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Dark resonances as local probes

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In this work we show theoretically and experimentally how to use dark resonances emerging from coherent population trapping (CPT) in a multi-level lambda-type system as local electric field and temperature probes. To do this, we include a third laser to the system to avoid optical pumping effects. We find that the nature of the dark resonances can be either preserved or affected by the additional laser depending on its optical power and polarization. We performed experiments with a single trapped calcium ion in a ring-shaped Paul trap using its S1/2-P1/2-D3/2 level system. We show that the obtained spectra can be used as a vectorial beam polarimeter allowing us to measure the electric field at the position of the ion in any spatial direction. Finally, we present an application of CPT spectra to perform single ion thermometry to be used to study heat transport in ion chains and out-of-equilibrium systems like 2D ion crystals.

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