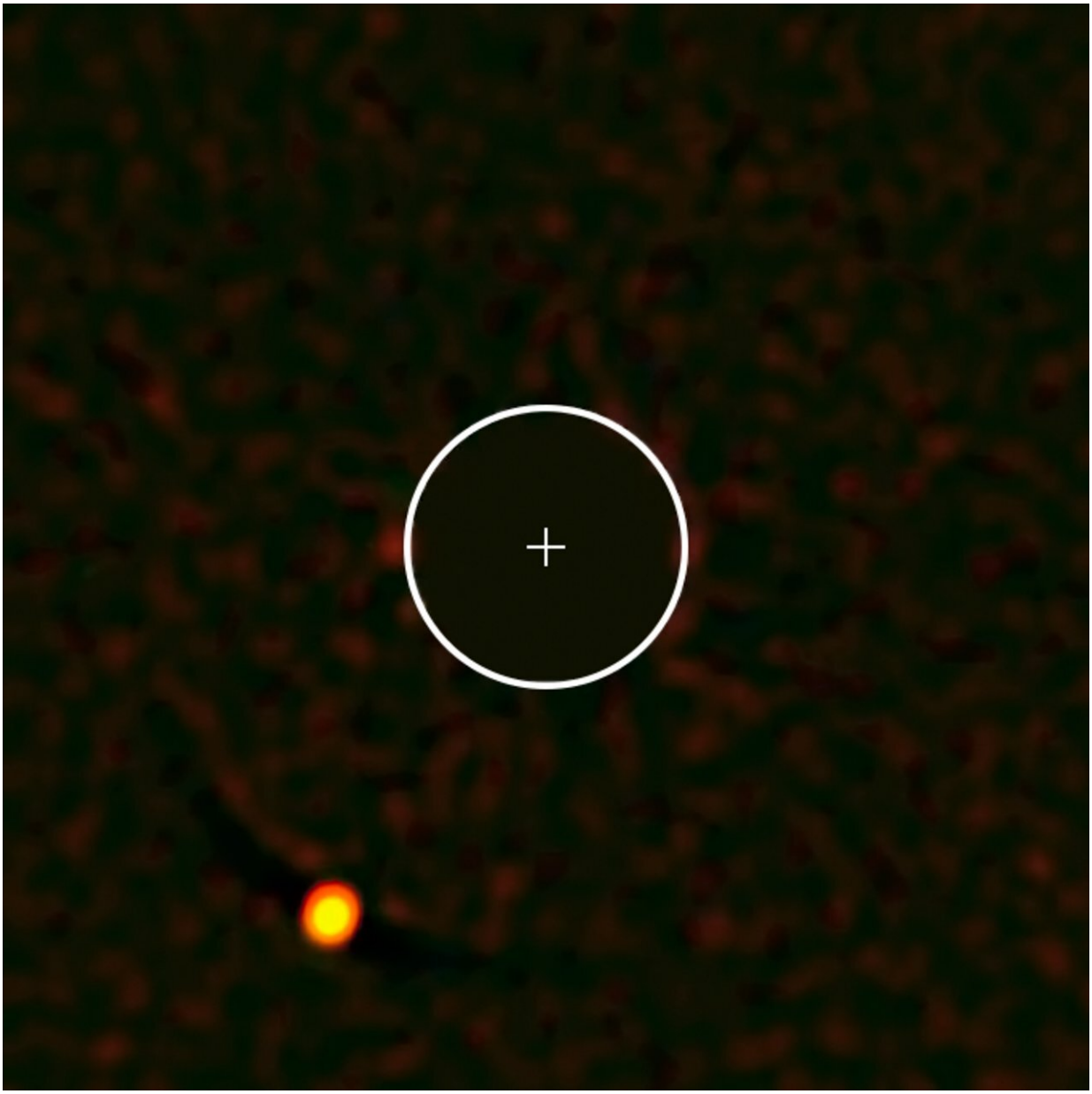
Astronomers might have imaged a ringed planet around Proxima Centauri

April 20 2020, by Matt Williams



The exoplanet HIP 65426b – the first to be seen by the SPHERE instrument on ESO's Very Large Telescope. Credit: ESO

