Mass loss from hot massive stars

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Mass loss is a key process in the evolution of massive stars, and must be understood *quantitatively* if it is to be successfully included in broader astrophysical applications such as galactic and cosmic evolution and ionization. In this review, we discuss various aspects of radiation driven mass loss, both from the theoretical and the observational side. We focus on developments in the past decade, concentrating on the winds from OB-stars, with some excursions to the winds from Luminous Blue Variables (including super-Eddington, continuum-driven winds), winds from Wolf-Rayet stars, A-supergiants and Central Stars of Planetary Nebulae.

After recapitulating the 1-D, stationary *standard model* of line-driven winds, extensions accounting for rotation and magnetic fields are discussed. Stationary wind models are presented that provide theoretical predictions for the mass-loss rates as a function of spectral type, metallicity, and the proximity to the Eddington limit. The relevance of the so-called bi-stability jump is outlined.

We summarize diagnostical methods to infer wind properties from observations, and compare the results from corresponding campaigns (including the VLT-FLAMES survey of massive stars) with theoretical predictions, featuring the mass loss-metallicity dependence.

Subsequently, we concentrate on two urgent problems, *weak winds* and *wind-clumping*, that have been identified from various diagnostics and that challenge our present understanding of radiation driven winds. We discuss the problems of ``measuring'' mass-loss rates from weak winds and the potential of the NIR Br_alpha-line as a tool to enable a more precise quantification, and comment on physical explanations for mass-loss rates that are much lower than predicted by the standard model. Wind-clumping, conventionally interpreted as the consequence of a strong instability inherent to radiative line-driving, has severe implications for the interpretation of observational diagnostics, since derived mass-loss rates are usually overestimated when clumping is present but ignored in the analyses. Depending on the specific diagnostics, such overestimates can amount to factors of 2 to 10, and we describe ongoing attempts to allow for more uniform results. We point out that independent arguments from stellar evolution favor a moderate reduction of present-day mass-loss rates.

We also consider larger scale wind structure, interpreted in terms of co-rotating interacting regions, and complete this review with a discussion of recent progress on the X-ray *line* emission from massive stars. Such emission is thought to originate both from magnetically confined winds and from non-magnetic winds, in the latter case related to the line-driven instability and/or clump-clump collisions. We highlight as to how far the analysis of such X-ray line emission can give further clues regarding an adequate description of wind clumping.

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