Internship proposal 2009-2010

Laboratory : Laboratoire Charles Fabry de l'Institut d'Optique **Address : Campus Polytechnique, 2 av. Augustin Fresnel, F-91127 Palaiseau cedex (Paris)** **Laboratory director : Pierre CHAVEL**	INSTITUT d'OPTIQUE GRADUATE SCHOOL
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Title for the scientific project

Anderson localization of Ultracold Atomic Gases

Scientific project :

Ultracold atoms form one of the most active research fields in modern physics, at the interface between atomic physics, condensed matter and statistical physics. They offer unprecedented possibilities to investigate model systems with remarkable control of all parameters, to understand the most fundamental properties of matter, such as Bose-Einstein condensation, superfluidity or superconductivity. During the past years, the physics of disordered ultracold atoms has emerged as a researcher front and has already produced landmark results.

How do quantum waves behave in disordered potentials (which can be represented as a landscape of very irregular valleys and hills) ? This question is not only academic, but is also at the heart of our understanding of superfluidity in real materials and superconductivity in real metals. While a classical particle with sufficient energy would propagate without an end, a quantum wave will suffer subtle interference effects, which completely stops it, even if its energy is well above the amplitude of the disordered potential. This phenomenon was predicted by P.W. Anderson in 1958 in the context of electronic systems, but has been observed only in 2008 ... with ultracold atoms. This work has been pioneered in our group, thanks to a close collaboration between theory and experiments [L. Sanchez-Palencia *et al.*, Phys. Rev. Lett. **98**, 210401 (2007); J. Billy *et al.*, Nature **453**, 891 (2008)].

Up to now, Anderson localization of ultracold atoms has been observed in one dimension. Here, we will study how to generalize it to two and three dimensions, which poses open questions, which the new tools of ultracold atoms allow to address with original viewpoints. This internship and subsequent thesis will be theoretical and could use analytical and/or numerical techniques. One of the original aspects of our theory team is that it has close collaborations with experiments lead at Institut d'Optique, which offers concrete applications and fruitful interactions.

Techniques in use : Numerical techniques (Gross-Pitaevskii)

Applicant skills : Quantum mechanics

Granted internship : consult us
C'nano IdF laboratory (France only) : yes
Possibility for a thesis : yes