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Quantum two-level systems in Josephson junctions as naturally formed qubits ALEXANDER ZAGOSKIN, Loughborough University, SAHEL ASHHAB, ROBERT JOHANSSON, FRANCO NORI — The two-level systems (TLSs) naturally occurring in Josephson junctions constitute a major obstacle for the operation of superconducting phase qubits. Since these TLSs can possess remarkably long decoherence times, we show that such TLSs can themselves be used as qubits, allowing for a well controlled initialization, universal sets of quantum gates, and readout. Thus, a single current-biased Josephson junction (CJJ) can be considered as a multiqubit register. It can be coupled to other CBJJs to allow the application of quantum gates to an arbitrary pair of qubits in the system. We also show that using the dynamics of a driven qubit, it could be possible to characterize the nature of the two-level systems and their coupling to the phase qubit.

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