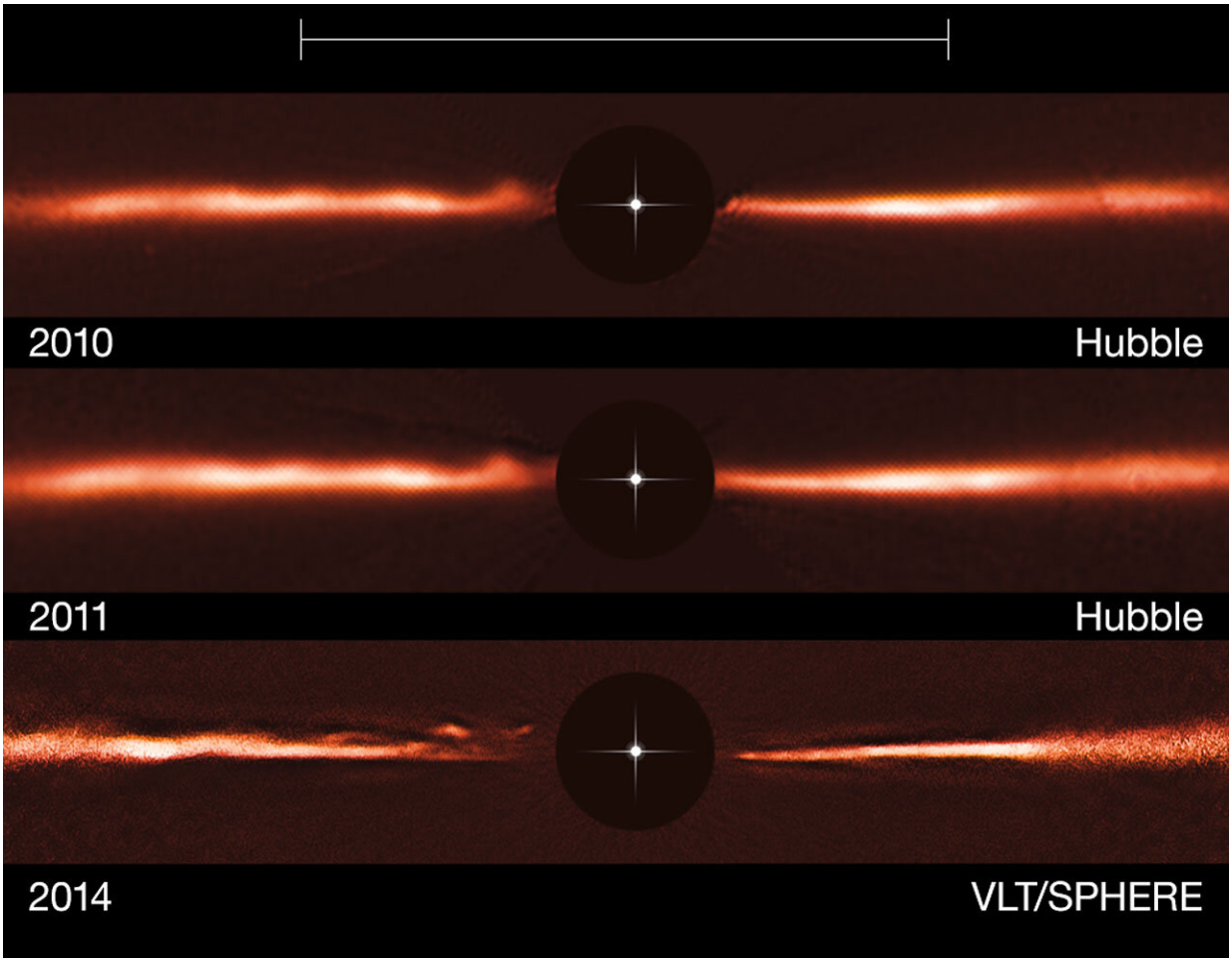
In 2016, astronomers working for the European Southern Observatory (ESO) confirmed the existence of a terrestrial planet around Earth's closest stellar neighbor—Proxima Centauri. The discovery of this nearby extrasolar planet (Proxima b) caused no shortage of excitement because, in addition to being similar in size to Earth, it was found to orbit within the star's habitable zone (HZ).

Thanks to an INAF-led team, a second exoplanet (a super-Earth) was found early this year around Proxima Centauri using the Radial Velocity Method. Based on the separation between the two planets, another INAF-led team attempted to observe this planet using the Direct Imaging Method. While not entirely successful, their observations raise the possibility that this planet has a system of rings around it, much like Saturn.

For the sake of their study, which recently appeared in the journal *Astronomy & Astrophysics*, the team relied on data obtained by the Spectro-Polarimetric High-contrast Exoplanet REsearch (SPHERE) instrument on the ESO's Very Large Telescope (VLT). This extreme adaptive optics system and coronagraphic facility is dedicated to the characterization of exoplanet systems at optical and near-infrared wavelengths.

For years, SPHERE has been revealing the existence of protoplanetary disks around distant stars, something that is extremely difficult to do using conventional optics. However, this particular set of data was gathered during the four-year SpHere INfrared survey for Exoplanets (SHINE) survey, where SPHERE was used to image 600 nearby stars in

the near-infrared spectrum.



