Dust modeling of the combined ALMA and SPHERE datasets of HD163296

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1802.03328 Multi-wavelength observations are indispensable in studying disk geometry and dust evolution processes in protoplanetary disks. We aimed to construct a 3-dimensional model of HD 163296 capable of reproducing simultaneously new observations of the disk surface in scattered light with the SPHERE instrument and thermal emission continuum observations of the disk midplane with ALMA. We want to determine why the SED of HD 163296 is intermediary between the otherwise well-separated group I and group II Herbig stars. The disk was modelled using the Monte Carlo radiative transfer code *MCMax3D*. The radial dust surface density profile was modelled after the ALMA observations, while the polarized scattered light observations were used to constrain the inclination of the inner disk component and turbulence and grain growth in the outer disk. While three rings are observed in the disk midplane in millimeter thermal emission at ~80, 124 and 200 AU, only the innermost of these is observed in polarized scattered light, indicating a lack of small dust grains on the surface of the outer disk. We provide two models capable of explaining this difference. The first model uses increased settling in the outer disk as a mechanism to bring the small dust grains on the surface of the disk closer to the midplane, and into the shadow cast by the first ring. The second model uses depletion of the smallest dust grains in the outer disk as a mechanism for decreasing the optical depth at optical and NIR wavelengths. In the region outside the fragmentation-dominated regime, such depletion is expected from state-of-the-art dust evolution models. We studied the effect of creating an artificial inner cavity in our models, and conclude that HD 163296 might be a precursor to typical group I sources.

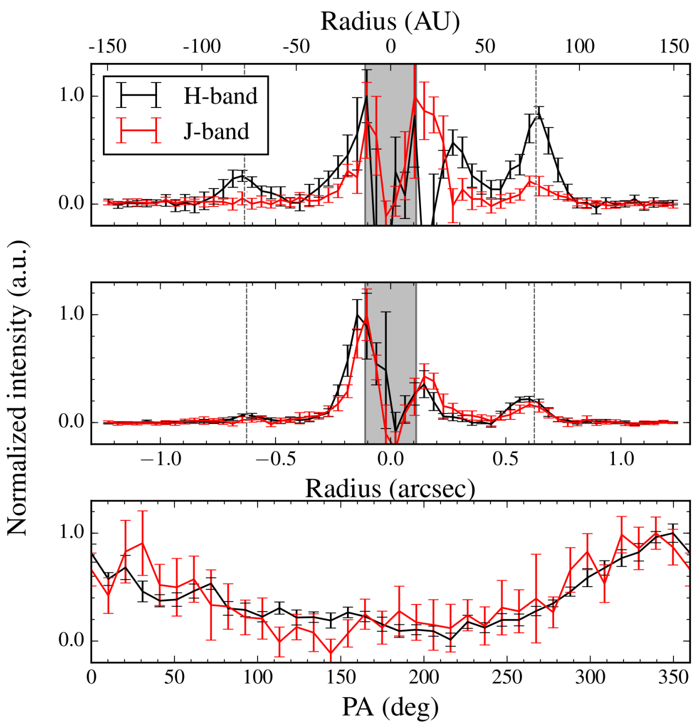

Fig. 2: Top: radial polarized intensity profile through the center of the ring along the major axis for H-band (black) and J-band (red) Q_ϕ images. Middle: radial polarized intensity profile through the star in the direction of the major axis for both bands. Positive radii correspond to the North-West direction, and negative radii to the South-East direction. The vertical dashed lines mark the approximate location of the ring at 77 AU. The grey region at the center of the figure corresponds to the location of the coronograph. Bottom: azimuthal intensity profile of the ring in H-band (black) and J-band (red) at a distance of 77 and 74 AU from the center of the disk, respectively, centered at the center of each ring. The position angle PA is measured East-from-North. All profiles are normalized to the maximum intensity.

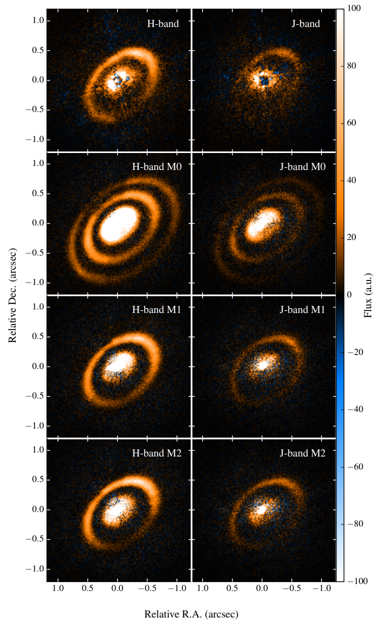

Fig. 5: Side-by-side comparison of the Q_ϕ scattered light images for both H-band (left) and J-band (right) for our observations (top), model M0 (second row), model M1 (third row) and model M2

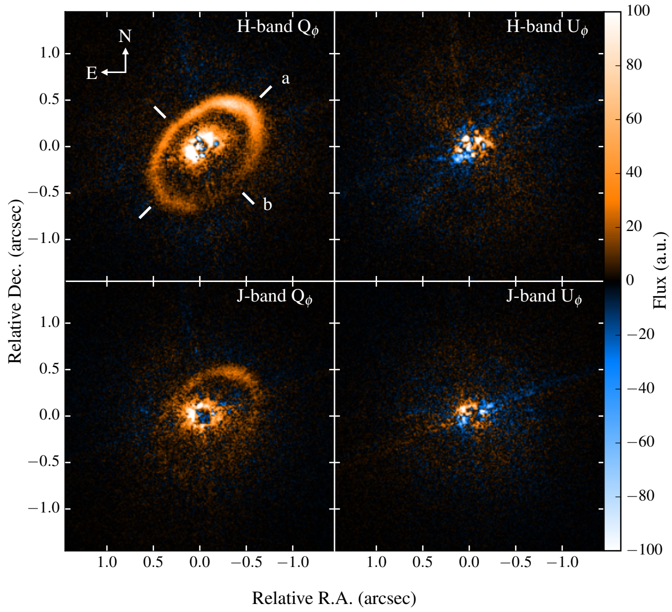

Fig. 1: H-band (top) and J-band (bottom) DPI observations of HD 163296 with SPHERE/IRDIS. Left column shows the Q_ϕ images, with the right column showing U_ϕ. A single asymmetrical ring is obserbed in scattered light at ~0.6 arcsec from the center of the disk in both Q_ϕ images, slightly offset from center in the South-West direction. An additional bright inner component shows up in both bands, the center of which is obscured by the coronograph. Some residual signal shows up in both U_ϕ images, mostly constrained to the inner 0.2-0.3 arcsec. The white dashes indicate the position of the major and minor axes, labeled a and b respectively.