Dark resonance fringes and dressed matter-waves: quantum technologies from atomic physics

By

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Host: Assoc Prof David Wilkowski

Abstract

Quantum technology is now becoming an active field mixing atomic physics and quantum Hamiltonian engineering based on state superpositions and entanglement for a new generation of extreme accurate sensors. I will focused during this talk on a few applications from atomic physics emerging as successful methods to realize compact atomic CPT clocks based on dark resonance fringes and developing new concepts with atomic systems manipulated trough off-resonant time-periodically modulated electromagnetic fields. Dark resonance fringes in double lambda atomic systems have been realized in atomic vapor cells with buffer gas paving the way to compact stable atomic clock sensors for unprecedented metrological application. Dark resonances have also been suggested as new frequency standards in optical lattice clock with forbidden transitions of alkaline earth atoms using a combination of Electromagnetically Induced Transparency (EIT)/Raman and pulsed spectroscopy techniques to accurately cancel frequency shifts arising from laser fields. The proposed scheme for optical clocks using bosonic systems was offering an efficient population transfer up to 60% with potential inaccuracy $10^{-17}$. Quantum engineering of phase-shifts for an hyper Raman-Ramsey optical clock will be also presented to produce an ultra-narrow optical transition in bosonic alkali-earth systems free from light shifts and with a significantly reduced sensitivity to laser parameter variations. I will finish the talk with the Floquet dressed atom and matter-wave concept in order to renormalize and control atomic properties for quantum sate engineering leading to a new class of Stern-Gerlach interferometers and Zeeman-free optical clocks with nuclear spin where the atomic Landé factor is modified.

Short Biography

Dr Thomas Zanon-Willette received in 2005 a phd about hot vapor cell CPT clocks based on dark resonance fringes at SYRTE laboratory from université UPMC (now Sorbonne-Université SU).

He thus spend almost two years as a postdoc position at JILA with Dr Jun Ye’s group working on a strontium optical lattice clock with fermionic ultracold atoms and starting a new EIT/Raman clock project based on bosonic atoms with no nuclear spin. He spend one year between 2007 and 2008 as a temporary lecturer at LPL located in Paris 13 with Dr Bruno Laburthe-Tolra’s cold atoms group working on a 52Cr BEC production within an all-optical method and using highly non resonant radio-frequency dress fields effects to modify BEC magnetic properties. He spend two years from 2008 to 2010 at Institut National de Métrologie (INM) near Paris with Dr J-J Zondy to realize a singly resonant optical parametric oscillators source for molecular spectroscopy applications.

As an assistant professor at SU since 2011, he is working on a new experimental project to realize high resolution molecular spectroscopy of $O_3$ around 10 $\mu$m based on a QCL stabilized to a frequency-comb for atmospheric science applications.