

Towards hybrid trapping of cold molecules and cold molecular ions

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Hybrid systems of cold atoms and ions have been studied insensitively in recent years. The simultaneous trapping of atoms with ions has opened up new possibilities for the investigation of interactions between the two species and has greatly contributed to the understanding of collisional and chemical processes at low temperatures [1]. Here, we report on the development of an advanced hybrid trapping technique which aims at trapping neutral molecules and molecular ions simultaneously. A translationally cold package of neutral molecules is produced by means of either Stark deceleration or Zeeman deceleration. With the deceleration technique, a molecular package at translational temperature in the mK regime can be produced [2]. During the last deceleration stage, the molecular package is loaded into a magnetic trap, which is incorporated into an RF ion trap. With this set-up, the superposition of cold neutral molecules with molecular ions allows for quantum-state selective investigations of elastic, inelastic and reactive collisions at low translational energies. Initial experiments will focus on $\text{OH} + \text{Ca}^+$, $\text{OH} + \text{N}_2^+$ and $\text{OH} + \text{H}_2\text{O}^+$ as collision systems.

[1] Stefan Willitsch, *Proceedings of the International School of Physics "Enrico Fermi"*, **2015**, 189, 255.

[2] Sebastiaan Y. T. van de Meerakker, Hendrick L. Bethlem, Nicolas Vanhaecke, and Gerard Meijer, *Chemical Reviews*, **2012**, 112, 4828-4878.