EVIDENCE OF AN ACCRETION DISK AROUND THE HERBIG AE/BE STAR MWC 297

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Abstract

The article discusses most young, low-mass stars are surrounded by circumstellar disks. The same is also true for intermediate-mass stars up to a spectral type of ∼B8. Direct detections of disks around early B or O stars are rare. This does not mean that high-mass stars do not have accretion disks; rather, it indicates that disks are much more short-lived around high-mass stars, so that by the time these stars become optically visible they have already dispersed their accretion disks. Furthermore, high-mass stars are generally more distant than low-mass stars, making it harder to spatially resolve their accretion disks. Even O stars with stellar masses of 20–30 Me appear to have disks in their heavy accretion phase. However, such stars are difficult to study.

Keywords*:* circumstellar disks, accretion, absorption, emission.

Introduction. MWC 297 belongs to the family of young, hot Herbig Ae/Be star. MWC 297 is a highly reddened object, notable for its extremely strong Balmer fine emission. In the plane of the sky, it is seen superimposed on the HII region S62 [23]. The role, if any, of MWC 297 in the excitation of this HII region is unclear. MWC 297 was included in the original list of 26 stars compiled by Herbig (1960) that is seen now as the first compilation of Herbig Ae/Be (HAEBE) stars. Herbig (1960) adds that H_β and H_γ were strongly in emission in 1931, but that on his plates H_γ was weak and H_β very weak, if in emission at all [12]. He found Ca II to be in very strong absorption and saw no other absorptions. A large infrared excess was found [2] ($V - K > 8m$). [22] call attention to the strong emission in H_β, calling the star Be object and [15] discovered CO emission, confirmed later on by [7].

[6] made a photometric study of the object in the Johnson UBV RIJHK system and found.

a) variations of up to $0^m.48$ in V, of up to $3^m.26$ in U and of less than $1^m.00$ in I, J, H, K.

b) an anticorrelation between U and K variations, implying a dust component in the variations.

c) the color curve (U, B, ... K) can be decomposed into that of a heavily extinguished B0 type star plus a body with T = 1300 K.

It subsequently found its way into [8] important optical study of HAeBe stars, and was also included in the sample considered by [13]. Like many of the more luminous Herbig Be (HBe) stars it has, until now, evaded attempts to assign to it anything more than a vague spectral type.

Observations & data reduction. The star was observed at the Haute Provence Observatory (OHP) of the CNRS in 1997. The wavelength regions and dates of observation are given in Table 1. The observations were made with the 152 cm telescope, in July 1997. The spectrograph used was Aurelie [10] with a Thomson 7832 double bar detector, with 2048 photodiodes (750×13 μ). The grating used had 300 grooves/mm, blazed at 6000 Å. The original dispersion is 33 Å /mm, with a resolution of 1.3 Å, equivalent to 65 km s^{-1} at 6000 Å.

Calibrations were made with a tungsten lamp for flat field and in wavelength by means of a hollow cathod of thorium and argon for the blue and the red and thorium-neon for the near infrared.

Table 1. Observational material of MWC 297

4119 − 4939 Å	21 07 1997
4914 − 5734 Å	23 07 1997
6297 – 7118 Å	24 07 1997
7123 – 7944 Å	25 07 1997
8091 – 8911 Å	20 07 1997

Based upon this material [3] had made line identifications in the traditional way, paying attention to both wavelengths and intensities within the multiples. The identifications were made with the help of the tables of [19] for Fe II we also used [14] compilation and for [Ni II] [20]. In addition in this measurment have used [17] catalogue for lines which authors could not identify.

