

*Letter to the Editor***A young stellar group associated with HD 199143 ( $d = 48$  pc)\***M.E. van den Ancker<sup>1,2</sup>, M.R. Pérez<sup>3</sup>, D. de Winter<sup>4,5</sup>, and B. McCollum<sup>6</sup><sup>1</sup> University of Amsterdam, Astronomical Institute “Anton Pannekoek”, Kruislaan 403, 1098 SJ Amsterdam, The Netherlands<sup>2</sup> Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, MS 42, Cambridge MA 02138, USA<sup>3</sup> Emergent-IT Corp., 9315 Largo Drive West, Suite 250, Largo MD 20774, USA<sup>4</sup> Instituto de Astrofísica de Canarias, C/ Via Láctea s/n, 38200 La Laguna, Tenerife, Spain<sup>5</sup> TNO-TPD, Stieltjesweg 1, P.O. Box 155, 2600 AD Delft, The Netherlands<sup>6</sup> IPAC-Caltech, SIRT Science Center, MS 314-6, Pasadena, CA 91125, USA

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**Abstract.** We present new optical and ultraviolet spectroscopy of the anomalous EUV emitter HD 199143 (F8V). High resolution spectra in the H $\alpha$  and Na I D wavelength regions show evidence for very rapid (a few hundred km s<sup>-1</sup>) rotation of the stellar photosphere. Using archive *IRAS* data we also show that the star has excess emission above photospheric levels at 12  $\mu$ m. *IUE* data of HD 199143 reveal the presence of emission lines of Mg II, C I, C II, C III, C IV, Si IV, He II and N V and show a large variability, both in the continuum and line fluxes. We propose that all available data of HD 199143 can be explained by assuming that it has been spun up by accretion of material from a close T Tauri like companion, responsible for the emission lines, the ultraviolet variability and the excess infrared emission. The bursting or flaring nature of this object, mostly in high energies, could be explained as episodic mass transfer between the star and its close companion. We show that HD 199143 and the Li-rich late-type dwarf BD-17°6128 form a physical pair and suggest that both may be part of a new nearby (48 pc) young ( $\sim 10^7$  yr) stellar association in Capricornius.

**Key words:** stars: individual: HD 199143 – stars: peculiar – stars: rotation – Galaxy: open clusters and associations: general – ultraviolet: stars

**1. Introduction**

Zuckerman & Webb (2000) sketch a picture of the recent star formation history of the solar neighbourhood in which 10–40 million years ago an ensemble of molecular clouds were forming stars at a modest rate near the present position of the Sun. About

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\* Based on observations collected at the European Southern Observatory, La Silla, Chile, observations made by *IUE* at NASA-GSFC, and with the Isaac Newton Telescope operated on the island of La Palma by the Isaac Newton Group in the Spanish Observatorio del Roque de los Muchachos

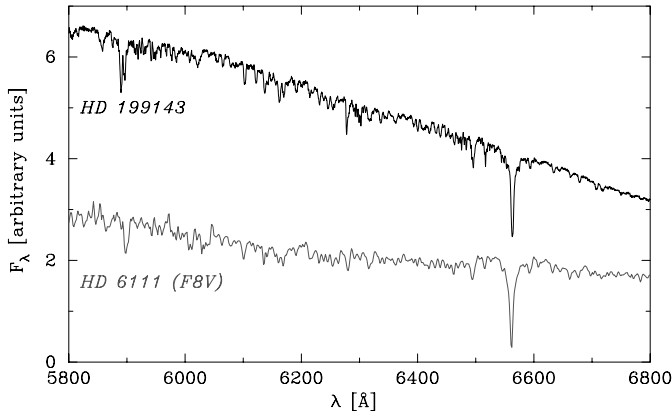
10 Myrs ago, the most massive of these newly formed stars exploded as a supernova, terminating the star formation episode and generating the very low density region seen in most directions from the present Sun (Welsh et al. 1998). This scenario can not only explain the presence of young stellar groups close to the earth, but also explains how the  $\beta$  Pic moving group can be so young (20 Myr; Barrado y Navascués et al. 1999), and yet so close. However, currently this scenario is largely speculative.

HD 199143 is a poorly studied bright ( $V = 7^m27$ ) star in the constellation of Capricornius. It has been classified as F8V in the Michigan Spectral Survey (Houk & Smith-Moore 1988), after an initial classification of G0 by Cannon & Mayall (1949). The star would be completely inconspicuous, if it hadn't been detected as a bright extreme-ultraviolet source by the *ROSAT* (2RE J205547–170622) and *Extreme Ultraviolet Explorer* (2EUVE J2055–17.1) missions (Pounds et al. 1993; Malina et al. 1994; Pye et al. 1995; Bowyer et al. 1996).

