

Spectra of $(\text{H}_2)_N$ -molecule clusters: The search for superfluidity in *para*-hydrogen

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Spectroscopic studies of small to medium-sized helium clusters doped with a molecular chromophore have provided detailed insight into the evolution of the property superfluidity from the microscopic, molecular scale. In particular, it was found that the rotational constant, B , of He_N -molecule clusters (N is the number of solvating helium atoms) begins to increase at a certain critical N -value with the addition of further helium atoms. For example, such turn-around in B was observed at $N=10$ for $\text{He}_N\text{-OCS}$. This non-classical behaviour indicates a decoupling of the helium density from the rotational motion of the molecule and marks the onset of microscopic superfluidity.

Apart from helium, hydrogen is the only other substance suspected to have a superfluid phase under laboratory conditions. The transition temperature is predicted to be ~ 6 K for *para*- H_2 . However, hydrogen freezes at 13.8 K and it has thus far not been achieved to supercool hydrogen to below the transition temperature. The spectroscopic study of $(\text{para}\text{-H}_2)_N$ -molecule clusters provides an alternative route for the detection of superfluid *para*- H_2 . In analogy to the He_N -molecule cluster studies, we investigate spectra of $(\text{para}\text{-H}_2)_N$ -molecule clusters with successively increasing number of hydrogen molecules. We anticipate finding a turn-around in B at a certain critical N -value, which would indicate microscopic superfluidity for the case of *para*- H_2 . Experimental progress on the $(\text{H}_2)_N$ -carbonyl sulfide, $(\text{H}_2)_N$ -cyanoacetylene, and $(\text{H}_2)_N$ -nitrous oxide systems will be reported.