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Few-body physics of quasi-one dimensional atomic gases

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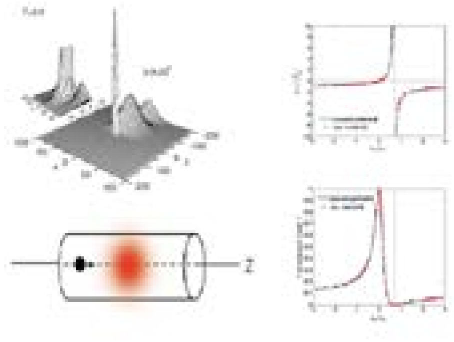
We investigate a theoretical method to study the quantum dynamics of ultracold atomic gases inside an atomic waveguide. Ultracold atomic gases are that are maintained at temperatures below some tenths of microkelvins. At these temperatures, the thermal de Broglie wavelength of the atoms are of the order of the atomic distances, therefore the quantum mechanical properties of the system become important. Due to the excellent experimental control of their trapping as well as their interatomic interactions, ultracold atoms have a variety of applications. Of particular interest are quasi-1D gases. By employing optical dipole traps or atom chips, we can fabricate the so-called quasi-1D gas in which the atoms are frozen to occupy a few lowest quantum states of a transverse 2D confinement potential such that in these directions the characteristic lengths are of the order of the atomic de Broglie wavelength. The quantum dynamics of these systems is strongly influenced by the geometry of the confinement potential and therefore behaves very differently compared to gases in free space. As an example, in contradiction with spin-statistics in free space, the "Fermi-Bose duality" maps strongly interacting bosons to weakly interacting fermions and vice versa. These systems are expected to play an important role, for example in quantum computing, atom interferometries, and studying novel 1D many-body states. Most of the many-body properties of gases are the outcome of atom-atom scattering events. Of particular interest are scattering resonances. For quasi-1D gases, the confinement potential of the waveguide leads to the so-called confinement induced resonance (CIR). In a bosonic gas in the vicinity of CIR, the atom-atom coupling strength diverges, resulting in the phase transition of the gas to the impenetrable regime (known as the TG gas). In this regime the bosons repel each other strongly and behave like fermions. We analyze the elastic as well as inelastic multi-channel scattering of two ultracold atoms under harmonic confinement. For elastic scattering, the effects of the interatomic potential and the waveguide anisotropy on the width and position of the CIR are studied.



Biography

Shahpoor Saeidian has his expertise in ultracold atomic physics. He has completed his PhD at from University of Heidelberg, Germany. He is Assistant Professor and Director of a research team focusing on Ultracold Atomic Physics at Institute for Advanced Studies in Basic Sciences, Iran.

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