In this *Letter* we present new optical and ultraviolet spectroscopy of HD 199143 and show that it is a variable and rapidly rotating F8V star. We infer that all characteristics of the HD 199143 system can be explained by assuming that it is a binary system, in which the primary has been spun up by accretion of mass from a low-mass companion. Its association with a previously studied T Tauri-like system (BD-17°6128) suggests that these two stars could be the first two members of a close (48 pc) new region of recent star formation and may provide compelling support for the star formation history of the solar neighbourhood outlined in the first paragraph.

**2. Optical observations**

Low-resolution (0.53 Å pix<sup>-1</sup>) spectra of HD 199143 in the wavelength region of 5700–6800 Å were taken with the 2.5 m Isaac Newton Telescope (INT) at La Palma during the nights of August 29 (JD 2451023.072), 30 (JD 2451024.122) and 31 (JD 2451025.076), 1998. The spectra were reduced with the usual steps of bias subtraction, flatfielding, background subtraction and spectral extraction, and wavelength and flux calibration.



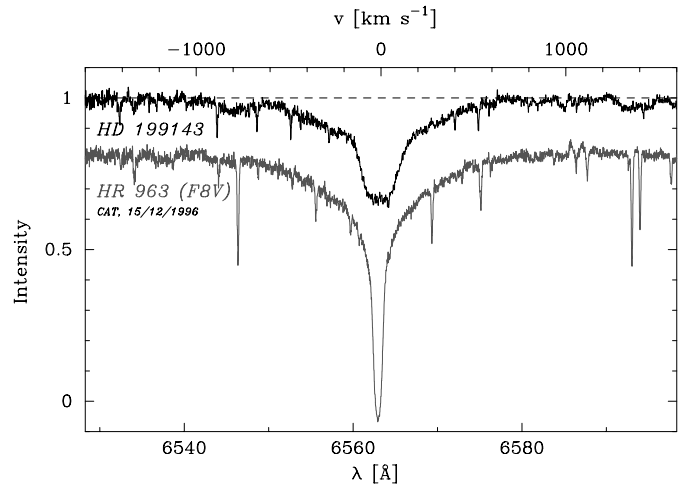
**Fig. 1.** Red spectrum of HD 199143 obtained at the INT. For comparison we also show the spectrum of HD 6111 (F8V) from the spectral database by Jacoby et al. (1984).

Apart from a multiplicative factor, due to the fact that the nights in which the spectra were taken were not of photometric quality, the spectra taken in the different nights were identical. In Fig. 1 we show the spectrum of Aug. 30, 1998. For comparison we also show the spectrum of HD 6111 (F8V), obtained from the spectral database by Jacoby et al. (1984). The resolution of this spectrum is about three times lower than that of the INT spectrum. Apart from the differences expected because of the differences in spectral resolution, the two spectra are identical, confirming the F8V spectral classification of HD 199143.

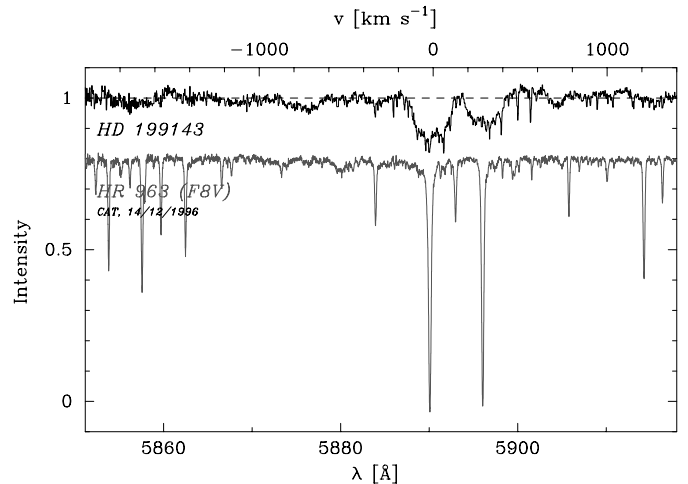
High-resolution ( $0.05 \text{ \AA pix}^{-1}$ ) spectra of HD 199143 in the  $H\alpha$  (6536–6591 Å) and Na I D (5858–5910 Å) wavelength ranges were obtained with the Coudé Auxiliary Telescope (CAT) at La Silla, Chile, on Dec. 16 (at JD 2450432.016) and Dec. 15 (JD 2450431.016), 1996. The spectra were reduced in a standard fashion, after which the continuum was normalized to unity. They are shown in Figs. 2 and 3, together with the spectra of HR 963 (F8V), obtained during the same night as the HD 199143 spectra. Apart from a number of very sharp absorption features due to water vapour in the earth's atmosphere, a number of highly broadened ( $\text{FWHM} \approx 250 \text{ km s}^{-1}$ ) photospheric absorption lines (most prominently  $H\alpha$  and the Na I doublet) are visible in the HD 199143 spectra. The same lines are present in HR 963, but much narrower, again confirming the spectral classification of F8. From the photospheric lines we measure a radial velocity of  $-9 \pm 16 \text{ km s}^{-1}$  for HD 199143. The wings of the  $H\alpha$  profile appear identical in HD 199143 and HR 963, demonstrating that the broadening of the lines in HD 199143 is not due to a luminosity classification smaller than V, but must be caused by a high (a few hundred  $\text{km s}^{-1}$ ) value of  $v \sin i$ .

