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ASTRONOMY AND ASTROPHYSICS

*Research Note*

# More on the reflection nebula surrounding HD 87643 and the non-uniform atmosphere of the central star*

J. Surdej** and J. P. Swings

Institut d'Astrophysique, B-4200 Cointe-Ougrée, Belgium

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**Summary.** Different equivalent widths and line displacements of Hβ and Fe II are observed in spectra of two condensations located within the reflection nebula surrounding HD 87643: they indicate important relative motions ($\Delta v \sim 150\,\mathrm{km\,s^{-1}}$) between various parts of the nebulosity and demonstrate that the stellar atmosphere in which the lines are formed is not isotropic and/or not homogeneous.

The spectrum of another reflection nebula situated in the vicinity of HD 87643 is also briefly described.

**Key words:** reflection nebula – HD 87643 – emission lines

## 1. Introduction

From direct plates in narrow bands, as well as in the broad *B*-band, Surdej et al. (1981, referred to as Paper I) showed that the nebula around the B[e] star HD 87643 is of reflective origin. Furthermore, an image-tube spectrogram of a filamentary condensation lying E–W at 17″ *N* of HD 87643 revealed strong emission lines – some of which with P Cygni profiles – forming a replica of the spectrum of the central object. It was therefore argued in Paper I that the reflection nebula surrounding HD 87643 is associated with the mass-outflow from the central hot (~B0) star.

Paper I also summarizes the data available on HD 87643; more recently de Freitas Pacheco et al. (1982) presented IUE observations of HD 87643 and attempted to derive a mass-loss rate on the basis of the Fe II lines; the latter result remains however totally unconvincing due to the inappropriate method used by these authors.

Bouchet and Swings (1981) have shown that the near IR colors and magnitudes of HD 87643 (observed with a 13 arc sec. diaphragm) have not varied with respect to previous measurements, indicating no noticeable change in the amount and/or temperature of the dust surrounding the B[e] star.

Polarimetric measurements in the visible (14″ diaphragm) have been reported for HD 87643 by Barbier and Swings (1981): with $p \simeq 0.6$–$0.7\,\%$ in *U*, *B*, *V* HD 87643 exhibits slightly less polarization than several other B[e] stars.

In paper I, it was mentioned that "the extended atmosphere around HD 87643, from which arise the Fe II and P Cygni Balmer lines, might not be spherically homogeneous and /or in isotropic expansion and that, consequently, the reflection spectrum could differ from the stellar one (in radial velocities e.g.)". It is the purpose of the present paper to investigate this point more thoroughly on the basis of new spectroscopic data obtained for two small condensations located in the nebula surrounding HD 87643.

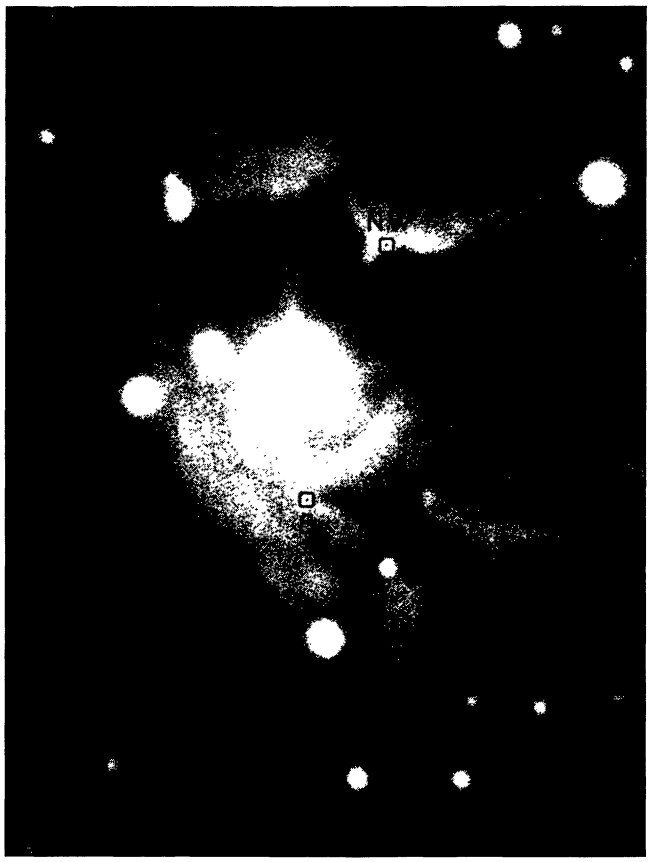

**Fig. 1.** Location of the two condensations observed spectroscopically in the reflection nebula surrounding HD 87643. The two squares illustrate the projection of the 2″ ×2″ slots defining the slit environment of the IDS spectra. North is up and East is to the left

*Send offprint requests to:* J. P. Swings

* Based on observations collected at the European Southern Observatory (La Silla, Chile)

