

THE FORMATION OF HABITABLE WORLDS: CONSTRAINTS, CHALLENGES & PATHWAYS. D. Apai^{1,2}, ¹Steward Observatory and Lunar and Planetary Laboratory, University of Arizona (933 N. Cherry Avenue, Tucson, AZ 85721, apai@arizona.edu), ²Earths in Other Systems Team, NASA Nexus for Exoplanet System Science.

Introduction: The discovery and characterization of habitable worlds is at the forefront of exoplanet science, but identifying habitable worlds among habitable zone planets remains a major challenge. Many small, Earth-sized planets in the present-day habitable zones may be inhospitable to life due to their formation pathways or due to their subsequent evolution. Developing a robust understanding of habitable planet formation and of the key factors that determine whether a planet accretes the right inventory of volatiles and organics represents a major step toward our long-term goal of surveying habitable planets for biosignatures.

Constraints: I will review the key constraints on rocky planet formation from the young solar system (mainly cosmochemistry and orbital dynamics), from forming planetary systems (via studies of protoplanetary disks and forming planets), and from mature exoplanetary systems (mainly exoplanet population statistics). I will explore the time and amount of mass available for forming planetary systems and the constraints they pose on the planet formation process.

Challenges: The delivery of volatiles and organics in amounts that are compatible with allowing life to exist on rocky planets is a major challenge to habitable planet formation. I will review the challenges disk evolution, stellar luminosity evolution, and the presence of giant planets pose on the availability and delivery of volatiles and organics to rocky planets that will end up in present-day habitable zones.

Pathways: Finally, I will review the different formation mechanisms that may lead to rocky planets and explore how the different pathways may influence the volatile and organics inventory of the forming (present-day) habitable zone small planets.

Throughout the talk I will highlight interdisciplinary connections and opportunities, as well as ongoing relevant research within the exoplanet and the NExSS communities. I will also connect the emerging knowledge on habitable planet formation to possible target selection strategies for next-generation NASA space telescopes aiming to explore habitable exoplanets.