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Fluctuation Effects in Open Many Body Systems

Dr Ameneh Sheikhan (University of Bonn, Germany)

Friday, 6 February 2026 | 15h00 – 16h00 SAST

Venues: NITheCS Seminar Room, Stellenbosch University; and Online

ABSTRACT

We investigate the steady state phase diagram of interacting atoms subjected to an optical lattice and coupled to a high finesse optical cavity with photon losses. The coupling between the atoms and the cavity field is induced by a transverse pump beam. Taking fluctuations around the mean-field solutions into account, we find that a transition to a self-organised phase takes place at a critical value of the pump strength. In the self-organised phase the cavity field takes a finite expectation value and the atoms show a modulation in the density. Surprisingly, at even larger pump strengths two self-organised stable solutions of the cavity field and the atoms occur, signalling the presence of a bistability. We show that the bistable behaviour is induced by the atoms-cavity fluctuations and is not captured by the mean-field approach. We further investigate the non-equilibrium spreading of correlations following a quench, showing that while short-range interactions lead to an emergent light-cone-like propagation at short and intermediate distances, the interplay with cavity-mediated global interactions induces a crossover to a supersonic, distance-independent growth of correlations. This behaviour persists in one and two dimensions and in the presence of dissipation, and is characterised by a short-time power-law scaling of density–density correlations.

BIOGRAPHY

Dr Ameneh Sheikhan is a permanent researcher at the University of Bonn, Germany, a position she has held since 2020. Prior to this, she was a postdoctoral researcher in Bonn. She also held a postdoctoral appointment at the National Institute for Theoretical Physics (NITheP) at Stellenbosch University from 2011 to 2013. Dr Sheikhan completed her PhD at Sharif University of Technology in Tehran in 2009. She works on driven and open quantum systems, strongly correlated matters and non-equilibrium phenomena in many body systems.



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