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PHOTOMETRY OF HR 1817 AT TWO SITES WELL SEPARATED IN LONGITUDE

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HR 1817 (HD 35850, HIP 25486) is a remarkably active, young, relatively close, rapidly rotating, single solar-type star, whose relative brightness invites more intensive study to help understand Sun-like stars. It has been estimated to have radius $1.18R_\odot$, mass $1.15M_\odot$, $v\sin i$ 50km/s, distance 26.8 pc and an age of $\approx$ 12Myr. This F7V star shows intense X-ray, extreme ultraviolet (EUV) emission and strong lithium abundance. (cf. e.g. Tagliaferri et al., 1997; Gagné et al., 1999). EUV data suggest that HR 1817 is in a state of continuous low-amplitude flaring (Mathioudakis & Mullan, 1999; Zuckerman et al., 2001).

Strong surface fields were also measured using Zeeman Doppler Imaging (ZDI), together with microwave emission that fits highly energized coronal models (Budding et al., 2002). These latter radio and spectrometric studies indicated a period of around 1 day, or a little less. Although HIPPARCOS photometry (ESA, 1998) confirms photometric variability, with an amplitude of up to 0.08m in V, a photometric period was not yet obtained. For "spot" type variability, with a period close to one whole day (Carter, 2003) (or, indeed, any integral number of days), it is difficult to establish a photometric period from any single observatory, since a prominent macula may change its position before enough time has elapsed for adequate phase coverage. In this situation, a useful approach is to combine photometry from sites that are widely separated in longitude.

We present here results of photometry of HR 1817, combining data from MLO (long. $\sim$8h W) and UAO (long. $\sim$2h E) during a short campaign carried out earlier this year. The diagrams show standardized BVR observations gathered at the two sites during the central interval Jan 14-25, 2003. They have been phased here with a 1-day trial period and confirm variability on this timescale, with an expected amplitude of around 0.05 mag (V). The fact that the next change is comparable in B and V, but definitely less in R, can be taken as a significant indicator of a maculation type variation.

The telescopes used in this campaign were the 40-cm f/10 Meade Cassegrain-Schmidt telescope of the Çanakkale Onsekiz Mart University Ulupinar Astrophysics Observatory (UAO), with Optec Mark III photometer and the 61-cm telescope of Mt. Laguna Observatory (MLO), using a Hamamatsu R943-02 pmt at 1450V. Reductions of the UAO instrumental source data were made with the ATMEX[1] software. Photometer calibration procedures have followed regular lines, as spelled out in, for example, Henden & Kaitchuck (1982) or Budding (1993). Individual points, at both observatories, were averaged from 2 or 3, 10s integrations. Comparison star and sky readings were checked after, typically 3 readings of HR 1817.

The UAO photometer has been calibrated with respect to a few dozen standard star observations in the early months of 2003, yielding calibration coefficients $\epsilon = -0.09 \pm 0.01$, $\mu(B-V) = +1.24 \pm 0.03$ and $\psi(V-R) = 0.90 \pm 0.03$, in typical terminology (cf. Hardie, 1962). Recent values for MLO are $\epsilon(V) = -0.09 \pm 0.01$, $\mu(B-V) = 1.02$ and $\psi(V-R) = 1.05$. Although HR 1817 has V magnitude 6.2-6.3, the count rates with the facilities used were at most an order of magnitude less than those ($\sim 10^6$ cts/sec), at which the instrument manual indicates dead time effects start to be detectable. Since both observatories used comparisons of similar magnitudes, differential effects of brightness-related non-linearity should be negligible.

The main reference stars were HD 35643 ($V = 7.28$, $B-V = 0.383$) and HD 35591 ($V = 6.55$, $B-V = 1.084$), the latter (closer in magnitude) being used more frequently at MLO and the former (closer in colour) being used more at UAO. Intercomparisons of the determinations on these stars allow us to believe that the longitude separated measures can be lined up at the 0.01 mag level of confidence. A similar project, involving joint monitoring of CG Cyg by MLO and another group in Turkey, allowed agreement about the magnitude of the then-used comparison (BD+34°4216) to within 0.01 mag (cf. also Milone et al., 1979).

Some additional short-term irregularity may also be present, as the scatter, for this bright a star, is greater than nominal photometric accuracies would suggest ($\sim$0.005 mag from simple Poissonian counting statistics). UAO data from 2 Nov 2002 and 2 Mar 2003 support variations of the same order and timescale, but, as yet, there appears insufficient high quality coverage to allow a clear photometric period to be established. The 2/3/03 data (also plotted in the light curves) show a rise similar to that in the phase range $\sim$0.3-0.5, hence indicating a period quite close to one whole day, or $\sim$30 min less than that, down to about 22 h, when coherence is lost among the separate data segments. The 2/11/02 data (not shown), do little other than confirm the general magnitudes and colours.

