

# INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

2A&B, Raja S.C. Mullick Road, Jadavpur, Kolkata-700032, India

## Seminar Notice

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| <b>Title:</b>    | <b>Harnessing fluctuations with cold atoms - a three-dimensional Brownian motor, realized with symmetric optical lattices</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Speaker:</b>  | <b>Professor Anders Kastberg of University of Nice, France</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Date:</b>     | <b>August 03, 2017</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Time:</b>     | <b>11:30 a.m.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Venue:</b>    | <b>C.V. Raman Hall, 2nd Floor, Main Building, IACS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Abstract:</b> | <p>Cold atoms in controlled experiments offer a means to investigate classical fluctuation induced phenomena. The sizes of the system is mesoscopic, typically with <math>10^6</math>-<math>10^9</math> atoms; and in the laser cooling regime, the dynamics of atoms is dominated by fluctuations caused by stochastic cycles of absorption followed by spontaneous emission. Thus, there is a constant flow of energy through the system, from the applied laser fields to the vacuum field.</p> <p>We have developed systems for high precision measurements of position and velocity of our laser cooled ensemble. With this, we have studied the fundamental issue of particles trapped in a periodic potential (in our case an optical lattice), with a very slight tilt (in our case caused by gravity), and with thermal energies far below the potential depths. In the presence of fluctuation, a biased drift along the drift direction is induced, depending on the interplay between the various energies in the system.</p> <p>We have also used a system of two phase-shifted and coupled optical lattices in order to partially rectify the isotropic fluctuations, thus realizing a three-dimensional Brownian motor.</p> <p>Brownian motors are systems where isotropic noise and fluctuations are rectified in order to achieve controlled directed motion. In order to accomplish this, the system has to be out of thermal equilibrium, and somehow spatio-thermal symmetry must be broken (the Curie principle).</p> <p>We have experimentally implemented a system where cold atoms are trapped in</p> |

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|  | <p>either of two optical lattices, of equal spatial topography, but trapping two different internal states. Inherent in the system are isotropic fluctuations, due to incoherent light scattering, leading to a diffusion, which is typically symmetric. Associated with this scattering is also optical pumping between the two optical lattices, that is, the atom will transfer back and forth between the two internal states and the two respective optical lattices.</p> |
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|  | <p>If, and only if, we prepare the system in a way, that the transfer between the lattices is asymmetric, and at the same time impose a spatial phase shift between the lattices, we bias the drift and get directed motion in a controllable direction. Since we can control the spatial phase in three dimensions, we are able to demonstrate a three-dimensional Brownian motor, and we have a system where isotropic fluctuations can be used as source for propelling atoms along a predetermined path.</p> |
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**All are cordially invited to attend the seminar**