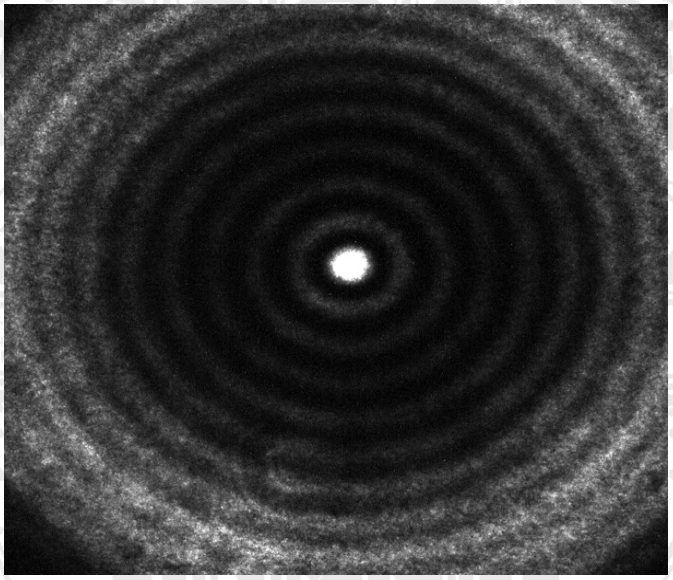
PHYSIKALISCHES KOLLOQUIUM

AM 3. JULI 2017 UM 17 UHR C.T.

IM HÖRSAAL I, PHYSIKHOCHHAUS



PROSPECTS FOR USING LEVITATED OPTOMECHANICS TO TEST QUANTUM MECHANICS AND GRAVITY

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We will discuss our trapping and cooling experiments of optically levitated nanoparticles. We will report on the cooling of all translational motional degrees of freedom of a single trapped silica particle to ~1mK simultaneously at vacuum of 10^{-5} mbar using a parabolic mirror to form the optical trap. We will further report on the squeezing of a thermal motional state of the trapped particle by rapid switch of the trap frequency.

We will further discuss ideas to experimentally test quantum mechanics by means of collapse models by both matter-wave interferometry and non-interferometric methods. While first experimental bounds by non-interferometric tests have been achieved during the last year by a number of different experiments, we at Southampton work on setting up the *Nanoparticle Talbot Interferometer* (NaTalI) to test the quantum superposition principle directly for one million atomic mass unit particles.

We will further discuss some ideas to probe the interplay between quantum mechanics and gravitation by (levitated) optomechanics experiments. One idea is to seek experimental evidence about the fundamentally quantum vs classical nature of gravity by using the torsional motion of a non-spherical trapped particle, while another idea is to test the existence of a gravity related shift of energy levels of the mechanical harmonic oscillator, which is predicted by semi-classical gravity (the so-called Schrödinger-Newton equation).