

## AN ION IN A SEA OF ULTRACOLD NEUTRAL ATOMS

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I will give an overview over research ideas for an experiment which is currently set up in my laboratory. A single, trapped,  $\text{Ba}^+$  ion is immersed in an ultracold sea of neutral Rb-atoms. The atom-ion interaction gives rise to an interesting attractive  $1/r^4$  polarization potential. Given this long range potential it will be interesting to study the cold collisions of ultracold atoms and ultracold ions. Large elastic cross sections could have applications in sympathetic cooling of trapped ions. Further, we will search for a predicted mesoscopic atom-ion bound state where atoms are bound in shells around the ion. Ultracold chemistry with the Ba ion and the neutral Rb atoms will be investigated. Similar to experiments with neutral atoms, quantum chemistry should be possible in various ways, e.g. ramping across Feshbach resonances, photoassociation and three body collisions. Putting the neutral atoms in a Mott insulator state with the help of an optical lattice, we can try to entangle individual atoms with the ion. This might be even used for quantum information processing. The ion then acts a write and read head and transports quantum information between lattice sites. This scheme might be a solution for the addressing problem in quantum computation schemes based on neutral atoms in optical lattices. Finally, charge hopping and charge mobility in an ultracold gas of atoms can also be investigated with the set-up.