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Buffer gas cooling of a trapped ion to the quantum regime MICHAL TOMZA, University of Warsaw, THOMAS FELDKER, HENNING FURST, HENRIK HIRZLER, NORMAN EWALD, MATTEO MAZZANTI, University of Amsterdam, DARIUSZ WIATER, University of Warsaw, RENE GER-RITSMA, University of Amsterdam — Significant advances in precision measurements in the quantum regime have been achieved with trapped ions and atomic gases at the lowest possible temperatures. These successes have inspired ideas to merge the two systems [1]. In this way, one can study the unique properties of ionic impurities inside a quantum fluid. Remarkably, in spite of its importance, experiments with ion-atom mixtures remained firmly confined to the classical collision regime. Here, we report buffer gas cooling of a single ion in a Paul trap to the quantum regime of ion-atom collisions [2]. We have achieved collision energy as small as 1.15(0.23) times the s-wave energy (or 9.9(2.0) μ K) for a trapped ytterbium ion in an ultracold lithium gas. We have observed a deviation from classical Langevin theory by studying the spin-exchange dynamics, indicating quantum effects in the ion-atom collisions. By developing a theoretical model of measured energy-dependent spin-exchange rate constants, we have obtained singlet and triplet ion-atom scattering lengths. Our results open up numerous opportunities, such as the exploration of ion-atom Feshbach resonances, in analogy to neutral systems. [1] Tomza et al, Rev. Mod. Phys. 91, 035001 (2019) [2] Feldker et al, Nature Physics, doi:10.1038/s41567-019-0772-5 (2020)

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