DIFFUSION AND REACTIVITY OF GROUND STATE ATOMIC NITROGEN N(^{4}S) IN SOLID PHASE AT LOW TEMPERATURE: IMPLICATIONS FOR DENSE INTERSTELLAR CLOUD CHEMISTRY.

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In the last few years, ambitious programs were launched to probe the interstellar medium always more accurately. One of the major challenges of these missions remains the detection of prebiotic compounds and the understanding of reaction pathways leading to their formation. These complex heterogeneous reactions mainly occur on icy dust grains, and their studies require the coupling of laboratory experiments mimicking the extreme conditions of extreme cold and dilute media. Using near infrared spectroscopy, (a region which is accessible to ground-based observations) laboratory experiments at very low temperature and very low pressure under non-energetic conditions are of primary importance to help understanding processes that may take place in some interstellar regions such as dense clouds. For that purpose, we have developed an original experimental approach that combine the study of heterogeneous reactions (by exposing neutral molecules adsorbed on ice to non-energetic radicals H, OH, N...) and a neon matrix isolation study at very low temperatures, which is of paramount importance to isolate and characterize highly reactive reaction intermediates. Such experimental approach has already provided answers to many questions raised about some astrochemically-relevant reactions occurring in the ground state on the surface of dust grain ices in dense molecular clouds[1,2].

The aim of this new present work is to show the implication of ground state atomic nitrogen on hydrogen atom abstraction reactions from some astrochemically-relevant species at very low temperatures (3K-20K), without providing any external energy. Under cryogenic temperatures and with high barrier heights, such reactions involving ground state N(^{4}S) nitrogen atoms should not occur spontaneously and require an initiating energy. However, the detection of some radicals species as byproducts, in our solid samples left in the dark for hours, proves that hydrogen abstraction reactions involving ground state *N*(*^{4}S*) nitrogen atoms may occur in solid phase at cryogenic temperatures, just by controling the mobility of the reactants between 3 and 10K. These results show the efficiency of radical species formation stemming from non-energetic N-atoms and astrochemically-relevant molecules such as CH_4, CH_3OH and NH_3. We will then discuss how such reactions, involving reactants in their ground states, at cryogenic temepratures, might be the first key step towards complex organic molecules production in the interstellar medium.

References:

[1] C. Pirim, L. Krim. (2011) Phys. Chem. Chem. Phys, 13, 19454-19459. [2] C. Pirim, L. Krim. (2014) RSC Advances, 4, 15419-15427.