Proposition de stage M1/M2

**Titre :** Relativistic measurements and quantum information protocols: qubit and spin dynamics in moving frames

**Sujet :**  
Relativistic quantum information is an emerging field that combines quantum information with relativistic quantum mechanics, with the aim to develop protocols in relativistic frameworks. Indeed, in a relativistic setting, the standard quantum information protocols are not expected to work: entanglement will differ for distinct inertial observers, whereas the physical support of qubits, such as the spin for massive particles, becomes intrinsically mixed with the spatial wavefunction in a frame-dependent way.

Against this backdrop, there are current efforts aimed at identifying relativistic spin operators that would allow to generalize certain classes of quantum information protocols. Indeed, spin-1/2 systems are the privileged physical support for qubits. Different operators corresponding to distinct relativistic spin observables have been proposed. For a single qubit, the relativistic version of the Stern Gerlach experiment appears as a versatile manner to investigate such operators, given that the Dirac equation mixes the particle spin and the spatial part of the wavefunction in a frame-dependent way.

The aim of the internship will be to investigate theorically the spin behavior of a Dirac particle in a relativistic Stern-Gerlach device in terms of generalized measurements. The specific characteristics of pointer states as well as the type of pointer-system coupling will be examined. One particular objective will be to understand how the entanglement between the space and spin degrees of freedom changes the value of the operationally measured spin.

**Prérequis :** Excellent record in quantum mechanics classes is necessary. Notions of relativistic quantum mechanics are not required but would be helpful. The internship is aimed at Master2 students, though motivated Master1 students can also be considered.

**Lieu du stage :** Laboratoire de Physique théorique et modélisation, CY Cergy Paris Université, Cergy-Pontoise.

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