Three images of the fast-moving wave-like features in the dusty disc around the nearby star AU Microscopii. Credit: ESO/NASA/ESA

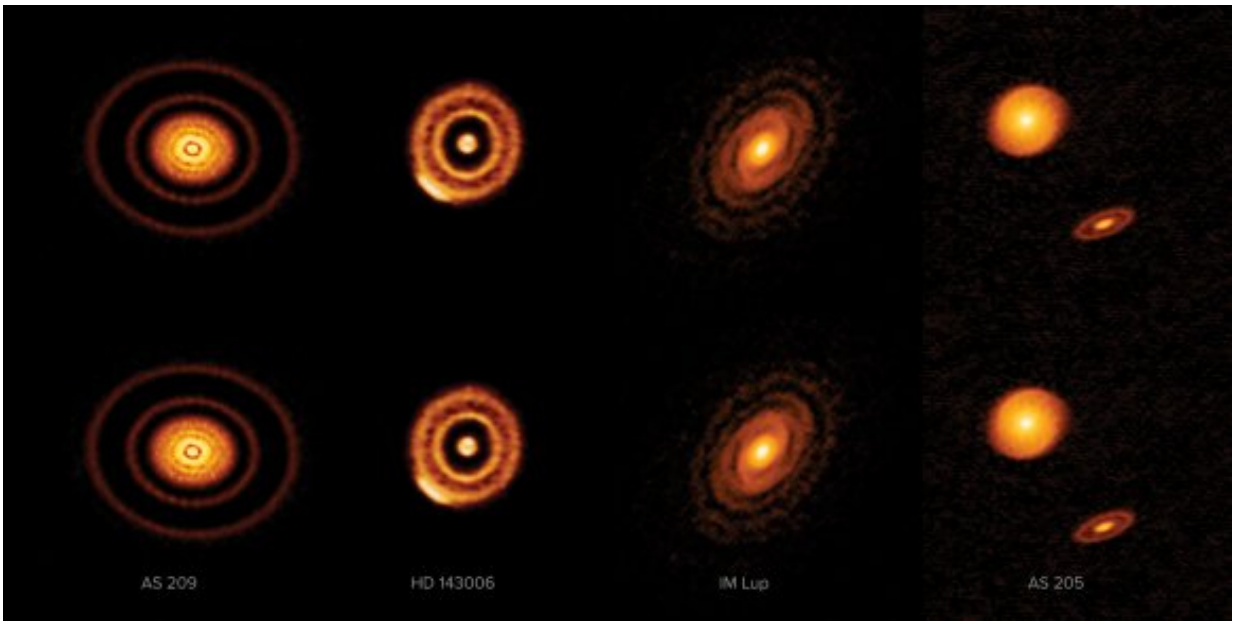
Relying on SPHERE's high contrast and high angular resolution, the purpose of this survey was to characterize new planetary systems and explore how they formed. One such system was Proxima Centauri, a low-mass M-type (red dwarf) star located just 4.25 light-years from our Solar System. At the time of the survey, which ran from to , the existence of

Proxima c was not yet known.

Like Proxima b, Proxima c was discovered using the Radial Velocity (aka. Doppler Spectroscopy) method. This consists of measuring a star's movement back and forth (or "wobble") to determine if it is being acted on by the gravitational influence of a system of planets. However, the team was confident that if Proxima c was producing a large enough signal in infrared, SPHERE would have detected it.

As the team—which was led by Raffael Gratton of the Astronomical Observatory of Padova—explained their methods in their study: "We searched for a counterpart in SPHERE images acquired during four years through the SHINE survey. In order to account for the expected large orbital motion of the planet, we used a method that assumes the circular orbit obtained from radial velocities and exploits the sequence of observations acquired close to quadrature in the orbit. We checked this with a more general approach that considers keplerian motion, K-stacker."

Unfortunately, the SPHERE data did not reveal any clear detections of Proxima c. What they did find was a candidate signal that had a strong signal to noise ratio and that the orientation of its orbital plane fit well with a previous image taken using the Atacama Large Millimeter/submillimeter Array's (ALMA).



Labeled version of four of the twenty disks that comprise ALMA's highest resolution survey of nearby protoplanetary disks. Credit: ALMA (ESO/NAOJ/NRAO) S. Andrews et al.; NRAO/AUI/NSF, S. Dagnello

