Effective interactions and trap-induced resonances between tightly confined ultracold polar molecules

Michał Zdziennicki [1], Piotr Kulik [1], Sakthikumaran Ravichandran [1], Krzysztof Pawłowski [2], Mateusz Ślusarczyk [2], Krzysztof Jachymski [1,†]

[1]Faculty of Physics, University of Warsaw, ul. Pasteura 5, 02-093 Warszawa, Poland
[2]Center for Theoretical Physics PAN, Al. Lotników 32/46, 02-668 Warszawa, Poland
†kajac@fuw.edu.pl

Ultracold dipolar atoms and molecules provide a flexible quantum simulation platform for studying strongly interacting many-body systems. Determining microscopic Hamiltonian parameters is then crucial. Here we study effective interactions in quasi-one-dimensional (q1D) dipolar quantum gases, as well as in double well potentials, revealing significant nonuniversal corrections to the commonly used pseudopotential. We demonstrate that a full 3D treatment employing realistic interaction potentials is essential for describing the reduced-dimensional system and for prediction of confinement-induced resonances. Our findings resolve existing discrepancies in q1D dipolar models and are particularly relevant to experiments probing nonequilibrium phenomena and quantum technological implementations.