Astronomy in Focus - XXX
Proceedings IAU Symposium No. XXX, 2018
M. T. Lago, ed.

doi:10.1017/S1743921319004952

Constraining dust properties in circumstellar envelopes of C-stars in the Magellanic Clouds: Optical constants and grain size of carbon dust

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In galaxies with sub-solar metallicity, such as the Magellanic Clouds (MCs), a large fraction of the thermally pulsing asymptotic giant branch (TP-AGB) stars evolve through the carbon-rich phase (C-stars), shaping the near and mid-infrared colours of the resolved stellar populations. The spectra of C-stars are largely affected by the presence of carbon dust that condenses in their circumstellar envelopes (CSEs). The study of dust growth and radiative transfer in the CSEs of these stars allows us to investigate the properties of carbon dust. In particular, the main uncertainties in the input physics of radiative transfer models are related to the choice of the grain size distribution and of the optical constants for carbon dust. The former cannot be directly derived from observations, while for the latter several sets of lab measurements, very different from each other, are available. The results obtained by using different combinations of those inputs can be tested against the observations of thousands of C-stars in the MCs, providing constraints on the carbon dust properties. By requiring our models to simultaneously reproduce several observed infrared colour-colour diagrams (CCDs), we found the best agreement with the observations of the MCs for nano dust particles, with sizes between 0.035–0.1 μm, rather than by larger grains, of 0.2–0.7 μm (Nanni *et al.* 2016). The inability of large grains to reproduce the infrared colours is independent of the adopted optical data set and the deviations between models and observations tend to increase for increasing grain sizes. In addition to that, some sets of optical constants are always unable to reproduce the infrared colours. This investigation also allows us to identify a possible trend between the grain size or grain structure (more graphite-like or diamond like) and the mass-loss rate. The optical constants that satisfactorily reproduce the observed CCDs are adopted to compute grids of spectra as a function of the input stellar quantities. By employing these grids, we fit the spectral energy distribution of the C-stars in the MCs and we estimate their mass-loss rates and dust production rates (Nanni *et al.* 2018).

References

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