The mass-loss rates of red supergiants and the de Jager prescription

N. Mauron and E. Josselin

GRAAL, CNRS and Univ. of Montpellier, Place Bataillon, 34095 Montpellier, France

Mass loss of red supergiants (RSG) is important for the evolution of massive stars,
but is not fully explained. Several empirical prescriptions have been proposed, trying to express the mass-loss rate as a function of fundamental stellar parameters (mass, luminosity, effective temperature). Our goal is to test whether the de Jager et al. (1988) prescription, used in some stellar evolution models, is still valid in view of more recent mass-loss determinations. By considering 40 Galactic RSGs presenting an infrared excess and an IRAS 60-micron flux larger than 2 Jy, and assuming a gas-to-dust mass ratio of 200, it is found that the de Jager rate agrees within a factor 4 with most mass-loss rate estimates based on the 60-microns signal. It is also in agreement with 6 of the only 8 Galactic RSGs for which the mass-loss rate can be measured more directly through observations of the circumstellar gas. The two objects that do not follow the de Jager prescription (by an order of magnitude) are mu Cep and NML Cyg. We have also considered the RSGs of the Magellanic Clouds. Thanks to the works of Groenewegen et al. (2009) and Bonanos et al. (2010), we find that the RSGs of the Small Magellanic Cloud have mass-loss rates consistent with the de Jager rate scaled by (Z/Zsun)**(alpha), where Z is the metallicity and alpha is 0.7. The situation is less clear for the RSGs of the Large Magellanic Cloud. In particular, for L > 160000 solar luminosities, one finds numerous RSGs (except WOH-G64) having mass-loss rates significantly smaller than the de Jager rate and indicating that it would no longer increase with L. Before this odd situation is confirmed through further analysis of LMC RSGs, we suggest to keep the de Jager prescription unchanged at solar metallicity in the stellar evolutionary models and to apply a (Z/Zsun)**(0.7) dependence.

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Comments:

Email: mauron@graal.univ-montp2.fr