
Solid state systems for quantum information, Session 5

Assistants : franco.depalma@epfl.ch, filippo.ferrari@epfl.ch

1 Exercises

Exercise 1 : The DC SQUID

The DC SQUID is largely used in the case of superconducting qubits. This SQUID consists of two JJs in parallel forming a loop. An external flux can thread the loop and generate a DC current that flows through the junctions, changing their dynamics.

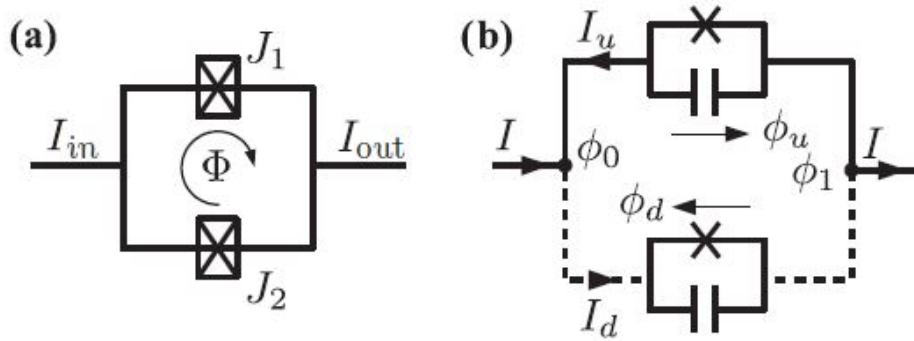


Figure 1: (a) A DC-SQUID is a device consisting on two junctions in parallel, threaded by some magnetic flux. (b) A more detailed version of the circuit must take into account the capacitive and inductive energy of the junctions if the pair is unbalanced.

1. Find the Lagrangian of the system.

Hint: Assume that out and in going currents are the same. Take the notation $\phi_{\pm} = \frac{1}{2}(\phi_d \pm \phi_u)$. Assume $\dot{\Phi} = 0$ and that the junctions are identical.

2. Find the associated Hamiltonian. Why can this device be used to design "tunable" qubits?