NUCLEOBASES AND OTHER PREBIOTIC SPECIES FROM THE ULTRAVIOLET IRRADIATION OF PYRIMIDINE IN ASTROPHYSICAL ICES. S. A. Sandford[1], M. Nuevo[1,2], C. K. Materese[1,2], and S. N. Milam[3], [1]NASA Ames Research Center, MS 245-6, Moffett Field, CA 94035, USA (Scott.A.Sandford@nasa.gov), [2]SETI Institute, 189 N. Bernardo Ave., Ste. 100, Mountain View, CA 94043, USA, [3]NASA Goddard Space Flight Center, MS 691.0, Greenbelt, MD 20771, USA.

Introduction: Nucleobases are *N*-heterocycles that are the informational subunits of DNA and RNA, and are divided into two families: pyrimidine bases (uracil, cytosine, and thymine) and purine bases (adenine and guanine). Nucleobases have been detected in meteorites [1,2] and their extraterrestrial origin confirmed by isotope measurement [3]. Although no *N*-heterocycles have ever been observed in the ISM [4,5], the positions of the 6.2-µm interstellar emission features suggest a population of such molecules is likely to be present [6]. In this work we study the formation of pyrimidine-based molecules, including nucleobases, as well as other species of prebiotic interest, from the ultraviolet (UV) irradiation of pyrimidine in combinations of H_2O, NH_3, CH_3OH, and CH_4 ices at low temperature, in order to simulate the astrophysical conditions under which prebiotic species may be formed in the interstellar medium and icy bodies of the Solar System.

Experimental: Gas mixtures are prepared in a glass mixing line (background pressure ~10^{-6}–10^{-5} mbar). Relative proportions between mixture components are determined by their partial pressures. Gas mixtures are then deposited on an aluminum foil attached to a cold finger (15-20 K) and simultaneously irradiated with an H_2 lamp emitting UV photons (Lyman α and a continuum at ~160 nm). After irradiation samples are warmed to room temperature, at which time the remaining residues are recovered to be analyzed with liquid and gas chromatographies.

Results: These experiments showed that the UV irradiation of pyrimidine mixed in these ices at low temperature leads to the formation of several photo-products derived from pyrimidine, including the nucleobases uracil [7,8] and cytosine [8], as well as their precursors 4(3*H*)-pyrimidone and 4-aminopyrimidine [7,8] (Fig. 1). Theoretical quantum calculations on the formation of 4(3*H*)-pyrimidone and uracil from the irradiation of pyrimidine in pure H_2O ices are in agreement with their experimental formation pathways [9]. In those residues, other species of prebiotic interest such as urea and the amino acids glycine and alanine could also be identified [8]. However, no pyrimidine derivatives containing CH_3 groups, including the third nucleobase thymine, could be identified [10], suggesting that the addition of methyl groups to pyrimidine is not an efficient process [10].

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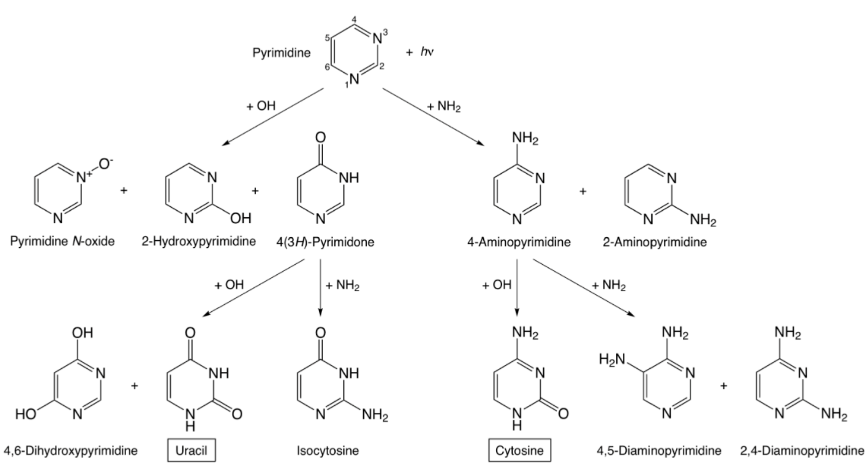

Fig. 1: Pyrimidine derivatives formed after addition of OH groups from H_2O and NH_2 groups from NH_3. Photochemistry with CH_3OH is similar to that of H_2O, with additional compounds such as 4-pyrimidinemethanol.