P212a Improved mass predictions of the potential planets in gaps of ALMA disks

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ALMA has recently identified a wealth of gap substructures from the dust continuum data of nearby protoplanetary disks, which is important in understanding how the planets form in the protoplanetary disks. According to the modern core accretion scenario, the protoplanet starts with a rocky core and then grows via pebble accretion. When the protoplanet is small, it can only carves a gap in the dust component, while the gas component is largely unperturbed. As it grows and reaches the so-called pebble isolation mass, it starts to open a gas gap and creates a pressure bump that terminates the pebble accretion by trapping the pebbles. The planet continues growing via gas accretion in due course and carves deeper gaps in both the gas and dust components. The gap width-planetary mass relation revealed by simulations depends on whether the observed gap exists only in the dust component or in both the gas and dust components. Previous works only estimate the mass of the gap-embedded planet by assuming either of the situations. We improve the prediction by proposing two criteria to distinguish these two cases based on the assumption that the gas gap will only open if the planetary mass exceeds the pebble isolation mass.

We classified 55 gaps from 35 disks into four groups using our criteria, and found that the outer gaps are more likely to be dust-only gaps, while the inner ones are mostly gas gaps. Our predicted population has little overlapping with the observed exoplanets, implying that significant migration and mass accretion may happen before the disk dispersal.