

# 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.

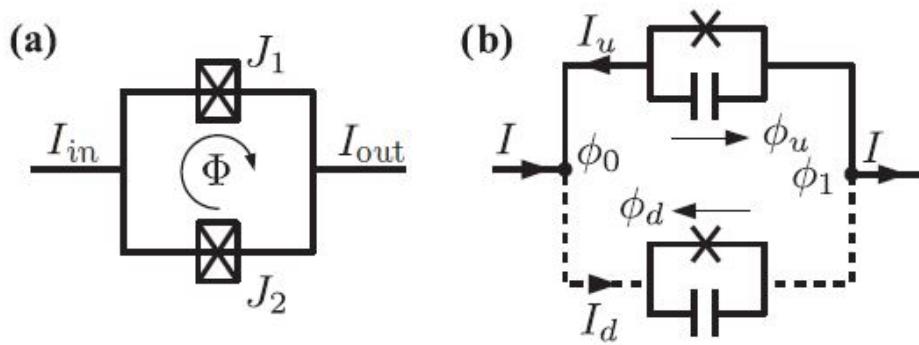


Figure 1: (a) A DC-SQUID is a device consisting on two junctions in parallel, threaded by some magnetic flux. (b) A more detailed version of the circuit must take into account the capacitive and inductive energy of the junctions if the pair is unbalanced.

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?