

Strong coupling and dark modes in the motion of a pair of levitated nanoparticles

The oscillatory motion of levitated nanoparticles has been recently cooled down to the quantum ground state. This opens the way to the realization of an ensemble of coupled, macroscopic quantum oscillators. We experimentally investigate a system composed of two levitating nanospheres. The dual optical tweezer is generated by two copropagating lasers operating at different wavelengths, where chromatic aberration leads to the formation of two separate trapping sites.

Surface charges on the nanospheres produce a Coulomb force that couples their motion along the tweezer axis. The strong coupling regime is achieved, as evidenced by the observed avoided crossing of the normal-mode frequencies.

When positioned inside an optical cavity, the motions of two nanospheres couples via coherent scattering in a single optical cavity mode. We achieve strong coupling between each pair of modes in the transverse plane of the tweezer, and we show the emergence of dark modes in the overall coupled motion.