Planet formation in Earth-like orbit around a young star

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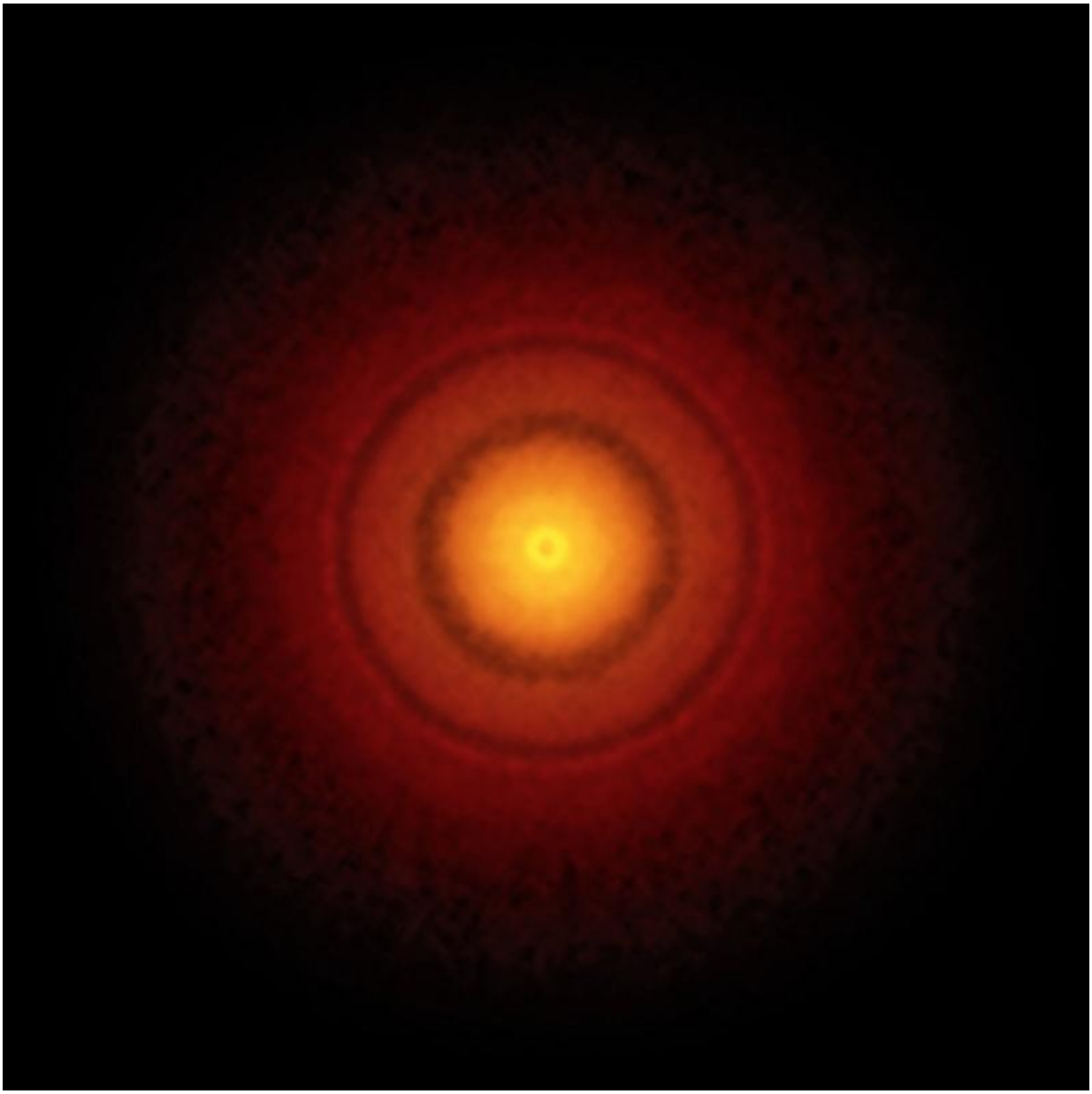


