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

Number 5312

Konkoly Observatory
Budapest
4 September 2002

HU ISSN 0374 – 0676

GK Dra: A DELTA SCUTI STAR IN A NEW ECLIPSING SYSTEM DISCOVERED BY HIPPARCOS

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GK Dra (HIP 82056, HD 152028, spectral type G0) has been discovered to be an eclipsing system by the Hipparcos satellite (V_T^{max}=8^m.81, B_T^{max}=9^m.21, Δm=0.4 mag and almost equal depth of primary and secondary eclipses; ESA 1997), that provided the following ephemeris for the primary eclipses:

$$\text{Min. I} = \text{HJD } 2448515.6 + 16^d.96 \times E.$$

No other information exists in the literature for this star, and we decided in 1999 to place it on the Asiago eclipsing binary program (e.g. Dallaporta et al. 2000, Munari et al. 2001). At the time of writing, spectral monitoring with the Asiago Echelle+CCD spectrograph is half completed (29 high resolution spectra secured in 25 different nights and distributed in orbital phase), while acquisition of B,V photometry is completed. We present here the basic results of photometry, a full orbital solution including radial velocity data being postponed to conclusion of the spectroscopic campaign.

We observed in B and V (standard Johnson filters) from a private observatory near Cembra (Trento), Italy. The instrument was a 28 cm Schmidt-Cassegrain telescope equipped with an Optec SSP5 photometer. The diaphragm had a size of 77 arcsec, and usual exposure time was 10 seconds. HD 151541 (HIP 81813, V_J=7^m.56, $(B-V)_J$=0.76, spectrum K1V) was chosen as a comparison and HD 152376 (HIP 82214, V_J=7^m.61, $(B-V)_J$=+1^m.10, spectrum K0) as a check star.

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 BV system. The variable, comparison and check stars are very close on the sky so the atmospheric corrections were rather small.

Altogether we obtained 1309 observations in B and 1328 in V from April 2000 to February 2002. Typical error for both B and V observations is 0^m.01. The light curves of GK Dra in each band as well as the $B-V$ color variations are shown in Fig. 1. Expanded plots around primary and secondary eclipse are shown in Fig. 2.

To the aim of determining the orbital period, we have performed a period search with various tools, all converging on the same result:

$$\text{Min. I} = \text{HJD } 2452005.56(\pm 0.01) + 9\overset{\text{d}}{.}9742(\pm 0.0001) \times E.$$

The 16.96 day period reported in the Hipparcos Catalogue is obviously wrong when applied to our photometry. The almost exactly 10 day period makes impossible to cover all orbital phases by observing for just a couple of years. We were lucky that at the time we performed our observations the inconvenient beating did not affect full coverage of both primary and secondary eclipses.

