PROTOPLANETARY DISKS

Extended family portraits

Just over a year ago, the DSHARP collaboration presented a gallery of 20 protoplanetary disk images observed with the Atacama Large Millimeter/submillimeter Array (ALMA) in exquisite detail, showing a variety of rings, narrow gaps and other substructure. Now Logan Francis and Nienke van der Marel (*Astrophys. J.* **892**, 111; 2020) have pulled together a new set of family portraits, of a slightly more evolved generation of circumstellar disks: transition disks (pictured). Thirty-eight disks are shown, in archival ALMA observations of 100/230/345 GHz continuum. The ALMA beam size is indicated by the cyan contour in the bottom-left corner of each panel, demonstrating that all disk cavities (apart from TW Hya) are fully spatially resolved, and the cyan scale bar represents 30 au.

Transition disks are evolved protoplanetary disks with large cavities in their circumstellar dust distributions either seen directly, as here, or inferred from spectral energy distributions. As with less evolved protoplanetary disks, the cause of the cavities and gaps is not definitively known, but leading theories invoke the presence of planets or gas pressure gradients that can trap the dust particles that are largely responsible for the continuum emission. Despite the cavities in these disks, transition disks have high accretion rates — comparable to ‘full’ protoplanetary disks — which imply the presence of an inner disk. Francis and van der Marel are particularly interested in quantifying the properties of these inner disks across a number of systems, and identify inner dust disks in 18 of the 38 disk samples (marked in magenta in the image). Using the ALMA data, which records the emission from millimetre-sized dust grains, the authors measure disk size and inclination for the 14 inner disks that can be resolved. They find that typically the inner disks are ~5 au in radius, although some extend out to double that distance, and inclinations range from 26–59°, often with large uncertainties. These quantities lead to an estimate of inner-disk dust mass, which is generally a fraction of an Earth mass,

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apart from GG Tau, a multiple system that harbours nearly half an Earth mass, and WSB 60, which holds more than 3.5 Earth-masses worth of millimetre-sized dust. The inner dust disk is likely to be substantially (one to three orders of magnitude) depleted compared to the outer disk, which is indicative of a rapid radial drift of material onto the star, in line with previous expectations. An exception to this

depletion is PDS 70, where two planets have recently been detected in the gap. The authors suggest that in this case the planets are very young, they are still accreting, and material from within the cavity could still be replenishing the inner disk. □

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