COMMISSION 27 OF THE I. A. U.
INFORMATION BULLETIN ON VARIABLE STARS
Number 3618

Konkoly Observatory
Budapest
6 June 1991
HU ISSN 0374 - 0676

HD 181943: AN ACTIVE SINGLE SUBGIANT WITH LITHIUM

From 11 years of *V*-band photometry, Hooten and Hall (1990) found a photometric period of 385.3±0.6 days for this chromospherically active, single G8 subgiant (Balona 1987). If the photometric period is interpreted as the rotation period due to the modulation by cool starspots, the period of 385 days would be the longest known rotation period for any chromospherically active star. Quite opposite to the general rule, however, that the longer the rotation (photometric) period of late-type stars the less CaII H and K emission, HD 181943 is a *very* active system in several respects: very strong CaII H and K emission, Hα and Hϵ emission, and continuum light variations. In this paper we demonstrate the strong chromospheric emissions and show that the star has also a strong LiIλ6707 Å absorption line, which is generally believed to be an indicator of stellar youth. However, there exists the possibility to confuse the evolutionary status of chromospherically active stars because both very active post-main sequence stars and pre-main sequence or very young main-sequence K stars, show a strong to moderate Lithium line (Fekel 1988). Fekel also noted that the primary observational difference is that in post-main sequence stars Hα appears as a strong absorption feature.

All observations presented here were obtained at Kitt Peak National Observatory with the coudé feed telescope in April 1991. Grating A and camera 5 were used in second order (centered at λ_c=6560 and 6700 Å) and in third order (λ_c=3950 Å) at dispersions of 0.105 Å/px and 0.070 Å/px, respectively. The observations utilized a 800-pixel TI CCD and had effective wavelength resolutions of 0.17 Å in the blue and 0.18 Å in the red region. The blue spectra have S/N ratios of around 30:1 and the red spectra approximately 150:1.

Figure 1 shows parts of our spectra centered at, from top to bottom, Ca II H and K, LiI λ6707 Å, and Hα. Very strong H and K emission well above the continuum is present and even Hϵ is an emission line almost up to the continuum. The middle panel in Fig. 1 shows the 6700 Å region where the position of the Lithium blend is indicated. In this panel the spectrum of HD 181943 has been shifted to match the spectrum of the G8IV reference star β Aql. No obvious Lithium is present in β Aql and the difference spectrum, HD 181943 minus β Aql, yields an equivalent width for the LiIλ6707 line of 92±5 mÅ (a Gaussian to the line profile gives 102 mÅ not correcting for the presence of the FeIλ6707.44 line). From theoretical curves of growth for temperatures around 5100 K and log g = 3.75 given by Duncan and Jones (1983) we obtain log n(Li) = 2.0 for HD 181943. This places the star well within the range of *Pleiades* Li abundances but above the *Hyades* relation by about a factor of ten. Thus, HD 181943 is most likely a pre-main-sequence object. The bottom panel of Fig. 1 shows the Hα line which appears "filled in" up to almost the continuum level and has a core-emission line with a deep central reversal. From the width of the two peaks in the Hα

