

# ***Ab Initio* Studies of the Collisions Involving Lanthanide Atoms and Ions**

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Lanthanide atoms and ions were considered as the useful model systems for understanding radiative and collision processes involving heavier elements. Recent progress in low-temperature physics has made lanthanides interesting on its own, allowing one to explore previously unattainable regimes of atomic collision dynamics. Combination of the state-of-the-art *ab initio* techniques and quantum scattering theory has been used for studying a number of challenging systems and processes involving neutral and singly-ionized Yb, Eu, Tm and some others. In particular, the survey presented covers (i) simulations of the Zeeman relaxation in Tm + He collisions at sub-Kelvin temperature that reveal suppression of the angular momentum interaction anisotropy caused by unfilled submerged 4f electronic shell; (ii) dynamical studies of the trapped Yb<sup>+</sup> ion immersed in the Rb Bose-Einstein condensate that prove the radiative mechanism of charge transfer and identify the second-order spin-orbit interaction as the driver of efficient spin relaxation; (iii) modelling of the potential energy curves and energy levels of Yb<sub>2</sub>, YbTm and Eu<sub>2</sub> molecules for comparison with ultraprecise spectroscopy and for understanding of spin coupling. Investigation of the mobility of Yb<sup>+</sup>, Eu<sup>+</sup>, Lu<sup>+</sup> and Gd<sup>+</sup> ions in rare gases is also presented, as an attempt to correlate ion transport properties with the electronic configuration of the ion. These and some other examples are discussed in order to assess the prospects and challenges in using the lanthanides for benchmark spectroscopic and dynamical studies of complex heavy elements.

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