### 3. Ultraviolet observations

HD 199143 was observed with *IUE* on several occasions in 1995, under a discretionary program (OD89Z), and the observatory program (USSBS). Archival data taken by the NC119 program, in November 1992, are also included in our analy-



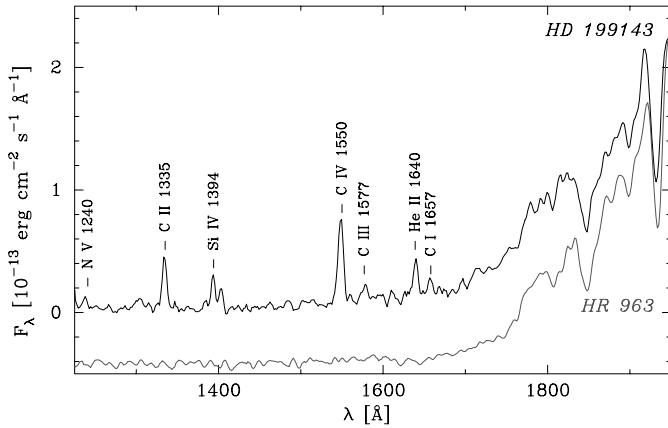
**Fig. 2.** High-resolution spectrum of HD 199143 in the  $H\alpha$  wavelength region. For comparison we also show the spectrum of HR 963 (F8V), shifted for clarity, obtained during the same night.



**Fig. 3.** High-resolution spectrum of HD 199143 in the Na I D wavelength region. We again show the spectrum of HR 963 (F8V) for comparison.

sis. A total of 19 archived images are available, both in low- ( $1.68 \text{ \AA pix}^{-1}$  for SWP,  $2.66 \text{ \AA pix}^{-1}$  for LWP) and high-dispersion ( $25 \text{ km s}^{-1}$ ,  $\lambda \sim 0.2 \text{ \AA}$  resolution), which were secured through the large aperture (oval-shaped:  $10'' \times 20''$ ). There are 11 SWP camera (1150–2000 Å) exposures all in low-dispersion, and eight LWP (1800–3200 Å) exposures, of which six are in high-dispersion.

A preliminary inspection of the short-wavelength data reveals an emission spectrum typical of T Tauri, Herbig Ae/Be (HAeBe) stars and planetary nebulae. The SWP low-dispersion images present clear emissions in N V (1240 Å), C II (1335 Å), Si IV (1394 Å), C IV (1550 Å), C III (1577 Å), He II (1640 Å) and C I (1657 Å). With the exception of a few lines such as N V and He II, the emission spectrum of HD 199143 resembles the spectra of T Tauri stars such as RW Aur and GW Ori (Imhoff & Appenzeller 1987). In Fig. 4 we present the emission spec-



**Fig. 4.** *IUE* Short wavelength spectrum of HD 199143 (top) identifying the emission lines. For comparison we also show the shifted spectrum of the bright F8V star HR 963 (bottom), which is clearly devoid of emission lines.

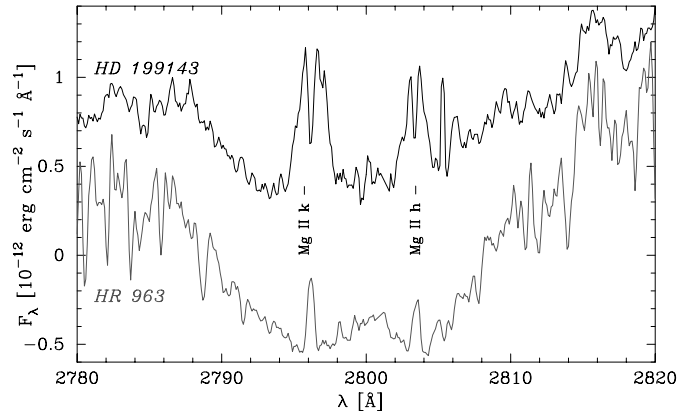
trum corresponding to the well-exposed (80 min.) image SWP 55183. This spectrum is compared with the spectrum of HR 963 (SWP 52921), which is a typical F8V, high-proper motion star.

