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Many-Body Simulations of Ultracold 1D Atom-Ion Quantum Systems JOHANNES M. SCHURER, ANTONIO NEGRETTI, Zentrum für Optische Quantentechnologien, Universität Hamburg, RENE GERRITSMA, Institut für Physik, Johannes Gutenberg-Universität Mainz, PETER SCHMELCHER, Zentrum für Optische Quantentechnologien, Universität Hamburg — We consider a atom-ion hybrid system consisting of an ultracold bosonic atom cloud and a single ion. The polarization interaction between the atoms and the ion scales like $-1/r^4$ and is therefore long-range and attractive featuring bound states. Hence, this interaction induced an additional length and energy scale to the system and is expected to trigger the formation of density bubbles [1] or large molecular ions [2]. We investigated the influence of this interaction on the ground-state [3] as well as the dynamical [4] properties of the atomic ensemble for various intra-atomic interactions and particle numbers. Furthermore, we show that the atom-ion scattering properties can be exploited to switch the dynamics of a bosonic Josephson junction by an ionic impurity in the weak link [5]. Our study is carried out by means of the multiconfiguration time-dependent Hartree method for bosons [6], a numerical exact and ab initio method to calculate many-body quantum dynamics.
[1] Goold et al, PRA 81, 041601 (2010) [2] Côté et al, Lett. 89, 093001 (2002) [3] Schurer et al, PRA 90, 033601 (2014) [4] Schurer et al, NJP 17 083024 (2015) [5] Schurer et al, arXiv:1511.00977 [6] Alon et al, PRA 77, 033613 (2008)

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