Chemistry of Exoplanets

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For the last three decades, we have witnessed remarkable developments in exoplanet research. As of May 2022, there are more than 5000 exoplanets documented in the literature. Such research has impacted many areas in planetary science, including the planet formation theory and the planet habitability. Equations of state of key materials provided from high pressure research have played an essential role in understanding the composition and structure of exoplanets using their mass-radius relations. However, in these efforts, layered internal structure has been assumed mostly because of the lack of critical data to address chemical behavior of materials at the high pressure and high temperature conditions of exoplanets' interiors.

In this talk, I will introduce our recent efforts to understand the chemistry of exoplanets, particularly sub-Neptunes (hydrogen-rich and water-rich exoplanets) and their gas-loss forms (some super-Earths), which are the most common types of exoplanets so far. I will present our recent work on water-rock, hydrogen-rock, water-metal, and hydrogen-metal reactions in laser-heated diamond-anvil cells conducted at the Advanced Photon Source and Arizona State University. I will discuss a few examples of how such studies can provide important data for on-going and future space telescope missions as well as ground-based telescope observations, specifically providing data on understanding the interactions between the atmosphere and interior of exoplanets.

Group website: https://www.danshimlab.info
Media highlight:

- Exo-geology: Arizona PBS Catalyst, Nature News Feature
- Water-rock mixing in water-rich exoplanets: Nature Astronomy News and Views, APS Science Highlight
- Carbon rich exoplanets: CNN news, AGU EOS highlight