In the long-wavelength spectrum the most conspicuous emission is the Mg II doublet at 2798.0 and 2802.7 Å, which is only detectable in high-dispersion exposures. This normally P-Cygni emission has been shown to be typical of chromospherically active stars and other pre-main sequence (PMS) stars such as T Tauri and HAeBe objects. The Mg II doublet from the well-exposed (110 min.) image LWP 30968 is presented in Fig. 5 along with the comparison spectrum of HR 963. Note the self-absorption feature on top of the h & k emissions. The Mg II spectrum of HD 199143 resembles that of the T Tauri star GW Ori (Imhoff & Appenzeller 1987), or that of the “double emission peak” HAeBe stars classification described by Imhoff (1994).

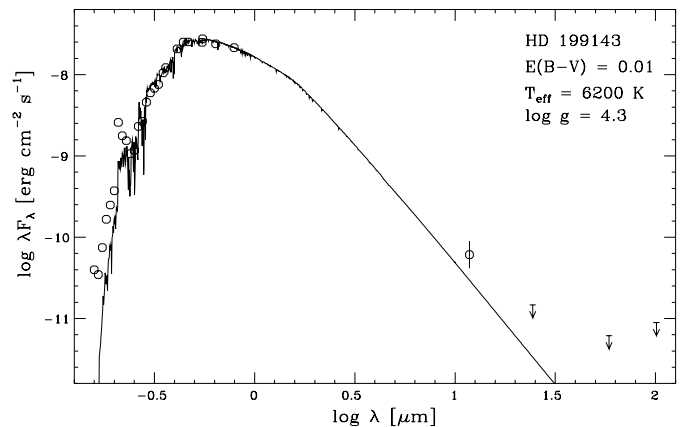
#### 4. Analysis

The ultraviolet emission spectrum of HD 199143 is somewhat peculiar because emission lines such as N V, which corresponds to a temperature regime of about  $2 \times 10^5$  K, is rarely present in PMS stars. Furthermore, lines such as He II, which has a complex origin, are commonly present in planetary nebulae and in only a handful young objects. The ratio of the emission fluxes for C IV to Si IV in T Tauri stars ranges from 2–3 (typical of chromospheric activity) to less than unity (Imhoff & Appenzeller 1987). In HD 199143 this range is from 1.2 to 1.4, compatible with an origin in a T Tauri star.

Repeated observations with *IUE* allow us to address the issue of ultraviolet variability, beyond the instrument flux repeatability (3%). Comparisons of the well-exposed section of the *IUE* images indicate a variability of 10–20% in the continuum and 20–50% in the emission lines of C II, C IV, N V and He II. From the repeated SWP images taken closely in time, we detected that flux variability (continuum and lines) was found to be random and not associated with the period of 1.6 days recently suggested



**Fig. 5.** *IUE* Long wavelength high-resolution spectrum of HD 199143 (top) and HR 963 (bottom) centered around the 2800 Å Mg II doublet (h & k). The broad photospheric absorption at these wavelengths is also clearly identifiable. Broad circumstellar emission can be seen in the case of HD 199143, whereas incipient Mg II emission lines are detected in HR 963, typical of late-type main sequence stars showing an onset of chromospheric activity.



**Fig. 6.** Observed spectral energy distribution of HD 199143 (circles) compared to a Kurucz (1991) model for  $T_{\text{eff}} = 6,200$  K and  $\log g = 4.3$  (solid line).

by Handler (1999), whom classified HD 199143 as a  $\gamma$  Doradus candidate.

We have searched for infrared emission by checking the raw *IRAS* scans at the position of HD 199143 using routines from the Groningen Image Processing System (GIPSY). In the 12  $\mu\text{m}$  band, a point-like source is clearly present at the position of HD 199143. No source was detected at longer wavelengths. From these data we derive a flux of  $0.24 \pm 0.04$  Jy in the *IRAS* 12  $\mu\text{m}$  band, and upper limits of 0.12, 0.12 and 0.30 Jy for the fluxes at 25, 60 and 100  $\mu\text{m}$ , respectively.

