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Enhanced precision of low-temperature quantum thermometry via dynamical control

Zwick A[1],Mukherjee V[2],Ghosh A[2],Kurizki G[2]
[1] *Departmento de Fisica Medica, Centro Atómico Bariloche, CNEA, CONICET*
[2] *Weizmann Institute of Science, Israel*

Precise probing of quantum systems is one of the keys to progress in diverse quantum technologies, including quantum metrology, quantum information processing and quantum many-body manipulations. We consider a thermometer modelled by a dynamically-controlled multilevel quantum system in contact with a thermal bath. As opposed to the diverging relative error near absolute zero of previously suggested thermometers, dynamical control of the probe enables high-precision thermometry close to the absolute zero, with a constant (temperature-independent) relative error bound, by maximizing its quantum Fisher information. The proposed approach may find diverse applications related to precise probing of the temperatures of many-body quantum systems in condensed matter and ultracold gases, as well as in different branches of quantum metrology beyond thermometry, for example in precise probing of different Hamiltonian parameters in many-body quantum critical systems.