PHYSIQUE DES INTERACTIONS IONIQUES ET MOLÉCULAIRES

Taking a three-photon Coherent Population Trapping resonance to its ultimate performance

Atomic coherence are a key ingredient for achieving full control of the interaction between electromagnetic fields and an atomic sample. A coherence based effect is the quantum interference between two excitation paths that is responsible for coherent population trapping (CPT) in an atom showing a Λ-excitation scheme. As the destructive interference happens only at two-photon resonance, the resulting dark line in the fluorescence can be used as a frequency reference. This approach is used in the so-called "CPT-microwave clock", where the reference transition is in the GHz frequency domain, with no microwave cavity needed for excitation[1].

We are exploring the extension of this mature two-photon protocol to multi-photon coherent excitation protocols for precision measurements with the dark line obtained by three-photon coherent population trapping in a Ca+ ion cloud, laser-cooled in a radio-frequency trap. This line is referenced to a magnetic dipole transition in the THz range (1.82 THz), without the need for a THz source to probe it [2]. The coherences created between the atomic states by the dressing of three lasers are at the core of the laser interrogation process. In our experiment, these 3 lasers cover a spectral range of 65 THz and are simultaneously locked on the same optical frequency comb, frequency stabilized thanks to an ultra-stable laser [3], and soon disciplined by comparison with the metrology signal Refimeve+ which will allow the absolute measurement of the transition frequency.

One of the key added-value of multi-photon protocols is the potential suppression of the first order Doppler effect by a phase-matching condition. After a first identification of the main sources of broadening and shift [4], and the Doppler effect cancellation, this project aims to quantify the impact of the relative coherence of the three lasers involved. This is a first step to a relevant evaluation of the precision measurements that can be achieved through this excitation process.

To join this project, we are looking for a young researcher with a strong experimental practice and expertise in ultra-stable lasers and/or high precision spectroscopy and/or laser cooled trapped ions. He or She will join the ion trapping group in Aix-Marseille University, Marseille, and benefit from its strong expertise in RF-ion traps, laser stabilization and multi-photon cooling and excitation protocols (http://piim.univ-amu.fr/Presentation).

application and conditions : https://bit.ly/38jfulh,

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[1] 10.1103/PhysRevApplied.9.064002 [2] 10.1103/PhysRevLett.99.013001

[3] 10.1364/OL.44.000859 [4] 10.1103/PhysRevApplied.12.034035