THE OXIDATION OF AMMONIA ICES. G. Vidali[1] , J. Shi[1], T. Hopkins[1], J. He[1,2] , J.L. Lemaire[3] and R. T. Garrod[4,5], [1]Syracuse University, 201 Physics Dept., Syracuse, NY 13244-1130, USA, [2]Current address: University of Hawai'i at Manoa, Dept. of Chemistry, Honolulu, HI 96822, USA, [3]Paris Observatory, F-75014 Paris, France, [4]Center for Radiophysics and Space Research, Cornell University, Ithaca, NY 14853, USA, [5]Current address: Depts. of Astronomy and Chemistry, University of Virginia, Charlottesville, VA 22904 (USA)

Introduction: N-bearing molecules are considered precursors to complex organic molecules, such as amino acids and prebiotic compounds. It is now recognized that in the interstellar medium (ISM) many molecules of interest to astrobiology are formed on or in ices coating dust grains. Ammonia is an important constituent of such ices. In this presentation, we report on laboratory experiments of oxidation of ammonia, leading to the formation, among other N-containing molecules, of hydroxylamine (NH_2OH) [1]. Hydroxylamine is one of the best precursors to glycine. Although it has not yet been detected in space, it is considered a likely target of detection with ALMA. The experimental data are used in a simulation of the formation of NH_2OH in dense cloud conditions ($n_{H2}=10^4$ /cm^3).

Methods: We used neutral atomic and molecular beams to deposit the reactants on an amorphous silicate film kept under ultra-high vacuum conditions. In a preliminary report, we studied the oxidation of two equivalent layers of NH_3 on an amorphous silicate film [1]. Now we report on further experiments with both simultaneous (NH_3 and O) and sequential (NH_3 then O, repeated) depositions over a range of temperatures using two independent highly collimated beam lines. The evolution of the ices was studied in-situ by Reflection Absorption InfraRed Spectroscopy (RAIRS) and quadrupole mass spectrometry (QMS). The data were analyzed and then fed into the three-phase gas-grain chemical kinetics model MAGICKAL [2].

Results: We detected the formation of hydroxylamine under a variety of conditions appropriate for different ISM environments. The results of simulations show the conditions under which hydroxylamine forms via two competing mechanisms, oxidation of ammonia and step-wise hydrogenation of NO, another constituent of ISM ices.

Based on the results of the experiments and of the simulation we are able to make predictions on the ISM environments most favorable to the observation of hydroxylamine.

References:

[1] He, J., Vidali, G., Lemaire J.L., and Garrod R. T. (2015) *Astrophys. J. 799*, 49

[2] Garrod, R. T. (2013) *Astrophys. J. 765,* 60

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Additional Information: Syracuse University Laboratory Astrophysics Research Group Website: http://astro.syr.edu