Interaction of Charged Particles with Kuiper Belt Ices and Astrobiological Implications

<u>R.I. Kaiser</u>,[1,2] B. Jones[1]

[1]*Department of Chemistry, University of Hawaii at Manoa, Hawaii, USA & W.M. Keck Laboratory in Astrochmistry, Hawaii, USA*
[2]*NASA Astrobiology Institute, University of Hawaii at Manoa, Hawaii, USA*

The Kuiper Belt consists of about 70,000 icy bodies, which extend beyond the orbit of Neptune at 30 AU. These bodies are thought to have maintained low temperatures (30-50 K) since the formation of the Solar System and therefore hold a well-preserved record of the primitive volatiles from which the solar system formed. While the icy inventory consist of water, observations have also confirmed the presence of methane, ammonia, carbon monoxide, nitrogen, carbon dioxide, and methanol. These surfaces have been exposed to galactic comic radiation (GCR) and solar wind particles, which are thought to produce biologically important species. Since KBOs are also considered as 'precursor objects' to short periodic comets, KBOs might be also a source to bring such molecules to the primordial Earth, perhaps helping to instigate the origin of life. Our research has been focused on trying to understand how these ices have evolved over the age of our solar system under the chemical processing – primarily of species containing the atoms carbon, hydrogen, oxygen and nitrogen – and to what extend the variation of composition and temperature may help explain these observations and enable us to trace backwards, to determine the primordial composition of the solar system. Results on the formation of simple sugars such as glycolaldehyde, amino acids like glycine, carboxylic acids, and molecules carrying the peptide bond (form amide, dipeptides) will be presented. We also present new results from the newly commissioned W.M. Keck Research Laboratory in Astrochemistry at the University of Hawai'i at Manoa. This lab comprises a next generation ultra-high vacuum experimental set-up which allows the study of the interaction of monoenergetic photons and charged particles with icy surfaces using a plethora of complementary analytical techniques within a single machine including Fourier Transform Infrared, Raman, and UV-VIS spectroscopy, as well as quadrupole and time-of-flight mass spectrometry coupled with soft vacuum ultraviolet photoionization. Here, we present recent results regarding the formation of high molecular weight (~ C_{18}) hydrocarbons starting from pure, simple hydrocarbons ices upon interaction of these ices with ionizing radiation: methane (CH_4), ethane (C_2H_6), propane (C_3H_8) and n-butane (C_4H_{10}). Specifically, we have utilized for the very first time a novel application of reflection time-of-flight mass spectrometry to observe the nature of high mass hydrocarbons as a function of their respective sublimation temperature. Coupled with soft vacuum ultraviolet photoionization of the subliming products at 10.5 eV, generated via tripling in a pulsed xenon jet of the 355 output of a Nd:YAG laser, our results indicate that larger, more complex hydrocarbons up to C18 are formed easily under conditions relevant to the environment of Kuiper Belt Objects which may help elucidate part of the puzzle regarding the 'colors' of these objects along with the formation of carbonaceous material throughout the interstellar medium.

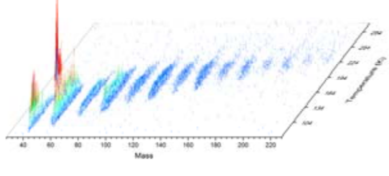

Figure 1: Time-of-Flight spectra as a function of temperature of the newly formed hydrocarbon species from the energetic processing of a pure amorphous ethane ice taken at a photoionization energy of 10.5 eV.