INTERNSHIP PROPOSAL

(One page maximum)

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CNRS identification code: **UMR 8233**
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Thesis possibility after internship: **NO**
Funding: **NO**
Publication possibility: **YES** If YES, which type of funding:

Qudit hyper-clock with SU(2) dynamic symmetry

In quantum computing, higher-dimensional quantum bits (N>2) or qudits with multilevels have attracted attention in increasing the efficiency of computation. Qudits provide a larger state space than qubits to store and process information and enhance quantum computation speed [1]. In the future, many various physical platforms based on ultra-cold atoms, ions, molecules and in solid-state physics that can implement qudit computation might soon compare their performances with their qubit counterparts. For the first time, we will extend the application of hyper-Ramsey interferometry of a quantum two-level system (a qubit) to a larger quantum N-level system made of equally energy spaced levels (a qudit) interacting simultaneously with N-1 identical coherent electromagnetic fields (basic model).
We will focus on the ultimate achievable robust control of quantum interferences between states of the qudit by appplying SU(2) coherent control dynamics of spinor rotations. From a geometrical point of view, hyper-Ramsey interferometry can be seen as successive rotations by composite pulses on a Bloch sphere leading to robust quantum interferences. These interferences are associated in atomic or molecular spectroscopy to a better precision in the frequency measurement of state energies, for example, in quantum metrology application. A quantum computational circuit version is the application of a double Hadamard gate separated by a free evolution time, a basic component in quantum information processing techniques for high fidelity gate analysis. To reach our internship goal, the applicant will have opportunities to explore Ramsey and hyper-Ramsey interferometry within a qudit system. Very important steps and key techniques in atomic or molecular spectroscopy of qubit transitions based on composite pulses eliminating probe induced frequency-shifts have already been published **[2]**. The main theoretical objective will be now to transfer these qubit results to a qudit architecture connecting SU(2) dynamical symmetry **[3,4]** with the Majorana-Rabi decomposition formula **[5]**, a direct analytical solution of the population dynamics of any spin J = {1,3/2,2,5/2…} that can be decomposed into an arbitrary combination of spin ½.
The applicant will also check that the Majorana-Rabi decomposition formula is an efficient quantum algorithm to reduce time computation of sophisticated interrogation protocols of our qudit hyper-clock by compacting in size the Hilbert space into a irreducible representation based on complex Pauli matrices for efficient computation.

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

Condensed Matter Physics: NO Soft Matter and Biological Physics: NO
Quantum Physics: YES Theoretical Physics: YES