Quantum clock laser interrogation protocols for light-shift elimination with Generalized Hyper-Ramsey resonances

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Résumé

High-precision atomic clocks based on neutral atoms in optical lattices and trapped ions are reaching today relative accuracies in the $10ˆ{-18}$ range requiring new techniques in very precise control of external systematic corrections.
Unconventional spectroscopic probing protocols manipulating the laser phase with modified or generalized (Hyper) Ramsey-type schemes have been studied to fully eliminate one of them: the light-shift perturbation by off-resonant atomic states.
Quantum engineering of these protocols is investigated leading to a very robust composite laser pulses detection scheme which uses a combination of phase-modulated (GHR) resonances including a population transfer between ground and excited states. The robustness of the synthesized laser frequency locked point is thus absolute simultaneously against pulse area errors and uncompensated probe-induced frequency-shifts in presence of laser induced decoherence and relaxation caused by spontaneous emission and collisions. The future generation of optical clocks will now be able to perfectly cancel probe-induced frequency-shifts in a dissipative environment achieving a new breakthrough in ultra-high precision measurement well below the $10ˆ{-18}$ level of relative accuracy.

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