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AGB circumstellar envelope dust mineralogy from ground based mid-IR imaging and photometry

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Abstract

The possibility to constrain the mineralogy of dust in AGB circumstellar envelopes with mid-IR ground based imaging observations is discussed, and the consequences on mass loss mechanisms and the AGB evolution are evaluated. The analysis is made deriving mid-IR colors for a sample of ~400 AGB sources in the IRAS LRS database, in order to simulate photometric observations with a mid-IR camera. Radiative transfer modelling is used to reproduce the colors of each individual source, obtaining an estimate of the envelope optical depth, dust condensation temperature, dust to gas mass ratio and dust grain detailed composition. The 10 and 20 microns images of each modelled source are then simulated for various infrared telescopes (UKIRT, NASA IRTF, TIRGO and KECK) with different mid-IR imaging cameras, to select a subsample of AGB envelopes that can be spatially resolved with mid-IR ground based observations. Real observations of 30 AGB sources are then compared with the model data, in order to test the modelling technique, and the results of the simulations. The statistical analysis of the sources in the sample shows that Mid-IR colors of O-rich AGB have a larger scatter than the colors of C-rich sources, as a consequence of a larger variety in their surface composition, reflecting their initial mass and age. The colors of C-rich AGB dust can be explained by mixtures of amorphous carbon and SiC, while in the case of O-rich envelopes there is not a single "astronomical silicate" dust, but each O-rich envelope should be fitted mixing a large variety of components in various proportions, that can be estimated for each source from the mid-IR colors. The dust and gas mass loss rates are not necessarily correlated due to the different techniques used for their determination (mid-IR observations for dot M_d and radio for dot M_g), that probe separate parts of the AGB envelope. This result favors mass loss scenarios in which the dust formation varies on timescales shorter than the crossing time of the envelopes at gas escape velocity.