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V1154 Tau: A NEW ECLIPSING STAR WITHIN A TRIPLE SYSTEM

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V1154 Tau (= HD 32641 = BD +22°.818, spectral type B5) has been discovered as a variable star by the Hipparcos satellite (HIP 23699, V_T=6^m.72, B_T=6^m.80, H_P=6^m.73) which did not however recognize its type of variability. V1154 Tau was therefore logged as an "unsolved" variable in the *Hipparcos Catalogue* (ESA 1997), with an amplitude of ΔH_P= 0.243 mag. V1154 Tau is located (J2000.0) at α=05^{h}05^{m}37^s.72 and δ=+23°03′39″.8, corresponding to galactic coordinates l=179°.90 and b=–10°.73. The parallax measured by Hipparcos is $\pi = 4.02 \pm 1.21$, for a distance of 250 pc.

V1154 Tau long known as a close double, under the name Stt 97. Early speckle observations by McAlister and DeGioia (1979) gave a separation ρ=0.358±0.002 arcsec and a position angle θ=154.1±0.3 deg for 1977. Hipparcos in 1991 obtained ρ=0.355±0.003 and θ=152.0±0.5, and Prieur et al. (2001) got ρ=0.355±0.003 and θ=150.4±0.8 with speckle observations in 1998. Such data do not show evidence of orbital motion, nor different proper motion during the 21 elapsed years, and therefore support a physical association of the pair (physical separation ∼90 AU). Hipparcos has derived a 1.48 mag difference in H_P magnitude for the two components. According to Fabricius and Makarov (2000), the two components of the physical pair have:

- Component A: H_P=6.974±0.005, B_T=7.06±0.01, V_T=7.00±0.01
- Component B: H_P=8.452±0.019, B_T=8.68±0.01, V_T=8.42±0.01

V1154 Tau lies in the vicinity of the NGC 1746/1750/1758 complex of possible real open clusters. During a photometric investigation of such complex, Straižys et al. (1992) obtained for V1154 Tau in the Vilnius photometric system V=6.67, $U-P$=0.33, $P-X$=0.43, $X-Y$=0.28, $Y-Z$=0.18, $Z-V$=0.12, $V-S$=0.25, from which they derived a B4 V classification, M_V=–0.8, A_V=0.99 and a distance of 280 pc, in good agreement with what later determined by Hipparcos. Such a short distance rules out partnership with both NGC 1750 and NGC 1758 that should lie at 510 and 680 pc according to Straižys et al. (1992; NGC 1746 does not seem to be a real cluster according to them).

We observed V1154 Tau in B and V (standard Johnson filters) from a private observatory near Cembra (Trento), Italy, in a similar way to our previous investigations of unsolved Hipparcos variables GV Dra and V432 Aur (Dallaporta et al., 2000, 2002b) and the eclipsing binary GK Dra with wrong Hipparcos orbital period (Dallaporta et al., 2002a). The instrument was a 28 cm Schmidt-Cassegrain telescope equipped with an Optec SSP5

photometer. The diaphragm had a size of 77 arcsec, and the exposure time was usually 10 seconds. HD 32811 (HIP 23784, V_J=7$^{\rm m}$.146, $(B-V)_J = 0.131$, spectrum B9) was chosen as comparison star and HD 32500 (HIP 23606, V_J=7$^{\rm m}$.842, $(B-V)_J$ = 1$^{\rm m}$.120, spectrum K0. As for HD 32811, Jonhson's B_J, V_J are derived from Tycho's values following Bessell (2000) transformations) as a check star. The comparison has been measured by Hipparcos 102 times and found constant. We have measured it against the check star five times in different nights and found V_J=7$^{\rm m}$.843 (r.m.s. 0.009 mag) and B_J=8$^{\rm m}$.971 (r.m.s. 0.007 mag), thus pretty well confirming the absence of variability.

