HEMI Seminar

Exoplanet Geoscience: Challenges and Opportunities for the Extreme Materials Community

Dr. Cayman Unterborn
Assistant Research Scientist
Nexus of Exoplanet System Science, ASU

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In our search for "Earth-like" planets, we have discovered more than 4000 exoplanets to date with the rate of discovery ever increasing in the current TESS era. In the most idealistic case, we can learn much about an individual exoplanet: its radius, mass, orbital parameters and atmospheric composition. These observations combined with mass-radius models reveal a wide diversity of exoplanets from water worlds to super-Earths, with most being unlike anything in our Solar System.

More recent mass-radius work, however, shows that these models are able to at best characterize an exoplanet being broadly rocky, watery, or gassy. Given that Venus is nearly the same mass and radius at the Earth, a more detailed understanding of an exoplanet's geology and evolution is necessary to truly characterize a planet as "Earth-like." Critically important parameters for a rocky exoplanet being "Earth-like," such as its composition, structure, mineralogy, and thermal state, are unknown and unlikely to ever be directly observed. Instead, we must turn to other observables such as host-star composition, system age, and lab measurements, and combine them with geophysical models to quantify a planet's potential geochemical and geodynamical state.

In this talk, I will provide an overview of the recent work in this new field of exogeoscience, paying particular attention to the diversity of rocky exoplanets. From super-Earths, water-worlds, and diamond-planets, rocky exoplanets represent a wholly new parameter space for extreme materials research spanning pressures, temperatures, and compositions unlike anything seen in our Solar System. Even for those planets not particularly extreme in their composition, little is measured about the material properties, melting behavior, or phase equilibria for non-Earth compositions. Without these data, we cannot fully quantify whether a rocky exoplanet is indeed "Earth-like" in its geochemical and geodynamical state, thus limiting us in our ability to classify these exoplanets as habitable and, indeed, deduce whether it is hosting life.

Dr. Cayman Unterborn is an Assistant Research Scientist for the Nexus of Exoplanet System Science at Arizona State University, a position held since 2018. He received his Ph.D in Geological Sciences from The Ohio State University in 2016 and formerly was the School of Earth and Space Exploration Fellow at Arizona State University.

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