ALMA's best image of a protoplanetary disc to date. This picture of the nearby young star TW Hydrae reveals the classic rings and gaps that signify planets are in formation in this system. Credit: S. Andrews (Harvard-Smithsonian CfA); B. Saxton (NRAO/AUI/NSF); ALMA (ESO/NAOJ/NRAO)

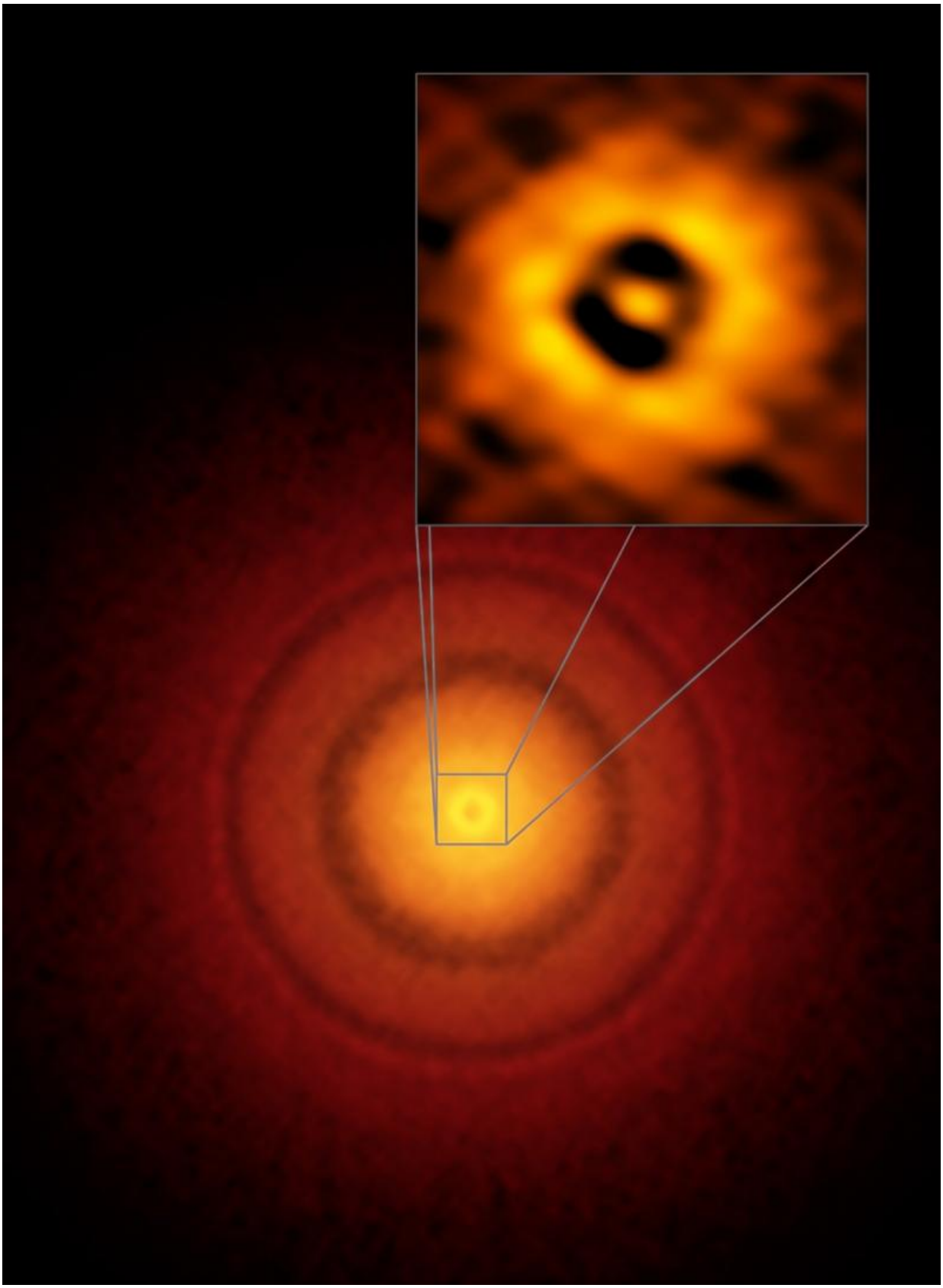
The star TW Hydrae is a popular target of study for astronomers because of its proximity to Earth (only about 175 light-years away) and its status as an infant star (about 10 million years old). It also has a face-on orientation as seen from Earth. This gives astronomers a rare, undistorted view of the complete protoplanetary disc around the star.

