# A PHOTOMETRIC STUDY OF HERBIG Ae/Be STARS

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It is well known (cf. Mendoza 1983) that "classical"Be stars, and Herbig Ae/Be objects, in addition to hydrogen lines in emission, also share at least two photometric characteristics, namely, light variations, and infrared color excesses.

We have selected the $\alpha(16)\Lambda(9)$ {Mendoza 1979}, and the JHKL-photometric systems, in order to study some photometric properties of Be stars. The observations have been carried out at the National Astronomical Observatory (San Pedro Martir, B.C.N., and Tonantzintla, Pue.), Mexico, from 1976 to 1986. The sample consists of 104 stars, whose spectra have or had at some time, one or more hydrogen lines in emission:

13 supergiant stars
45 "classical" Be stars (including P Cyg and $\beta$ Lyr)
49 Herbig Ae/Be stars

The main results are summarized in Table 1, and in Figure 1.

Table 1.- Some derived statistics in %

| Group | Emission stronger than absorption | | Shell-like characteristics |
|---|---|---|---|
| | Hα | OI | |
| supergiant | 77 | 0 | |
| classical | 83 | 25 | 19 |
| Herbig | 93 | 44 | 22 |

Figure 1 shows the $\alpha(16)\Lambda(9)$-plane for the observed stars, where it can be seen that several Herbig Ae/Be stars are well separated from other Be stars. It also shows that during our observations, 2 Herbig Ae/Be stars, 8 "classical" Be stars, and 1 supergiant star showed no photometric indication of any emission in Hα. It also should be pointed out that in the two color diagrams, and those combined with the line photometry, again, many Herbig Ae/Be stars are well separated from the other Be stars. Thus, in conclusion, it is found that in our sample (a good representation of Be stars) several Herbig Ae/Be stars have the most "extreme" photometric characteristics, namely,

i) strongest emission in Hα
ii) strongest emission in OI (λ7774A)
iii) strongest absorption in OI (λ7774A)
iv) Largest infrared excesses

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REFERENCES

Mendoza, E.E., 1979 Astron. Astrophys. *71*, 147.
Mendoza, E.E., 1983 Rev. Mexicana Astron. Astrof. *7*, 141.

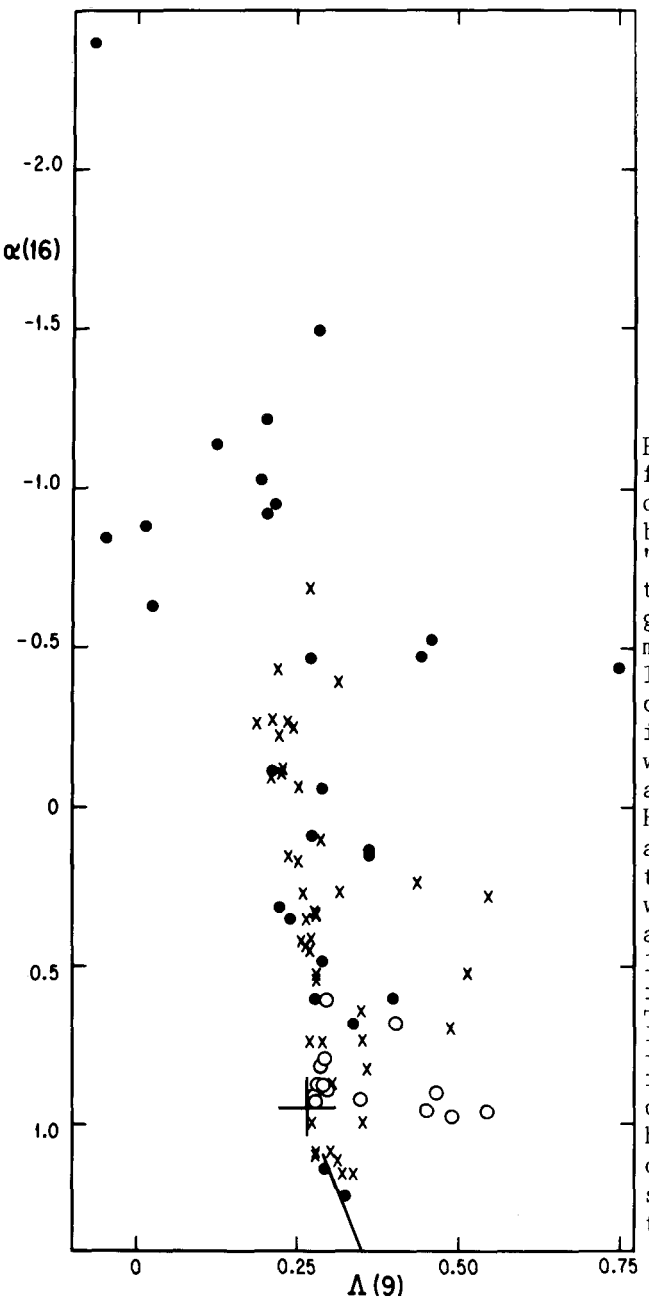


Fig. 1.- The α(16)Λ(9)-plane for Be stars. The symbols denote, filled circles, Herbig Ae/Be stars; crosses, "classical" Be stars (see text); open circles, supergiant stars; the line segment, MK standard stars of luminosity class V; the big cross marks the point where in this plane the equivalent widths are equal to zero, approximately. Objects with Hα line in emission lie above the horizontal line of this big cross. Stars in which the absorption dominates in the OI (λ7774A) line lie to the right of the vertical line of the big cross. The farther to the right, the larger the total absorption in this OI line. Notice that one Herbig Ae star (VV Ser) has the largest Λ(9)-index of all the objects in our sample. As matter of fact, the largest among 600 stars.

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## DISCUSSION FOLLOWING MENDOZA

Dachs:

Can you give transformation equations to convert your photometric $\alpha$ and $\lambda$ indices into equivalent widths of the H$\alpha$ and OI line emission or absorption?

Mendoza:

This has been given in two papers: Mendoza and Johnson (1979) and Mendoza *et al.* (1983).

Garrison:

There is some confusion among classifiers about the distinction between Herbig stars and other Be stars, because the definition of the former is not completely spectroscopic. Perhaps some of the mixture of types in the diagram is due to misclassification. Have you taken the classifications from a homogeneous source? Do you think that it is possible that the 2 groups are actually exclusive?

Mendoza:

As far as I know there is not a complete homogeneous spectral classification for Herbig Ae/Be stars. If we have two spectra which one corresponds to a classical Be star, and the other to a Herbig Ae/Be star, but the observer does not know it, then it will be about 50% probability to notice the difference. This is also true in photometry, in both cases several Herbig Ae/Be stars are separated from other Be stars because of *extreme* characteristics.

Buscombe:

Have you measured the variability of your indices with time in the erratic variable stars?

Mendoza:

Only for a few classical Be star and a couple of Herbig Ae/Be stars.

Waters:

Do you find evidence for the presence of circumstellar dust in the IR photometry?

Mendoza:

Yes, in a number of Herbig Ae/Be stars it is clear the dust presence, as I have shown in one of the slides.

Waters:

Is there a difference in IR colors between classical Be stars and Herbig Ae/Be stars?

Mendoza:

Yes, again, many Herbig Ae/Be stars have larger infrared color excesses than classical Be stars, as I also have shown in one of the slides.