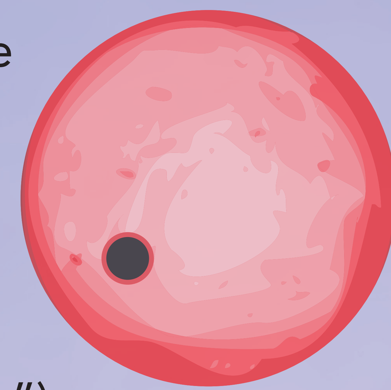
The MEarth Project: Looking for Habitable Exoplanets Transiting Nearby, Small Stars & Finding the Best Targets for Atmospheric Characterization with JWST

(an ongoing survey for "Earth"-like planets transiting "M" dwarf stars)

Zach Berta-Thompson
Torres Exoplanet Fellow
Massachusetts Institute of Technology

on behalf of the MEarth team:
David Charbonneau, Jonathan Irwin,
Elisabeth Newton, Jason Dittmann
Harvard-Smithsonian Center for Astrophysics

If a planet transits its host star, we can observe the planet's mass, radius, and atmosphere. Making such measurements for a small, cool planet like the Earth is easier if the planet transits a small, cool star. The MEarth Project aims to find planets in the habitable zones of nearby, very small stars ("mid-to-late M dwarfs"), to provide the best targets for atmospheric study with large telescopes like the James Webb Space Telescope.



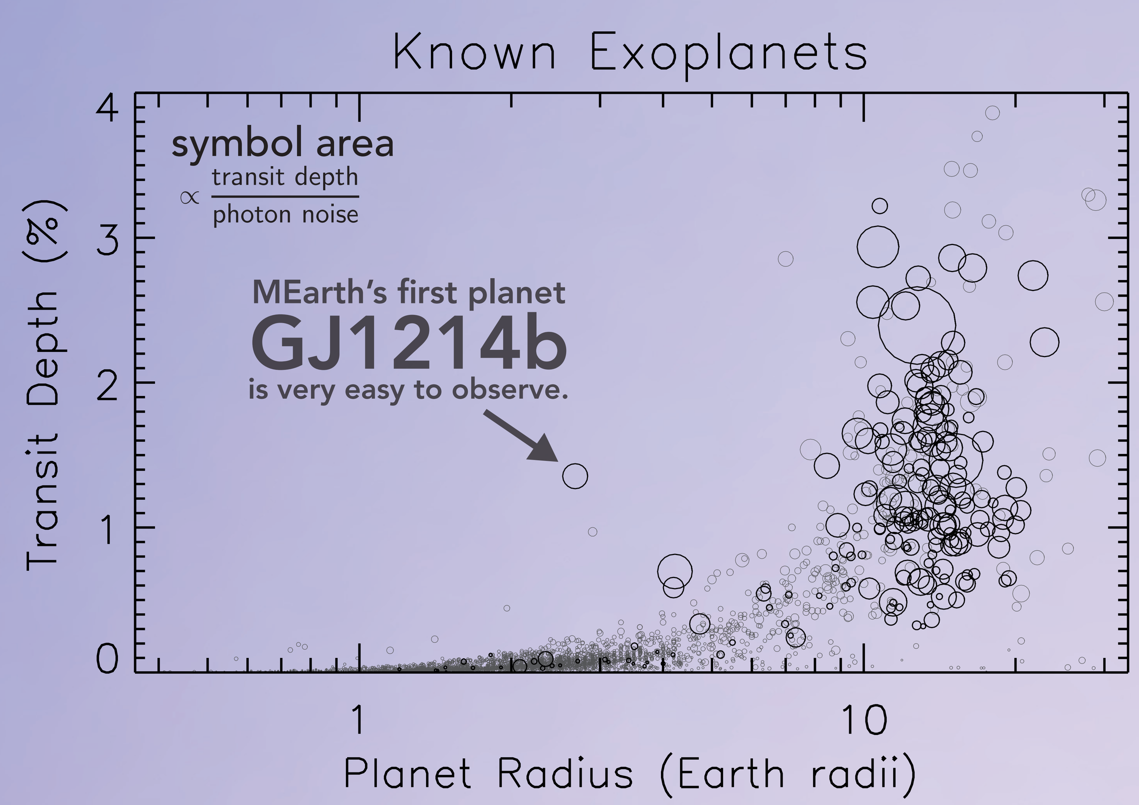
MEarth-North

eight 40 cm telescopes
at **Mt. Hopkins, Arizona**
monitoring the brightness of
small (0.1-0.3 solar radii),
nearby (<100 lightyears)
M dwarf stars,
since **2008**

