Why Galaxies Care About AGB Stars:
A Continuing Challenge through Cosmic Time
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A DARWIN C-star model grid with new dust opacities

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Abstract. We have improved the treatment of dust opacity from the small-particle limit approximation to size-dependent which leads to models with smaller grains, lower dust-to-gas ratios, but about the same mass-loss rates and outflow velocities. The K-magnitudes get brighter, whereas the V-magnitudes can be either brighter or dimmer depending on the wind properties.

Keywords. stars: AGB and post-AGB, stars: winds, outflows, stars: carbon

1. Introduction

Winds of AGB stars are presumably driven by a combination of pulsation-induced shock waves and radiation pressure on dust. We have computed a grid of RadiationHydroDynamic atmosphere+wind models for C-rich AGB stars using the DARWIN code. It calculates time-dependent radial structures by solving the hydrodynamical equations using non-gray radiation transport and time-dependent dust formation/destruction. The gas opacities come from the COMA11 code. The main difference to the Eriksson *et al.* (2014) grid is that we now use **size-dependent dust opacities (SDO)** instead of the **small-particle limit (SPL)** approximation for the amorphous carbon grains, see also Mattsson & Höfner (2011). For each model, synthetic spectra and photometry in the range $0.3 - 25\,\mu$m were computed *a posteriori* with the COMA11 code (Aringer *et al.* 2009) for selected time-steps (about 200 covering about six pulsation periods per model).

2. Grid parameters

The grid parameters are the same as in Eriksson *et al.* (2014): **Teff**: 2600, 2800, 3000, 3200 K, **log L**: 3.55, 3.70, 3.85, 4.00 $L_\odot$, and **Current mass**: 0.75, 1.0, 1.5, 2.0 $M_\odot$. For each of these, we use three carbon excesses: **log (C-O)**: 8.2, 8.5, 8.8, and three **pulsational amplitudes**: 2, 4, 6 km/s.

3. Results

As seen in Fig. 1, showing quantities for the SDO vs. the SPL models, we find that: the mass-loss rates and the outflow velocities are similar, while the carbon condensation degreees, the grain sizes, and the dust-to-gas mass ratios are smaller.

The dust opacity in the visual region with its high-momentum radiation is increased compared to the SPL case, especially for grains with radii of $0.1 - 0.4\,\mu$m. This gives a higher outward acceleration and the dust grains then move faster through the dust

