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Spin and electronic-excitation exchange in ultracold ion-atom collisions RUTI BEN SHLOMI, TOMAS SIKORSKY, ZIV MEIR, NITZAN AKERMAN, YEHONATAN DALLAL, MEIRAV PINKAS , ROEE OZERI, weizmann institute of science — We experimentally study the dynamics of single and many inelastic collisions between ultracold ^{87}Rb atoms and a single $^{88}Sr^{+}$ ion. A single ion is trapped in a linear Paul trap, laser cooled to 1 mK, and initially optically pumped to the higher excited metastable D-state. Then the ion is immersed in an ultracold ^{87}Rb cloud. We investigated relaxation rates of the ion from the D-state due to collisions with atoms. We measured relaxation to the S-state after two Langevin collisions on average, followed by an energy release of 1500 K. This can be explained by a non-adiabatic excitation-exchange process: $Sr^{+}(D)+Rb(S) \rightarrow Sr^{+}(S)+Rb(P)$. We further studied the dependence of this process on the mutual spin orientation of the ion and atoms and on initializing the ion in the different spin-orbit split $D_{5/2}$ and $D_{3/2}$ levels. We also initially spin polarized the ion and atoms in their electronic ground state and investigated the spin dynamics of the ion after one to several collisions. We observed that after 7 Langevin collisions on average, the spin of the ion aligned with the spin direction of the cloud, indicating that the dominant interaction between the ion and atoms spins during a collision is that of spin-exchange. Since the steady-state spin population of the ion reached only 90%, we conclude that a spin-relaxation mechanism is involved as well.

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