APPLICATIONS OF H-ATOM QUANTUM-DIFFUSION REACTIONS IN SOLID *PARA*-HYDROGEN TO ASTROCHEMICAL STUDIES: FINDING A MYSTERIOUS LINK BETWEEN INTERSTELLAR ISOCYANIC ACID [HNCO] AND FORMAMIDE [$H_2NC(O)H$]

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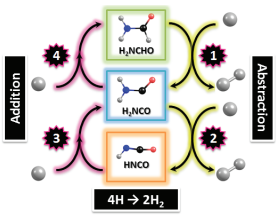
Formamide [$H_2NC(O)H$], the smallest molecule containing the biologically important peptide bond, was detected in the interstellar medium (ISM) almost 50 years ago. Recent observations have shown that a strong correlation between its abundance and that of isocyanic acid [HNCO] exists in pre- and protostellar environments. It was proposed that this correlation is due to effective synthesis of formamide from HNCO by consecutive H-atom addition reactions.[a] However, Nobel *et al.* showed that bombardment of HNCO ice with H atoms led no formation of formamide.[b] So far, no laboratory experiment or theoretical calculations can explain the linkage between these two species.



We utilized the advantages of the solid *para*-H_2 quantum host to investigate the H-atom reactions linking HNCO and formamide. Reactions of $H_2NC(O)H$ with H atoms lead to H_2NCO, and subsequently HNCO. Further hydrogenation reactions convert some HNCO back to H_2NCO and $H_2NC(O)H$; the reaction with $D_2NC(O)H$ clearly showed that these reactions took place. The correlation between the abundance of HNCO and $H_2NC(O)H$ can hence be understood by a dual-cycle mechanism shown in the figure, which connects the two species by a quasi-equilibrium. This mechanism and its generalized form for other molecular pairs can also play an important role in the formation of interstellar H_2 from H atoms.

[a] Lòpez-Sepulcre, *Montly Not. Roy. Astr. Soc.* **449**, 2438–2458 (2015).
[b] Nobel, J. A., *et al.*, *Astron. Astrophys.* **576**, A91 (2015).