MICROWAVE SPECTROSCOPY OF ISOTOPICALLY SUBSTITUTED MOLECULES IN ^{4}He NANODROPLETS: A TEST OF THE ADIABATIC FOLLOWING APPROXIMATION

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The microwave spectrum of HCN and DCN have been measured using Helium Nanodroplet Isolation Spectroscopy. A beam of cold (0.4 K) ^{4}He droplets is formed by expanding helium in vacuum through a 10 μm nozzle. After collimation, the droplet beam is doped with the molecule of interest via standard pickup technique. During the time of flight of the seeded droplet in a 10 cm long waveguide, about 10^3 absorption/relaxation cycles occur with resonant radiation, which leads to evaporation of helium atoms from the droplet. This is detected as a depletion of the beam flux which is monitored optothermally. The $J = 0 \rightarrow 1$ transition for both molecules has been recorded at 72.14$\pm$0.01 GHz for HCN and 59.82$\pm$0.01 GHz for DCN.

According to a recently developed superfluid hydrodynamic model[a] in which it is assumed that the helium density adiabatically follows the molecular rotation, the increase in moment of inertia caused by the helium is expected to be almost identical in each pair of isotopomers. In the case of HCN/DCN, it is predicted that DCN will be affected slightly less ($\sim$ 1%) because the center of mass and the geometric center of DCN are closer together, which makes the rotor dynamically more spherical.

Experimentally, the increase is found however, to be significantly smaller for the faster rotor, HCN, by about 11%. This result, which is in contradiction with the prediction of the hydrodynamic model, is interpreted as a breakdown of the adiabatic following approximation which is only valid for the slower rotors. Experiments with CH_3F and CD_3F are in progress and will be reported at the meeting.

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[a] C. Callegari, A. Conjusteau, I. Reinhard, K.K. Lehmann, G. Scoles, and F. Dalfovo Phys. Rev. Lett. **83**, 5058 (1999); **84**, 1848(E) (2000)