New Worlds, New Perspectives

In the search for exoplanets, and life beyond our own solar system, new small-scale, turnkey design telescopes are packing a big punch.

One of the most significant goals of modern astronomy is to discover if life exists on exoplanets encircling other stars—and innovations in ground-based telescope technology are proving to be an incredibly cost-effective way to reach this goal within the next decade. Inexpensive and easy to deploy, these new telescope projects offer an exciting opportunity to significantly boost the scientific returns of the next generation of advanced observatories, like the James Webb Space Telescope (JWST) launching in 2018.

New Planets Found Orbiting Ultra-Cool Stars

Using TRAPPIST, a robotic prototype telescope just 60cm in diameter in the Atacama Desert of Chile, researchers at the University of Liège and MIT EAPS postdoc Julien de Wit PhD ’14 (XII)—a member of the MIT Seager group—recently announced the exciting discovery of three terrestrial planets orbiting a nearby small, ultra-cool star: TRAPPIST-1.

The discovery of three temperate Earth-sized planets around such a star is a real game-changer. The TRAPPIST project (TRAnstiting Planets and PlanetesImals Small Telescope—Primary Investigators: Michaël Gillon and Emmanuel Jehin) proved that even the tiniest, coolest stars can amass enough orbital material to lead to the formation of planets.

But perhaps of most significance is that, at just 40 light-years away, these are the first exoplanets with conditions possibly hospitable to life which are suitable for thorough atmospheric studies with the JWST. Using the “transit method” to detect and study temperate terrestrial planets (observed when planets cross in front of their host star), relatively dim ultra-cool stars allow for a substantial amplification of a planet’s signal—up to 100 times that found when studying larger Sun analogs.
Using the Hubble Space Telescope, de Wit already got a first peek at the atmospheres of the two innermost planets, revealing that they are compact, much like Earth, Venus, or Mars. Such pre-screenings ensure that detailed follow-ups using the JWST can be optimized. The JWST will have a nominal lifetime of just 5-10 years, so it is vital for us to identify the most promising exoplanets now for further investigation. In addition, studying planets like TRAPPIST-1’s will also inform the development of tools for the characterization of the non-transiting world recently found orbiting our Sun’s neighbor, Proxima Centauri.

The Opportunity for Science and for MIT
The TRAPPIST-1 discovery was achieved in the prototype phase of the project SPECULOOS (Search for habitable Planets Eclipsing Ultra-coOL Stars), which aims to explore all of the nearest and brightest ultracool stars for potentially habitable planets which are well-suited for assessment with emerging technologies. SPECULOOS will soon be composed of a network of six telescopes, with five in Chile and one in Morocco.

To optimize its potential for detecting planets like those orbiting TRAPPIST-1, the SPECULOOS project needs to be expanded to widen our view of the northern skies. The most efficient and cost-effective way to achieve this is to install more TRAPPIST-like telescopes in northern hemisphere astronomical sites. At least two additional telescopes are required, with the individual cost of each telescope just $400,000. The technology is turnkey and agile, able to go from site selection to first light in a swift 6-9 months. Further, SPECULOOS observatories would be the best assets to follow-up on and confirm the planet candidates to be found by the MIT-led NASA TESS mission (Transiting Exoplanet Survey Satellite), scheduled for launch in 2017. At present, MIT doesn’t yet own any such facilities.

The Department of Earth, Atmospheric and Planetary Sciences (EAPS) is now engaging colleagues from MIT’s School of Science in this groundbreaking and time-sensitive project. “Expanding the SPECULOOS mission quickly into the northern hemisphere would double the planet yield before JWST’s launch, and hence our chance of identifying habitable exoplanets. Scientists across MIT and around the world are eager to partner in this exciting opportunity,” said EAPS principal collaborator, Dr. de Wit.
In contrast to its larger space-based cousin Kepler, which was designed to survey hundreds of thousands of faraway stars, the diminutive and inexpensive TRAPPIST ground telescope is purpose-built to track only those cool, dim, dwarf stars in our immediate galactic neighborhood which could be hosting temperate terrestrial planets. Studies have shown that habitable Earth-sized planets transiting one of the 1000 nearest ultra-cool stars would be the only suitable candidates for thorough atmospheric study and analysis with coming technologies. After scanning just 20 of these ultra-cool stars, TRAPPIST was already able to find 3 such planets—the first ever observed orbiting a dim star—opening an exciting new chapter in the hunt for life beyond our solar system.

Pictured here in an artist’s rendering is the dwarf star TRAPPIST-1 and its three newly-discovered planets—a star just one-tenth the size of our sun, a mere 40 light-years away.

Join Us

MIT has an extraordinary, time-limited opportunity to play a central role in this historical scientific initiative to identify habitable exoplanets and discover signs of life outside of our solar system. Our goal is to raise $800,000 to build two new TRAPPIST-design telescopes by summer 2017. To secure MIT’s role as a world leader in this important research, please consider making a gift to the SPECULOOS project.

For more information about SPECULOOS and EAPS planetary science research, or to make a contribution, please contact Angela Ellis, EAPS Senior Development Officer at 617-253-5796 or aellis@mit.edu.