Quantum two-body problem in external field without center-of-mass separation

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Pair atomic collisions in restricted geometry principally differ from the conventional two-body free-space scattering. The restricted geometry leads to quantization of the atomic motion in the direction of confinement. Another non-trivial effect for two distinguishable quantum particles in a transverse harmonic trap is the confinement induced nonseparability of the center-of-mass (CM) and the relative motions. These effect have experimental *mesoscopic* developments for ultaracold atoms in optical traps and atom chips. However, only simple analytical estimates were performed for the special case when identical atoms occupy lowest quantum states of a confining trap. In this limit the total atom-atom reflection has been predicted for the case of confinement-induced resonance (CIR)[1]. The origin of the CIR is a virtual transition from the ground transverse state to the first excited state if the energy spacing between the levels of the confining potential coincides with the binding energy of the two-atom molecular state[2].

We have investigated what happens if the energy range of colliding atoms encompasses several quantum states of the confining potential[3]. We have also fully took into account the coupling between the CM and the relative motion in case of distinguishable atoms[4]. Specifically we explore in detail the recently discovered[5] dual CIR which is based on a destructive interference mechanism leading to complete transmission in the waveguide although the corresponding scattering in free space exhibits strong s and p wave scattering.

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