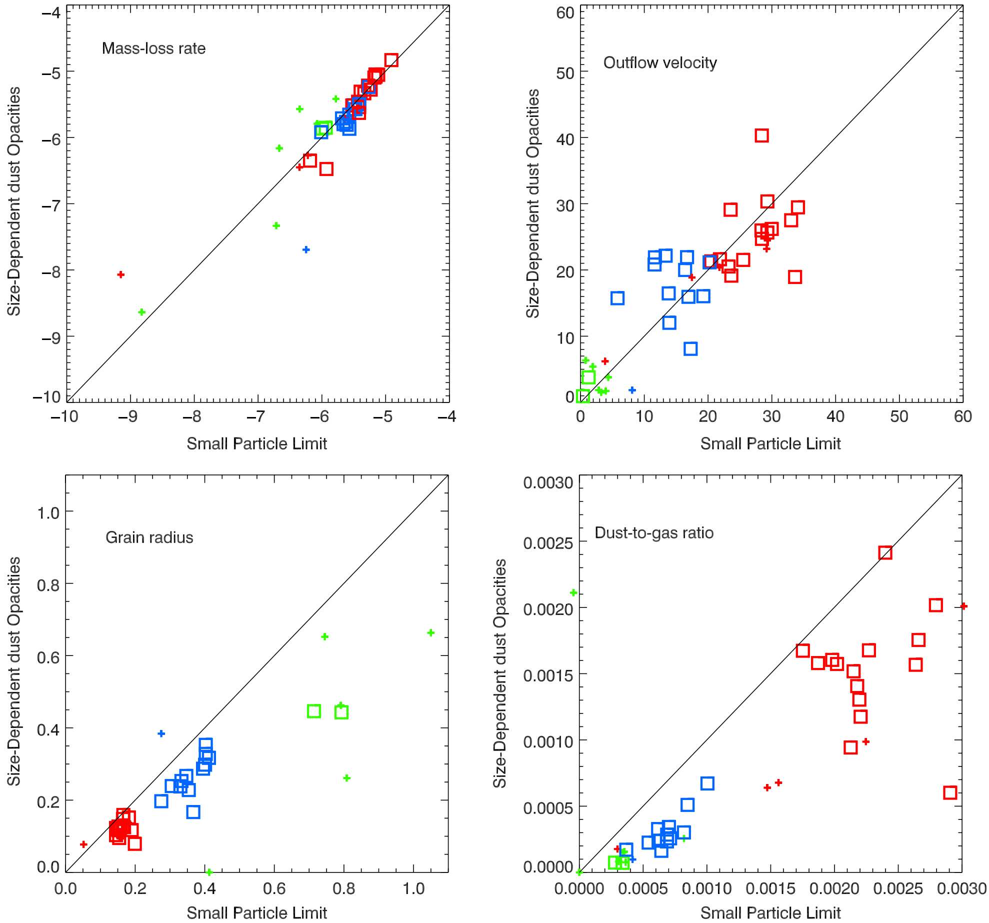

Figure 1. Comparing SDO results to the SPL ones. Squares: wind models, pluses: episodic models. Colours denote the carbon-excess: Green: 8.2, Blue: 8.5, Red: 8.8. Only results for 1 solar mass models are shown.

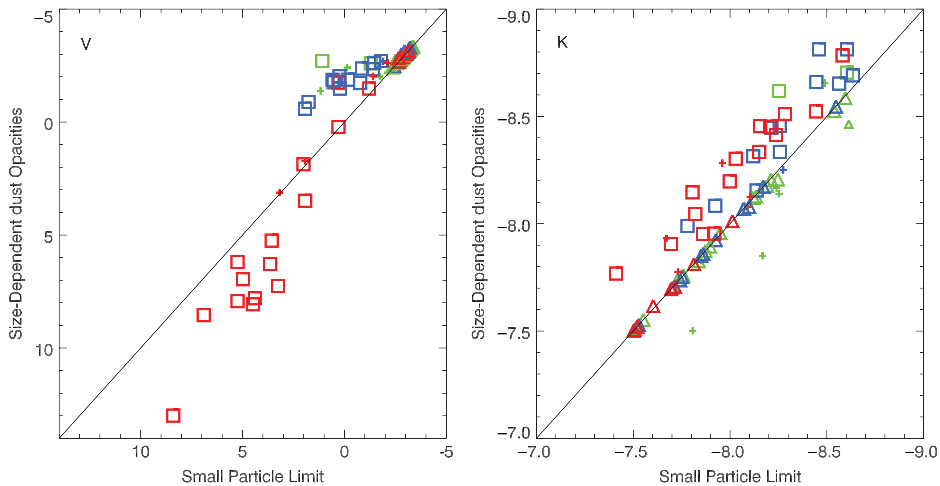

Figure 2. V and K photometry for SDO vs. SPL case. Symbols as in Fig. 1; in addition triangles denote no-wind models. Only 1 solar mass models are shown.

condensation zone. Hence, they will be smaller, like the condensation degree and the dust-to-gas mass ratio.

The different treatment of the dust opacity also affects the synthetic spectroscopy and photometry. For the V magnitude, we see in Fig. 2 that models with moderate winds (say, with $V < 0$) display brighter V magnitudes than in the SPL case: this is due to smaller dust condensation making the maxima brighter. Also the minima in the SPL case are usually significantly deeper. For the more massive winds in cool, luminous and carbon-rich models, the larger dust opacity makes V dimmer. For the K magnitudes, we see that for almost all models with a wind it is brighter than in the SPL case due to increased dust emission. More details will be given in Eriksson *et al.* (2018, in preparation).

References

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