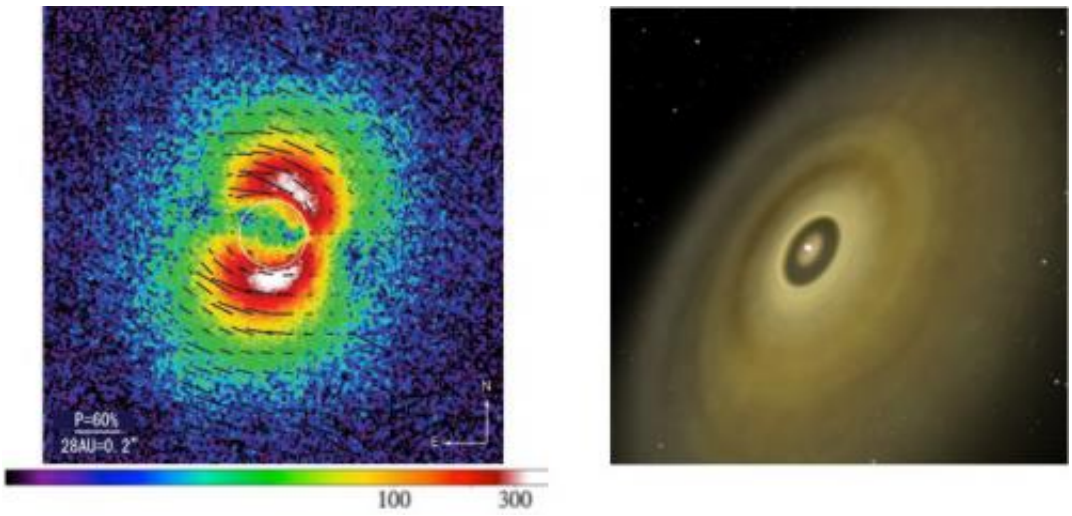
Dust grains highlight the path to planet formation

November 28 2012



UX Tau A's protoplanetary disk extends to a radius of 120 AU (1 AU = the distance between the Earth and the Sun) with a high spatial resolution of 0.1" (arcsecond). Credit: NAOJ)

(Phys.org)—An international team of researchers from the National Astronomical Observatory of Japan (NAOJ) and the Japanese universities of Kobe, Hyogo, and Saitama used the Subaru Telescope to capture a clear image of the protoplanetary disk of the star UX Tauri A. The team's subsequent, detailed study of the disk's characteristics suggests that its dust particles are large in size and non-spherical in shape. This exciting result shows that these dust grains are colliding with and adhering to each other, a process that will lead to their eventual

formation into planets.

A major goal of the SEEDS Project is to explore hundreds of nearby stars in an effort to directly image extrasolar planets and protoplanetary/debris disks. As part of this important project, the current team of researchers used the Subaru High Contrast Instrument for the Subaru Next Generation Adaptive Optics (HiCIAO) mounted on the Subaru Telescope to observe UX Tau A, a young star in the constellation Taurus's molecular cloud or "star nursery", where many lower mass stars are being born. They were able to detect the disk of gas and dust around the star, its "circumstellar disk", which is then referred to as a protoplanetary disk when it is a site of planet formation.

The team made a detailed study of UX Tau A in the near-infrared wavelengths. They measured the polarization of infrared light to find out the distribution of the dust particles that scattered the infrared light. Polarized light reflected from dust particles gives important information about planetary formation in disks. Even though dust particles only make up a tiny fraction of the protoplanetary disk, they can develop into planetesimals (solid objects less than a kilometer in diameter), and eventually, planets.

The light from this disk is strongly polarized; its angle of polarization shows a concentric pattern relative to the central star. Yoichi Itoh (University of Hyogo) expressed his surprise: "The objects we have observed so far show a high degree of polarization no matter what the angle is. However, the polarization of this particular object ranges widely from 2 to 66 % as the polarization angle changes. It was a pleasant challenge to explain this characteristic."

Dust particles in the protoplanetary disk originally came from interstellar space and are only 0.1 microns in size. Small grain particles, which are much smaller than the observed wavelength, can produce a high degree

of polarization regardless of their location. If the grain size is similar to the observed wavelength, the scattering performance is different. However, these principles do not account for the current observation. Itoh explained, "Only particles with a non-spherical shape and a size of 30 microns, which is much larger than the near-infrared wavelength that was used for the observation, can explain the features of our observation."

How did this happen? Dust in the disk of UX Tau A collided and stuck together to grow to 30 microns. The researchers were fortunate to witness dust particles at a critical phase in their path to becoming a fully-grown planet in the protoplanetary disk.

The research paper entitled "High-Resolution Near-Infrared Polarimetry of a Circumstellar Disk around UX Tau A" by Tanii et al. is scheduled to be published in the *Publications of the Astronomical Observatory of Japan* in December 2012.

Provided by Subaru Telescope