

The Chemical Evolution of Cosmic Carbon: Laboratory Studies with the COSmIC Facility

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Cosmic dust plays an essential role in our understanding of the chemical and physical evolution of the universe. Our understanding of cosmic dust relies on a combination of astronomical observations (either remote or on extraterrestrial dust samples), astrophysical modeling and laboratory studies of realistic analogs of cosmic dust grains. The COSmIC facility was developed at NASA Ames to study the evolution of cosmic carbon from circumstellar outflows to interstellar clouds to planetary atmospheres in the laboratory [1]. COSmIC stands for “Cosmic Simulation Chamber” and is dedicated to the study of neutral and ionized molecules and grain particles under the low temperature and density conditions that are required to simulate space environments. COSmIC integrates a variety of instruments that allow generating, processing, and monitoring simulated space conditions in the laboratory. It is composed of a Pulsed Discharge Nozzle (PDN) expansion that generates a plasma in a free supersonic jet expansion, coupled to high-sensitivity, complementary in situ diagnostic tools used for the detection and characterization of the species present in the expansion: Cavity Ring Down Spectroscopy (CRDS) and fluorescence spectroscopy systems for photonic detection and an orthogonal Reflectron Time-Of-Flight Mass Spectrometer (oReTOF-MS) for mass detection.

Recent advances achieved in laboratory astrophysics using COSmIC’s laboratory data in synergy with observational data will be presented. These results include the formation of dust grains and aerosols from gas-phase molecular precursors in environments as varied as circumstellar outflows of late AGB stars [2] and planetary atmospheres [3] and the evolution of our understanding of the diffuse interstellar bands (DIBs) with applications to the ESO Diffuse Interstellar Bands Large Exploration Survey (EDIBLES [4, 5]). Plans for future laboratory developments and techniques to study the evolution of cosmic carbon molecules and grains (including NIR-MIR CRDS, laser induced fluorescence (LIF) and incandescence (LII)) will also be addressed as well as their astronomical applications.

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References

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