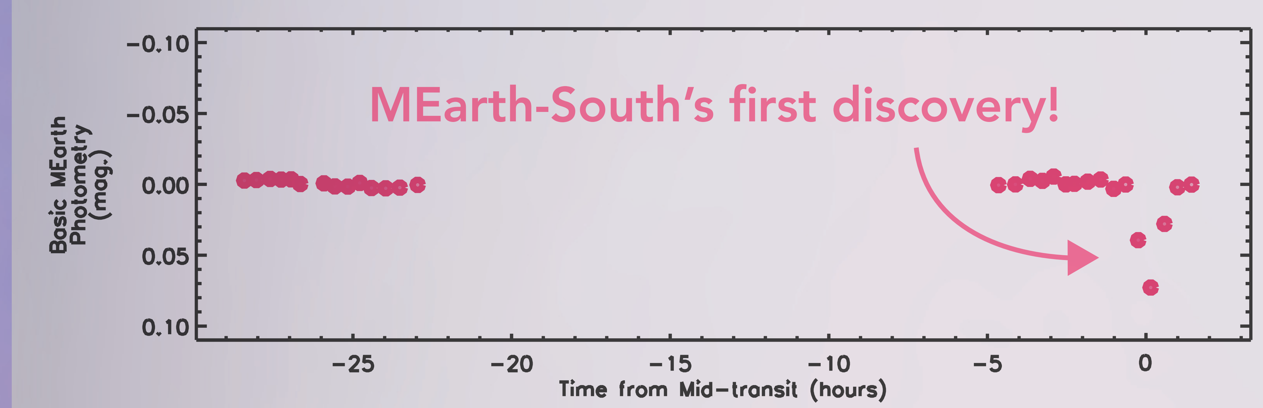
MEarth-South

eight 40 cm telescopes
at **Cerro Tololo, Chile**
monitoring the brightness of
small, nearby M dwarfs
since **2014**

We built a duplicate telescope array in Chile, to search new M dwarfs for planets and to find systems observable with current and future large telescopes in the southern hemisphere. MEarth-South harnesses the expertise and infrastructure we developed for MEarth-North, and began operations in January 2014.

