EVOLUTION OF A DUST SHELL ALONG A STELLAR POST-AGB TRACK

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We study the spectral appearance of an evolving post-AGB object by means of two-fluid radiation hydrodynamics (gas and dust) in spherical symmetry. The stellar parameters as well as mass-loss rates are assumed to vary consistently with the stellar model calculations of Blöcker (1989, Diplom Thesis, University of Kiel) for a $3\,M_\odot$ sequence, resulting in a $0.605\,M_\odot$ remnant. The expelled mass is assumed to consist of spherical astronomical silicates with grain radii of $0.1\,\mu m$ and an *initial* dust-to-gas mass ratio of $7.5 \cdot 10^{-3}$. For further details on the computational method we refer to Szczerba & Marten (1992, in: Proc. of the ESO/CTIO Workshop, Mass Loss on the AGB and Beyond, La Serena 1992, *in press*).

Following the last 30000 yrs of AGB evolution along Blöckers $3\,M_\odot$ sequence with increasing mass-loss rates and an initial wind velocity of 5 km/sec, the star finally becomes totally obscured by a thick dust shell which expands with a final velocity of about 15 km/sec. In the calculations of Blöcker, the heavy mass loss of the red giant is eventually smoothly decreased between the stellar radial fundamental pulsation periods of 100 and 50 d (see also Blöcker & Schönberner, 1990, A&A 240, L11). During this short phase of only about 200 yrs the stellar continuum reappeares as a bump shortwards of the L photometric band. The decreasing mass loss (density) reduces the frictional coupling between dust and gas, and the dust is accelerated to about 150 km/sec ($v_{gas} \approx 50$ km/sec). As a result, the contribution of newly formed (hot) dust from this high velocity/low density wind region to the overall spectra during the post-AGB phase is much smaller than expected from the quasi-stationary approach of other authors. Consequently, our model tracks with and without further dust condensation show a very similar behaviour in the $\log(\lambda F_\lambda(60)/\lambda F_\lambda(25))$ versus $\log(\lambda F_\lambda(25)/\lambda F_\lambda(12))$ plane with a maximum difference in their colors of only about 0.4 dex. At a post-AGB age of about 600 yrs ($T_{eff} \approx$ 7500 K), our model sequences in the IRAS diagram start to deviate from what is expected for a simply expanding and cooling shell. Instead of evolving downwards, describing a big loop until the colors of black bodies with the corresponding stellar temperature(s) are reached, the dust shells are re-heated due to the growing stellar temperatures and the models start to proceed to the upper right.

Both, the non-linear dynamical effects of the dust acceleration as well as consistent evolutionary changes of the stellar parameters and mass-loss rates *must* be taken into consideration in order to understand the exact course of the mass loss and its influence on the timescales for post-AGB evolution.