Nonequilibrium qubit thermometers: Finite-time quantum metrological limits

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In this seminar, we will analyze the thermometry of the inverse temperature of a thermal bath in contact with a finite-dimensional quantum system, employed as a quantum thermometer. Under the assumption that the quantum thermometer is subject to Markovian thermalization dynamics, we outline the metrological limits of thermometry operated in non-equilibrium dynamical regimes. In our analysis, we consider a quantum thermometer initialized in a generic quantum state, possibly including quantum coherence w.r.t. the Hamiltonian basis. We prove that the sensitivity of the thermometer, quantified by the quantum Fisher information, is enhanced by the quantum coherence in its initial state. We analytically show this in the specific case of qubits thermometers for which the maximization of the quantum Fisher information occurs at a finite time during the transient of the thermalization dynamics. Such a finite-time sensitivity enhancement can be better than the sensitivity that is achieved asymptotically.