# SPECTROSCOPY OF LARGE, COLD MOLECULAR CLUSTERS

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A review will be presented of our work in the spectroscopy of large, cold molecular clusters. Growth of clusters in He droplets at T = 0.38 K has been studied.[a] Infrared spectra indicate that ammonia clusters consisting of about $10^4$ molecules have a compact structure and that inner molecules in the clusters have similar hydrogen-bonded coordination as in crystalline ammonia.[b] Compact structures were also obtained in the case of $CH_4$ and HCl clusters.[c] These findings are consistent with ballistic aggregation of particles in the superfluid He droplets. Vibrational and rotational Raman spectra were used to study the state of hydrogen clusters.[d] Clusters formed in expansion of a neat para-$H_2$ gas are solid as evidenced by the vibrational frequency and characteristic splitting of the rotational $S_0(0)$ line. However, clusters of about $10^5$ molecules at estimated $T < 1$ K, obtained upon expansion of highly diluted para-$H_2$ in He (<1%) have a singular $S_0(0)$ line characteristic of a fluid state. These results offer prospects for observation of superfluidity in hydrogen, which has long been predicted theoretically, but still eludes experimental confirmation.

[a] V. Mozhayskiy, M. N. Slipchenko, V. K. Adamchuck and A. F. Vilesov *J. Chem. Phys.* **127**, 094701 (2007).

[b] M. N. Slipchenko, B. G. Sartakov and A. F. Vilesov *J. Chem. Phys.*, in press (2008).

[c] D. Skvortsov, M. Y. Choi and A. F. Vilesov *J. Phys. Chem. A* **111**, 12711 (2007).

[d] K. E. Kuyanov, M. N. Slipchenko, B. Khalajestani, R. Sliter, and A. F. Vilesov *62th International Symposium on Molecular Spectroscopy*, paper RB05 (2007).