars. Two of them (1 and 2) are new candidate sdO stars, and the other two a known sdO star (3) and a DO white dwarf (4). Some astrometric and photometric data for the new sdO stars from Hipparcos and Tycho are given in Table 1.

The four systems under discussion are:

1. HD 39927 B. A new candidate hot subdwarf. It is in all probability identical to the far-ultraviolet source observed by Schmidt & Carruthers (1993) listed as number 489. The measured instrumental magnitude at the effective wavelength 1519 Å was $m_{1519} = 7.16$ mag. The main component of the binary is classified as an A2III star in the Simbad database. It may be noted that the star HD 39911 of spectral type A0 is situated $3'.4$ to the SW. Although it seems to match better the position of the UV source 489, the latter was determined

Send offprint requests to: makarov@astro.ku.dk

⋆ Based on observations made with the ESA Hipparcos satellite.

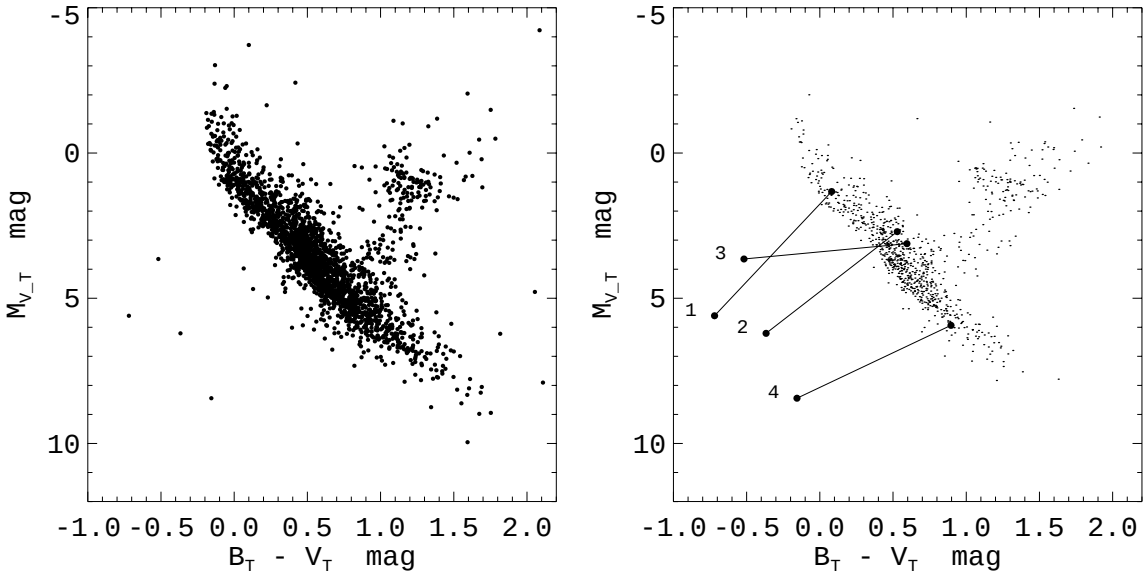

Fig. 1. Observational HR diagram for 2600 components of close binary stars with statistically significant Hipparcos parallaxes ($\pi/\sigma_\pi > 5.0$) and angular separations 0.32 to 2.0 arcsec (left plot). On the right, the same HR diagram, but with only the four blue subluminous components left, and the location of 1000 bona fide single Hipparcos stars is indicated with small dots for comparison. The primary and secondary components of a binary are connected with a straight line. The following binaries are marked: 1. HD 39927. 2. HD 30187. 3. HD 113001. 4. HD 149499. Estimated formal errors of the colour are typically 0.1 to 0.2 mag for the faintest stars.

Table 1. Astrometric and photometric data for two visual binaries with hot dwarf secondary components discovered by Tycho photometry. The equatorial coordinates are given in the ICRS system (columns 3 and 4). Parallaxes and angular separations from the Hipparcos catalogue are given in columns 5 and 6. B_T magnitudes and $(B_T - V_T)$ colours for primary (I) and secondary (II) components from the Tycho photometric solutions are given in columns 7 through 10. Estimated absolute magnitudes in V_T for the secondary components and their standard errors are given in column 11.

HD	HIP	RA h m s	Dec ° ′ ″	$\pi_{\rm HIP}$ mas	$\rho_{\rm HIP}$ mas	$B_T^{\rm I}$ mag	$(B_T-V_T)^{\rm I}$ mag	$B_T^{\rm II}$ mag	$(B_T-V_T)^{\rm II}$ mag	$M_{V_T}(\pm\sigma)$ mag
30187	21874	04 42 10.35	−56 07 8.3	8.25	347	8.65	0.53	11.26	−0.37	6.21(0.13)
39927	28019	05 55 35.38	−04 47 18.7	10.17	374	6.37	0.08	9.85	−0.72	5.60(0.07)

with a great uncertainty of a few arcminutes. HD 39911 has the same distance and proper motion as HD 39927 according to Hipparcos, and is present in the Celescope catalogue of UV stars (Davis et al. 1973), but with no magnitudes determined, probably due to its faintness in the ultraviolet.

2. HD 30187 B. A new candidate hot subdwarf. It matches the far-ultraviolet source FAUST 586 (Bowyer et al. 1995) with the measured flux of 0.0028(8) photons/s/cm^2/Å at the effective wavelength about 1650 Å. The main component of the binary is classified as an F5V star in the Simbad database.

3. HD 113001 B. A known sdO star in a visual binary system. It is listed by Heber 1991, as one of the only two hot subdwarfs known in visual binaries. It has a relatively rich record of spectroscopic and ultraviolet observations. The angular separation of the components from Hipparcos is 0.536 arcsec, and the parallax 4.05 mas. Judging from the Tycho data, the difference between the components in V is only 0.6 mag, which along with the larger separation, made it much easier to discover the blue component than in the case of the two previous stars. The Hipparcos parallax, despite its unusually large error of 4.0 mas, seems to be accurate enough. We attempted an astrometric solution for this star with the published Hipparcos transit data, and achieved a parallax of 4.6 ± 1.7 mas. The main component of the binary is classified as an F2V star in the Simbad database.

4. HD 149499 B = WD 1634-573. A known DO white dwarf in a binary. With the Hipparcos parallax of 26.94 mas, it is by far the nearest white dwarf of its kind. The angular separation of the components from Hipparcos is 1.319 arcsec. The primary component is classified as a K0V star in the Simbad database.

Ulrich Heber wrote in 1991: "Hot subluminous stars in binary systems could provide an important tool for checking the evolutionary scenarios ... since they possibly allow stellar masses to be determined. Visual binaries and eclipsing spectroscopic binaries are of utmost importance in this respect". The two discovered hot subdwarfs, HD 39927 B and HD 30187 B, if confirmed by ultraviolet spectroscopic observations, will meet perfectly this quest. Being at a distance of only 100 pc from the Sun, they should have orbital periods of about 100 years, which is approximately 10 times shorter than the orbital period of the previously known binary HD 113001. Already now, accu-

rate positional observations could reveal an orbital motion with respect to the mean Hipparcos epoch of 1991.

Noteworthy, the other candidate hot subdwarf in a visual binary listed by Heber 1991, HD 17576 B, is also present in our photometric solution. But having a $(B_T - V_T)$ colour of $+0.49$ mag and $M_{V_T} = 4.87$ mag, it seems to belong rather to the ordinary subdwarf stars.

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