Two-tone electrical drive of spin qubits

J.Carlos Egues*
University of São Paulo, University of Basel

Recent experiments on Si spin qubits in fin field-effect transistors (finFETs) [1] have demonstrated qubit operations up to 4 K [2]. In this talk, I will discuss our work [3] on the bimodal electrical microwave driving of single Si spin qubits in finFETs. More specifically, we consider simultaneous Rabi ("transverse") and phase ("longitudinal) driving fields at significantly different frequencies (GHz and MHz). We use standard numerical techniques to propagate the time-dependent Schrödinger equation, thus determining the qubit evolution. We also obtain some analytical results within a generalized version of the usual rotating wave approximation, which provide insight into the role of the many harmonics at play. We find that the interplay of the two distinct drives gives rise to novel effects such as the collapse and revival of Rabi oscillations and the appearance of side bands. Finally, we use Floquet theory to discuss how phase driving can make qubits robust against noise for some range of parameters. Our theoretical description is general and could be applied to both electron and hole quantum dot spin qubits. This work was supported as a part of the NCCR-SPIN, funded by the Swiss National Science Foundation (grant no. 51NF40-180604).

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[3] Bosco, Geyer, Camenzind, Eggli, Fuhrer, Warburton, Zumbühl, Egues, Kuhlmann and Loss, arXiv:2303.03350.