A young stellar group associated with HD 199143 (d=48 pc)
van den Ancker, M.E.; Perez, M.R.; de Winter, D.; McCollum, B.

Published in:
Astronomy & Astrophysics

Citation for published version (APA):

General rights
It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations
If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: http://uba.uva.nl/en/contact, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.
Letter to the Editor

A young stellar group associated with HD 199143 (d = 48 pc)*

M.E. van den Ancker1,2, M.R. Pérez3, D. de Winter4,5, and B. McCollum6

1 University of Amsterdam, Astronomical Institute “Anton Pannekoek”, Kruislaan 403, 1098 SJ Amsterdam, The Netherlands
2 Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, MS 42, Cambridge MA 02138, USA
3 Emergent-IT Corp., 9315 Largo Drive West, Suite 250, Largo MD 20774, USA
4 Instituto de Astrofísica de Canarias, C/ Vía Láctea s/n, 38200 La Laguna, Tenerife, Spain
5 TNO-TPD, Stieltjesweg 1, P.O. Box 155, 2600 AD Delft, The Netherlands
6 IPAC-Caltech, SIRTF Science Center, MS 314-6, Pasadena, CA 91125, USA

Received 17 October 2000 / Accepted 2 November 2000

Abstract. We present new optical and ultraviolet spectroscopy of the anomalous EUV emitter HD 199143 (F8V). High resolution spectra in the Hα and Na D wavelength regions show evidence for very rapid (a few hundred km s\(^{-1}\)) rotation of the stellar photosphere. Using archive IRAS data we also show that the star has excess emission above photospheric levels at 12 μm. IUE data of HD 199143 reveal the presence of emission lines of Mg I, 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 (∼ 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 10 Myr 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 β 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°27) 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\(^{-1}\)) 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.
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 Å 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 (FWHM = 250 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 $-9^{+16}_{-1}$ 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 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 analysis. A total of 19 archived images are available, both in low-dispersion (25 km s$^{-1}$, λ ~ 0.2 Å resolution), which were secured through the large aperture (oval-shaped: 10′′ × 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-
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\textsubscript{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\textsubscript{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\textsubscript{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\textsubscript{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\textsubscript{II}, which has a complex origin, are commonly present in planetary nebulae and in a handful young objects. The ratio of the emission fluxes for C\textsubscript{IV} to Si\textsubscript{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\textsubscript{II}, C\textsubscript{IV}, N\textsubscript{V} and He\textsubscript{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 by Handler (1999), whom classified HD 199143 as a γ 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 μm 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 ± 0.04 Jy in the IRAS 12 μm band, and upper limits of 0.12, 0.12 and 0.30 Jy for the fluxes at 25, 60 and 100 μm, 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
The Hipparcos catalogue (ESA 1997) lists a parallax of 21.0 ± 1.0 milliarcseconds for HD 199143 (HIP 103311). Using a distance d of 47.7 ± 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 ± 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.

**Acknowledgements.** The authors would like to thank the referee, Ben Zuckerman, for valuable suggestions for improving the manuscript. Bruce McCollum and Mario Pérez thank Yoji Kondo for Discretionary Time to observe HD 199143 with IUE. This research has made use of the Simbad data base, operated at CDS, Strasbourg, France.

**References**


ESA, 1997, The Hipparcos Catalogue, ESA SP-1200


Schmidt-Kaler, Th. 1982, “Landolt-Bornstein Catalogue”, VI/2b
