ICFO Colloquium JURGEN ESCHNER & GIOVANNA MORIGI '´Quantum crystals of matter and light´ and ´Quantum networking tools with single ions and photons´'

JURGEN ESCHNER & GIOVANNA MORIGI

February 17, 2015

Tuesday, February 17th, 12:00, ICFO's Auditorium

JURGEN ESCHNER & GIOVANNA MORIGI

Jurgen Eschner is Professor and leader of the Quantum Photonics group at Saarland University, Saarbrücken, Germany.

Giovanna Morigi is Heisenberg Professorship, Professor and leader of the Theoretical Quantum Physics group at Saarland University, Saarbrücken, Germany. $$Jürgen has a special relationship with ICFO, having led the ´Quantum information and quantum opt cs with single trapped atoms´ group at ICFO from 2003-2009. At ICFO, his work focused on

ion trapping, ion-photon interfaces, atom trapping, and quantum optical informa
ion technologies. He also coordinated the ´QOIT´ Consolider project. Now a Profes
or at Saarland University, Germany, his experimental research is dedicated to the cont
olled interaction between light and matter in the quantum r

Giovanna, with ongoing collaborations with Jürgen in many areas, focuses on theoretica
 physics with a special interest in atomic, molecular and optical physics, Quantum an
 Nonlinear Optics, and Statistical Physics of photonic systems

This is a two part Colloquium.

JURGEN ESCHNER- "Quantum networking tools with single ions and photons"

Trapped ions are considered a promising approach for implementing a small- or medium-scale quantum processor, while single photons are ideal carriers for communicating quantum information. Integrating these systems, and possibly other platforms, into a quantum network requires faithful bi-directional conversion between atomic and photonic quantum bits. I will review our developments of tools and building blocks for quantum interfaces between single ions and single photons, from their heralded interaction to high-fidelity photon-to-atom quantum state transfer.

GIOVANNA MORIGI- "Quantum crystals of matter and light"

Atoms can spontaneously form spatially ordered structures in optical resonators when they are transversally driven by lasers. This occurs when the laser intensity exceeds a threshold value and results from the mechanical forces on the atoms associated with super-radiant scattering into the cavity mode. We treat the atomic motion semi-classically and show that, while the onset of spatial ordering depends on the intracavity-photon number, the stationary momentum distribution is a Gaussian function whose width is determined by the rate of photon losses. Above threshold, the dynamics is characterized by two time scales: after a violent relaxation, the system slowly reaches the stationary state over time scales exceeding the cavity loss rate by several orders of magnitude. In this transient regime the atomic momenta form non- Gaussian metastable distributions, which emerge from the interplay between the long-range dispersive and dissipative mechanical forces of light. We argue that the dynamics of self-organization of atoms in cavities offers a test bed for studying the statistical mechanics of long-range interacting systems, such as non-neutral plasmas and gravitational clusters.

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