Spectroscopy of Cold Molecular Ions

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Cryogenic multipole ion traps have become very popular devices in the development of sensitive action-spectroscopic techniques, including Laser Induced Reaction (LIR) spectroscopy, IR predissociation spectroscopy of Van-der Waals-clusters, and more recently, Laser Induced Inhibition of Cluster growth (LIICG). The low ion temperature leads to enhanced spectral resolution, and less congested spectra.

In the LIR method a chemical reaction between stored ions and neutral collision partners is promoted by the excitation of the trapped ion. The spectrum is detected by recording the number of reaction products as a function of wavelength. Recently the resolution of ro-vibrational spectroscopy of CH_2D^+ and CD_2H^+ [1] was pushed to predict rotational spectra in the THz regime helping to identify these molecules in astrophysical observations. Employing a frequency comb in combination with cw-OPOs, transition frequencies of ro-vibrational lines of CH_5^+ have been determined with sub-MHz resolution [2]. This development paves the road to pinpoint combination differences (CDs) of complex spectra where thousands of lines lead to an enormous number of CDs. Pure rotational transitions of several molecular ions have been detected by using the state-dependent association rate with He at 4 K. Such laboratory spectra led to the identification of l-C_3H^+ in space [3]. IR-THz two photon double resonance spectroscopy has been used to record the J=1-0 rotational transition of OH^- [4]. Also spectra of complexes such as He-H_3^+ and He-D_3^+ have been measured very recently.

References

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