Title: Non equilibrium and non linear dynamics of atom photon interacting system

Abstract: We consider a coupled atom-photon interacting system described by a dimer of anisotropic Dicke model in the presence of photon loss, exhibiting a rich variety of non equilibrium phases and nonlinear dynamics. A key feature of this system is the multistability of different dynamical states, particularly the coexistence of various superradiant phases.

Remarkably, this dimer system manifests self-trapping phenomena, resulting in a photon population imbalance between the cavities. Additionally, we identify a unique class of oscillatory dynamics, "self-trapped limit cycle," hosting self-trapping of photons.

The absence of stable dynamical phases leads to the onset of chaos, which is diagnosed using the saturation value of the decorrelator dynamics.

Moreover, in an array of cavity systems described by the Tavis-Cummings-Hubbard model, we demonstrate the emergence of a quasi-steady state in a dissipative environment that exhibits intriguing ergodic behavior.