EMISSION FEATURES OF SEVERAL Be STARS AS RELATED TO THEIR LUMINOSITY CLASS AND SPECTRAL TYPE

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1. Introduction

At the Haute Provence Observatory, a survey of the Be stars brighter than the seventh magnitude was initiated by Herman and her collaborators twenty years ago.

With this material, the relationship of emission features of Be stars to their luminosity class and spectral type is investigated. At the present time, about fifty B2 and B8–9 emission stars have been studied. The plates were taken at the 1.20 meter telescope with dispersion 77 Å mm^{-1} at Hγ, 120 Å mm^{-1} at Hβ and 300 Å mm^{-1} at Hα. All these Be stars have been classified by Herman-Rojas (1973–1974). Their classification is based on the hydrogen lines. Our study of the B3 emission stars was published this year (Delplace and Hubert, 1975) and the results will only be summarized. For the B8–9 emission stars the results will be given in detail.

2. The B2 Emission Stars

About twenty five B2 emission line stars were studied. Using the Herman-Rojas (1974) and Rountree-Lesh (1968) classifications, we have been able to distinguish three groups of stars:

(1) *First group*; two sub-groups are found:

(a) the stars exhibit strong emission of the higher Balmer lines – Metallic emission lines are present.

The emission is observed to be fairly stable.

The time scale of the emission features is long: about 30 or 40 years.

(b) the stars exhibit strong emission in the higher Balmer lines, but metallic emission lines are faint or missing. The emission features are not as stable; a hydrogen shell is often present which is enhanced during the minimum of the emission.

The time scale of the emission variations is longer than or equal to 16 years.

In the first group, the stars would generally have luminosity class V or V–IV.

(2) *In the second group*, the stars exhibit emission only in the first Balmer lines. The emission features are not as stable. In these stars the emission lines disappear and then reappear, giving: Be → B → Be.

The time scale of the emission variation is about 12 years.

In the Herman-Rojas and Rountree-Lesh classifications these stars would generally have luminosity class IV–III.

A. Slettebak (ed.), Be and Shell Stars, 33–36.

(3) *The third group* includes the typical shell stars; they would have luminosity class III.

3. B8–B9 Emission Stars

Twenty-three B8–B9 emission stars were studied. As for the B2 stars, a relation between the emission features and the luminosity class is investigated.

Four stellar groups are found.

(1) *In the first group* the stars exhibit rather strong emission at Hα. Hα is always in emission and Hβ also. The emission variations would be very faint and large. On our plates they are chiefly visible at Hβ. Though these stars have been observed for thirty to fifty years, no time scale of the emission variation can yet be given.

During the maximum of the emission, some Fe II emission lines in the long wavelength range are observed. A faint hydrogen shell is also present before and during the maximum of the emission and some enhancements of the Mg II and He I lines are also possible.

All these stars have homogeneous emission features. In the Herman-Rojas classification, they would generally have luminosity class V (Table I).

TABLE I

Group 1 of B8–9 emission stars

Star	Herman-Rojas classification	Morguleff classification	Miczaika classification	Rotational velocity (Slettebak)
HD 6343	B8 IV-V	–	–	–
HD 9709	B8 V	–	–	350
HD 18552	B8 V	B9 V	–	320
HD 21641	B9 V	–	B8 V	160
HD 23552	B8 IV ?	–	–	250
HD 47054	–	–	–	270
HD 53416	B9 V	–	–	–
HD 192044	B8 V	B8 V	–	350
HD 196712	B7–8 V	–	–	250
HD 207232	B8 IV ?	–	–	330

(2) *In the second group* the emission features are not stable. The emission in these stars disappears and reappears (giving Be → B → Be) but when the emission is present, Hα is strong (Hubert, 1971, 1973).

The time scale of the emission variations is longer than forty-five years. During the transition phase (B → Be), Na I, Ca II, and Mg II lines are enhanced.

In the Herman-Rojas classification these stars would have luminosity class V–IV or IV (Table II). We recall the case of Pleione (B7IV), for which the time scale of the emission variations is about 60 years (Delplace and Hubert, 1973).

TABLE II

Group 2 of B8–9 emission stars

Star	Herman-Rojas classification	Morguleff classification	Miczaika classification	Rotational velocity (Slettebak)
HD 164447	B8 IV	B7 IV	–	250
HD 142926	B8 IV–V	–	B8 V	350
HD 210129	B8 IV	–	B8 V	200
HD 216057	B8 IV–V	B8	–	370

(3) *In the third group* the stars exhibit very faint emission on a strong absorption at Hα. Unhappily these stars have not been observed for a long time and, on our plates, the dispersion is not sufficient to give a time scale of the emission variations. These variations are very faint, but perhaps shorter than for the first group.

In the Herman-Rojas classification these stars would generally have luminosity class IV–III (Table III).

TABLE III

Group 3 of B8–9 emission stars

Star	Herman-Rojas classification	Morguleff classification	Miczaika classification	Rotational velocity (Slettebak)
HD 6811	B9 III	B8 III	B8 III	70
HD 175511	B9 V?	–	–	–
HD 175869	B8 IV–III	–	–	–
HD 195554	B9 IV	–	–	250
HD 205551	B9 III	–	–	200

(4) *In the fourth group* the stars exhibit a faint emission at Hα (sometimes also at Hβ) or an absorption.

The time scales are certainly very large, because the absorption phase is about 40 years.

In the Herman-Rojas classification these stars would generally have luminosity class III (Table IV).

TABLE IV

Group 4 of B8–9 emission stars

Star	Herman-Rojas classification	Morguleff classification	Miczaika classification	Rountree-Lesh classification	Rotational velocity (Slettebak)
HD 144	B9 III–II	B8 III	B8 III	–	170
HD 23302	B8, 5 IV–III	B7–8 III	B6 III	B6 III	230
HD 23630	B8 III	B8 III	B7 III	B7 III	210
HD 23850	B8 IV–III	B8 III	–	–	–
HD 24479	A1 III	–	B9 III	–	110

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4. Conclusions

(1) For a given luminosity class, the emission features are much more important for B2 than B9 stars.

(2) When the stars are going through the phases Be → B → Be, the time scale of the emission variations is longer for B9 stars than B2.

(3) Emission features probably vary with luminosity class.

(4) The Be phenomenon is present

(a) when the B stars are leaving the main sequence

(b) when the B stars are at the end of the post main sequence contraction.

References

Delplace, A. M. and Hubert, H.: 1973, *Compt. Rend. Acad. Sci. Paris* **277**, 575.
Delplace, A. M. and Hubert, H.: 1975, *Astron. Astrophys.* **38**, 75.
Herman, R.: 1973, in Ch. Fehrenbach and B. E. Westerlund (eds.): 'Spectral Classification and Multicolour Photometry', *IAU Symp.* **50**, p. 17.
Herman, R.: 1974, private communication.
Hubert, H.: 1971, *Astron. Astrophys.* **11**, 100.
Hubert, H.: 1973, *Astron. Astrophys. Suppl.* **9**, 133.
Rountree-Lesh, J.: 1968, *Astrophys. J. Suppl.* **16**, 371.