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Observation of a power-law energy distribution in atom-ion hybrid system ZIV MEIR, NITZAN AKERMAN, TOMAS SIKORSKY, RUTI BEN-SHLOMI, YEHONATAN DALLAL, ROEE OZERI, Department of Physics of Complex Systems, Weizmann Institute of Science, Rehovot 7610001, Israel — Understanding atom-ion collision dynamics is at the heart of the growing field of ultra-cold atom-ion physics. The naive picture of a hot ion sympathetically-cooled by a cold atomic bath doesn't hold due to the time dependent potentials generated by the ion Paul trap. The energy scale of the atom-ion system is determined by a combination of the atomic bath temperature, the ion's excess micromotion (EMM) and the back action of the atom-ion attraction on the ion's position in the trap. However, it is the position dependent ion's inherent micromotion which acts as an amplifier for the ion's energy during random consecutive collisions. Due to this reason, the ion's energy distribution deviates from Maxwell-Boltzmann (MB) characterized by an exponential tail to one with power-law tail described by Tsallis q-exponential function. Here we report on the observation of a strong deviation from MB to Tsallis energy distribution of a trapped ion. In our experiment, a ground-state cooled $^{88}Sr^{+}$ ion is immersed in an ultra-cold cloud of ^{87}Rb atoms. The energy scale is determined by either EMM or solely due to the back action on the ion position during a collision with an atom in the trap. Energy distributions are obtained using narrow optical clock spectroscopy.

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