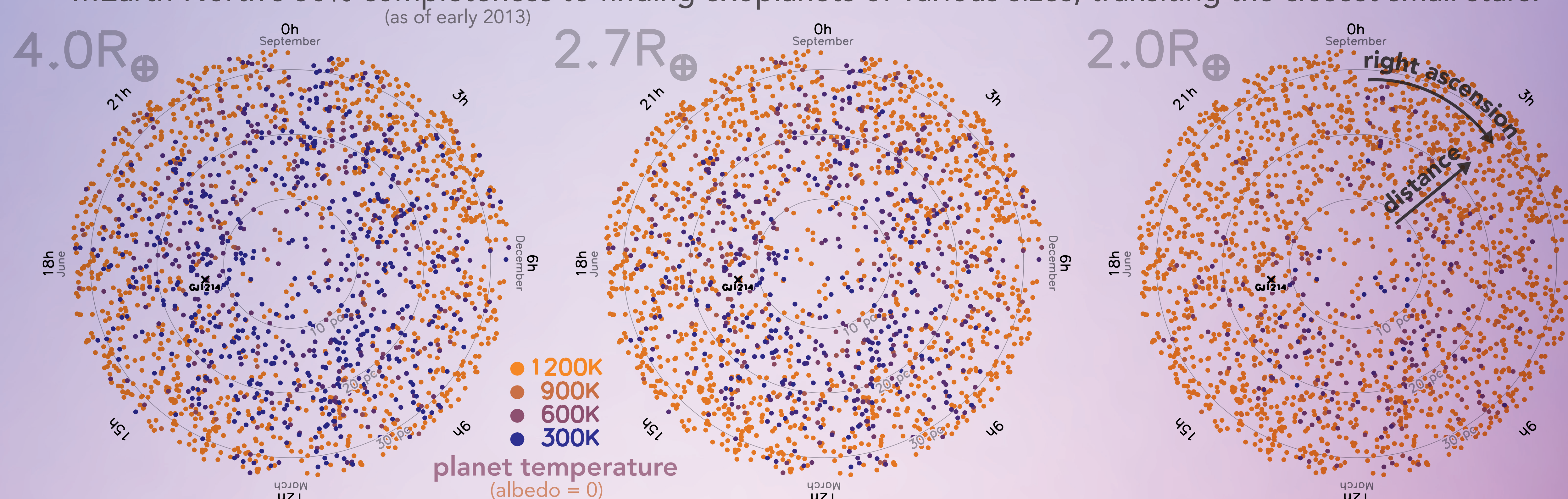


GJ1214b is the first planet we found with MEarth. It transits an M dwarf that is both small (1/5 the size of the Sun) and nearby (among the 1000 closest stars), making it an ideal target for atmospheric study. Deep observations (including 76 orbits with Hubble and 20 days with Spitzer) revealed the presence of high-altitude clouds in the atmosphere of GJ1214b. With a temperature of 500K, GJ1214b's is among the coolest exoplanet atmospheres yet studied. A planet in the habitable zone of an M dwarf like GJ1214 would have an orbital period of 10 days, which is short enough to be detectable from the ground.

