The most accurate quantum thermometer

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Scientists have defined the smallest, most accurate thermometer allowed by the laws of physics—one that could detect the smallest fluctuations in microscopic regions, such as the variations within a biological cell.

The research, involving mathematicians at The University of Nottingham and published in the latest edition of the journal *Physical Review Letters*, focuses on the sensitivity of thermometers made up of just a handful of atoms and small enough to exhibit distinctive 'quantum' features.

Devising sensitive and practical nano-scale thermometers would represent a huge leap forward as such technology would enable a plethora of applications in bioscience, chemistry, physics and in the diagnosis and treatment of many diseases.

The study was conducted as part of an ongoing collaboration between the Quantum Correlations Group in Nottingham's School of Mathematical Sciences and the Quantum Information Group at Universitat Autònoma de Barcelona.

Dr Gerardo Adesso, who led Nottingham's involvement in the study, said: "In this work we provide a full characterisation of those probes that estimate temperature with maximum accuracy and also the margin of error that must accompany any temperature estimate. To that end, we combine the tools of thermodynamics and 'quantum metrology', which deals with ultra-precise measurements on quantum systems, finding beautiful and insightful connections between the two."

The academics also illustrate how by sacrificing some accuracy it is possible to gain other desirable features in a thermometer, such as a constant sensitivity over a wide range of temperatures.

Finally, they also looked at the maximum accuracy achievable in realistic situations in which the time available for the temperature measurement may be short due to unavoidable experimental limitations.

More information: Individual quantum probes for optimal thermometry, Luis A. Correa, Mohammad Mehboudi, Gerardo Adesso, et al. *Physical Review Letters*. 05 June 2015

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