Stellar and wind parameters of galactic OB stars

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Звездни и ветрови параметри на галактични OB-звезди

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The thesis contains main results from a long-term extensive survey of stellar winds from single OB stars in the Milky Way with emphasis on three main issues:(i) effects of line-blocking and blanketing;(ii) wind variability and structure; (iii) validity of the standard wind predictions.

In **Chapter 2**, the "blanketed" stellar and wind parameters of a large number of Galactic OB stars derived by means of a modified version of the approximate method of Puls et al. ([1996]), and by means of the model atmosphere code FASTWIND (Puls et al. [2005]), are outlined. Among the outcomes the most important are: (i) due to line blanketing the temperatures of Galactic OB stars need to be reduced by 10 to 20 %, with larger values being appropriate for stars with stronger winds; (ii) in full contradiction to theoretical predictions, the wind momenta of O-stars turned out to follow the low-temperature ($12\,500 \leq T_{\rm eff} \leq 22\,500$ K) predictions; most of the early B0-B1.5 subtypes are consistent with the high-temperature ($T_{\rm eff} \geq 27\,599$ K) predictions whilst the later subtypes (from B2 on) lie below (!), by about 0.3 dex (Markova et al. [2004], Markova and Puls [2008]).

In **Chapters 3**, the outcomes of two long-term, monitoring campaigns to study wind variability in α Cam (Sect. 3.1) and HD 199 478 (Sect. 3.2) are outlined, and a statistical approach to detect and quantify variations in line profiles affected by wind emission is announced and used to study the dependence of wind variability on the stellar and wind parameters of O-stars (Sect. 3.3). We show that OB star winds are variable down to its base, and that at least for O-stars with not too large wind density, the H_α variability can be successfully interpreted in terms of density perturbations uniformly distributed over the contributing volume. In the particular case of α Cam, clear evidence for the presence of two rotationally-modulated large-scale wind structures likely caused by low-mode non-radial pulsations are reported (Markova [2002], Prinja et al. [2006]). Concerning HD 199 478, this star is characterised by a photospheric variability which seems to be generated by non-radial g-mode oscillations, and a deep-seated wind variability which properties suggest presence of equatorial disc-like structure caused more likely from the influence of a weak dipole magnetic field (Markova et al. [2008]).

In **Chapter 4**, the main results of a 20-year spectroscopic and photometric survey of the LBV P Cygni are described with particular emphasis on three general issues: the nature and origin of the emission line spectrum

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(Sect. 4.2); the large diversity of variability patterns identified in the spectral and photometric behaviour of the star, and their possible interrelations and interpretations (Sect. 4.3); and the discovery of the short S Dor phase (Sect. 4.4). Among the outcomes, the most important ones are as follows: (i) the structures generating Discrete Absorption Components in UV resonance lines do not develop in the outer parts of the wind, as believed initially, but originate in the inner wind and developed outwards (Markova [1986]); (ii) P Cygni shows "100d-type microvariations" in the stellar brightness which seem to be directly coupled to changes in the wind as traced by optical lines (Markova [2001]); (iii) P Cygni experiences a long-term photometric and spectral oscillation, whose properties resemble those of the short SD-phases observed in S Dor and R71. The phenomenon is more likely due to a mixture of an expanding radius/decreasing temperature and an expanding pseudo-photosphere (Markova et al. [2001]).

In **Chapter 5**, the clumping properties of a large sample of Galactic O-stars are investigated by combining own and archival data for H_α, IR, mm and radio fluxes, and using approximate methods, calibrated to more sophisticated models. The main outcomes indicate that clumping starts at or close to the wind base; for denser winds, the innermost region is more strongly clumped than the outermost one, whereas thinner winds have similar clumping properties in the inner and outer regions; due to the effects of wind clumping, the mass loss rates derived from H_α are by about a factor of 2 and 4 larger than the actual ones (Puls et al. [2006]).

In **Chapter 6**, original results about the properties of OB star winds are confronted to theoretical predictions to check our standard picture of radiation driven winds. In fair accordance with recent results, our findings indicate a gradual decrease instead of a jump in v_∞ over the bi-stability region, where the limits of this region are located at lower $T_{\rm eff}$ than those predicted. On the other hand, and in contrary to theoretical predictions of Vink et al. [2000], we found that the strength of OB star winds is a well defined, monotonically increasing function of $T_{\rm eff}$ *outside* the bi-stability region whilst *inside* and from hot to cool, this quantity changes by a factor which is much smaller than the predicted factor of 5. Thus, the decrease in v_∞ over the bi-stability region is *not* over-compensated by an increase of $\dot{M}$, as frequently argued[1] (for more details see Puls et al. [2006]).

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[1] provided that wind-clumping properties on both sides of this region do not differ substantially.