Towards bolometric measurement of the heat of erasure in a quantum bit

Olli-Pentti Saira

The concept of the heat of erasure elegantly captures the equivalence of informational and thermodynamic entropy that governs all physical computing devices. After decades of study, it remains relevant due to its wide range of applicability, and profound technological implications for the minimum energy consumption of processors. In my talk, I will describe in detail a new experimental approach for measuring the heat of erasure utilizing superconducting flux qubits and ultrasensitive bolometers. In our experiment, all damping that enables the execution of irreversible logical operations is localized at a resistor residing on a bolometer platform. This allows us to explore a new regime where the repeated execution of a logical cycle has a weak yet accurately measurable effect on the environment of the bit. Previous works have dealt with environments that are either massive – and hence unaffected by entropy transfer at the scale of individual bits – or deeply quantum and host at most a few quantized excitations at any given time. The main benefit of the bolometer approach is that it is impervious to the operation of the logical cell. In practice, this means that there are no additional constraints on the magnitude or rate of change of the external controls that steer the computation. This enables fast logical cycles, and promises compatibility with more complex multi-bit logical operations in the future. I will show detailed simulations and preliminary experimental data.