Simulation of large scale open quantum systems for superconducting architectures

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The increasing complexity of scalable quantum circuits, such as Josephson-based superconducting devices, asks for new theoretical ideas in order to simulate open many-body system under possibly non-equilibrium driving conditions. We present a simple yet powerful approach to this problem that relies on the superposition principle of trajectories in the phase space of the circuit elements [1]. This idea allows us to tackle reliably problems where brute force methods would require the exploration of an exponentially large Hilbert space. We illustrate this methodology by studying the challenging problem of particle production in the situation where photons scatter from a two-level system along a waveguide. We discover surprisingly that counter-rotating processes dominate the inelastic response due to the phase space associated to multiple photon creation [2].

[1] Nicolas Gheeraert, Xin H. H. Zhang, Soumya Bera, Nicolas Roch, Harold U. Baranger, and Serge Florens, "Particle Production in Ultra-Strong Coupling Waveguide QED ", preprint arXiv:1802.01665

[2] Nicolas Gheeraert, Soumya Bera, and Serge Florens, "Spontaneous emission of Schrödinger cats in a waveguide at ultrastrong coupling", New J. Phys. **19**, 023036 (2017)