Study and control of chemi-ionization reactions

Content

Ultracold mixtures of different atomic species are used to obtain dense samples of ultracold heteronuclear molecules which may feature long-range and anisotropic interactions. Such interactions allow for new physics and chemistry studies in a regime purely dominated by quantum effects. To achieve the co-trapping of ultracold atoms, reactive collisions must be efficiently suppressed.
As a first step towards co-trapping, we study the chemi-ionization of ultracold Li by metastable He (He*). For this, we combine a supersonic-beam source for He* with a magneto-optical trap for Li [1]. To distinguish in between the contributions of He(23S1) and He(21S0) to the ionization rate, we deplete the He*population in the 21S0 state using a novel laser-excitation scheme [2]. We also use laser-optical pumping to prepare both He(23S1) and Li(22S1/2) in selected magnetic sub-levels prior to the collision [3].*
*Here, we demonstrate the efficient control of He**-Li chemi-ionization at thermal energies using spin- and quantum-state preparation. Our results imply a strong suppression (enhancement) of chemi-ionization for non-spin-conserving (spin-conserving) reaction channels [4]. These results are in good agreement with a model based on spin angular momentum coupling of the prepared atomic states to the molecular reaction channels. Small deviations from the model are indicative for a violation of spin-conservation rules. The ionization rate also decreases when Li is laser-excited to the 22P1/2,3/2 states. This is due to the conservation of the projection of the total molecular orbital angular momentum along the internuclear axis [5].

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