# SESSION 4

## Organic Evolution in the Solar System

***Invited Lecture***

DAY 2 – Feb.14, 2017
4:30 pm – 5:30 pm

# Organic Evolution in the Solar System

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**Introduction:** The astrochemical cycles that spawn nebulae and stars also produce and deliver organic compounds and their precursors in the solar system. These organic species can further evolve as the solar system condenses into small bodies and planets where geochemical processes interreact with cosmochemistry. On Earth (and possibly elsewhere), this interface between geochemistry and cosmochemistry lead to life. On Earth, biochemistry has dominated and subsumed organic geochemistry and cosmochemistry. Thus, to understand the journey of organics before life, we must look to spectroscopy of the interstellar medium, the examination of samples, and tests with models and experiments to tie them together.

**Observations and Analyses:** The 1930s saw the spectroscopic detection of small organic ions and neutral gas molecules in the interstellar medium and isotopic studies followed over 40 years later. The inventory and distribution of simple molecules in gas, grains, and ices was further advanced by ground and space-based observatories, such as ISO, Spitzer, ALMA, and soon JWST. These observations provide context for studies of samples generated in models, laboratory experiments, and the analysis of meteorites.

Though studies of the organic content of meteorites date to Berzelius in 1834, it did not accelerate until the 1970s. Until recently, most of these focused on a few carbonaceous chondrites. Meteorite analyses today show a complex and highly diverse suite of organics, including hydrocarbons, carboxylic acids, aromatics, hydroxy acids, polyols, amino acids, and more. Antarctic and other systematic meteorite collection campaigns now provide an astounding wealth of samples to study. The study of one suite of compounds across meteorite types is now beginning to provide insight into the early solar system. Though the study of prebiotic chemistry in the laboratory from the 1950s and 60s helped interpret the complex mix of compounds in samples, it was preparation for the study of moon rocks that catalyzed the study of extraterrestrial organics.

**Sample Return:** Apollo 11 returned the first samples from space for laboratory organic analysis. Human and robotic lunar sample return was followed by the capture of IDPs from the edge of space, then samples from a comet and asteroid by Stardust and Hayabusa. Today the Hayabusa2 and OSIRIS-REx spacecraft are traveling to different asteroids to collect and return samples for the next frontier in the study of primitive solar system organics. The addition of pristine samples in context will bring new depth to our increasingly sophisticated understanding of solar system organics.