LOW TEMPERATURE TRAPPING: FROM REACTIONS TO SPECTROSCOPY

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The kinetics of ion - molecule reactions are investigated in higher-order multipole traps by observation of the temporal evolution of mass selected parent ions in the presence of a neutral reaction partner. Rate coeffients for fast reactions (proceeding at collision rate) and very slow reactions (taking millions of collisions) are determined over a wide range of temperatures. Endothermic or hindered reactions can be promoted by excitation of the ion via absorption of a photon. Scanning the photon energy while detecting the number of product ions establishes an action spectroscopy method which we developed over the last 10-15 years and termed LIR: laser or light induced reactions. [a] The main advantages of LIR are mass selection of the parent ion and low temperature conditions in the trap. Long storage times in combination with a near unity detection efficiency make LIR one of the most sensitive spectroscopy methods. The status quo of LIR will be discussed on selected examples. Recent measurements are concerned with ro-vibrational spectra of CH_2D^+ [b] and CH_5^+ [c] at highest resolution using cw OPO radiation. In the particular case of CH_5^+, the lines in the mid IR have been measured at a nominal temperature of 10 K and a frequency comb has been used for absolute calibration. Line positions can be determined to an accuracy which shall enable us in the future to obtain rotational spectra in a THz-IR double resonance approach. We tested the feasibility of this two photon method recently on H_2D^+.

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[b] S. Gaertner, J. Krieg, A. Klemann, O. Asvany and S. Schlemmer, Rotational transitions of CH_2D^+ determined by high-resolution IR spectroscopy, Astron. Astrophys., 516 (2010) L3.

[c] O. Asvany, J. Krieg, and S. Schlemmer, Frequency comb assisted mid-infrared spectroscopy of cold molecular ions, Rev.Sci.Instr., 83 (2012), 076102.