INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

2A & 2B, Raja S. C. Mullick Road, Jadavpur, Kolkata-700 032

School of Physical Sciences

SEMINAR NOTICE

Title : Cavity Optomechanical Sensing and Manipulation of an Atomic Persistent Current

Speaker : Dr. Pardeep Kumar, Max Planck Institute for the Science of Light, Staudstr. 2, 91058 Erlangen, Germany

Date : August 24, 2022 (Wednesday)

Time : 15:00 hours (IST)

Venue : Online Mode using Zoom Platform

Zoom link of the seminar:

https://zoom.us/j/91214797729

Meeting ID: 912 1479 7729

Passcode: 230191

Abstract:

Coherent control of light-matter interaction1 is pivotal to modern-day optics and photonics. It paves the way for numerous remarkable applications such as quantum memory2, sensing3, lasing4, ultrafast information processing5, fundamental studies of quantum physics6 etc. In this talk, I will describe a versatile platform for sensing the rotational states of an annular Bose-Einstein condensate (BEC), a system which shows dissipationless flow. Characterization of the quantum circulation of a ring BEC is one of the challenging tasks in atomic physics7. Recently, a solution to this outstanding problem has been proposed8 by using cavity optomechanics9, a unique platform to explore the interaction of micro-or-nanomechanical systems with the light fields confined inside an optical resonator. The model8 under consideration is a ring BEC contained inside a cavity interacting with orbital angular momentum carrying light beams. It is the first platform that can measure the rotation of a ring BEC with *minimal destruction*, *in situ* and *in real-time*, unlike the existing fully destructive techniques. For experimentally accessible parameters, the proposed method improves the rotation sensitivity of ring BECs by *three* orders of magnitude. Also, the system shows a unique way to manipulate rotating matter waves by generating optomechanical entanglement between persistent currents. Thus, this work provides a novel platform not only for sensing and coherent manipulation of atomic currents but also for studying high-temperature superconductivity and superfluidity. It also opens up the possibility of using atomic superflow for the storage and retrieval of information.

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4. R. M. Pettit, W. Ge, **P. Kumar**, D. R. Luntz-Martin, J. T. Schultz, L. P Neukirch, M. Bhattacharya, and A. N. Vamivakas, *Nature Photonics*, **13**, 402 (2019).
5. **P. Kumar**, T. M. Herath, S. A. O. Motlagh, and V. Apalkov, *Physica E: Low-dimensional Systems and Nanostructures* **140**, 115145 (2022).
6. **P. Kumar**, and S. Dasgupta, *Phys. Rev. A* **91**, 043803 (2015).
7. A. Fetter, *Rev. Mod. Phys*. **81**, 647 (2009).
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9. M. Aspelmeyer, T. J. Kippenberg, and F. Marquardt, *Rev. Mod. Phys.* **86**, 1391 (2014).

All are cordially invited to attend the seminar