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Rydberg molecules for ion-atom scattering in the ultracold regime MICHAL TOMZA, University of Warsaw, THOMAS SCHMID, CHRISTIAN VEIT, NICOLAS ZUBER, ROBERT LW, TILMAN PFAU, Universitt Stuttgart, MICHAL TARANA, J. Heyrovsk Institute of Physical Chemistry of the ASCR — We propose a novel experimental method to extend the investigation of ion-atom collisions from the so far studied cold, essentially classical regime to the ultracold, quantum regime [1]. Key aspect of this method is the use of Rydberg molecules to initialize the ultracold ion-atom scattering event. We exemplify the proposed method with the lithium ion-atom system, for which we present simulations of how the initial Rydberg molecule wavefunction, freed by photoionization, evolves in the presence of the ion-atom scattering potential. We predict bounds for the ion-atom scattering length from ab initio calculations of the interaction potential. We demonstrate that, in the predicted bounds, the scattering length can be experimentally determined from the velocity of the scattered wavepacket in the case of $^6Li^+$-^6Li, and from the molecular ion fraction in the case of $^7Li^+$-^7Li. The proposed method to utilize Rydberg molecules for ultracold ion-atom scattering, here particularized for the lithium ion-atom system, is readily applicable to other ion-atom systems as well. [1] T. Schmid, C. Veit, N. Zuber, R. Löw, T. Pfau, M. Tarana, M. Tomza, Phys. Rev. Lett. 120 (2018), arXiv:1709.10488

Michal Tomza
University of Warsaw

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