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Exploring the Nature of Habitable Sub-Neptunes: From Theory to the Lab

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Sub-Neptunes, planets between the size of Earth and Neptune, are found to be the most abundant type of exoplanets, yet their nature remains enigmatic as we do not have such type of planets in the solar system. Sub-Neptunes are thought to be either bloated versions of terrestrial planets (the so-called “super-Earths”), miniature giant planets (the so-called “mini-Neptunes”), or perhaps something in between (e.g., “water worlds”). Temperate sub-Neptunes are particularly intriguing due to their potential habitability prospects. In this talk, I will discuss the work from our group, using a combination of photochemistry and modern geochemistry theoretical tools to understand the nature of temperate sub-Neptunes. I will give several examples of our model, in tandem with recently acquired JWST atmospheric characterization data for K2-18 b, LHS 1140 b, TOI-270 d, and LP 791-18 c. Lastly, I will talk about ongoing laboratory efforts to facilitate our understanding of the puzzling nature of temperate sub-Neptunes.