Spectroscopy and dynamics of molecules in quantum fluids and solids:
Towards molecular superfluidity and ultracold chemistry

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Spectroscopy of molecules embedded in quantum fluids and solids, such as superfluid helium droplets and parahydrogen crystals, has revealed various unique properties of atoms and molecules at temperatures around 4 K or below.[1] We have been using these quantum fluids and solids to the study of dynamics of cold molecules, such as quantum tunneling reactions and quantum diffusion as well as an investigation of a possible superfluid phase of molecular hydrogen. To further reduce the temperature of molecules below 100 mK, we have also been working on the development of a technique to create quantum gases of molecules in vacuum. Recently, we were successful in trapping reactive free radicals in a magnetic trap at a temperature of < 200 mK.[2] The study of reactive scattering with the trapped free radicals will provide an opportunity to investigate chemical reactions at ultracold temperatures. In this talk, we will discuss a couple of topics related to the unique nature of cold molecules. They include (1) a possible superfluid phase of hydrogen molecules at 0.4 K, and (2) the creation of quantum gases of reactive molecules.

1. T. Momose, and T. Shida, "Matrix Isolation Spectroscopy Using Solid Parahydrogen as the Matrix: Application to High-resolution Spectroscopy, Photochemistry and Cryochemistry" *Bull. Chem. Soc. Jpn.*, **71**, 1 (1998).
2. Y. Liu et. al. "Magnetic Trapping of Cold Methyl Radicals", *Phys. Rev. Lett.*, **118**, 093201 (2017).

Section: QG - Quantum gases

Keywords: Cold Chemistry, cold molecules, molecular superfluidity