Bending the rules of low-temperature thermometry with periodic driving

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There exist severe limitations on the accuracy of low-temperature thermometry, which poses a major challenge for future quantum-technological applications. Low-temperature sensitivity might be manipulated by tailoring the interactions between probe and sample. Unfortunately, the tunability of these interactions is usually very restricted. Here, we focus on a more practical solution to boost thermometric precision-driving the probe. Specifically, we solve for the limit cycle of a periodically modulated linear probe in an equilibrium sample. We treat the probe-sample interactions *exactly* and hence, our results are valid for arbitrarily low temperatures T and any spectral density. We find that weak near-resonant modulation strongly enhances the signal-to-noise ratio of low-temperature measurements, while causing minimal back action on the sample. Furthermore, we show that near-resonant driving changes the power law that governs thermal sensitivity over a broad range of temperatures, thus 'bending' the fundamental precision limits and enabling more sensitive low-temperature thermometry. We then focus on a concrete example-impurity thermometry in an atomic condensate. We demonstrate that periodic driving allows for a sensitivity improvement of several orders of magnitude in sub-nanokelvin temperature estimates drawn from the density profile of the impurity atoms. We thus provide a feasible upgrade that can be easily integrated into low-T thermometry experiments.