Stellar Rotation
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Evolutionary State of "Field" Be Stars Deduced from BCD Parameters

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Abstract. BCD (λ_1, D) parameters of 49 "field" Be stars are used to show that the Be phenomenon may appear over the whole main sequence evolutionary span. Models of rotating B stars are used to estimate the incidence of the fast rotation in the (λ_1, D) parameters.

1. Aim and Observations

The use of (λ_1, D) parameters avoids to deal with perturbations introduced by the emissions/absorptions produced by the circumstellar envelope (CE) of Be stars on quantities employed to estimate their fundamental parameters and to discuss their evolutionary status. The evolutionary status of Be stars matters to understand whether their fast rotation is due to initial formation conditions, or it is an evolutionary consequence of their internal momentum redistribution mechanisms. The stellar sample used in the present contribution was presented in Zorec & Briot (1991), which was frequently observed since 50 years, so that their (λ_1, D) parameters are fairly well determined and reliable conclusions can be drawn from them. We assume, however, that each Be star studied evolves as a single object. Fig. 1a shows the HR diagram of the program Be stars given in terms of λ_1 (luminosity class or $\log g$-related quantity) and D (spectral type or $T_{\rm eff}$-related parameter). The figure suggests that even we use raw (λ_1, D) parameters, the Be phenomenon in "field" Be stars can appear at whatever evolutionary phase on the main sequence (MS), and, that the tendency for being in the second half of the MS is limited to late type Be stars.

2. Models

The rotationally induced stellar deformations were obtained for rigid rotation by solving Poisson's equation (Zorec et al. 1988) for the stellar internal density distributions with barotropic relations $P = P(\rho)$ (P = pressure; ρ = density) of non-rotating stars at different MS evolutionary phases for Z = 0.02 (Schaller et al. 1992). For the gravitational darkening effect we used von Zeipel's theorem.

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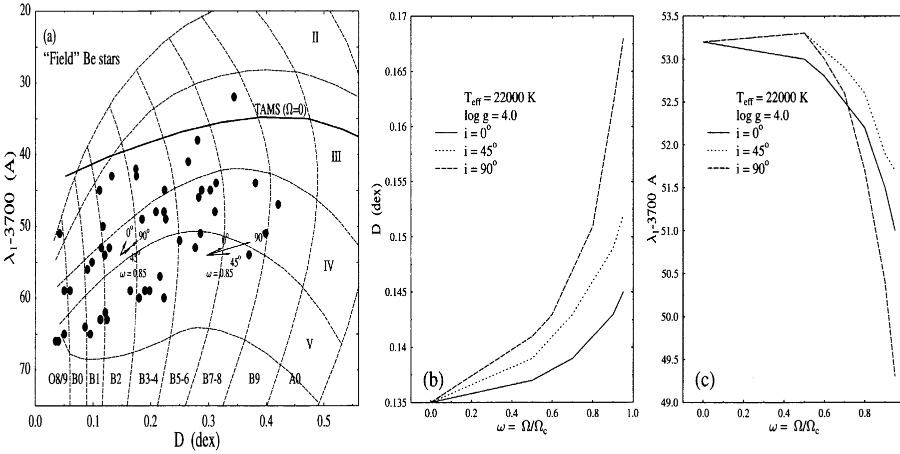

Figure 1. (a) HR diagram of Be stars in terms of observed (λ_1, D) parameters. (b) and (c) respectively D and λ_1 as a function of Ω/Ω_c for different aspect angles i, $T_{\rm eff}(\Omega = 0) = 22000$ K and $\log g(\Omega = 0) = 4.0$

Figues 1b and 1c show respectively the (λ_1, D) parameters as a function of $\omega = \Omega/\Omega_c$ (ratio of the angular velocity to the critical one) and i (aspect angle) for initial unperturbed $T_{\rm eff} = 22000$ K and $\log g = 4.0$. In Fig. 1a are shown the displacements produced by $\omega = 0.85$ at different i in stars that would have rotationally unperturbed spectral types B2V and B6V.

3. Comments

Rotationally induced instabilities and diffusioin of yields from the stellar core produce "blue-shifted" evolutionary tracks and enlarged stays of stars in the MS (Meynet & Maeder 2000). It is expected then that the absolute age and mass estimates of our program stars may be somewhat underestimated. The stellar age ratios $t/t_{\rm TAMS}$ for each star may however be still reliable, reflecting hence that the Be phenomenon in the earliest spectral types may appear in the whole $0 < t/t_{\rm TAMS} < 1$ age ratio as suggested in Fig. 1a by the (λ_1, D) parameters, though they are not corrected for rotational effects. The interval $0.5 \lesssim t_{\rm TAMS} \lesssim 1$ seems to suite to late type Be stars.

References

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