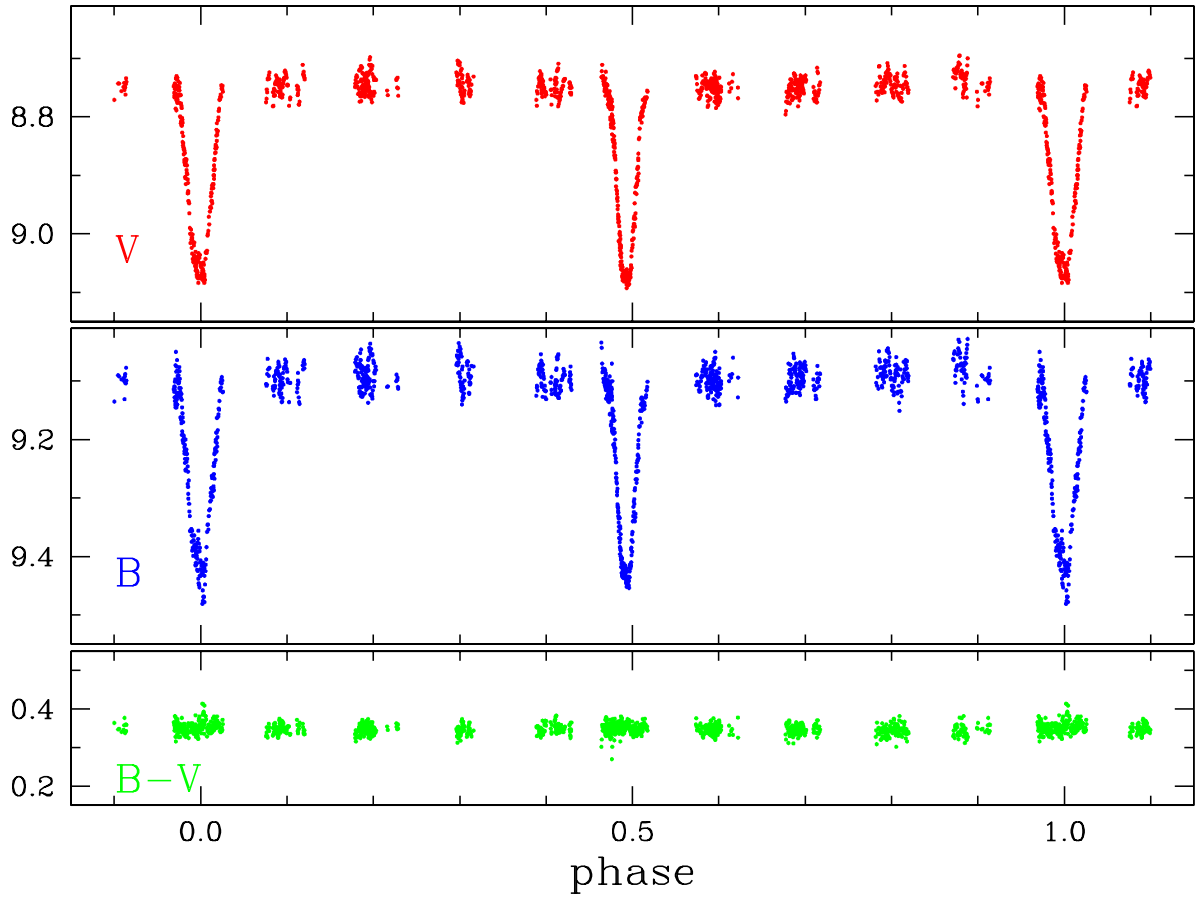

Figure 1. B, V and color curves of GK Dra folded with the 9.9742 period.

Primary and secondary eclipses last for about 0.050 and 0.039 of the orbital period, and their depth in B is about 0.37 and 0.36 mag, respectively. Maximum brightness outside eclipses is B=9.08 and V=8.73 mag. The secondary eclipse falls at phase 0.493 instead of 0.500, indicating a modest eccentricity of the system. Figure 2 compares primary and secondary eclipses and shows that no colour variation is present during eclipses.

The derivation of accurate photometric values is disturbed by the fact that one of the components is itself a variable star, which causes the apparent *noise* in the light curve of Figure 1. The intrinsic variable star is the one passing in front during primary eclipse, which is the reason for the less *noisy* secondary one. Its variability is rapid (about 2.7 hours) and of low amplitude (about 0.04 mag), reminiscent of the δ Sct type.

For a preliminary analysis of the properties of the δ Sct component we have isolated

