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Oral
(Keynote Speaker)
Discovery of over 5500 exoplanets with Kepler mission, TESS, the Hubble Space Telescope, and JWST suggests that rocky exoplanets in the habitable zones around G, K, and M dwarfs are common in our Galaxy. These detections open a new era in the characterization of the planetary atmospheric environments, the critical step in the search for conditions suitable for life and signatures of their biospheres. How our Earth acquired a biosphere? Why Earth is a habitable planet, while Venus and Mars are uninhabitable worlds? Are biospheres of terrestrial-type exoplanets a common phenomenon? How can we detect a biosphere from an Earth-like exoplanet? Critical examination of the heliophysical and physico-chemical conditions that supported the emergence of life on the early Earth and other inner planets in our Solar System is a promising way to address these fundamental questions. Understanding the conditions for habitability requires the characterization and assessment of several factors: retention of a relatively thick atmosphere, presence of basic molecular compounds, and availability of persistent external energy fluxes. The consistent characterization of space environments and their impact on exoplanetary upper atmosphere and climate requires a new system science approach to characterize habitability as the evolving physico-chemical phase of an exoplanetary system. These factors could have promoted the emergence and complexification of biological systems on early Earth. In this talk, I will describe our recent observational campaigns of young solar-like (G-type) analogs, and data-constrained state-of-the-art theoretical models of their coronae and transient events and discuss the impact of solar/stellar X-ray, Extreme UV, and wind magnetic field on atmospheric escape. I will then describe how the extreme space weather events in the form of flares, coronal mass ejections, and energetic particle events from the recent past of our Sun provides critical insights into the atmospheric chemistry of early Earth-Moon system and terrestrial-type exoplanets driven by the activity of the young Sub and assessment of their role in the formation of biologically relevant molecules. Finally, I will present the recent results of laboratory experiments that reproduce the energy fluxes of particles from the young Sun and study the expected formation of amino acids and carboxylic acids, the chemical precursors of life.
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