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High-resolution Energy Control of Ultracold Atom-ion Collisions

MEIRAV PINKAS, RUTI BEN-SHLOMI, TOMAS SIKORSKY[1], ZIV MEIR[2], NITZAN AKERMAN, ROEE OZERI, Weizmann Institute of Science — In the low collision energy regime, the quantum nature of the collision can modify the classical cross-section energy dependence, for example as a result of shape resonances. We report on a method for controlling cold atom-ion collision energy in the single collision regime. This is done by sweeping a one-dimensional optical lattice with cold Rb atoms, on a Sr^+ ion in a Paul trap. When the ion is cooled down to its ground state, this technique permits a delicate control over the collision energy, with a resolution of $\sim 100\mu$K, limited only by the excess-micromotion energy of the ion. This resolution is one order-of-magnitude better than in previous experiments in cold atom-ion collisions. We demonstrate this method by measuring the energy dependence of the cross-section of the Electronic-Excitation-Exchange (EEE) process, when the ion is prepared in the metastable electronic excited state decay into the electronic ground state after a collision. We found that for collision energies ranging between 0.2-12 mK, the EEE cross-section obeys the classical Langevin cross-section. This method can be extended for measuring various inelastic processes cross-sections and its high energy resolution enables detection of subtle changes in the classical cross-section.

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