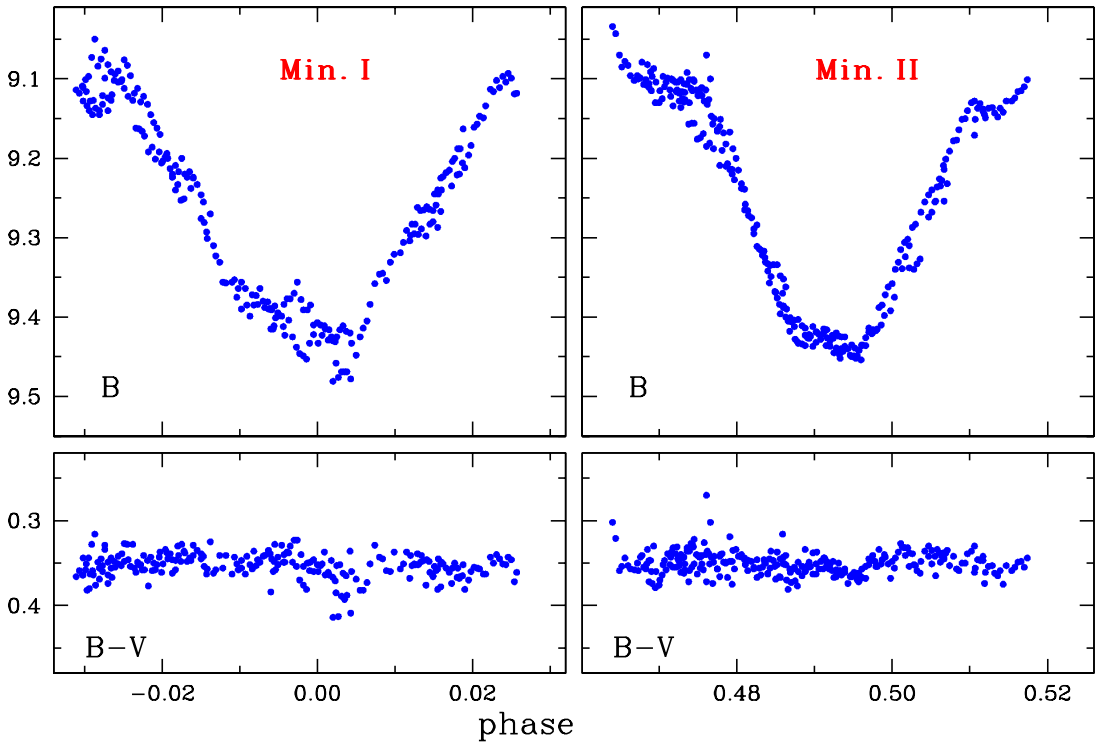

Figure 2. Expanded view around the primary and secondary eclipses of GK Dra.

the data pertaining to a narrow range of orbital phases, and performed a period search on them. We have selected the data falling between 0.75 and 0.85 in orbital phase, and we have found a stable and phased sinusoidal variation with an amplitude of $\Delta B{=}\Delta V{=}0.040$ mag following the ephemeris

$$\text{Min. I} = \text{HJD } 2450005.588(\pm 0.003) + 0\overset{\text{d}}{.}1137601(\pm 0.0003) \times E.$$

A phase plot of the δ Sct variability is presented in Figure 3.

No color variation is associated to the δ Sct variability, and its true amplitude is around Δm ∼0.08 mag when the light of the non variable component is subtracted. Small differences (0.01 mag) in the mean brightness from night to night are evident.

Acknowledgments. This study was partly sponsored by Polish KBN Grant No. 5 P03D 00320

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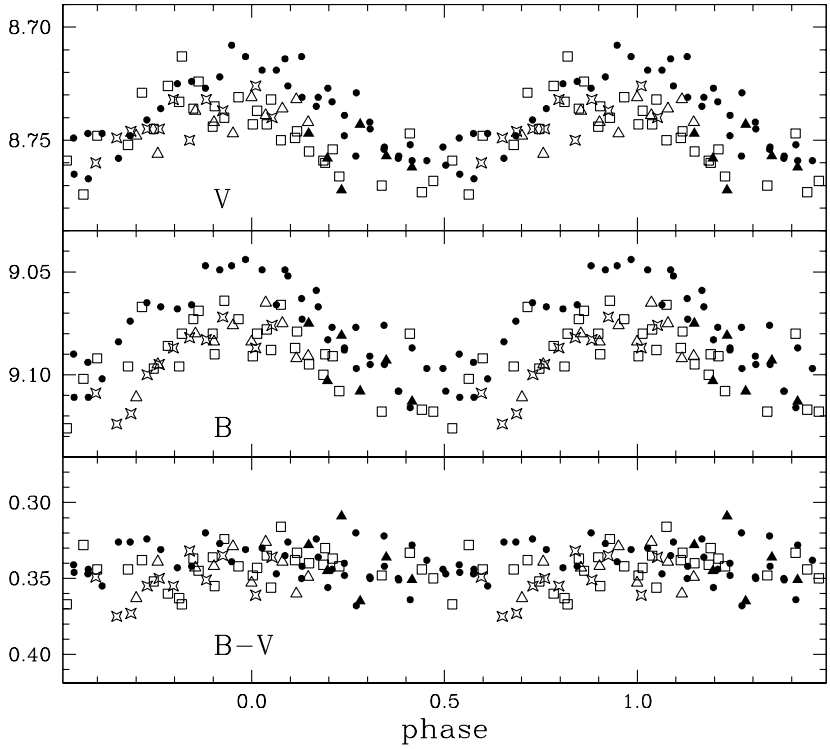

Figure 3. Pulsational light curve with P=2.7 hour of the δ Sct component of GK Dra. Different symbols are associated to different observing dates: night 13/14 Jan 2001 to open triangles, 22/23 Feb 2001 to filled circles, 13/14 Apr 2001 to filled triangles, 23/24 Apr 2001 to stars, and 22/23 June 2001 to open squares.