Merged Beams Studies for Astrobiology

D. W. Savin[1], A. P. O'Connor, K. A. Miller, N. de Ruette, and X. Urbain[2]

[1] *Columbia Astrophysics Laboratory, Columbia University, New York, NY 10027, USA*

[2] *Institute of Condensed Matter and Nanosciences, Université catholique de Louvain, B-1348 Louvain-la-Neuve, Belgium*

The chain of chemical reactions leading towards life is thought to begin in molecular clouds when atomic C and O are fixed into molecules. Reactions of neutral C with H_3^+ is one of the first steps in the gas-phase chemistry leading to the formation of complex organic molecules. Water, believed to be vital for life, can form via a chain of gas-phase reactions that begin with neutral O reacting with H_3^+. Uncertainties in the rate coefficient for these reactions hinder our ability to understand the first links in the chemical chain leading towards life. Theory provides little insight as fully quantum mechanical calculations for reactions involving four or more atoms are beyond current capabilities. Experimental data are sparse due to the challenge of producing sufficiently intense and well-characterized beams of neutral atoms.

We have developed a novel merged-beam apparatus to study reactions of neutral atoms with molecular ions at the low collision energies relevant for molecular clouds. Photo-detachment of keV-energy atomic anion beams is used to produce beams of neutral C and O. A velocity-matched H_3^+ beam is then merged with the neutrals. The merged-beams method allows us to achieve kinetic temperatures below 30 K. Using our results, we are able to generate thermal rate coefficients for use in chemical models of molecular clouds.