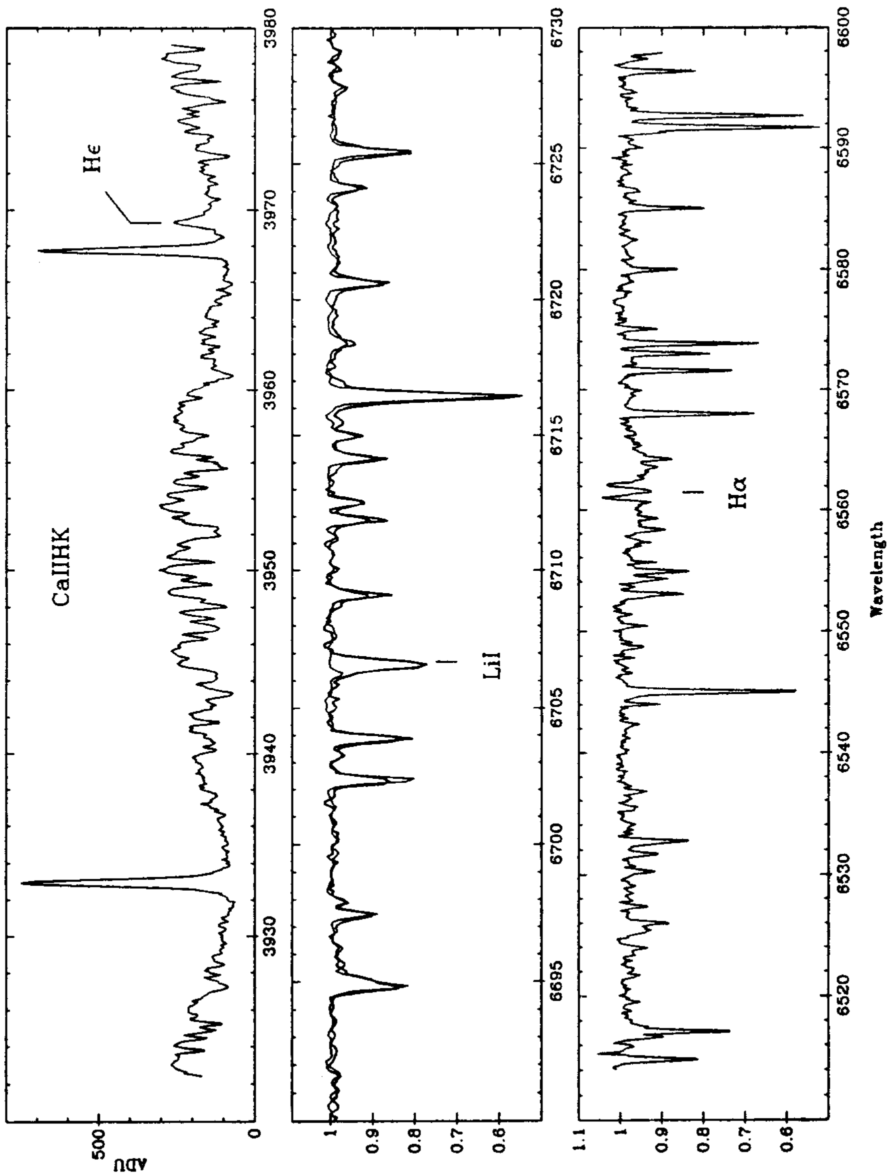

Figure 1

emission profile ($\Delta\lambda$=1.071 Å) and the peak flux relative to the continuum (F_{max}/F_c=1.035) we find an electron density of 5 10^{11} cm^{-3}. This value is on the borderline of a "collision-dominated" and a "mixed-type" Hα line formation (i.e., collisions *and* photoionization in the source-sink terms control the shape of the Balmer line) which occurs for $N_e \geq 7\ 10^{11}$ cm^{-3} for T_{phot} = 5150 K (G8IV) and an assumed chromospheric temperature of 10,000 K.

From comparison of several unblended photospheric lines with β Aql ($v\sin i$=2.6 km s^{-1}; Gray and Nagar 1985) and an empirical relationship between FWHM and line broadening we derive $v\sin i$ for HD 181943 of 4.2±1.0 km s^{-1} and a radial velocity of −33.4 km s^{-1} (JD 2,448,375.9708) in agreement with the radial velocities given by Balona (1987) and his conclusion that HD 181943 is a single star. If we assume that the photometric period measured by Hooten and Hall (1990) is the rotation period, our $v\sin i$ measure translates into a minimum radius of 32±8 $R_\odot$. Clearly, either the subgiant classification must be revised or the photometric period is not the rotation period or is just a spurious value. Since the spectrum of HD 181943 is rather well matched by the G8IV "standard" β Aql and the light curve in Fig. 24 in Hooten and Hall (1990) shows only small scatter (despite its 11 year baseline) we believe that the 385-day period is *not* the rotation period but most likely some spot-cycle period and the star is seen almost pole-on. The lithium abundance and strong chromospheric emissions suggest that HD 181943 is a young star or even a pre-main sequence object and thus should be a rapid rotator. An observationally very similar case might be HR 1362 (Strassmeier *et al.* 1990), another G8 subgiant with a 335-day photometric period, low $v\sin i$, and strong chromospheric emission.

K. G. STRASSMEIER
Institut für Astronomie
Universität Wien
Türkenschanzstraße 17
A-1180 Wien
AUSTRIA
(STRASSMEIER@AVIA.UNA.AC.AT)

References

Balona, L. A. 1987, *S.A.A.O. Circ.* **11**, 1.

Duncan, D. K., Jones, B. F. 1983, *Astrophys. J.* **271**, 663.

Fekel, F. C. 1988, in A DECADE OF UV ASTRONOMY WITH IUE, ESA SP-281, Vol. 1, p. 331.

Gray, D. F., Nagar, P.: 1985, *Astrophys. J.* **298**, 756.

Hooten, J. T., Hall, D. S. 1990, *Astrophys. J. Suppl.* **74**, 225.

Strassmeier, K. G., Hall, D. S., Barksdale, W. S., Jusick, A. T., Henry, G. W. 1990, *Astrophys. J.* **350**, 367.