"Previous studies with optical and radio telescopes confirm that TW Hydrae hosts a prominent disc with features that strongly suggest planets are beginning to coalesce," said Sean Andrews with the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts, USA and lead author on a paper published today in the *Astrophysical Journal Letters*. "The new ALMA images show the disc in unprecedented detail, revealing a series of concentric dusty bright rings and dark gaps, including intriguing features that may indicate that a planet with an Earth-like orbit is forming there."

Other pronounced gaps that show up in the new images are located three billion and six billion kilometres from the central star, similar to the average distances from the Sun to Uranus and Pluto in the Solar System. They too are likely to be the results of particles that came together to form planets, which then swept their orbits clear of dust and gas and shepherded the remaining material into well-defined bands.

For the new TW Hydrae observations, astronomers imaged the faint radio emission from millimetre-sized dust grains in the disc, revealing details on the order of the distance between the Earth and the Sun (about

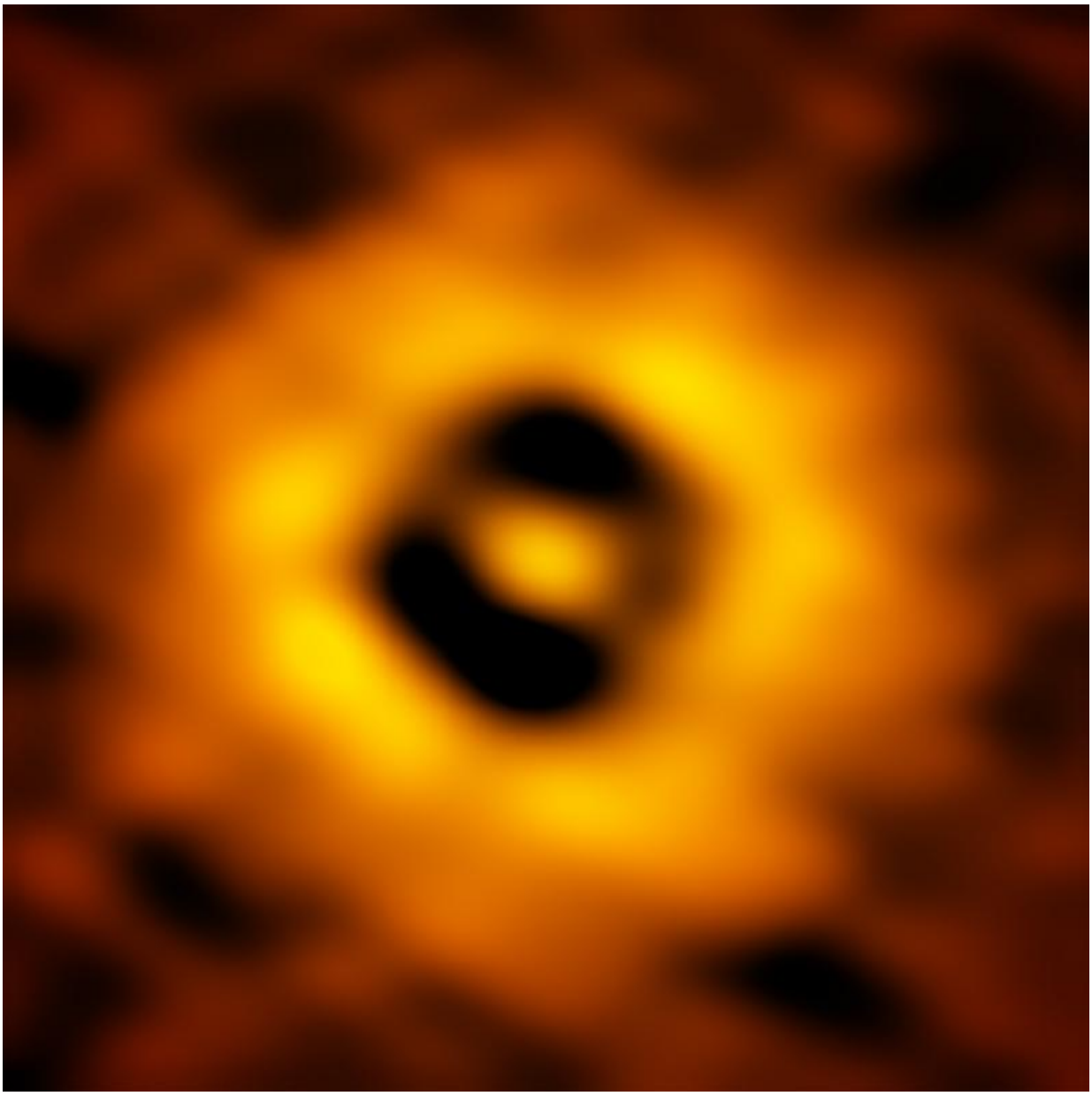
150 million kilometres). These detailed observations were made possible with ALMA 's high-resolution, long-baseline configuration. When ALMA's dishes are at their maximum separation, up to 15 kilometres apart, the telescope is able to resolve finer details. "This is the highest spatial resolution image ever of a protoplanetary disc from ALMA, and that won't be easily beaten in the future!" said Andrews.



