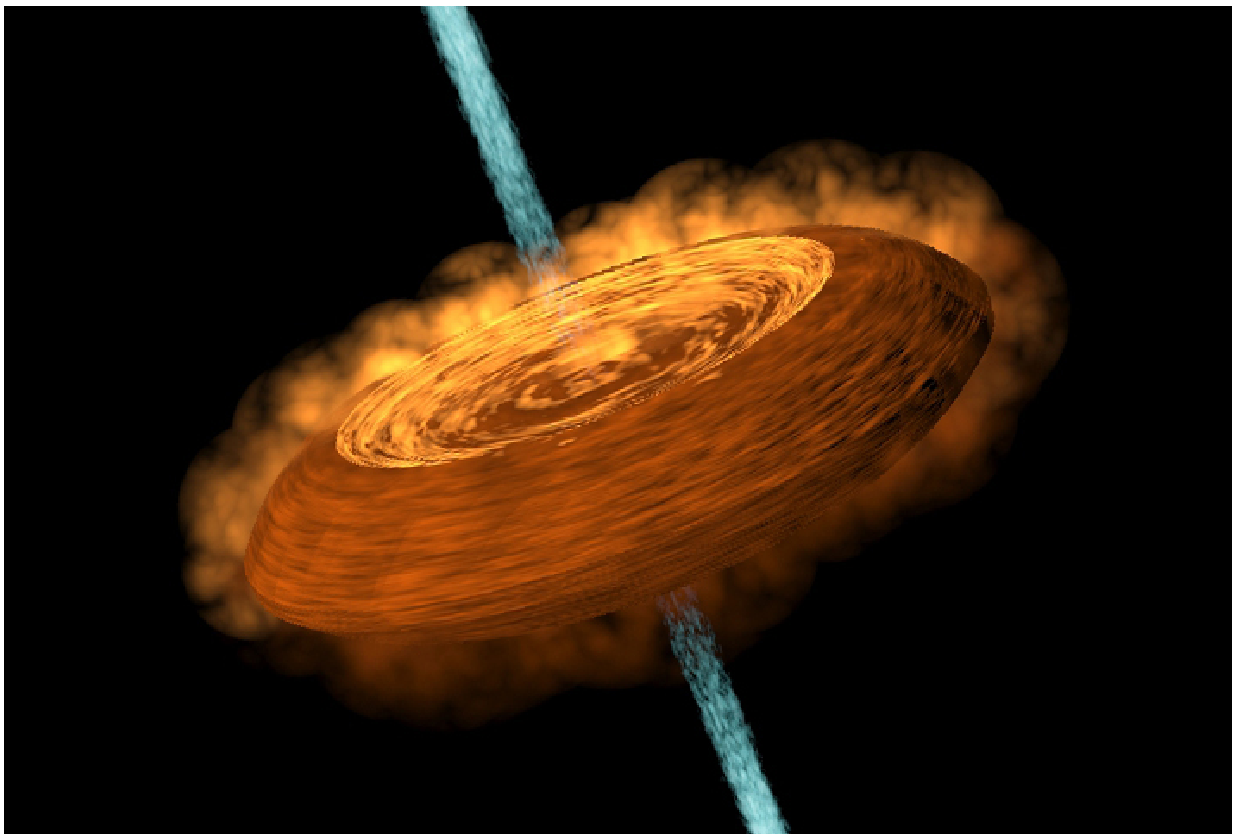
First clear image made of accretion disk surrounding young star

April 20 2017, by Bob Yirka



An illustration of an accretion disk feeding a central young star, or protostar, and the gaseous jet ejected from the protostar. Credit: Yin-Chih Tsai/ASIAA

