INFN Istituto Nazionale di Fisica Nucleare

UNIVERSITÀ DEGLI STUDI DI TRIESTE

INFN - Trieste & Dipartimento di Fisica Joint Seminar

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Strada Costiera, 11 – Trieste

Prospects to use levitated optomechanics to test quantum mechanics and gravity

Abstract: We will discuss ideas to experimentally test collapse models [1] by both matter-wave interferometry [2] and non-interferometric methods [3]. Testing collapse models intrinsically also means to test the quantum superposition principle. Collapse models predict a heating effect, which results in a Brownian-like random motion of any isolated particle in space. We will emphasise levitated optomechanical systems and discuss the possibility to test the heating effect by detecting the motion of the particle in position space [4], as well as in the frequency domain where the collapse heating effect is theoretical treated as noise in a Langevin type approach and predicted to manifest itself as an increase of the area of the related power spectral density [3]. We shall also explain if gravitation decoherence has strong prospects to be tested with levitated optomechanical systems.
We will further discuss some recent ideas to probe the interplay between quantum mechanics and gravitation. One idea is to try to directly test if gravity is quantum or classical, while a second is to test an effect which is predicted for semi-classical gravity (Schrödinger-Newton equation)[5], which would allow to experimentally test whether that semi-classical approach is valid or not.
We shall also give an update on trapping and cooling experiments of levitated optomechanics at Southampton in order to explore the experimental feasibility of tests of quantum mechanics and gravitation [6]. The overarching goal of our attempts is to build a complete toolbox to generate and manipulate Gaussian but also non-Gaussian states, such as a spatial superposition state, of the motion of nano- and micro-particles in order to realise all possible states of the motional dynamics in phase space. This to be done for massive nanoparticles and the systematic investigation of noises will further the prospects for sensing applications of levitated optomechanics too.

References:

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