TRAPPING AND SPECTROSCOPY OF MOLECULES IN COLD HELIUM DROPLETS

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Helium droplets containing 5000 to 10000 atoms are generated in a supersonic expansion of about 50 bar of helium through a 5 micron nozzle at 10 to 20 K temperature. They have a diameter of about 10 nm and an internal temperature of 0.4 K and in the case of 4He, are believed to represent finite size samples of a superfluid. By doping the droplets with spectroscopically well known atoms or molecules, their interaction dynamics can be probed. Many molecules were shown to become solvated inside the droplet and to exhibit sharp vibrational spectra. We investigated the optical S1 - S0 excitation of pentacene in large helium clusters around 18500 cm⁻¹ with cw single frequency dye lasers. The total linewidth of 9 GHz for an individual vibrational band turned out to be due to both inhomogeneous and homogeneous broadening. By applying a pump-probe technique (hole burning spectroscopy), the homogeneous linewidth was shown to be about 5 GHz which may be due to overlapping rotational structure. The inhomogeneous broadening probably originates from the rather wide helium cluster size distribution. Alkali atoms, when deposited on helium droplets, reside on the surface and form molecules in cold collisions. Singlet dimers as well as aggregates of spin polarized alkali atoms were observed. Again the causes for line broadening were studies with optical pump-probe techniques and will be discussed.