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Cold reactive collisions between laser-cooled ions and velocity-selected neutral molecules MARTIN BELL, STEFAN WILLITSCH, ALEXANDER GINGELL, SIMON PROCTER, TIMOTHY SOFTLEY, Department of Chemistry, University of Oxford — The recent development of a range of techniques for producing "cold" molecules at very low translational temperatures T < 1 K in the gas phase has provided the opportunity for studying molecular collisions in a new physical regime. We report a new experimental method to study reactive collisions between ions and neutral molecules at very low temperatures which allows for tunable collision energies and a variety of chemically diverse reaction partners. Our technique relies on the combination of a quadrupole-guide velocity selector for the generation of cold polar molecules with a facility to produce strongly ordered samples of laser-cooled ions in an ion trap, usually referred to as Coulomb crystals. Despite the low fluxes of neutral molecules obtained from the quadrupole-guide, the strong localization and long trapping times of the ions allows chemical reactions to be studied at the single-particle level. In a proof-of-principle experiment, we have studied the chemical reaction between translationally cold CH_3F molecules and laser-cooled Ca^+ ions in a collision energy range corresponding to 1-10 K. The characteristics of our cold-molecule sources and the performance of the new technique as well as perspectives for further developments will be discussed.

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