# HIGH-RESOLUTION INFRARED SPECTROSCOPY OF $H_2$ IN ION CLUSTERS PRODUCED BY $\gamma$-RAY IRRADIATION OF PARAHYDROGEN CRYSTALS

TAKAMASA MOMOSE, *Division of Chemistry, Graduate School of Science, Kyoto University, Kyoto 606-8502, Japan*; C. MICHAEL LINDSAY, YU ZHANG, and TAKESHI OKA, *Department of Chemistry, Department of Astronomy and Astrophysics, and the Enrico-Fermi Institute, The University of Chicago, Chicago IL, 60637, USA.*

Infrared absorption of hydrogen molecules in $\gamma$-ray irradiated parahydrogen ($p$-$H_2$) crystals has been studied by a high-resolution color center laser spectrometer. The pure vibrational transition $Q_1(0)$ (v=1←0, J=0←0) of $H_2$ becomes infrared active under the strong Coulomb field of ionic species localized in the crystal. We have earlier observed a very sharp $\Delta$k=0 pure vibrational exciton (vibron) $Q_1(0)$ transition induced by a macroscopic electric field resulting from the imbalance of positive and negative charges [a]. Here, we report our observation of a new set of extremely sharp lines which appeared at a frequency region to the red of the field free $Q_1(0)$ transition. The spectral widths were as narrow as 60 MHz. These transitions are assigned to the Stark shifted infrared absorption of hydrogen molecules in ion clusters in the $p$-$H_2$ crystal. The spectral lines remain the same over many days indicating the stability of the ionized system. The observed sharpness and the reproducibility of the spectrum indicate that the local structures of crystals surrounding the ions are homogeneous due to the self-repairing nature of the solid hydrogen. We will discuss the analysis of the spectra and the possible candidates of positive and negative ion cores produced by $\gamma$-ray irradiation of parahydrogen crystals.

[a] T. Momose, K. E. Kerr, D. P. Weliky, C. M. Gabrys, R. M. Dickson, and T. Oka, J. Chem. Phys. **100**, 7840 (1994).