Mid-infrared interferometric monitoring of evolved stars - The dust shell around the Mira variable RR Aql at 13 epochs

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We obtained 13 epochs of mid-infrared interferometry with the MIDI instrument at the VLTI between April 2004 and July 2007, covering pulsation phases 0.45-0.85 within four cycles. The data are modeled with a radiative transfer model of the dust shell where the central stellar intensity profile is described by a series of dust-free dynamic model atmospheres based on self-excited pulsation models. We examined two dust species, silicate and Al2O3 grains. We performed model simulations using variations in model phase and dust shell parameters to investigate the expected variability of our photometric and interferometric data. The observed visibility spectra do not show any indication of variations as a function of pulsation phase and cycle. The observed photometry spectra may indicate intracycle and cycle-to-cycle variations at the level of 1-2 standard deviations. The best-fitting model for our average pulsation phase of 0.64+/-0.15 includes the dynamic model atmosphere M21n (T_model=2550 K) with a photospheric angular diameter of 7.6+/-0.6 mas, and a silicate dust shell with an optical depth of 2.8+/-0.8, an inner radius of 4.1+/-0.7 R_Phot, and a power-law index of the density distribution of 2.6+/-0.3. The addition of an Al2O3 dust shell did not improve the model fit. The photospheric angular diameter corresponds to a radius of 520^+230_-140 R_sun and an effective temperature of ~ 2420+/-200 K. Our modeling simulations confirm that significant visibility variations are not expected for RR Aql at mid-infrared wavelengths within our uncertainties.
We conclude that our RR Aql data can be described by a pulsating atmosphere surrounded by a silicate dust shell. The effects of the pulsation on the mid-infrared flux and visibility values are expected to be less than about 25% and 20%, respectively, and are too low to be detected within our measurement uncertainties.

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