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Thermoelectric corrections to quantum voltage measurement[1]

CHARLES STAFFORD, University of Arizona, JUSTIN BERGFIELD, Northwestern University — The voltage measured by a floating probe of a nonequilibrium quantum system is shown to exhibit nontrivial thermoelectric corrections at finite temperature. The voltage probe is modelled as a scanning potentiometer/thermometer that is allowed to equilibrate with a quantum system via local tunnel coupling. Once equilibrated, the net electrical and heat currents flowing into the probe are zero. This generalizes Buettiker's theory of voltage measurement [1] at zero temperature to finite-temperature systems. In a quantum conductor with electrical bias, it is shown that the probe temperature generally differs from ambient temperature due to Peltier cooling/heating within the system, and that the temperature difference can be sizeable for modest bias voltages. Conversely, if the probe is held at ambient temperature, its voltage is shifted from the equilibrated value, leading to a significant error in voltage measurement. However, if there is a large thermal coupling of the probe to the ambient environment, thermal coupling between the probe and system becomes unimportant, and the voltage measurement becomes similar to the process at zero temperature, with negligible thermoelectric corrections. [1] M. Buttiker, Phys. Rev. B 40, 3409 (1989).

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