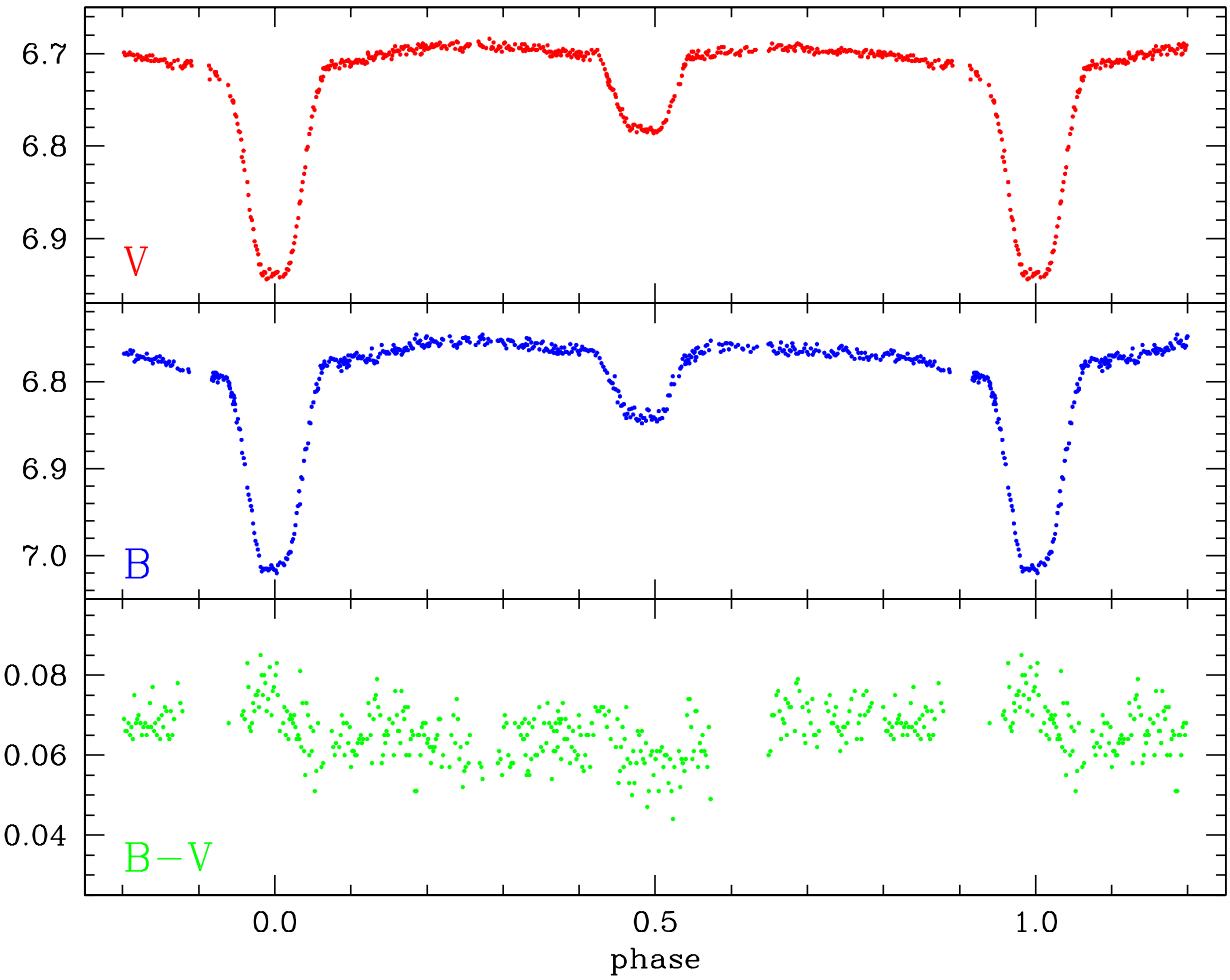

Figure 1. Our light and color curves of V1154 Tau for the 1$^{\rm d}$.7678805 period.

All together, 511 measurements in V, and 518 in B have been collected of V1154 Tau between Dec. 2002 and Feb. 2003. All the observations were corrected for atmospheric extinction and color corrections (via calibration on Landolt's equatorial fields), and the instrumental differential magnitudes were transformed into the standard Johnson UBV system. The variable, comparison and check stars are very close on the sky so the atmospheric corrections were rather small (36 arcmin distance for HD 32811 and 38 arcmin for HD 32500). The close similarity of the color between the variable and comparison star and the fact that all observations have been obtained for zenith distances $< 60^\circ$ argue for a high internal consistency of our photometry of V1154 Tau.

A Deeming-Fourier code has been applied to the set of data, resulting in the detection

of a strong periodicity at $1^{\rm d}.76789$. Combining with Hipparcos H_P data it has been possible to refine the period to $1^{\rm d}.7678805 \pm 0.000002$, with the ephemeris:

$$\text{Min. I} = \text{HJD } 2452643.3792(\pm 0.0003) + 1^{\rm d}.7678805(\pm 0.000002) \times E.$$

Our B and V photometric data folded to this ephemeris are presented in Figure 1. The system is clearly an eclipsing one, with both eclipses total and very well marked. Phase plot of Hipparcos and Tycho data according to the same ephemeris is presented in Figure 2. The eclipsing nature is well evident in Hipparcos data too, and it is surprising that automatic data treatment in preparation of the Hipparcos Catalogue has not solved the type of variability affecting V1154 Tau.