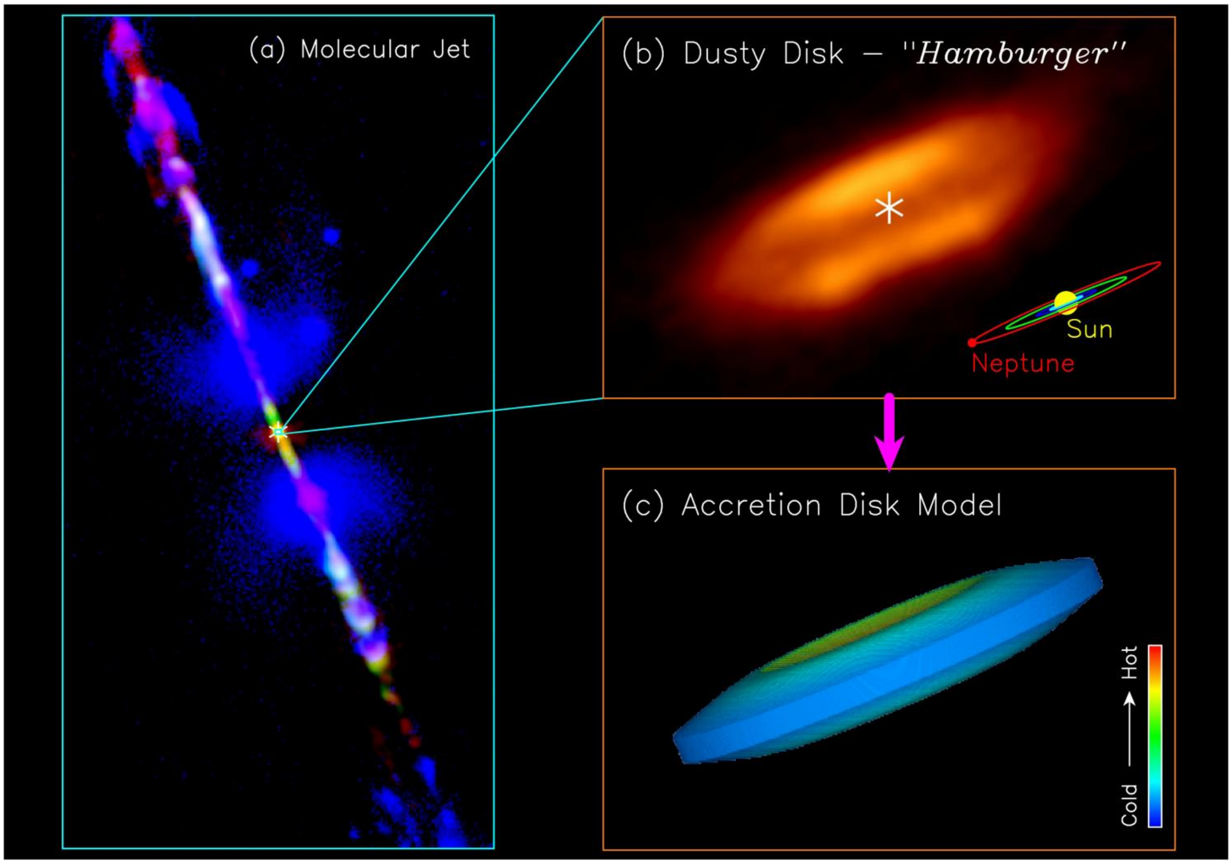
(Phys.org)—A team of researchers from the U.S. and Taiwan has captured the first clear image of a young star surrounded by an accretion disk. In their paper published in the journal *Science Advances*, the team describes how the image was captured and details of their find.

Astrophysics have theorized that accretion disks form around young stars acting as food, helping the young star to grow bigger. Such an accretion disk would also make up the material that would over time accrete into planets. But until now, no clear image of an accretion disk had been made because the technology to do so did not exist. Now, thanks to hard work by the team and the ALMA radio telescope in Chile, that has changed.

