From Generalized Resource Theories of Quantum Thermodynamics to Novel Quantum Thermometry

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In my talk I will review recent efforts of ICFO Quantum Optics Group in the field pf quantum thermodynamics. First, I will start by discussing generalized laws of thermodynamics in the presence of system-bath correlations, as well as thermodynamics as a consequence of information conservation. Second, I will discuss resource theory of heat and work with non-commuting charges, providing yet another new foundation of thermodynamics. Resource theory with two baths will allow to demonstrate the possibility of attaining Carnot efficiency with quantum and nanoscale heat engines. Third, I will discuss quantum engines that deliver maximum power with Carnot efficiency in one-shot finite-size regime. I will relate these results to the general bounds on the capacity and power of quantum batteries. Finally, time permitting, I will review our proposals to use Bose polarons, or more generally impurities in an ultracold Bose gas to measure ultra-precisely ultralow temperatures.