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The Winds and Disks of B[e] Supergiants

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Abstract. The problem of modeling the spectral energy distribution (SED) of B[e] supergiants (sgB[e]) is addressed. We suggest that the disks around sgB[e] are neutral in hydrogen at or close to the stellar surface, restricting the free-free (ff) and free-bound (fb) emission to the polar wind. Preliminary results for the LMC sgB[e] R 126 are in agreement with such a scenario and deliver a density contrast of $\rho_{\rm equator}/\rho_{\rm pole} \simeq 120$, typical for sgB[e].

1. Introduction

The spectra of sgB[e] show the so-called hybrid character which is defined by the co-existence of a line-driven polar wind and a high density but low velocity equatorial wind. The latter is assumed to form a disk-like structure. Porter (2003) has studied the possible nature of these disks by modeling their SEDs. He found that neither a disk-forming wind nor a Keplerian viscous disk can easily account for the observed free-free and dust emission self-consistently. This conclusion was based on the assumption that both, free-free *and* dust emission, arise in the disk. In such a case, the observed ff emission limits the equatorial mass flux. Dust formation in the disk can therefore be severely hampered.

The sgB[e] exhibit strong [O I] emission requesting a huge amount of neutral hydrogen within their disks. Modeling of the [O I] line luminosities indicates that the disks must be neutral (in hydrogen) already at or very close to the stellar surface (Kraus et al. 2006a,b). Consequently, the ff+fb emission must (mainly) originate in the polar wind. The equatorial mass flux is thus no longer limited.

2. Test Case: The LMC B[e] Supergiant R 126

We take the pole-on seen LMC sgB[e] R 126 as a test case. Stellar parameters are taken from Zickgraf et al. (1985), and the disk half opening angle is set to 10 deg. To model the [O I] line luminosities we assume that the outflowing disk

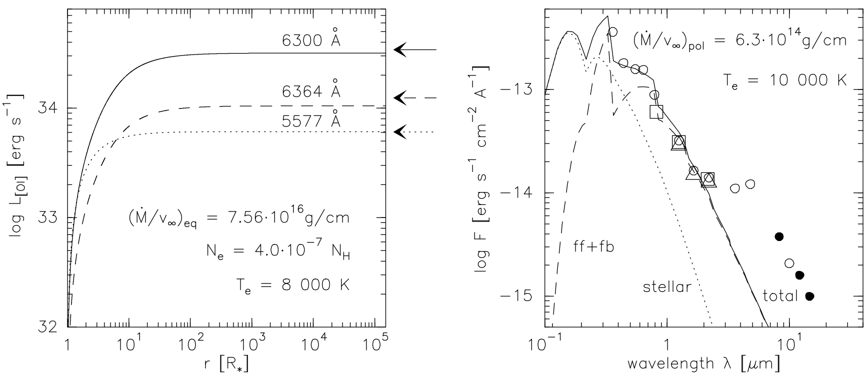

Figure 1. *Left:* Increase in [O I] line luminosities with increasing size of the hydrogen neutral disk. Observed values are indicated with arrows. *Right:* SED of R 126 consisting of the stellar and ff+fb continuum from the polar wind. Data are from Zickgraf et al. (1985, open circles), DENIS (squares), 2MASS (triangles), and MSX (filled circles). The step-like behaviour of the free-bound emission nicely fits the observations in the optical and near-IR.

is neutral in hydrogen right from the stellar surface. The free electrons needed to collisionally excite the levels are provided by elements with low ionization potentials like Fe, Ca, Mg, etc. The best fit is shown in the left panel of Fig. 1. The line luminosities saturate within $< 100\,R_*$. The ff+fb emission is calculated from the polar B-type line-driven wind. The resulting SED of R 126 (right panel of Fig. 1) nicely fits the photometric data in the optical and near-IR. From the modeling we find a density contrast between disk and polar wind of 120, typical for sgB[e]. This value is a lower limit. For more details see Kraus et al. (2006a).

3. Conclusions

We suggest that sgB[e] have outflowing disks that are neutral in hydrogen at or close to the stellar surface. The ff+fb emission must therefore arise in the polar wind. The disk mass loss rate is thus no longer limited but can be (much) higher than previously derived by e.g. Porter (2003), providing an ideal environment for effective dust formation to explain the strong IR excess.

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