Fakultät für Mathematik und Physik
Albert-Ludwigs-Universität Freiburg

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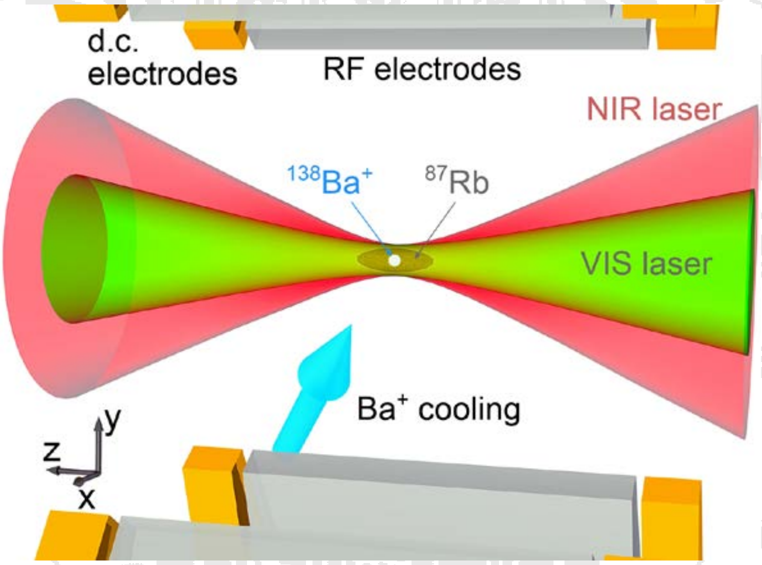
IM GROẞEN HÖRSAAL



TRAPPING IONS AND NEUTRAL ATOMS WITH LIGHT FIELDS

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Since optical traps have been proposed in 1970 by Ashkin, they have undergone an impressive evolution. This remarkably versatile instrument was successfully used across several disciplines to trap and manipulate particles ranging from individual bacteria, viruses and micron-sized glass spheres to ultracold atomic ensembles. Modern optical dipole traps have reached a point where minute control on the level of individual atoms is possible with an extensive degree of flexibility.

This kind of individual addressability is one of the outstanding features of another profoundly influential technology that has pushed the boundaries of control in atomic systems continuously over the course of several decades: radiofrequency (RF) traps for atomic ions. These systems offer a unique level of control accompanied by e.g. in long coherence times, excellent state preparation and readout efficiencies and record-worthy qubit gate fidelities. However, in some applications, most notably in investigations of ultracold ion-atom interactions, the presence of RF fields and the resulting driven motion leads to detrimental effects imposing severe restrictions on the available collision energies.

I will discuss a new experimental approach to studying ion-atom interactions aiming to combine several key features of ions, foremost their long-range Coulomb interaction, with the versatility of optical traps. This technique known as optical ion trapping allows for confining single ions or ion Coulomb crystals without RF fields and offers comparatively long lifetimes on the order of seconds. I will present our most recent results demonstrating sympathetic cooling of an ion immersed into an ensemble of ultracold atoms overlapped in a set of optical dipole traps, and discuss their potential applications in several fields ranging from quantum chemistry to novel quantum simulations.