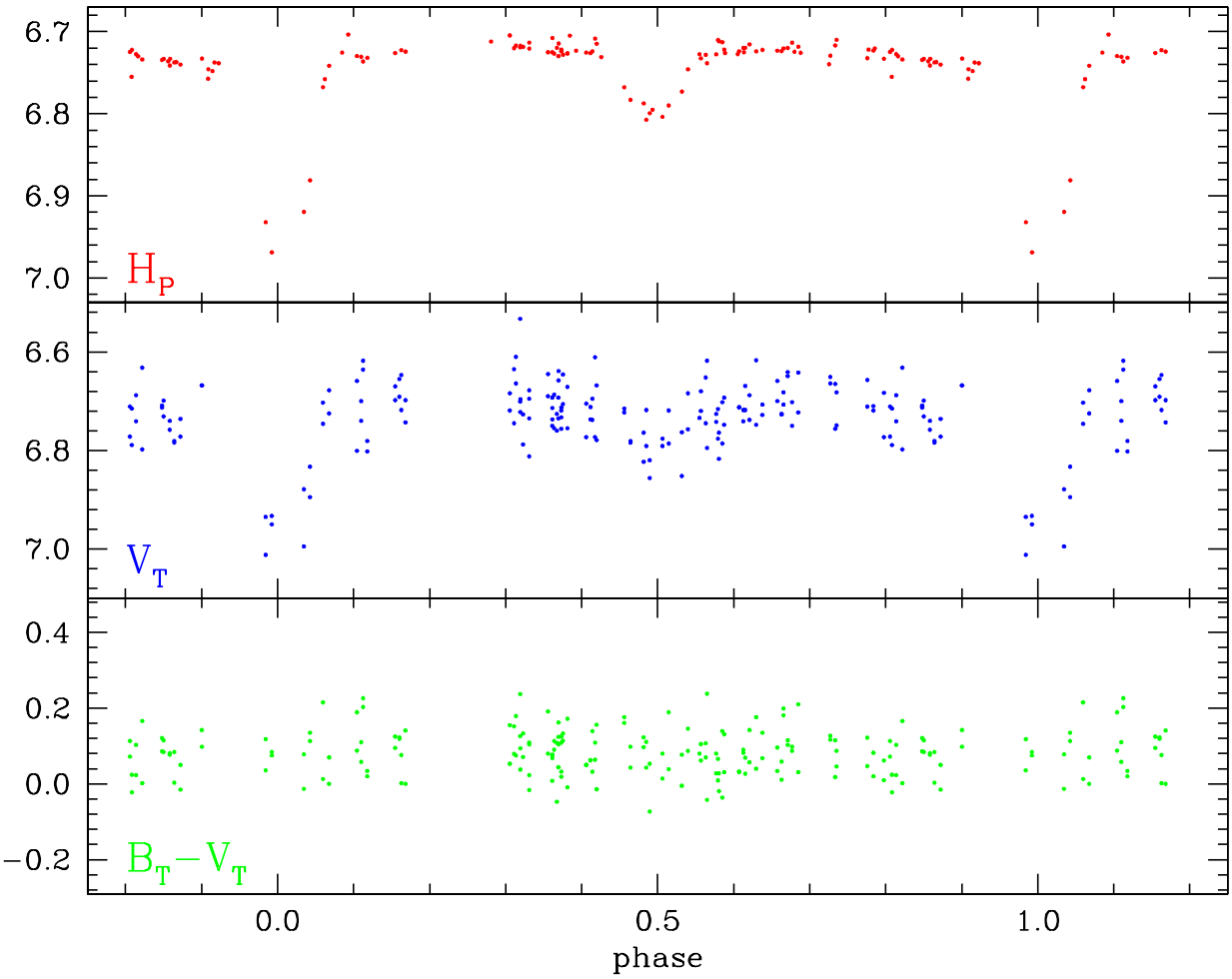

Figure 2. Hipparcos and Tycho data for V1154 Tau folded onto the $1^{\rm d}.7678805$ period.

Koen and Eyer (2002) have investigated with improved statistical methods a large set of Hipparcos epoch photometry data, and found likely periodicities for 2082 "unsolved" Hipparcos variables, including V1154 Tau for which they determined a period of $1^{\rm d}.8427$ (even if not assessing the nature of the variability). However, when plotting our as well as Hipparcos data according to Koen and Eyer (2002) period, the resulting light curve is not what expected, indicating automatic detection of a wrong periodicity (cf. Figure 3).

