# Entangling Mechanical Motion of Levitated Nanoparticles by Wave-Packet Dispersion

A A Rakhubovsky[1] and R Filip[1]

[1] *Department of Optics, Palacký University, Olomouc, Czech Republic*
Contact Email: rakhubovsky@optics.upol.cz

Levitated nanoparticles attracted significant interest thanks to promising applications in sensing and fundamental science tests. Ground-state cooling and coherent coupling of multiple nanoparticles' motion have been shown recently. One crucial difference of the nanoparticles from the traditional clamped mechanical resonators is the possibility to adjust the potential of the mechanical motion as the potential itself is defined by highly controllable tweezer field. In particular, it is possible to alternate harmonic-oscillator motion with the free motion, using the latter for nearly unitary expansion of the nanoparticles' wave packet which results in quantum squeezing of the mechanical motion. Here, we show that combining the free-fall-induced squeezing with the coupling of multiple nanoparticles can lead to the quantum entanglement between the nanoparticles. We evaluate the attainable entanglement in the presence of the relevant sources of decoherence and prove that the entanglement is achievable in state-of-the-art experiments.