

CHEMICAL AND SPECTROSCOPIC APPLICATIONS OF ULTRACOLD IONS IN ION TRAPS

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Over the past years, ultracold ($T < 10$ mK) atomic and molecular ions prepared by laser and sympathetic cooling in ion traps have found an increasing number of applications in molecular physics^a, chemistry^b and spectroscopy^c. At low temperatures the ions undergo a phase transition from a "gaseous" state to an ordered structure in the trap. Owing to their strong localisation single ions can be observed, addressed and manipulated opening up perspectives for new gas-phase experiments with single-particle sensitivity. In this talk, novel experimental schemes for reactive-scattering studies and high-resolution spectroscopy based on ultracold ions will be discussed. A new method to investigate reactive collisions between laser-cooled ions and velocity-selected neutral molecules will be introduced. The technique is particularly suited to measure ion-molecule reaction rates as a function of temperature down to ≈ 1 K. First results on the $\text{Ca}^+ + \text{CH}_3\text{F} \rightarrow \text{CaF}^+ + \text{CH}_3$ reaction will be presented. In the second part of the talk, prospects for the state-selected generation of cold molecular ions and their application in high-resolution spectroscopic experiments will be explored.

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