Ultrasensitive All-Optical Thermometry with Germanium-Vacancy Centers in Diamond and Its Heat Penalty Function

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This talk will provide an account of an unpublished work [1]. All-optical thermometry based on a laser-driven photoluminescence (PL) of germanium–vacancy (GeV^-) centers in diamond is quantified in terms of a tradeoff between temperature sensitivity and laser-induced heating. We show that, while, at low levels of laser heating, the noise floor η_T of the temperature readout based on the PL return from GeV^- scales as $(\mathrm{p}\Delta\mathrm{t})^{-1/2}$ with the laser power p and detection time Δt, in higher-p regimes, the behavior of η_T as a function of p tends to flatten out, with the gap between η_T and its $\propto (\mathrm{p}\Delta\mathrm{t})^{-1/2}$ lower bound increasing with p due to a gradual decrease in the Debye–Waller factor of the GeV^- zero-phonon line. Our studies [1] suggest that sub-mK/Hz$^{-1/2}$ levels of η_T are attainable at higher p.

References

[1] M A Solotenkov, I V Fedotov, S Ya Kilin, A B Fedotov and A M Zheltikov (2022), unpublished