HIGH RESOLUTION INFRARED SPECTROSCOPY OF MOLECULES TRAPPED IN SOLID PARAHYDROGEN

T. MOMOSE, *Division of Chemistry, Graduate School of Science, Kyoto University, Kyoto 606-01, JAPAN.*

High resolution spectroscopic techniques have been seldom applied to matrix isolation spectroscopy because of the inherent spectral broadening due to strong intermolecular/atomic interactions. However, a marked exception is found recently for parahydrogen matrix.[a] We have been utilizing the parahydrogen crystal as a new matrix in a series of papers.[b] Most of the observed infrared spectral bands of molecules trapped in solid parahydrogen are much sharper than those observed in the conventional matrices. The spectral linewidth is found to be as narrow as 0.003cm^{-1} (100MHz, FWHM). In addition, the hydrogen matrix is found to be almost free from strains which cause the formation of unwanted multiple trapping sites often encountered in the conventional rare gas matrices. These specific properties make parahydrogen crystal an excellent matrix for high resolution spectroscopic studies of the rovibrational state of molecules in condensed phase and the intermolecular interaction in great detail. In this paper we will present the high resolution study of rovibrational states of methane in parahydrogen as an example. It is found that methane rotates almost freely in parahydrogen matrix. The observed spectra are interpreted in terms of rovibrational states of the spherical free rotor which are subjected to the splitting due to the subtle intermolecular interaction between methane and hydrogen molecules. The observed polarization dependence of absorption will be accounted for successfully in terms of an extended group theory pertinent to the system.

[a] T. Oka, Ann. Rev. Phys. Chem. 44, 299 (1993).

[b] T. Momose et al. J. Chem. Phys. 103, 1400 (1995); M. Miki et al. J. Phys. Chem. 100, 12135 (1996); N. Sogoshi et al. J. Phys. Chem, 101A, 522 (1997).