** Also, Chercheur qualifié au Fonds National de la Recherche Scientifique (Belgium)

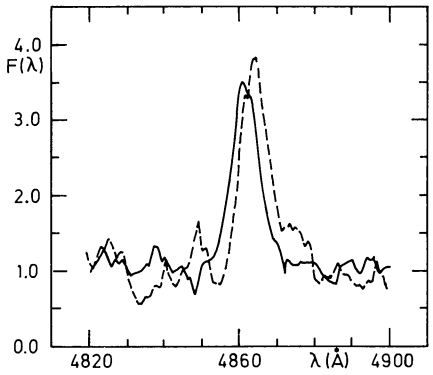


**Fig. 2.** Intensity tracings around the Hβ line as recorded for the NW (continuous line) and S (dashed line) condensations

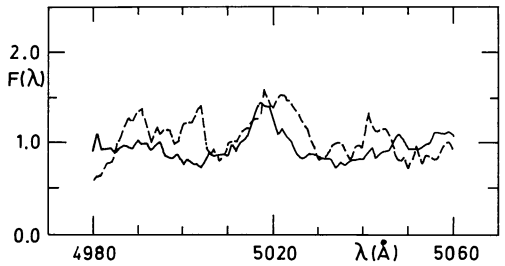


**Fig. 3.** Intensity tracings around the Fe II line at λ5018.4 (Mult. 42) as recorded for the NW (continuous line) and S (dashed line) condensations

## 2. Observations

On April 5 and 6, 1981, we obtained with the ESO 3.6 m telescope two IDS spectra (114 Å mm$^{-1}$) of two condensations in the nebula surrounding HD 87643 located at roughly 20″ NW and 17″ S from the central B[e] star. Their locations, as well as the positions of the 2″ × 2″ slots defining the slit environment of the IDS spectra, are illustrated in Fig. 1.

**Table 1.** Spectroscopic data for Hβ

| Condensation | Central wavelength (Å) | Heliocentric velocity (km s$^{-1}$) | Equivalent width (Å) |
|---|---|---|---|
| NW | 4861.8±0.2 | 30± 8 | 24.7±1.8 |
| S | 4864.2±0.7 | 179±48 | 33.7±3.2 |

N.B. Error estimates are rms values derived from three independent measurements of both IDS spectra

As expected (cf. Paper 1), Hβ is the only outstanding reflected emission line in the spectrum (see Fig. 2). The strongest Fe II line, at λ5018.4 (Mult. 42), appears as a faint emission (see Fig. 3) on all our spectra.

In Table 1, we summarize the central wavelength, heliocentric velocity, and equivalent width of the well defined Hβ emission line seen in the spectra of both condensations. From these data we conclude that the position of Hβ is definitely shifted (149 ±48 km s$^{-1}$) and that the ratio of their equivalent widths (1.36) is appreciably different from unity. A similar shift is observed between the Fe II λ5018 lines in the two condensations (132 ±27 km s$^{-1}$), although their heliocentric velocities are different from those of Hβ (−65 and 67 km s$^{-1}$); the ratio of the equivalent widths of Fe II λ5018 is found to be 1.5±0.3 for the NW and S condensations.

In addition we note that:

(i) for the S condensation, a faint emission satellite is definitely present in the red wing of Hβ (estimated heliocentric velocity ≃781±31 km s$^{-1}$, see Fig. 2);

(ii) the width of Hβ is similar in the spectra of both condensation;

(iii) the broadness and diffuse character of the Fe II emissions reported by Swings (1974) in the spectrum of HD 87643 are probably due to an integration over various parts of the nebula

