Seminar/Talk

Old and new capacitances

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Probably one of the most basic circuit elements is a linear capacitor, which accounts for the energy stored in the electric field built up when separating charges across different nodes of the device. The last years and decades have seen the emergence of a variety of more general capacitive elements, with a nonlinear charge-voltage relationship, for instance by means of ferro-electric materials. In this talk, I review some recent developments specific to quantum circuits. In the first part, I revisit the physics of quantum phase slip junctions, which are currently regarded as nonlinear capacitors, dual to the Josephson effect. I present a number of arguments why such junctions should actually be described as inductive elements instead of capacitive ones. Our treatment allows for an unambiguous computation of thermodynamic quantities like the circuit's entropy or heat capacitance, and a slender integration of recent insights regarding time-dependent flux driving. It further limits the valid forms of inductive couplings to a generic electromagnetic environment, and correctly predicts the size of the available computational space for qubit applications. In a second part, I show how quantum phase slips in regular transmons can nonetheless realize a genuine nonlinear capacitive element, by partitioning the offset charge induced by a nearby island. This element has a further noteworthy property: it is quasiperiodic in charge space, and may thus be pivotal to mimic transport versions of effects known from solid state physics, such as Anderson localization or twistronics. Finally, I provide a brief outlook on further recent ideas, such as a topologically protected in-situ control of the capacitance, based on recently predicted Chern physics of conventional Cooper-pair transistors.

Thursday, June 22, 2023 10:00am - 11:00am

Office Bldg West / Ground floor / Heinzel Seminar Room (I21.EG.101)

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