Enigmatic emission
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The detection of infrared emission from the dusty disk around a distant star signals the presence of the $H_3^+$ ion. The finding may provide a vital clue to how hydrogen and helium condense into gas-giant planets.

Although there is some consensus on how stars form from interstellar matter, how planets form is less certain. Observations of infrared and radio emissions from dust in protostars have established the presence of protoplanetary disks — regions where dust particles accumulate to form rocky planets like the Earth. But it's a different story for giant planets like Jupiter and Saturn. How the primordial gas of hydrogen and helium in the region condenses to form giant planets is still a mystery, although it is generally believed that the condensation occurs within a short period.

On page 57 of this issue, Brittain and Rettig report their observations of a protoplanetary disk around the star HD 141569, 320 light years from Earth, in which a giant planet might be in the process of forming. Particularly startling is the detection of strong emission of the hydrogenic ion $H_3^+$, which, according to one model, might originate from a gas-giant protoplanet. If the findings are confirmed, Brittain and Rettig have discovered a new astronomical object, opening up a new avenue for the study of the formation of giant planets.

A crucial question is whether protoplanetary disks contain sufficient raw material, $H_2$ and He, to form Jupiter-like planets. Observations have been controversial, even on this most fundamental issue. Zuckerman, Forveille and Kastner observed radio emission from CO molecules in the disks surrounding many young stars that are considered to be going through the period of planet formation; assuming the standard ratio of $H_2$ to CO (about $10^4$), they concluded that the amount of $H_2$ available was far short of that needed for the formation of a giant planet. However, using data from the Infrared Space Observatory, Thi et al. reported an abundance of $H_2$ in some of the same stars, as much as a mass equivalent to that of Jupiter. But this finding was subsequently challenged for one of the stars, β-Pictoris, by Lecavelier des Etangs et al., using data from the Far Ultraviolet Spectroscopic Explorer. More recent infrared observations by Richter et al. also seem to negate the claim of Thi et al.

Does this mean that Jupiter-like planets cannot form around those stars? Or have giant planets or protoplanets already formed in those systems, so that there is little $H_2$ left over in the disk to observe? Giant planets are clearly present in our Solar System and are also observed as extra-solar planets orbiting other stars. Are these giants exceptional? Questions abound.

Brittain and Rettig introduce a new observational tool in this field — the infrared vibration–rotation spectrum of $H_3^+$ at a wavelength of 4 μm. The $H_3^+$ ion is $H_2$ molecule with an extra proton attached. The third hydrogenic species (after $H$ and $H_2^+$), it has only recently been introduced into astronomical observations, but its excellence as an astrophysical probe is rapidly being recognized.

The $H_3^+$ spectrum has been seen in a wide variety of objects: in the giant planets...
be pointed towards HD 141569 and other young stars this year. It will be wonderful to
see H _3+ promoted as an essential probe for the studies of gas-giant protoplanets.

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