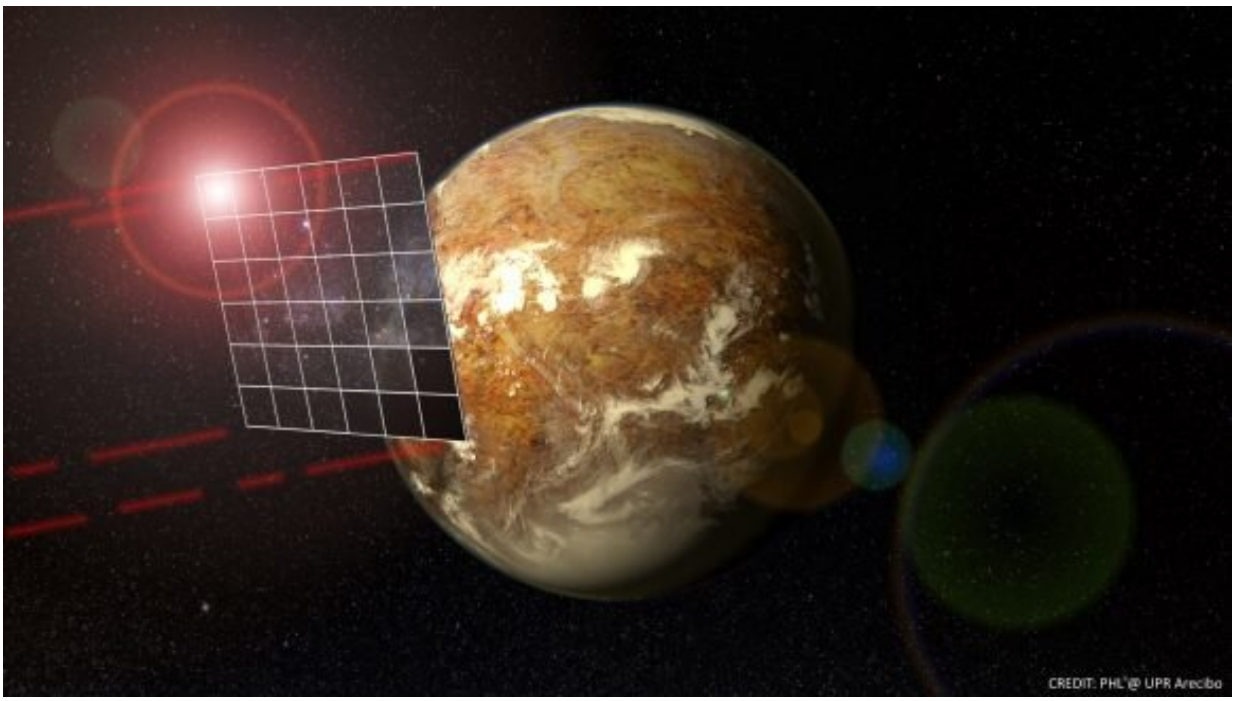
However, they also noted that its position and orbital motion (aka. astrometric signal) were not consistent with what was observed by the ESA's Gaia mission. Last, but not least, they found that the candidate had an unexpectedly high apparent brightness (aka. flux) a planet orbiting a red dwarf star. Because of this, the team could not say with any confidence whether or not what they observed was indeed Proxima c.

However, this last item raised another possibility that the team had to consider, that the unusual brightness may be the result of a circumplanetary material. In other words, they theorize that the brightness could be caused by a ring system around Proxima c, which would be radiating additional light in the infrared spectrum and

contributing to the total brightness. As they explain:

"In this case we envision either a conspicuous ring system, or dust production by collisions within a swarm of satellites, or evaporation of dust boosting the planet luminosity. This would be unusual for extrasolar planets, with Fomalhaut b, for which there is no dynamical mass determination, as the only other possible example."

This makes Proxima c a prime target for follow-up studies using radial velocity measurements, near-infrared imaging, and other methods. In addition, next-generation telescopes like the Thirty Meter Telescope (TMT), the Giant Magellan Telescope (GMT), and the ESO's Extremely Large Telescope (ELT), will be well-suited to conduct direct imaging surveys of this system to detect Proxima c.



Artist concept of a lightsail craft approaching the potentially habitable exoplanet Proxima b. Credit: PHL @ UPR Arecibo

What's more, if astronomers manage to confirm that the candidate seen here was Proxima c, then Breakthrough Starshot is likely to want to get in on the action! For years, this organization has been working towards the goal of sending a gram-scale wafercraft to the Alpha Centauri system by means of directed-energy propulsion. Ever since the discovery of Proxima b, there has been talk about making a flyby of Proxima Centauri as well.

Not only would this spacecraft be able to get a close-up look of Proxima b, it could also swing by Proxima c and get some snapshots of the planet and its (possible) ring system. Regardless, if the team's findings are confirmed, it will be the first time direct imaging of a planet discovered from radial velocity measurements was made and the second time where reflections from circumplanetary material occurred (after Fomalhaut b).

In any case, these results could have significant implications for future studies and the characterization of Proxima Centauri.

More information: Searching for the near infrared counterpart of Proxima c using multi-epoch high contrast SPHERE data at VLT: arxiv.org/pdf/2004.06685.pdf

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