SHELL PROFILES IN Be STAR SPECTRA

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1. Problem

Although very different in shape, Be-type and Be-shell-type spectral lines are thought to arise from the same kind of circumstellar environment, a disk-like envelope. The only discrimination between these two types of spectra is the inclination angle: If sufficiently high, a large column depth of circumstellar material causes partial obscuration of the stellar disk, i.e. shell absorption; otherwise a pure emission line is observed. A shell line can be considered as equivalent to P Cygni-type absorption trough for different geometry (disk instead of sphere) and kinematics (rotation instead of outflow; see Hanuschik, these proceedings).

Obviously, this very pronounced difference in line shape can be used to determine the *average opening angle of a Be star disk.* This is, however, difficult in practice since there seems to be nothing like a unique definition of "shell profile" in the literature. The mostly used criterion – central depression (cd) in Balmer lines visible below (or even above) stellar continuum – depends on spectral resolution and is ambiguous because of other effects influencing this parameter like underlying stellar absorption profile, additional circumstellar emission, kinematical broadening. Clearly, a reliable and objective definition of "shell line" is desirable.

2. Fe II line profiles

Circumstellar Fe II lines are the key to the problem because their shape is not distorted by most of the above effects. The straightforward shell criterion for these lines is $I_{\rm cd}({\rm FeII}) < I_*$. However, they are not always visible in Be star spectra, while Hα is (per definition). I have therefore searched for spectra with both Hα *and* Fe II lines, derived an Hα shell criterion from the above Fe II criterion, and applied this to a large sample of Be and shell-type stars. The Hα parameter is $I_{\rm p}/I_{\rm cd}$ ($I_{\rm p}$ = mean double peak intensity). Figure 1 shows the relation of these two parameters. Clearly, the domain with

$$I_{\rm p}/I_{\rm cd}(H\alpha) \geq 1.5 \quad (1)$$

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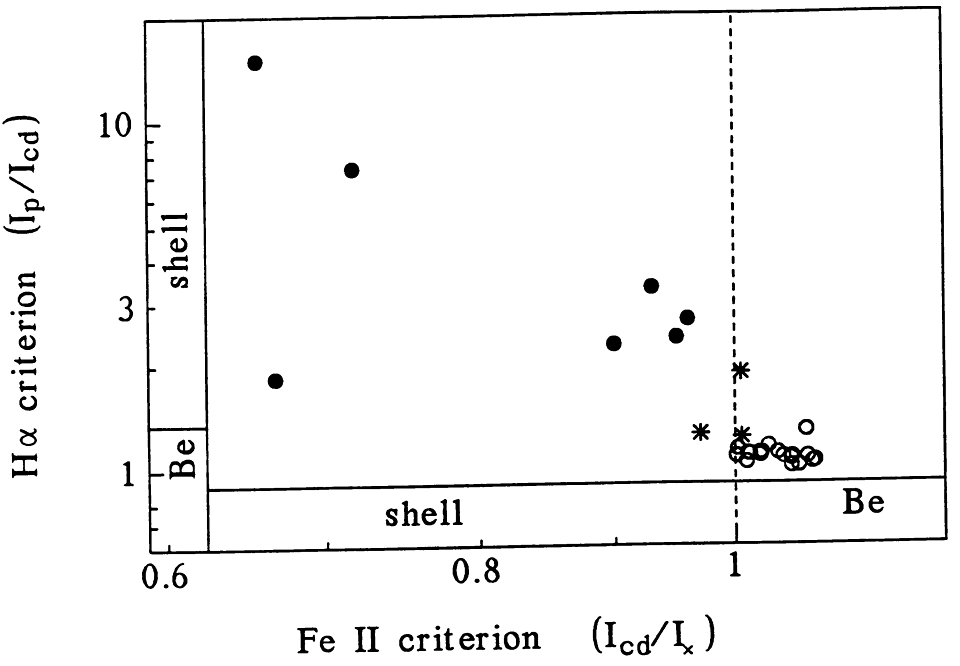

Fig. 1. Hα criterion I_p/I_{cd} vs. Fe II criterion I_{cd}/I_* for a sample of programme stars with both Hα and Fe II λ5317 measurements available.

is exclusively occupied by shell stars, giving confidence to adopt this criterion in the following.

Applying it to a sample of 109 stars from our atlas (Hanuschik et al., 1994) and that of Doazan et al. (1991), I find that $p = 21\%$ of the spectra are shell spectra. Assuming random distribution of inclination angles i, the average half opening angle $\alpha = 90° - \arccos p$ comes out as 12°. This value is in approximate agreement with results from model line profile calculations assuming a Keplerian disk in hydrostatic equilibrium (Hummel 1993).

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