DFNA Seminar

Applied Nuclear Physics Department Seminar

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building 33, 1st floor

Revision of 3.4 µm band destruction rates under ion beam irradiation of hydrogenated amorphous carbon as interstellar dust analogues

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The 3.4 µm IR absorption band, assigned to CH stretching vibrations of CH2 and CH3 aliphatic groups, widely observed in the diffuse interstellar medium (DIM) and also been observed for extragalactic sources, is associated with the presence of carbonaceous interstellar (IS) dust. Since the first reports in early 1980's on 3.4 µm band observations in space, a debate was present on whether this band can be used as an indication for the presence of complex organic molecules (COMs) in space. As result, various plasma devices are employed for carbon dust deposition of hydrogenated amorphous carbon (HAC or a-C:H) samples in order to match the astrophysical observations and related processes: capacitive coupled or inductive coupled radio frequency discharges, laser ablation plumes, pulsed discharge nozzle, spark and arc discharges, magnetron discharges, dielectric barrier discharges (last plasma technique to enter the scene). Many other deposition methods, not necessarily using plasmas, are also employed: mechanochemical synthesis, condensation, physical vapour deposition, combustion and pyrolysis.

Moreover, supplementary discussions where developed later on the processing in space for the 3.4 µm band carriers in diffuse and dense dust clouds. In order to obtain information on dust processing in space, laboratory astrophysics experiments are performed, usually employing energetic particles (UV photons, electrons or ions) and irradiation under vacuum conditions. Hydrogen recombination model and the phenomenological exponential decay fitting function are used to extract destruction cross section by cosmic-rays in the diffuse ISM, using the 1 MeV monoenergetic proton approximation.

The present work will review our results on Dielectric Barrier Discharge (DBD) studies, as a new method for low temperature deposition of HACs for interstellar dust analogues. Comprehensive characterisation of HACs is performed by microscopy and spectroscopic techniques, allowing to subtract relevant quantities such as CH2/CH3 ratio, H/C ratio or sp2/sp3 ratio. A comparison between DBD carbon dust and other analogues or carbonaceous materials in diffuse interstellar medium will be provided, using spectral data and ternary diagrams.

The talk will close by introducing our recent results on HACs energetic processing, using 3 MeV H+ and 1 MeV H+ and C+, aiming to revise the effects of analogues' morphology and density on the 3.4 µm band intensity drop. The characteristic times for CH bond destruction as compared with the dynamical times of diffuse regions and dense clouds allow to group the literature results into two families: data that support the scenario of unlikely aliphatic CH bonds destruction by cosmic rays (Godard et al. 2011; Maté et al. 2016) and data that support a possible aliphatic CH bonds destruction by cosmic rays (present work and Mennella et al. 2008).