

Title:

Pebble Transport and Water Delivery in Protoplanetary Disks around Solar-Mass Stars

Summary:

Planetary masses and compositions are determined by the growth and transport of solids in protoplanetary disks. Dust particles that grow to millimeter sizes, known as "pebbles," drift inward through aerodynamic drag from the disk gas. This radial drift promotes pebble concentration at pressure maxima and subsequent planet formation, while also delivering volatiles, including water, to terrestrial-planet-forming regions. However, it remains unclear how efficiently pebbles drift inward and are trapped at pressure maxima in observed disks.

This project will use the accepted ALMA Cycle 13 Large Program PEBBLES to systematically analyze high-resolution continuum observations in Bands 2, 6, and 7 of 24 disks around solar-type stars. By comparing these observations with radiative-transfer models, we will infer radial profiles of dust surface density, maximum dust size, and temperature. We will combine these results with dust-evolution models to quantify pebble transport and trapping efficiencies. We will further compare the inferred outer-disk pebble properties with inner-disk water-line observations from JWST to investigate the relationship between pebble transport and water delivery to the inner disk. This research will connect disk structures to the distribution of planetary building blocks and water, deepening our understanding of the formation of the Solar System and extrasolar planetary systems. The Project Assistant Professor appointed to this project will join the applicant's group at Institute of Science Tokyo and work with the international PEBBLES team, primarily undertaking ALMA data analysis. In collaboration with experts in dust evolution and radiative transfer, they will develop physical interpretations of the observations, publish research papers, submit follow-up observing proposals, and mentor students involved in the project.