H_2 formation on silicate dust: i) laboratory studies and ii) possible observational confirmation on a PNe using the VLT

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i) Silicate grains as an important fraction of dust in the general diffuse interstellar medium (ISM) are of great interest to astrophysicists. Silicate surfaces allow the recombination of the most abundant molecule, H_2, which drives further chemical complexity. Their properties depend on their location and lifetime in the ISM, where they can be irradiated by energetic photons and ions.
Nanometre-sized silicate samples (forsterite and fayalite, Mg_2- or Fe_2- SiO_4 end-members of the olivine family) are prepared (with both amorphous and micro-crystalline structure) in the Jena laboratory via laser ablation [1].
These silicates are carefully characterized using surface science and solid state physics techniques (HRTEM, EDX, SEM and AFM), building a bridge to the morphology, structure, and chemical composition of dust, just condensed and subsequently processed [1,2].
They are then used as surface catalysts in molecular hydrogen formation experiments [2] using the FORMOLISM setup in Cergy-Pontoise. The aim is to explore the direct effect of these different silicate dust species on H_2 formation and the ensuing formation energy partition. In addition to a summary of previous results [3-6], we will present results on H_2 formation on such silicates and the dependence on temperature, possible nuclear spin conversion effects, and rotationally "hot H_2".

ii) Such above study provides a major link to astronomical observations as a tool for identification of cosmic dust properties. We then have selected targets where the so-called formation pumping excitation mechanism of H_2 (targets if possible free of other excitation mechanisms like PDRs or shocks) may be detected. Following previous theoretical work prescriptions [7,8] indicating in particular that the presence of X-rays may play a role in the H_2 dissociation, we have selected a series of planetary nebulae (PNe) to perform exploratory observations using the VLT and KECK telescopes. In such objects H_2, if present, will be dissociated by the strong UV field of the dying star or by the strong stellar winds. However large amount of dust are also expelled behind which molecular hydrogen can re-form and be observed. We will present preliminary results on a particularly interesting and complex PNe on which diverging interpretations are found but that the formation pumping may reconcile [9].

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