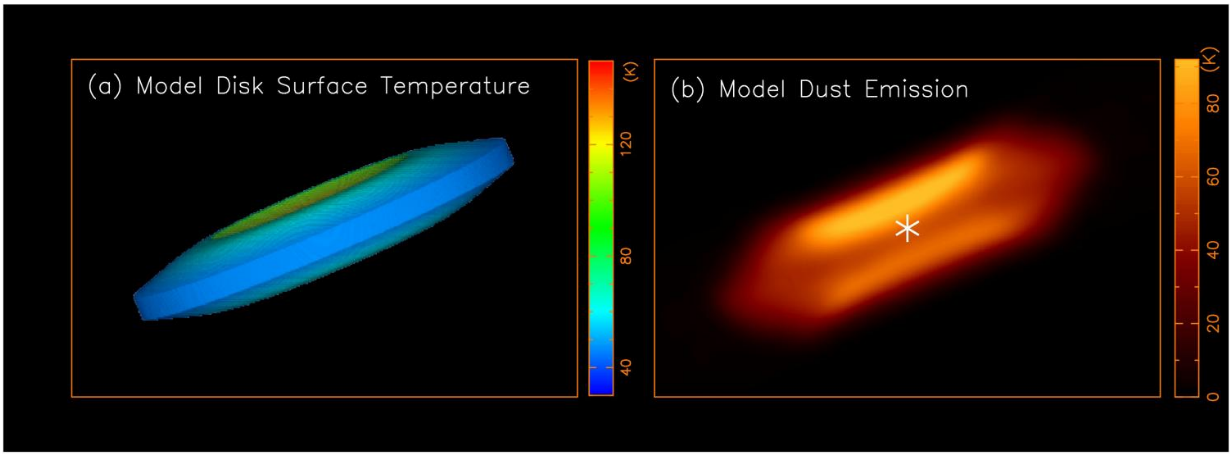
ALMA came online just four years ago—at a cost of $1.4 billion, it holds the record for the most expensive radio telescope ever built. But it also offers unprecedented resolution, capturing images in sharp detail that have appeared as fuzzy blobs in prior images. That resolution allowed the researchers to zoom in on a young star named IRAS 05413-0104 (part of the HH212 system and believed to be just 40,000 years old) that had around it a rotating accretion disk. Such disks are believed to be made of matter such as silicate, iron and other interstellar matter, and provide a steady source of food for the star. And because the disks are triple layered with brighter outer layers, the researchers describe it as looking like a hamburger.

The captured image lays to rest one critique of the prediction of accretion disks around young stars, which was that the magnetic field from the core of the star would be so strong that it would prevent the accretion disk from spinning, thus preventing its ability to gather matter. That is clearly not the case, as the new image shows. Also seen in the image were gaseous jets ejected from the star, which appear to pierce the hamburger at its center.

It is believed that more information about the formation of stars will contribute to understanding both the history of our sun and how planets form, perhaps offering a better way of filtering star systems while searching for signs of life beyond our own planet.



Jet and disk in the HH 212 protostellar system: (a) A composite image of the jet, produced by combining images from different telescopes. The orange image around the center shows the accretion disk at 200 AU resolution. (b) Close-up of the center of the dusty disk at 8 AU resolution. Asterisks mark the possible position of the central protostar. A dark lane is seen in the equator. Our solar system is shown in the lower right corner for size comparison. (c) An accretion disk model that can reproduce the observed dust emission in the disk. Credit: ALMA (ESO/NAOJ/NRAO)/Lee et al.



(a) The accretion disk model with the disk surface temperature. (b) The model dust emission map derived from the disk model. This model map is roughly the same as the observed map of the disk. Credit: Lee et al.

More information: Chin-Fei Lee et al. First detection of equatorial dark dust lane in a protostellar disk at submillimeter wavelength, *Science Advances* (2017). DOI: 10.1126/sciadv.1602935

Abstract
In the earliest (so-called "Class 0") phase of Sun-like (low-mass) star formation, circumstellar disks are expected to form, feeding the protostars. However, these disks are difficult to resolve spatially because of their small sizes. Moreover, there are theoretical difficulties in producing these disks in the earliest phase because of the retarding effects of magnetic fields on the rotating, collapsing material (so-called "magnetic braking"). With the Atacama Large Millimeter/submillimeter Array (ALMA), it becomes possible to uncover these disks and study them in detail. HH 212 is a very young protostellar system. With ALMA, we not only detect but also spatially resolve its disk in dust emission at submillimeter wavelength. The disk is nearly edge-on and has a radius of

~60 astronomical unit. It shows a prominent equatorial dark lane sandwiched between two brighter features due to relatively low temperature and high optical depth near the disk midplane. For the first time, this dark lane is seen at submillimeter wavelength, producing a "hamburger"-shaped appearance that is reminiscent of the scattered-light image of an edge-on disk in optical and near infrared light. Our observations open up an exciting possibility of directly detecting and characterizing small disks around the youngest protostars through high-resolution imaging with ALMA, which provides strong constraints on theories of disk formation.