

The Twist Marks the Spot: ESO Telescope Sees Signs of Planetary Birth

There are thousands of exoplanets identified so far, but little is known about how they form. Astronomers know that planets are born in dusty disks surrounding young stars, like AB Aurigae, as cold gas and dust clump together. We need to observe very young systems to really capture the moment when planets form. Until recently, astronomers rarely had the ability to take sharp and deep enough images of these young disks to directly discern regions of planetary formation. The new observations performed with the Very Large Telescope (VLT) in the

European Southern Observatory (ESO) at Cerro Paranal in the Atacama Desert of northern Chile, have provided crucial clues to help scientists better understand this process [1].

The new images feature a stunning spiral of dust and gas around AB Aurigae, located 520 light-years away from Earth in the constellation of Auriga (the Charioteer). Spirals of this type signal the presence of baby planets, which “kick” the gas, creating disturbances in the disk

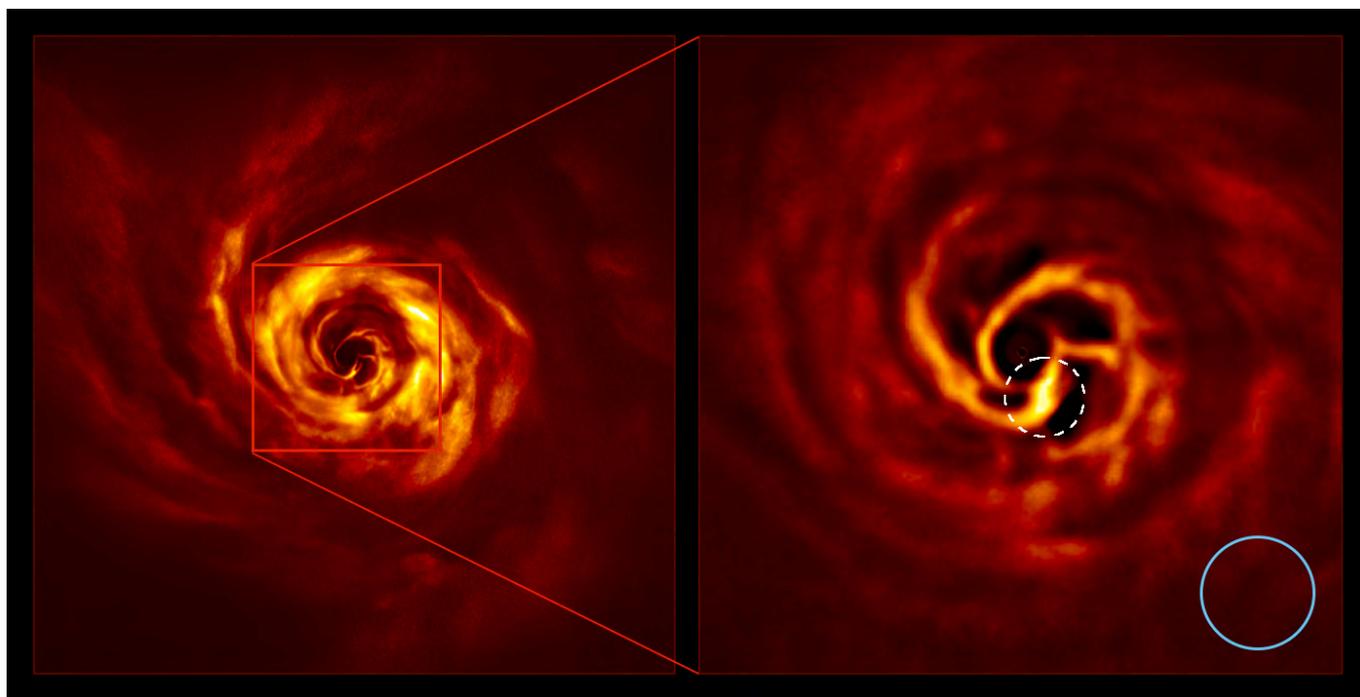


Fig 1: The images of the AB Aurigae system showing the disk around it. The image shows the inner region of the disk, including the 'twist' (marked with a white dashed circle) that scientists believe marks the spot where a planet is forming. This twist lies at about the same distance from the AB Aurigae star as Neptune from the Sun. The blue circle represents the size of the orbit of Neptune. The images were obtained with the SPHERE instrument on ESO's Very Large Telescope in polarised light. (Credit: ESO/Boccaletti *et al.*)



Fig. 2: Dr. Ya-Wen Tang of Academia Sinica in Taipei, Taiwan, spotted two spiral arms of gas in the AB Aurigae system with collaborators, using the ALMA telescope in 2017 [2]. When looked at more closely with the VLT telescope, the system points to the presence of ongoing planet formation [1] and hence might provide the first direct evidence of planets coming into existence. (Credit: Ya-Wen Tang)

in the form of a wave, somewhat like the wake of a boat on a lake. As the planet rotates around the central star, this wave gets shaped into a spiral arm. The very bright yellow ‘twist’ region close to the center of the new AB Aurigae image, which lies at about the same distance from the star as Neptune lies from the Sun, is one of these disturbance sites where Ya-Wen Tang’s team believes a planet is being made.

Observations of the AB Aurigae system performed with the Atacama Large Millimeter/submillimeter Array (ALMA) a few years ago in 2017 provided the first hints of the ongoing planet formation around the star [2]. In these ALMA images, scientists led by Ya-Wen Tang (Fig. 2) of the Institute of Astronomy and Astrophysics of the Academia Sinica in Taipei, Taiwan, spotted two

spiral arms of gas close to the star, lying within the disk’s inner region. Then, in 2019 and early 2020, A. Boccaletti and a team of astronomers including Ya-Wen Tang from France, the US and Belgium set out to capture a clearer picture by turning the Spectro-Polarimetric High-contrast Exoplanet Research Instrument (SPHERE), on ESO’s VLT in Chile, toward the star. The SPHERE images are the deepest taken of the AB Aurigae system to date.

With SPHERE’s powerful imaging system, astronomers could see faint light from small dust grains and emissions coming from the inner disk. They confirmed the presence of the spiral arms first detected by ALMA and also spotted another remarkable feature, a ‘twist’ that points to the presence of ongoing planet formation in the disk. The twist is expected, according to some theoretical models of planetary formation. It corresponds to the connection of two spirals — one winding inwards of the planet’s orbit, the other expanding outwards — that join at the planet’s location. They allow gas and dust from the disk to accrete onto the forming planet and make it grow. “It is exciting that these features could be the first direct evidence of baby planets coming to existence,” says Ya-Wen Tang.

References

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- [2] “Planet Formation in AB Aurigae: Imaging of the Inner Gaseous Spirals Observed inside the Dust Cavity”, Ya-Wen Tang, Stephane Guilloteau, Anne Dutrey, Takayuki Muto, Bo-Ting Shen, Pin-Gao Gu, Shu-ichiro Inutsuka, Munetake Momose, Vincent Pietu, Misato Fukagawa, Edwige Chapillon, Paul T. P. Ho, Emmanuel di Folco, Stuartt Corder, Nagayoshi Ohashi, and Jun Hashimoto, 2017, *The Astrophysical Journal*, 840, 32, <https://iopscience.iop.org/article/10.3847/1538-4357/aa6af7/meta>