ALMA image of the planet-forming disc around the young, Sun-like star TW Hydrae. The inset image (upper right) zooms in on the gap nearest to the star, which is at the same distance as the Earth is from the Sun, suggesting an infant version of our home planet could be emerging from the dust and gas. The additional concentric light and dark features represent other planet-forming regions farther out in the disc. Credit: S. Andrews (Harvard-Smithsonian CfA), ALMA (ESO/NAOJ/NRAO)

"TW Hydrae is quite special. It is the nearest known protoplanetary disc to Earth and it may closely resemble the Solar System when it was only 10 million years old," adds co-author David Wilner, also with the Harvard-Smithsonian Center for Astrophysics.

Earlier ALMA observations of another system, HL Tauri, show that even younger protoplanetary discs—a mere 1 million years old—can display similar signatures of planet formation. By studying the older TW Hydrae disc, astronomers hope to better understand the evolution of our own planet and the prospects for similar systems throughout the Milky Way.



This is the inner region of the TW Hydrae protoplanetary disk as imaged by ALMA. The image has a resolution of 1 AU (Astronomical Unit, the distance from the Earth to the Sun in our own Solar System). This new ALMA image reveals a gap in the disk at 1 AU, suggesting that a planet with the same orbit as Earth is forming there. Credit: S. Andrews (Harvard-Smithsonian CfA); B. Saxton (NRAO/AUI/NSF); ALMA (ESO/NAOJ/NRAO)

The astronomers now want to find out how common these kinds of features are in discs around other young stars and how they might change with time or environment.

More information: This research was presented in a paper "Ringed Substructure and a Gap at 1 AU in the Nearest Protoplanetary Disk", by S.M. Andrews et al., appearing in the *Astrophysical Journal Letters*. www.eso.org/public/archives/re … eso1611/eso1611a.pdf

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