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The Red Rectangle: a thin disk with big grains and gravel

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Abstract

The Red Rectangle is the prototype of a particular class of post-AGB nebulae associated with binary systems, characterised by the presence of stable circumbinary disks in Keplerian rotation. Here we present the results of high-resolution (20 to 55 mas) 0.9 mm ALMA observations of Red Rectangle's disk. The continuum maps are analysed with a model of dust emission, which reproduces the observational data at 0.9 and 0.45 mm. We find that most dust emission is concentrated in the central regions of the rotating disk. The settlement of dust grains onto the equatorial plane is very significant. The diameter of the dust-emitting region is 250 au, with a total width of 50 au, with a dust disk mass of 25 $M_\oplus$. The sub-mm spectral index confirms the presence of large grains at least 300 μm in diameter, supporting the long-lived hypothesis for this structure. cm-wavelength data suggests a population of even larger grains of sizes up to a few cm. We also confirm the existence of a compact, 10 au, ionised wind, probably emerging from the accretion disk around the companion main sequence star.

We detect ^{12}CO and ^{13}CO J=3–2, H^{13}CN J=4–3, and vibrationally excited emission from H^{13}CN, H_2O, and SiO. ^{12}CO traces both the disk and the faint outflow escaping from it. In ^{13}CO the disk shows an extent of 6″x2″, with an inner hole of 56 au. From the velocity profile, we derive an inner mass of 2 $M_\odot$. H^{13}CN and the detected vibrationally excited transitions arise from the innermost regions of the molecular gas disk.

From the similitude of Red Rectangle's disk with those of proto-stars, the existence of big grains, equatorial dust settlement, and poor molecular content, we suggest that these disks around binary post-AGN stars are excellent candidate sites for the long-sought second-generation planet formation

My poster in zenodo.org can be found here