Extremely extended dust shells around evolved intermediate mass stars: Tracing the history of mass loss, thermal pulses and stellar evolution

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ABSTRACT

Intermediate mass stars ($0.8 - 8 solar masses), at the asymptotic giant branch phase (AGB) suffer intensive mass loss, which leads to the formation of a circumstellar shell (s) of gas and dust in their circumstellar envelope. At the end of the AGB phase, the mass-loss decreases or stops and the circumstellar envelope begins to drift away from the star. If the velocity of the AGB phase wind has been relatively constant, then dust or molecular emission furthest from the star represents the oldest mass loss, while material closer to the star represents more recent mass loss. Therefore, the history of mass loss during the AGB phase is imprinted on the dust shells of the post-AGB envelope. Thus, by studying the distribution of material in the form of dust emission in the circumstellar shells of late evolved stars (i.e. the post AGB phases are pre - planetary nebula (PPN) and the planetary nebula (PN)) we can gain a better understanding of the mass-loss processes involved in the evolution of intermediate mass stars. I studied two groups of intermediate mass stars, namely six oxygen rich and six carbon rich candidates. In this thesis a study of evolution of intermediate mass stars is confronted by means of observations, in which far - infrared (FIR) images, are used to study the physical properties and the material distribution of dust shells of AGB and post AGB circumstellar envelope. Infrared radiation from thermal dust emission can be used to probe the entire dust shell because, near to mid-infrared radiation arises solely from the hottest regions close to the star; while the outer regions away from the star are cool such that they emit at longer infrared wavelengths. Essentially, radiation in the FIR to sub-millimeter wavelengths is emitted by the entire dust shell and hence can be used to probe the entire dusty envelope. Therefore far-infrared emission by late evolved stars can be used to probe the large scale - structure of AGB and post - AGB circumstellar shells.

Our results from space observations indicated the following:
The sizes of the circumstellar dust shell observed in oxygen rich stars are within $>$1 pc. We derived the dust masses derived from far infrared ISO PHT 32 observation of oxygen rich stars that are between 1.7 -- 4 x 10^{-4} solar masses . These results provides us with a lower limit in the progenitor masses of stars estimated to be within 0.56 -- 0.76 solar masses. These results indicate that the initial main sequence masses fro oxygen rich stars are within 1 – 3.5 solar masses. The time scales derived since the oldest mass was ejected during the evolution of oxygen rich stars are 4 - 13 x 10^{4} years. For the carbon rich stars: The size of the circumstellar dust shells are within 1 - 1.6 pc. The masses of dust in the shells are a approximated to be within 0.1 - 1.44 x 10^{-4} solar masses. A lower limit to the progenitor masses of carbon rich stars that are between 0.61 - 0.9 solar mass, suggesting that these stars evolved from the main sequence masses between 2. - 6 solar masses.