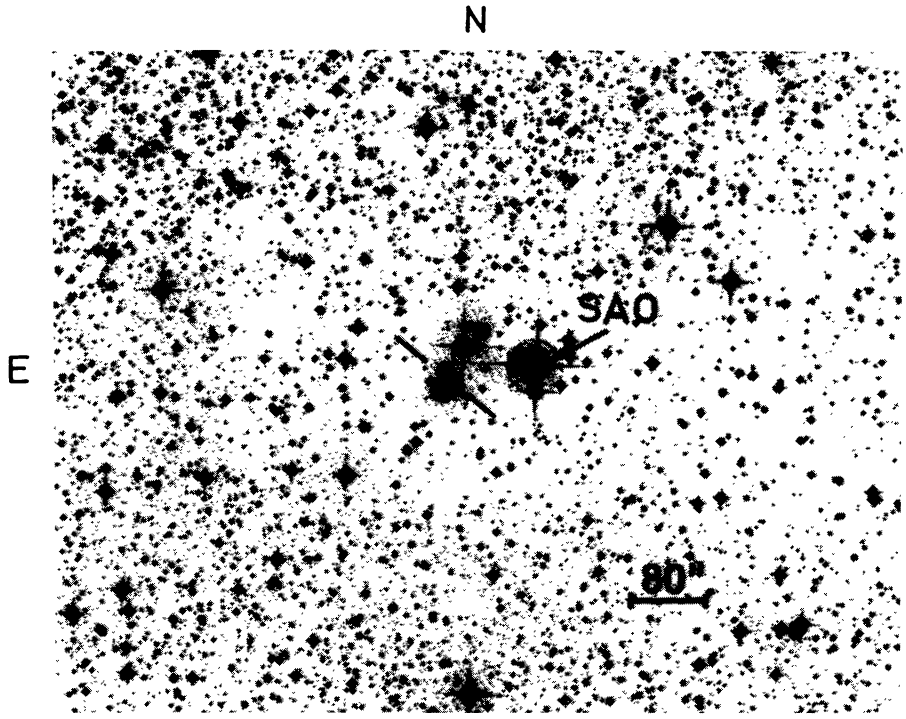


**Fig. 4.** Location of a reflection nebula discovered in the vicinity of the SAO star whose (1950.0) coordinates are R.A. = 10$^h$01$^m$13$^s$; Decl. = −59°02′22″ (from the SRC survey)

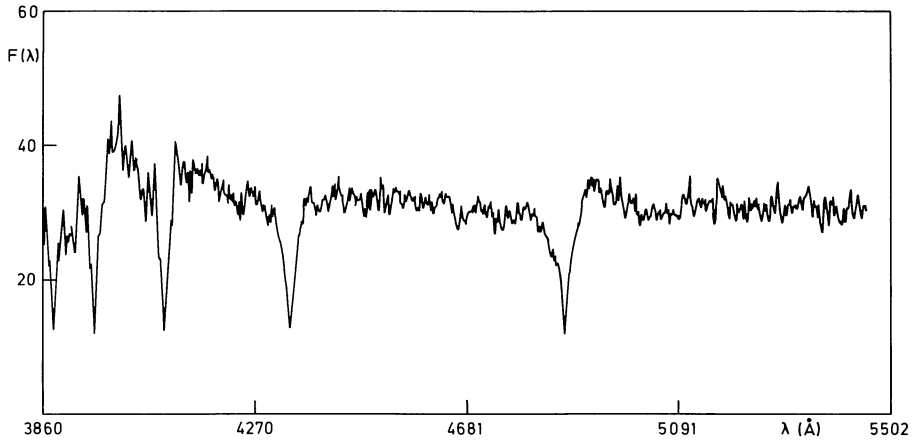


**Fig. 5.** Spectrum of the newly identified reflection nebula located within a few degrees from HD 87643. The flux scale is arbitrary

since no field rotator was used when recording the relevant long exposure coudé spectrogram.

### 3. Interpretation

The observations described above first confirm the conclusion given in Paper I, namely that there exist important relative motions ($\Delta v \gtrsim 150\,\mathrm{km\,s^{-1}}$) between different parts of the reflection nebula surrounding HD 87643. For example, the southern condensation is located in a region where motions (expansion plus rotation?) were suspected to be present (cf. Paper I).

Although the idea cannot be totally discarded, it seems very unlikely (see arguments in Paper I) that any part of the emission in the lines is intrinsic to the nebula; it is also improbable that dust plays any major role in modulating the radiation from HD 87643, since the effect would then be identical for both the continuum and the emission lines.

Therefore, from the differences observed in equivalent widths and heliocentric velocities for H$\beta$ (and Fe II) in the two condensations, we conclude that the atmospheric region of the star where these lines are formed is not isotropic and/or not homogeneous.

### 4. Addendum: a new reflection nebula

In the course of examining the field in the vicinity of HD 87643, our attention was struck by the diffuse object shown in Fig. 4: it is located near a 9.4 mag. SAO star whose (1950) coordinates are R.A. $= 10^{h}01^{m}13^{s}$; Decl. $= -59°02'22''$. Discovering an extragalactic object in a hole within the southern milky way would have been of high interest. However, spectra obtained both at the ESO 3.6 m telescope Cassegrain spectrograph equipped with an IDS, and at the Las Campanas Observatory 2.5 m telescope "*shectograph*" did not resemble the spectrum of a galaxy; on the contrary the spectrum of this nebulous object is similar to that of a galactic A 0 star (see Fig. 5), and it is therefore likely that the nebulosity is purely of reflective nature.

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### References

Barbier, R., Swings, J.P.: 1981, in Be *Stars*, *Proc.* IAU *Symp.* **98**, eds. M. Jaschek and H.-G. Groth, p. 103

Bouchet, P., Swings, J.P.: 1981, in Be *Stars*, *Proc.* IAU *Symp.* **98**, eds. M. Jaschek and H.-G. Groth, p. 241

de Freitas Pacheco, J.A., Gilra, D.P., Pottasch, S.R.: 1982, *Astron. Astrophys.* **108**, 111

Surdej, A., Surdej, J., Swings, J.P., Wamsteker, W.: 1981, *Astron. Astrophys.* **93**, 285

Swings, J.P.: 1974, *Astron. Astrophys. Letters* **34**, 333