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HH Nor: A DOUBLE STAR WITH TWO VARIABLE COMPONENTS

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In a recent paper Dvorak (2004) listed several misidentified and missing southern eclipsing binaries. He compared ASAS-3 observations (Pojmanski 2002) with the available information in the GCVS catalogue (Kholopov et al. 2003) and checked their consistency. One of the "incorrectly classified variable stars" was HH Nor, listed as an Algol-type eclipsing binary in the GCVS (period: 8.58313 d). Contrary to this, Dvorak (2004) reclassified the star as an RR Lyrae type variable and determined a period of 0.598275 days. The wild disagreement with the GCVS and the apparent scatter of the phased ASAS-3 data in Dvorak (2004) caught our attention and this note summarizes our findings.

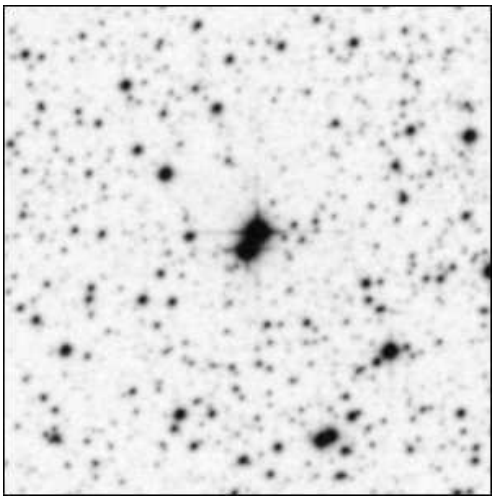

Figure 1. A $5' \times 5'$ DSS field centered on HH Nor. North is up, east is to the left.

The DSS image (Fig. 1) shows that the star is actually a visual double star of two comparable components. The first (and to our knowledge, the only) period determination was made by Alden (1935), who was fully aware of the double nature of the eclipsing binary named later as HH Nor. He referred to it as the fainter component of h 4794, a

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double star with similar components ($\Delta m \approx 1$ mag) separated by $12\farcs6$ in position angle 148°. The same parameters are also listed in the CCDM catalogue (Dommanget & Nys 2002), which also gives the proper motions of the components. Since their separation is smaller than the confusion radius of the ASAS observations (about 20 arcsec, Pojmanski 2002), the system remained unresolved, so that the measured magnitudes contain light from both components. Therefore, our first conclusion is that the brighter component of the system is a newly discovered RR Lyrae type variable that outshone the eclipsing component (=HH Nor) in the blended images. However, the predominantly downward scatter in Fig. 2 of Dvorak (2004) shows that besides the RR Lyrae variations there is also information on HH Nor itself.

To extract this further information, we downloaded V-band ASAS-3 observations (`http://archive.princeton.edu/~asas/`) and performed a secondary light removal in two steps. We adopted $V = 10.3$ mag for the outside-eclipse brightness of HH Nor (as given by Alden 1935); after converting all magnitude values to fluxes, we subtracted HH Nor's light from the measured brightnesses and converted the results back to magnitudes. The remaining outlying points (mostly caused by the eclipses) were removed manually from the phased data, using the RR Lyr ephemeris in Dvorak (2004). This way we arrived to the corrected mean light curve of the RR Lyr component (left panel in Fig. 2).

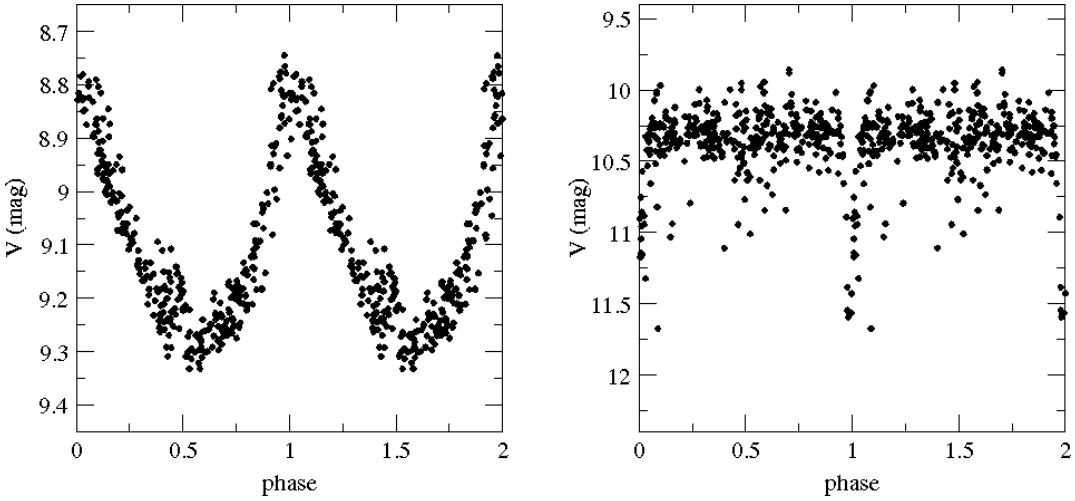

Figure 2. Corrected phase diagrams of the RR Lyrae component (left) and HH Nor (right).

In the next step we fitted this mean light curve with a third-order Fourier-polynomial, with which we corrected the initial data for the variations of the brighter star. The residuals were then analysed by a combination of the Phase Dispersion Minimization (Stellingwerf 1978) and the String Length method (Lafler & Kinman 1965). As a result, we derived a period of 8.5835(2) days, which is in very good agreement with that of by Alden (1935). The measured eclipse depth of the primary minimum (about 1.2 mag) is also in good agreement with the unblended observations of Alden (1935), which supports the consistency of the secondary light removal. We plot the final phase diagram of HH Nor in the right panel of Fig. 2. We summarize the main parameters for both variables in Table 1.

Finally, we have two concluding remarks. Firstly, Kiss & Bedding (2004) suggested in a recent work that blending calculations are highly advisable to be included into the regular

Table 1: Main parameters of "HH Nor" (=h 4794). E_0 is the epoch of minimum and maximum for the eclipsing and the pulsating component, respectively.

parameter	eclipsing component	RR Lyr component
RA(2000)[a]	15 43 30.17	15 43 29.37
Dec(2000)[a]	−51 50 48.9	−51 50 37.5
μ(RA) (mas/yr)[a]	2	−3
μ(Dec) (mas/yr)[a]	−23	−14
V (mag)[b]	10.3–11.5	8.8–9.3
period (d)	8.5835(2)[b]	0.598275[c]
E_0 (−2400000)	52503.348[b]	52093.53[c]

Data sources:[a] the CCDM catalogue; [b] this paper; [c] Dvorak (2004).

reduction procedure when working with large confusion radii. Here we wish to emphasize again this proposal: a cross-correlation with existing full-sky star catalogues with much smaller confusion radii (e.g. the USNO B1.0, Monet et al. 2003) would be necessary to add blending information in all cases when finally reduced data are made accessible to the wider community. If this star had been flagged as a possible blend, a misleading reclassification could have been avoided. And secondly, one shall always check the original references listed in the GCVS before concluding that there might be a misclassification. Although the NASA ADS Abstract Service is being constantly improved, early literature is rarely processed for linking objects via the SIMBAD database, so that one can easily miss the discovery papers or early analyses. To avoid this, the GCVS reference lists provide an important source of information.

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