Highlights

Advanced materials and techniques for organic electronics, biomedical and sensing applications - 2018

Josephson Thermal Memory

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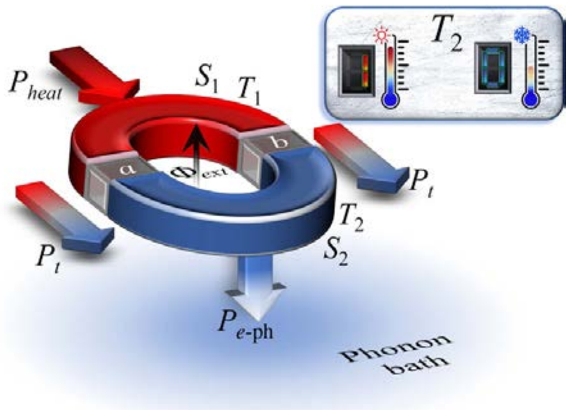
Traditionally, electronics and computation are implemented in electric systems; for example, the logical states are defined in terms of presence or absence of electric current and they are manipulated changing their electric state. Analogously, there is the possibility to use thermal states as logical states and manipulate them controlling the energy the system exchanges. Here, we propose a thermal memory based on a Josephson system. The physical system is composed by a SQUID (Superconducting Quantum Interference Device) thermally biased, i.e., with the two leads at different temperature. The logical states are associated to a different temperatures of the cold lead and their manipulation is done by a modulation of the magnetic flux applied to SQUID. This is possible because the coherent heat transport between the leads depends on the superconducting phase and it can be controlled by the external magnetic flux. The proposed device work at a basis temperature of 4.2 Kelvin for the cold lead and 6.5 Kelvin for the hot lead with a temperature separation between the thermal states of 0.1 Kelvin. We show that the magnetic flux allows us to switch between logical thermal states in 0.2 ns allowing fast writing operations. The proposed device paves the way for a practical implementation of thermal logic and computation. One of the advantages of this proposal is that it represents an example of harvesting thermal energy in superconducting circuits.

a)



b)

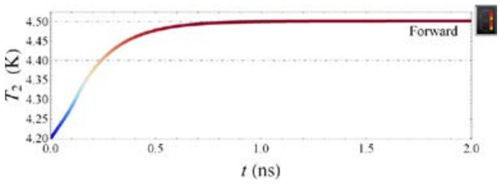


Fig. a): The schematic of the Josephson thermal memory based on a thermally biased SQUID (with leads S_1 and S_2 at temperature T_1 and T_2, respectively) controlled by the external magnetic flux Φ_{ext}. The logical states are the temperatures of the cold lead. b) Magnetic flux drive and temperature T_2 as a function of time for the two logical states. The steady state temperatures are reached after 0.2 ns.