Using the newly determined *IRAS* fluxes and the optical photometry of HD 199143 by Olsen (1983) and Cutispoto et al. (1999), we constructed a Spectral Energy Distribution (SED) of HD 199143, shown in Fig. 6. In this plot we also show UV fluxes of HD 199143 from archive *IUE* data. Also plotted is a Kurucz (1991) model for the photosphere of a F8V star, fitted to extinction-corrected optical photometry of HD 199143. In the

SED we can see that both the *IRAS* 12  $\mu\text{m}$  flux and the *IUE* fluxes below 2250 Å are significantly higher than that expected from the stellar photosphere. One explanation for the infrared excess could be the presence of circumstellar dust in the system, similar to that found in Vega-type systems. However, the tight 25 and 60  $\mu\text{m}$  upper limits show that if this is the case, only a very warm ( $> 1000$  K) dust component must be present, which is unlikely. A more likely source of the observed infrared excess might be a late-type companion to HD 199143, or to infer a modification of the photospheric structure of HD 199143 due to its rapid rotation (Sect. 2).

The *Hipparcos* catalogue (ESA 1997) lists a parallax of  $21.0 \pm 1.0$  milliarcseconds for HD 199143 (HIP 103311). Using a distance  $d$  of  $47.7 \pm 2.4$  pc obtained from this parallax we computed the luminosity of HD 199143 by integrating the flux of the Kurucz (1991) stellar photosphere model fitted to the optical photometry, and multiplying by  $4\pi d^2$  to correct for spatial dilution. Note that if the photospheric structure of HD 199143 has been altered by its rapid rotation, this procedure might not be completely correct since the emitted flux will be non-spherically symmetric distributed. However, the resulting stellar luminosity of  $2.4 \pm 0.2 L_{\odot}$  is in agreement with that expected of a F8V star ( $2.1 L_{\odot}$ ; Schmidt-Kaler 1982), showing that this is not a big effect. It also confirms our earlier conclusion that HD 199143 belongs to luminosity class V.

## 5. Discussion and conclusions

The presence of a normal late-type companion could not explain the ultraviolet excess, or the *EUVE* and *ROSAT* detections of HD 199143. However, the presence of an accretion disk around our hypothetical companion, such as that found in LMXB or T Tauri systems, might easily explain those properties, as well as the infrared excess, the presence of emission lines and the variability. In such a scenario, the high rotational velocity of HD 199143 could be due to a spin-up in its past by accretion from the companion.

At first glance, a scenario in which a nearby main-sequence star like HD 199143 would have a T Tauri-like companion would seem far-fetched. However, Mathioudakis et al. (1995) report the presence a strongly flaring K7e–M0e dwarf with a high Li abundance only 5 arcminutes from HD 199143. The optical spectrum of this star, BD–17°6128, is identical to that of many T Tauri stars. From Digital Sky Survey images we identify BD–17°6128 with HD 358623. An inspection of the Tycho-2 Catalogue (Høg et al. 2000) shows that this star has a proper motion of  $59 \pm 3$  and  $-63 \pm 3$  mas yr $^{-1}$  in  $\mu_{\alpha}$  and  $\mu_{\delta}$ , identical to that of HD 199143. From the fact that HD 358623 is the only star within a 5 degree radius for which this is the case, we exclude the possibility that this could be a coincidence and conclude that the two stars form a genuine proper motion pair. Using the data by Mathioudakis et al. (1995), and the newly determined distance, we compute the absolute luminosity of BD–17°6128 to be  $0.34 \pm 0.06 L_{\odot}$ , employing a similar procedure to that followed for HD 199143. Comparison with the pre-main sequence

evolutionary tracks by D’Antona & Mazzitelli (1997) yields an age of  $10^7$  years for BD–17°6128, consistent with a T Tauri nature of this star.

Using the radial velocity of HD 199143 determined in Sect. 2, and the parallax and proper motions listed in the *Hipparcos* catalogue, we compute the galactic space velocity components ( $U, V, W$ ) of HD 199143 to be  $(-10 \pm 13, -13 \pm 6, -13 \pm 6)$  km s $^{-1}$ . This space motion is similar to that of many stars in the vicinity of the Tucanae and TW Hydra associations (Zuckerman & Webb 2000), suggesting that these stars might have formed from the same cloud complex. We conclude that HD 199143 and BD–17°6128 could very well be the first two members of a region of recent star formation similar to the TW Hydrae Association and the newly identified Tucanae Association (Kastner et al. 1997; Zuckerman & Webb 2000). If confirmed, a further study of these two enigmatic stars could lead to a better understanding of the star formation history in the solar neighbourhood.

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