



Cold Molecular Ions in Traps: From Precision Measurements on Single Molecules to the Control of Chemical Reactions

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The recent progress in the preparation of neutral molecules and ions at temperatures close to the absolute zero point has paved the way for a range of new research directions at the interface between chemistry and physics. Ensembles of cold, spatially localized ions in traps, often referred to as Coulomb crystals [1], are particularly attractive systems in this context in which it is possible to observe, manipulate and control single isolated particles under precisely controlled conditions.

In the presentation, we will give an overview over some applications of cold molecular ions with recent examples from our work. We will first highlight results on chemical reactions between neutrals and ions at temperatures of a few millikelvin to illustrate exotic chemical processes that occur close to the absolute zero point of the temperature scale [2]. Second, we will discuss how single isolated molecules can be controlled on the quantum level [3] which serves as a basis for molecular quantum technologies and precision measurements of molecular properties [4]. Finally, we will present a new method to control chemical reactions of complex molecules by isolating distinct molecular conformations in an electric field and inducing their reaction with a localized reaction target of Coulomb-crystallized ions [5]. The presentation will finish with an outlook on future developments.

[1] S. Willitsch, *Int. Rev. Phys. Chem.* **31**, 175 (2012)

[2] F.H.J. Hall et al., *Phys. Rev. Lett.* **107**, 243202 (2011); *Phys. Rev. Lett.* **109**, 233202 (2012)

[3] X. Tong et al., *Phys. Rev. Lett.* **105**, 143001 (2010)

[4] M. Germann et al., *Nature Phys.* **10**, 820 (2014)

[5] Y.-P. Chang et al., *Science* **342**, 98 (2013)