The discovered eclipsing binary is the "A" speckle component listed above, and therefore V1154 Tau turns out to be a triple system, with the third body contributing a

constant 21% of the total system light in the V band light curve (our diaphragm obviously includes the triple system as a whole). The phase of the secondary eclipse indicates an eccentric orbit. The $\Delta(B-V)$=+0.01 at primary eclipse and $\Delta(B-V)$=–0.01 at secondary suggests a small temperature difference between the two components, with the hotter one being eclipsed at primary minimum. None of the components displays intrinsic variability larger than 0.003 mag.

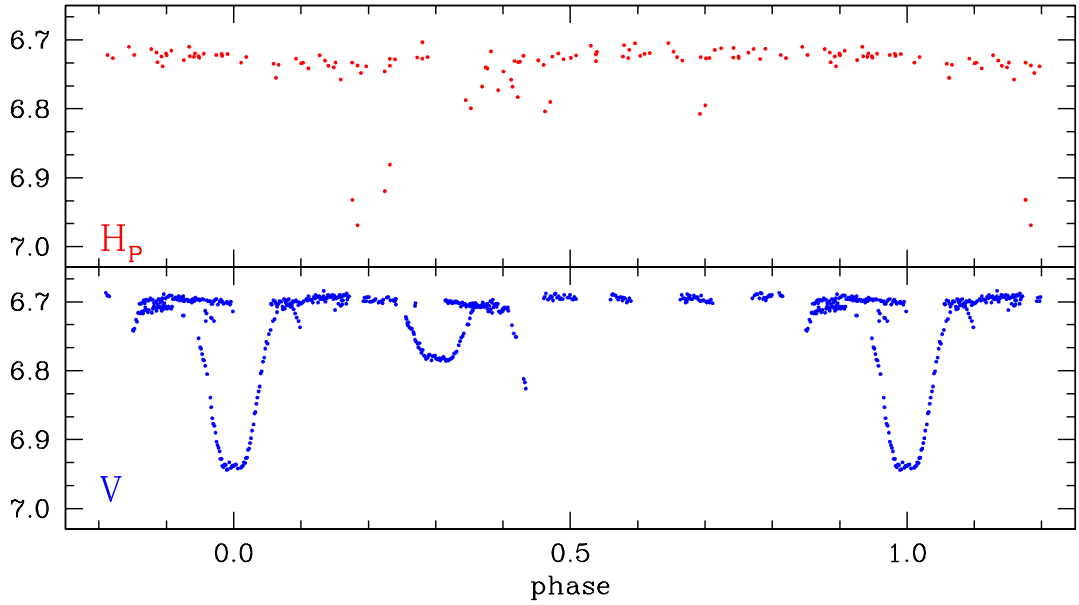

Figure 3. Hipparcos H_P and our V band data for V1154 Tau folded onto the $1\overset{d}{.}8427$ period reported by Koen and Eyer (2002), evidently not the correct orbital one.

Following these photometric results, V1154 Tau has been placed on the Asiago eclipsing binary program (e.g. Munari et al. 2001). At the time of writing, acquisition of radial velocities with the Asiago Echelle+CCD spectrograph is progressing, while B,V photometry is completed. We present here only the basic photometric evidences, with a full and detailed orbital solution including radial velocity data and synthetic spectral analysis being postponed to a devoted paper at the conclusion of the spectroscopic campaign.

References:

Bessell, M.S., 2000, *PASP*, **112**, 961
Dallaporta, S., Tomov, T., Zwitter, T., Munari U., 2000, *IBVS*, 4990
Dallaporta, S., Tomov, T., Zwitter, T., Munari U., 2002a, *IBVS*, 5312
Dallaporta, S., Tomov, T., Zwitter, T., Munari U., 2002b, *IBVS*, 5319
ESA, 1997, *The Hipparcos and Tycho Catalogues*, ESA SP-1200
Fabricius, C., Makarov, V. V., 2000, *A&A*, **356**, 141
Koen, C., Eyer, L., 2002, *MNRAS*, **331**, 45
McAlister, H. A., DeGioia, K. A., 1979, *ApJ*, **228**, 493
Munari, U., Tomov, T., Zwitter, T., Milone, E. F., Kallrath, J., et al., 2001, *A&A*, **378**, 477
Prieur, J.-L., Oblak, E., Lampens, P., et al., 2001, *A&A*, **367**, 865
Straižys, V., Cernis, K., Meistas, E., 1992, *Baltic Astron.*, **1**, 125