Arrested dimer's diffusion by self-induced back-action optical forces

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Abstract

The diffusion of a dimer made out of two resonant dipolar scatterers in an optical lattice is theoretically analyzed. When a small particle diffuses through an optically induced potential landscape, its Brownian motion can be strongly suppressed by gradient forces, proportional to the particle's polarizability [1]. For a single lossless monomer at resonance, the gradient force vanishes and the particle diffuses as in absence of external fields. However, we show that when two monomers link in a dimer, the multiple scattering among the monomers induces both a torque and a net force on the dimer's center of mass [2]. The “self-induced back-action” force leads to an effective potential energy landscape, entirely dominated by the mutual interaction between monomers, which strongly influences the dynamics of the dimer. Under appropriate illumination, single monomers in a colloidal suspension freely diffuse while dimers become trapped. Our theoretical predictions are tested against extensive Langevin molecular dynamics simulations.

References

[1] S. Albaladejo, M.I. Marqués, F. Scheffold, J.J. Sáenz, Nano Letters, **9** (2009) 3527-3531.
[2] J. Luis-Hita, J.J. Sáenz, M.I. Marqués (to be published)

Figures

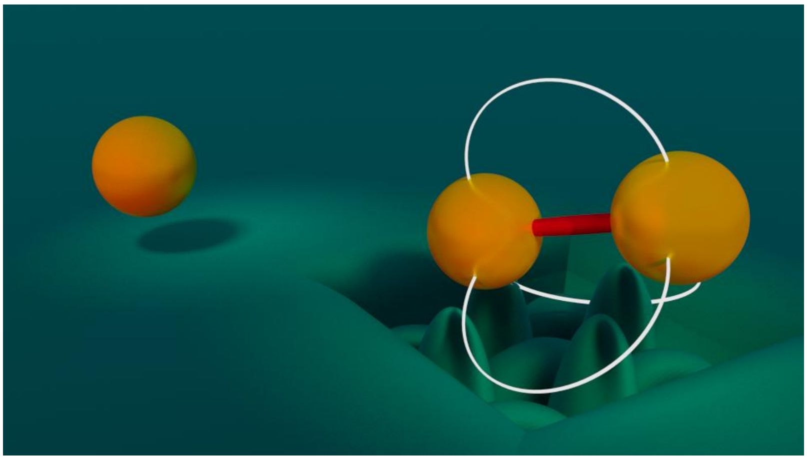

Figure 1: A single monomer at resonance, moving through an optical lattice, will not see its motion affected by any optical force. However, the diffusion of two monomers at resonance forming a dimer will be arrested via multiple scattering between the particles.