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SUPERGIANTS: STELLAR WINDS AND MASS-LOSS

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The knowledge of stellar wind properties and mass loss rates in massive stars is a milestone in the stellar evolution and disk formation process. Our current view of winds reveals they are often highly variable and inhomogeneous. We review here the wind structure of early-type stars, such as the new hydrodynamical solutions, the wind clumping and the weak-wind problem. We also discuss the peculiar circumstellar environment around some short-lived phases of evolved massive stars (i.e., LBV and B[e] supergiants). Accurate mass loss rate estimates are crucial keys to discuss the importance of different triggering mechanisms in driving a wind.

Massive stars return nucleosynthetically processed material to their surroundings through mass-loss events and supernovae. Depending on the amount of mass lost, stellar winds may modify the final stage of stars' life (stellar evolution timescales and the final core mass). The mechanical energy and momentum transfered by the wind to the circumstellar medium may lead to the formation of wind-blown bubbles and circumstellar shells, or initiate star formation processes. During some short-lived phases such as LBV and B[e] supergiants, the ejected mass is asymmetric and leads to disk-like structures which are often cool and dense enough for efficient molecule and/or dust condensation.

As massive stars go off the main sequence they transit phases not only of a strong mass loss rate but also of different pulsation properties (Saio et al. 2013). Radial and non-radial pulsation modes are observed in many supergiants and it was suggested that pulsations might trigger a variable mass-loss. Time spectral and photometric high-resolution observations are needed to investigate this possible connection.

Stellar winds of blue supergiants are mainly driven by line scattering of the star's continuum flux. The standard formalism of line-driven winds by Castor, Abbott & Klein (1975, CAK theory) enables to explain the global properties of O supergiants. However, the discrepancies found between mass loss rates derived from different line transitions and/or radio observations are attributed to the existence of wind instabilities leading to the formation of small density inhomogeneities (clumps). It has been shown that if clumps are assumed to be optically thick at certain frequencies (porosity or macroclumping approach) the same mass loss rate is able to fit the Hα and UV resonance lines (Šurlan et al. 2013).

On the other hand, the radiation-driven wind theory for rotating stars was re-examined by Curé (2004) some years ago. He found that for rotational speeds above ~ 75 % of the critical velocity, the wind solution can switch to a slow velocity regime (Ω-slow solution), characterized by a slower outward acceleration, a larger mass flux and a lower terminal velocity than the standard CAK-solution. This type of solution combined with changes in the line force parameters due to the bi-stability temperature jump might account for the outflowing disk observed in B[e] supergiants (Curé et al. 2005). There are also new slow wind hydrodynamical solutions (for both rotating and non-rotating cases) when the ionization of the wind (characterized by the line force parameter δ) changes with distance. This new δ-slow solution can explain the observed terminal velocities and the wind momentum-luminosity relationship of A supergiants (Curé et al. 2011). This type of solution is also promising to explain the wind velocity structure of B-type supergiants, which is currently approached by a β-law with β between 1 and 3 (Markova & Puls, 2008).

Accurate mass loss rate estimates are crucial keys to understand gaseous and dusty disk formation processes and discuss the different triggering mechanisms in driving a wind.

REFERENCES

Castor, J. I.; Abbott, D. C.; Klein, R. I. 1975, ApJ, 195, 157

Curé, M. 2004, ApJ, 614, 929

Curé, M., Cidale, L. and Granada, A. 2011, ApJ, 737, 18

Curé, M., Rial, D. and Cidale, L. 2005, A&A, 437, 929

Markova, N., Puls, J. 2008, A&A, 478, 823

Saio, H. et al. 2013, MNRAS, 433, 1246

Šurlan et al., 2013, A&A, 559, 130

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