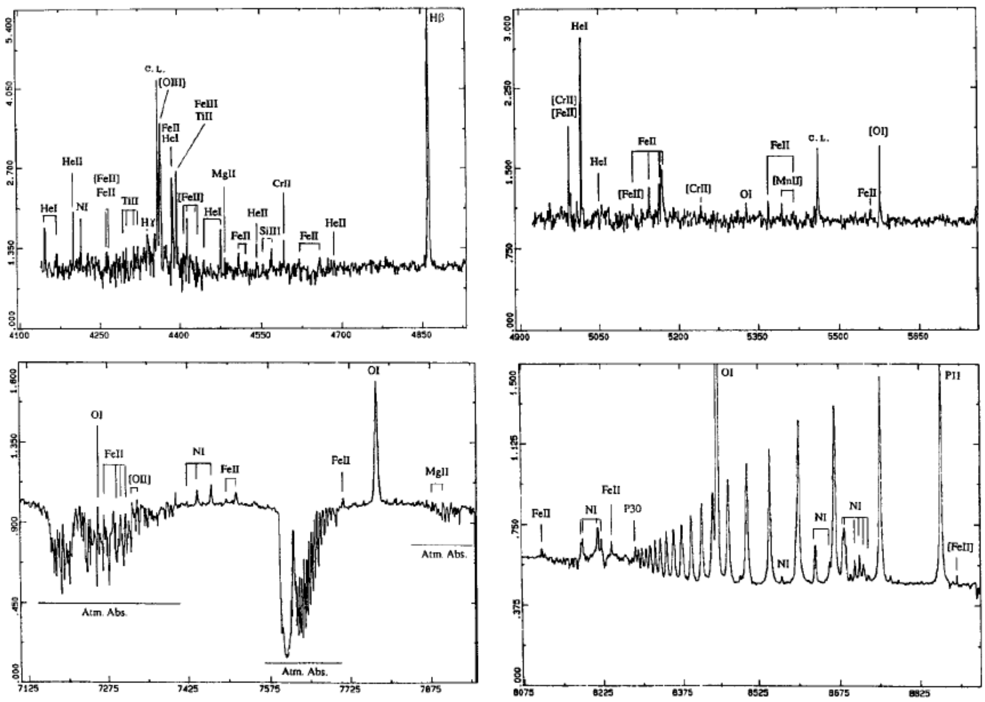

Fig. 1. The different parts are given from top to bottom and from left to right. The first wavelength range is 4133−4930 Å. The spectrum is under exposed, specially for λ 4470 Å. CL = city lights. The second range is 4923−5755 Å, the third is 7124−7942 Å and the fourth, 8073−8909 Å.

Part of the material is reproduced in Fig.1, where also some line identifications are provided. The region 7123 to 7400 has been corrected by atmospheric absorption, which, but being hardly visible in Fig. 1. The correction by atmospheric extinction was done in the conventional way by dividing the spectrum of the star by that of comparison stars observed at similar airmasses. [3] are present 197 emission lines and 4 absorption lines. [3] included in the latter count lines in which both emission and absorption features figure, like the He I lines. 18 emission lines could not be identified. The iron lines represent 40% of all identified emission lines.

Accretion proses. MWC 297 is 10 $M_\odot$ main sequence star which is already past the major accretion phase and has built up most of its mass. The star is optically visible indicating that it has cleared most of the surrounding material. [16] observed with the SMA show that it is still surrounded by a circumstellar disk of mass 0.07 $M_\odot$ and radius ≥ 80 AU. Observations of double-peaked CO lines in NIR spectra [4, 24] clearly indicate that an accretion disk is present in MWC297. However, the stellar rotational velocity, corrected for the inclination, indicates that the disk corotation radius, $R_{cor}=GM_*R_*/v_*^2)^{1/3}$, must be ∼7 $R_\odot$. Since the disk truncation radius must be smaller than the corotation radius, the accretion disk must extend down to nearly the stellar surface in MWC 297. [1, 11] reached a similar conclusion from modeling their interferometric data on MWC297, which failed to reveal an inner gap or cavity between the disk and the star. This result strengthens the claim that the model of magnetospheric accretion, widely accepted for lower mass Classical T Tauri stars, is probably not applicable to Herbig Be stars [18,21,25].

Other than MWC 297, compact dust continuum emission from the circumstellar disks surrounding optically visible early B-type stars (HBe stars) has been detected only around two B0 type stars, MWC 1080 and R Mon. Based on the disk masses derived from these observations, it has been argued that the disk masses in HBe stars are at least an order of magnitude lower than that in intermediate-mass Herbig Ae stars and low-mass T Tauri stars [9]. It also demonstrates that circumstellar disks can survive around massive stars well into their main sequence phase even after they have become optically visible.

The disk surrounding MWC 297 shows evidence for some degree of physical evolution. If the emission at sub mm and mm wavelengths is optically thin, then the low value of β that we derive implies that the circumstellar dust grains around MWC 297 have sizes larger than the interstellar grains. This indicates that the grain growth has possibly begun in the disk.

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