Contribution ID: **56** Type: **Oral Presentation**

Tensor network modeling of chain modes in Josephson junction arrays

We present a nonperturbative tensor network approach for computing excited states in superconducting quantum circuits, leveraging the DMRG-X algorithm. DMRG-X extends the density matrix renormalization group to target individual excited states, given a well-prepared trial state. We introduce a general strategy for constructing such trial states from the normal modes of the linearized system, enabling efficient convergence to highly excited eigenstates while preserving the compact, nonlinear structure of Josephson potentials.

We apply this framework to Josephson junction arrays, which are core components of high-impedance elements in superconducting architectures such as fluxonium. While these systems are often modeled using single-mode approximations, we show that hybridization between low-energy and high-frequency internal modes can lead to significant deviations from these effective theories. Our method captures these nonperturbative effects, enabling quantitative benchmarking of perturbative approaches and providing a scalable tool for analyzing the many-body excitation spectra of superconducting circuits.

Author: RUI, Emilio (Mines Paris - Alice & Bob)

Co-authors: PETRESCU, Alexandru (Mines Paris); COHEN, Joachim (Alice & Bob)

Presenter: RUI, Emilio (Mines Paris - Alice & Bob)

Session Classification: B - Contributed Talk