THE TEMPERATURE DEPENDENCE OF THE H + N_2O REACTION IN SOLID HYDROGEN

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In the late 1960s Andreev and Lifshitz predicted that at sufficiently low temperatures defects in quantum crystals such as solid parahydrogen should move freely through the crystal possessing the property of superfluidity.[a] The hydrogen atom (H-atom) is an ideal candidate for such a defect owing to its small mass and neutral charge. In 2013 our group published a communication[b] on the kinetics of the H + N_2O reaction in solid parahydrogen that showed an anomalous temperature dependence. In these studies we generate the H-atoms as byproducts of the *in situ* photodissociation of N_2O and monitor the subsequent reaction kinetics using rapid scan FTIR. Specifically, if we photolyze N_2O doped parahydrogen solids with a short duration of 193 nm UV radiation at 4.3 K, we observe little to no reaction; however, if we then slowly reduce the temperature of the sample after photolysis we observe an abrupt onset to the reaction at temperatures below 2.4 K. This change in the reaction kinetics is fully reversible with temperature. We have subsequently improved our experimental apparatus such that we can record the sample temperature with millisecond time resolution while we measure the reaction kinetics using FTIR spectroscopy. We have now performed a number of additional kinetic experiments at constant temperatures of 1.5 K, 4.0 K, and intermediate temperatures within the range from 1.5 to 4.0 K. These measurements have shown that the reaction yield changes dramatically over this temperature range, but the kinetic rate coefficients do not change significantly. The remarkable change in the reaction kinetics with temperature is not as abrupt as originally thought, but now has been reproduced under a variety of conditions. This strange behavior is intimately linked to the motion and reactivity of H-atoms in solid parahydrogen and the most recent experiments and analysis will be presented.

[a] A. F. Andreev and I. M. Lifshitz, *Sov. Phys. JETP.* **29**, 1107-1113 (1969).

[b] F.M. Mutunga, S.E. Follett, D.T. Anderson, *J. Chem. Phys.* **139**, 151104-4 (2013).