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Ion induced reactivity in systems of astrophysical interest

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Complex organic molecules are observed in many astrophysical objects, but little is known about their formation mechanism and survivability. In molecular clouds, atoms and molecules condense on dust particles leading to formation of icy mantles. Astrophysical ices contain mainly H_2O, while CO, CO_2, NH_3, and CH_3OH are also commonly observed. These ices are exposed to energetic processing by ions, photons and electrons, and/or thermal processes that trigger the chemical evolution of the ice.
Laboratory simulations on interstellar ices and molecular clusters are therefore of paramount importance for understanding the origin of complex organic molecules (possibly relevant to the origin of life). Studying in-situ the chemical evolution of ices and of remaining refractory organic residues (after slow heating-up) provides relevant hints on the fundamental physical and chemical steps associated with the increase of the molecular complexity in space. Several experiments show that the basic building blocks of organic matter can be formed by interaction of UV photons, electrons and keV-MeV light ions with ices. The aim of the present work is to mimic the reactivity in ices and molecular clusters triggered by heavier ions, also being present in space.
On the one hand, we will focus on the physical chemistry induced by heavy-ion cosmic rays inside ammonia-containing ices (e.g. H_2O:NH_3:CO) irradiated by Ni ions. The infrared spectra of the irradiated ice samples exhibit bands of several new species including HNCO, N_2O, OCN^-, and NH_4^+. After IR measurements the irradiated samples were slowly warmed up to room temperature. This IR spectrum contains bands that can be tentatively assigned to vibration modes of zwitterionic glycine and to hexamethylenetetramine. Moreover, we need to know the probability that such complex organic molecules survive when exposed to radiation. Therefore, we have also performed irradiations of adenine films with MeV ions.
On the other hand, it is believed that PAHs are omnipresent in the interstellar medium. We will also present very recent results on ion-induced reactivity in pyrene clusters and radiolysis of pyrene films.

Primary author: Dr DOMARACKA, Alicja (Centre de Recherche sur les Ions, les Matériaux et la Photonique (CEA/CNRS/ENSICAEN/Université de Caen-Basse Normandie))

Co-authors: Prof. DA SILVEIRA, Enio F. (Physics Department, Pontifícia Universidade Católica, Rua Marquês de S. Vicente 225, 22451-900 Rio de Janeiro, Brazil); Prof. STRAZZULLA, Giovanni (INAF-Osservatorio Astrofisico di Catania, 95123 Catania, Italy); Dr ROTHARD, Hermann (Centre de Recherche sur les Ions, les Matériaux et la Photonique (CEA/CNRS/ENSICAEN/Université de Caen-Basse Normandie), CIMAP-Ganil, Bld Henri Becquerel, BP 5133, F-14070 Caen Cedex 05, France); Dr BODUCH, Philippe (Centre de Recherche sur les Ions, les Matériaux et la Photonique (CEA/CNRS/ENSICAEN/Université de Caen-Basse Normandie), CIMAP-Ganil, Bld Henri Becquerel, BP 5133, F-14070 Caen Cedex 05, France); Dr PILLING, Sergio (Instituto de Pesquisa e Desenvolvimento (IP&D), Universidade do Vale do Paraiba (UNIVAP), Sao Jose dos Campos, SP 12244-000, Brazil)

Presenter: Dr DOMARACKA, Alicja (Centre de Recherche sur les Ions, les Matériaux et la Photonique (CEA/CNRS/ENSICAEN/Université de Caen-Basse Normandie))

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