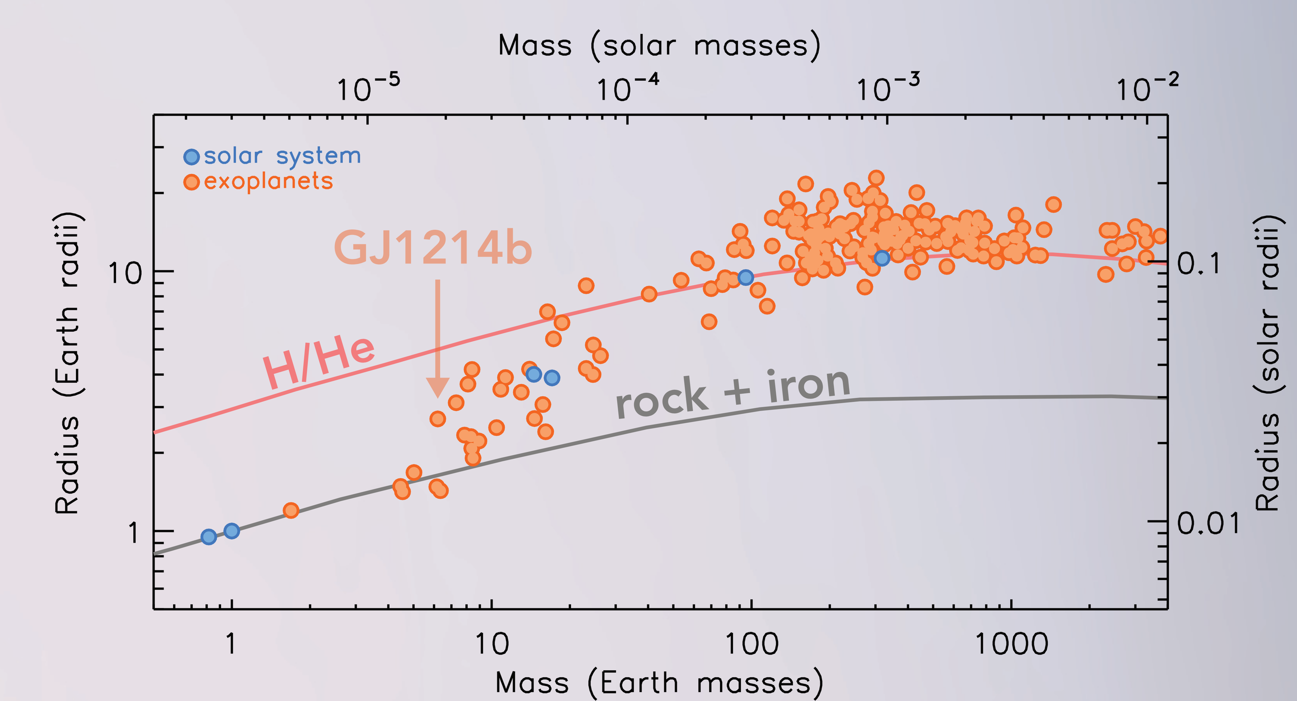


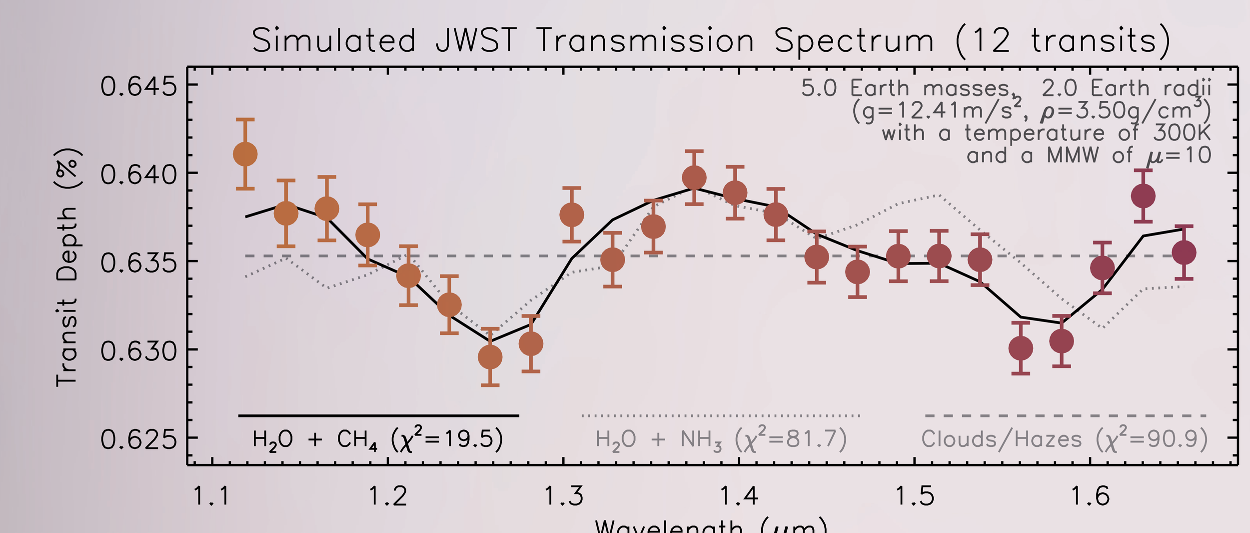
On the second night of commissioning, MEarth-South made its first discovery: an M dwarf eclipsing binary system. The photometric precision of the MEarth-South light curves is sufficient to detect planets $2R_\oplus$ and smaller.

MEarth-North's 50% completeness to finding exoplanets of various sizes, transiting the closest small stars:
(as of early 2013)



The MEarth Project is targeting planets small enough and cool enough to be habitable. Along the way, we will find slightly larger and warmer planets. We cannot measure masses for most of the Kepler planets, so the mass-radius diagram is still sparsely populated below $10M_\oplus$. We can measure masses for planets found by MEarth (and future missions like TESS), which will help constrain the basic physics of low-mass planets.





If MEarth finds a potentially habitable planet, JWST will be able to observe that planet's atmosphere. This simulation scales the performance achieved with Hubble/WFC3 on GJ1214b (Kreidberg et al. 2014) to what we expect for JWST for transmission spectroscopy of a planet in the habitable zone of a star just like GJ1214 (in both size and distance).

Of the 2000 small M dwarfs in the MEarth-North sample, we have searched about 1200 for planets. For these stars, we are confident we could have detected habitable-zone, Neptune-sized ($4R_\oplus$) exoplanets (Berta et al. 2012, 2013). However, results from Kepler indicate planets are most abundant below about $2.7R_\oplus$ in size (Dressing and Charbonneau 2013). We are shifting the focus of MEarth-North toward this still largely unexplored territory, to find the small exoplanets that we know must orbit the closest, smallest stars.

cfa.harvard.edu/MEarth
Download MEarth light curves (DR2), learn about our new parallaxes + spectra, watch time-lapse movies, and more!

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