Planets still formed in protoplanetary disk

Planets still formed in protoplanetary disk

By detecting unusual patterns in the flow of gas within the protoplanetary disk of a young star, two teams of astronomers have confirmed the distinct, telltale hallmarks of newly formed planets orbiting the infant star.

Scientists using NASA"s James Webb Space Telescope just made a breakthrough discovery in revealing how planets are made. By observing water vapor in protoplanetary disks, Webb confirmed a physical process involving the drifting of ice-coated solids from the outer regions of the disk into the rocky-planet zone.

The lack of such discoveries may be because planets have not fully formed at this age or because our view is blocked by the protoplanetary disk. However, we now know that many outer disks are ...

NASA"s Hubble Space Telescope has directly photographed evidence of a Jupiter-like protoplanet forming through what researchers describe as an "intense and violent process." This discovery supports a long-debated theory for how planets like Jupiter form, called "disk instability."

Scientists chip away at secrets of planet formation, origin of life in bevy of new research. The evolutionary sequence of protoplanetary disks with substructures, from the ALMA CAMPOS survey...

Theories have long proposed that icy pebbles forming in the cold, outer regions of protoplanetary disks -- the same area where comets originate in our solar system -- should be the fundamental seeds of planet formation. The main requirement of these theories is that pebbles should drift inward toward the star due to friction in the gaseous disk, delivering both solids and water to planets.

A fundamental prediction of this theory is that as icy pebbles enter into the warmer region within the “snowline” -- where ice transitions to vapor -- they should release large amounts of cold water vapor. This is exactly what Webb observed.

"Webb finally revealed the connection between water vapor in the inner disk and the drift of icy pebbles from the outer disk," said principal investigator Andrea Banzatti of Texas State University, San Marcos, Texas. "This finding opens up exciting prospects for studying rocky planet formation with Webb!"

"In the past, we had this very static picture of planet formation, almost like there were these isolated zones that planets formed out of," explained team member Colette Salyk of Vassar College in Poughkeepsie, New York. "Now we actually have evidence that these zones can interact with each other. It’s also something that is proposed to have happened in our solar system."

The researchers used Webb"s MIRI (the Mid-Infrared Instrument) to study four disks -- two compact and two

extended -- around Sun-like stars. All four of these stars are estimated to be between 2 and 3 million years old, just newborns in cosmic time.

The two compact disks are expected to experience efficient pebble drift, delivering pebbles to well within a distance equivalent to Neptune"s orbit. In contrast, the extended disks are expected to have their pebbles retained in multiple rings as far out as six times the orbit of Neptune.

The Webb observations were designed to determine whether compact disks have a higher water abundance in their inner, rocky planet region, as expected if pebble drift is more efficient and is delivering lots of solid mass and water to inner planets. The team chose to use MIRI"s MRS (the Medium-Resolution Spectrometer) because it is sensitive to water vapor in disks.