Mining Outer Space for Small Molecules

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Abstract: Science missions to comets and moons in our solar system have returned surprising results about the presence and abundance of small molecules, such as H2, O2, CH3OH, and even Glycine, whose origin remains a mystery especially under the extreme conditions of outer space. As manned missions are now planned, it becomes crucial to understand how small molecules form so they can be mined for propulsion and sustenance of life. This talk will explore reaction dynamics of hyperthermal molecules on surfaces of astrophysical relevance, where reaction barriers are overcome by kinetic energy. Water vapor is abundant on comets and various moons of solar planets, and it can be readily ionized by solar UV light producing water ions. When these ions acquire kinetic energy they become capable of driving novel chemistry on surfaces. Two such pathways will be discussed: (i) the direct formation of molecular H2 in single collisions of water ions with generic surfaces, and (ii) the abstraction of atomic oxygen from oxidized surfaces by water ions, which leads to facile production of molecular O2. The former is an example of an exotic intramolecular reaction pathway that involves formation of an excited state of water, analogous to photoexcitation pathways under extreme radiation. The latter is a fascinating example of an Eley-Rideal reaction, a class of reactions heretofore speculated to take place at the opposite end of heterogeneous catalysis. The talk will conclude by showing off the impact of Chemical Engineering in Astrophysics.

Biography: **Konstantinos P. Giapis** is a Professor of Chemical Engineering at the California Institute of Technology. He holds a Ph.D. degree in Chemical Engineering from the University of Minnesota. He was postdoctoral member of technical staff at Bell Laboratories, Murray Hill (NJ) before joining the California Institute of Technology in 1992. His current research interests include plasma chemistry, gas-surface dynamics, and fundamental aspects of nanoscience. The Rosetta mission has inspired him to move part of his research to Astrophysics, where he explores abiotic reaction pathways to produce small organic molecules relevant to the origin of life. He has received an NSF Career Award and a Dreyfus Teacher-Scholar Award.

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