Rotational dynamics of trapped nano-objects in vacuum

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Oral contribution

Stochastics non linear oscillators have been a subject of intensive researches concerning a great amount of fields going from proteins folding dynamics to Josephson junctions. In the huge inventory of these dynamical systems, energy landscape described by a tilted washboard potential have been intensively studied, presenting interesting features such as superdiffusion or dispersionless transport[1].

To study that kind of phenomenons, optical tweezers in air or near vacuum offer innovative tools, with their abilities to explore overdamped to underdamped regimes, bringing increasing interest from fundamental physics (as e.g. test of quantum mechanics) to applied science such as precision metrology or biophysics. The great sensitivities and precision measurements given by these experimental techniques offer the opportunity to characterize precisely the size and shape of nanoparticles to measure their complex dynamics in various optical energy landscapes. Recently, a growing interest in levitated otpomechanics platforms have been to investigate the rotational degrees of freedom in the dynamics of trapped particles. Under an elliptically polarized laser beam, the particle has shown the fastest spin (above ~GHz) for a man-made object [2]. The study of the rotational dynamics of these trapped nano objects also allows ultra sensitive torque measurement opening new fields of studies such as Casimir Torque or Ultimate tensile strength [3].

In this talk, after a general presentation of optical trapping, I will present some results concerning the optically induced rotation of trapped nano-objects. We demonstrate that above a certain critical range of pressures and ellipticity competition between spin and torque dynamics occurs. Thermally activated transitions between a locked state, where the particle librates around an equilibrium position, and a running state, where the particle spin, are investigated. This type of rotational behavior ca be associated to giant diffusion occurring in the weak thermal limit which has never been observed to this point in the underdamped regime [4]. This novel observation brings new insights into the understanding of the different mechanisms taking place in the rotational dynamics of a trapped nano objects in strongly inertial regimes.

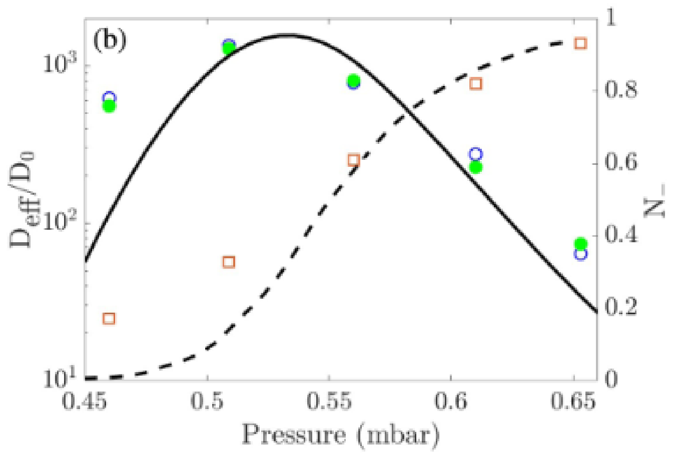

Fig. 1 Effective rotational diffusion as function of the gas damping for an optically trapped dimer trapped by an elliptically polarized beam. An enhancement of three order of magnitude is observed compared to bulk rotational diffusion.

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