The influence of carbon dust on mass loss

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We have investigated how the predicted wind properties of carbon-rich AGB stars are influenced by the choice of micro-physical dust parameters i.e. the optical properties of the dust, the intrinsic dust density, the assumed sticking coefficients and the surface tension of the grain material (these two last parameters control the efficiency of the dust formation), for details see Andersen et al. (A&A 400, 981).

For the theoretical predictions of mass-loss it is important to know how the uncertainty in the chosen dust parameters affects the obtained results. Varying the micro-physical parameters within the range typical of possible materials can change the value for the mean outflow velocity of the gas and dust as well as the predicted degree of dust condensation by a factor of ten and the predicted mass-loss by a factor of four. In the transition region between models with and without mass-loss the choice of micro-physical parameters is vital for whether a particular set of stellar parameters will give rise to a dust-driven mass-loss or not.

The main source of momentum for the stellar wind is the radiation pressure on dust. The radiation pressure on the dust and the radiative equilibrium grain temperature is determined by the wavelength dependence of the grain extinction efficiency. The steeper the dependence of wavelength, the larger the difference between the equilibrium grain temperature and the radiation temperature. The radiation pressure on the other hand is proportional to the flux mean opacity which both depends on the slope of the extinction efficiency as a function of wavelength and on its absolute value. The latter may differ by almost an order of magnitude for different types of amorphous carbon in the critical region around 1 μm. The density of the grain material has to be chosen consistently with the grain extinction efficiency.

The surface tension of the grain material and the sticking coefficients are very significant for the calculated rates at which grains are formed out of the gas (nucleation) and at which new material is added to existing grains (grain growth). Even a moderate variation of the values within the range expected for possible materials has noticeable consequences for the properties of the dust-driven stellar winds, including the resulting near-infrared colors.

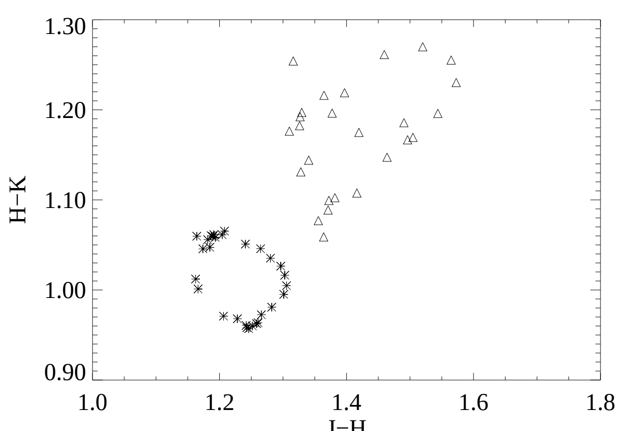

Figure 1: Near-IR colors for different phases of two similar models, which only differ by the assumed value of the sticking coefficient (α). For the $*$-models $\alpha = 0.3$ and for the $\triangle$-models $\alpha = 1.0$. The larger the sticking coefficient is assumed to be, the more efficient will the grain formation be and as a consequence the models will look redder.