This two-site collaboration proved a useful experience in assessing the practical possibilities and qualities of the standardization of magnitudes. A third site, around, say, $\sim$10-12h E, could have perhaps helped confirm if the descending branch of the apparent maculation effect observed at UAO ascended at the expected phase. Parallels could be drawn between HR 1817 and other active cool dwarfs; for example, AB Dor, where multi-site, multiwavelength studies have allowed the building up of 3-dimensional modelling of a stellar active region (Collier-Cameron & Robinson, 1989). Photometry has an important corroborative role to play in such studies, as well as providing independent data for model parameters.

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[1]Keskin, V., 2001, ATMEX, `http://astronomy.sci.ege.edu.tr/~keskinv/Software.html`

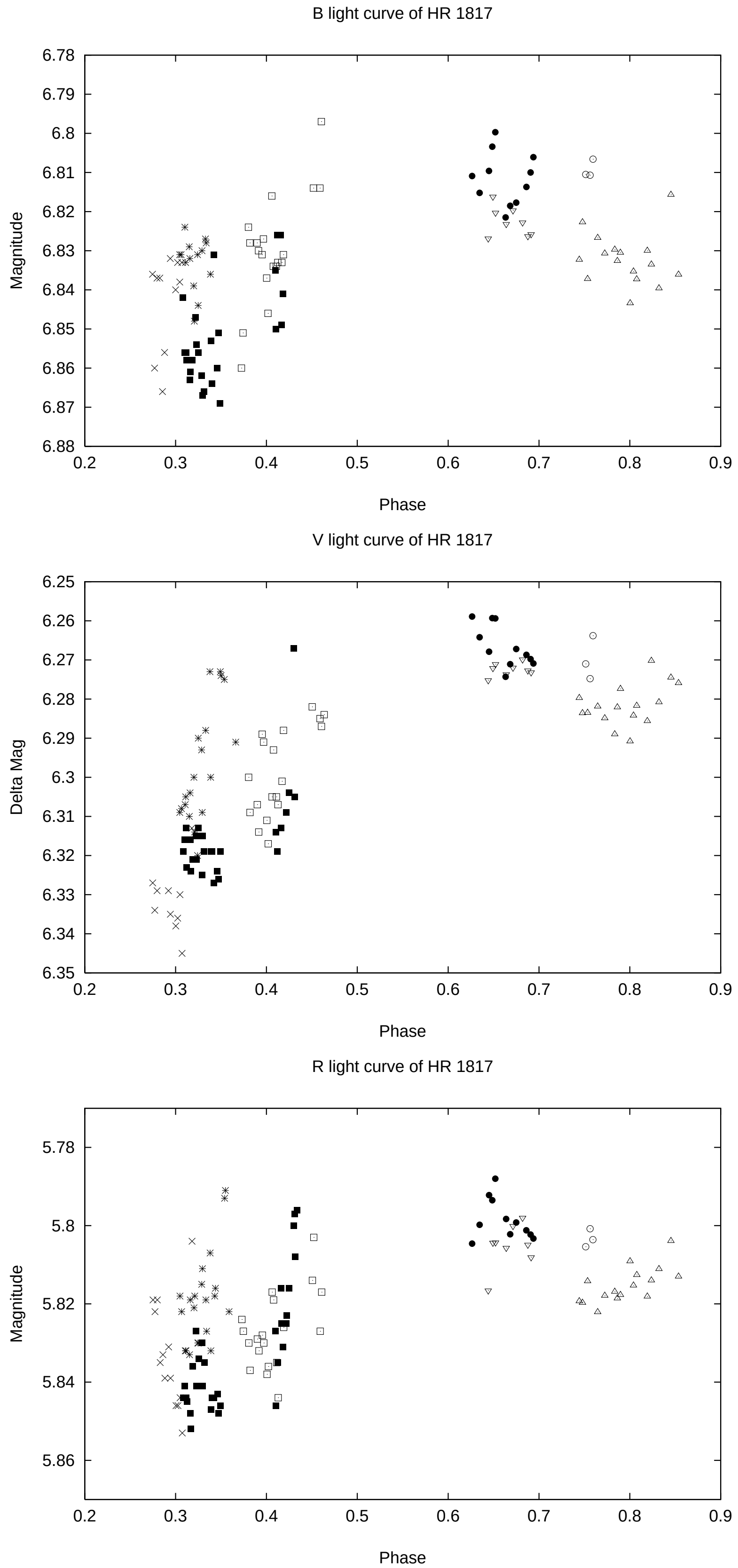

Figure 1. The MLO data appear here at later phases, as follows: triangle up, Jan 19; triangle down, Jan 22; circle, Jan 24; filled circle, Jan 26. The UAO data, at the left, are similarly: box, Jan 14; filled box, Jan 15; cross, Jan 17; star, Mar 2.

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