Spécialité de Master « Optique, Matière, Plasmas »

Stage de recherche (4 mois minimum, à partir de début mars)

Proposition de stage (ne pas dépasser 1 page)

Date de la proposition :

Responsable du stage / *internship supervisor*: Nicolas Sangouard			
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Nom du Laboratoire / *laboratory name*: University of Basel			
Code d'identification :		Organisme : Physics Department	
Site Internet / *web site*: https://qotg.physik.unibas.ch			
Adresse / *address:* Basel			
Lieu du stage / *internship place*: Basel			

Titre du stage / *internship title*: **Extending quantum theory to the macroscopic domain**

Even a superficial review of scientific developments over the last 100 years reveals the enormous success of quantum theory for describing the microscopic world and the technological benefits gained through the better understanding of the underlying physics. These successes have settled many of the initial concerns with quantum theory but opinions still diverge on whether quantum effects can survive at any scale. Nonetheless, things look like they could change dramatically in the near future as the techniques to manipulate many-body systems in the quantum regime have improved tremendously and today, one can envision engineering large optical, atomic and mechanical systems while mastering their many degrees of freedom. This opens up the possibility to look for quantum effects in unexplored regimes and provides a strong motivation to revisit a great number of foundational questions, e.g. on the quantum/classical transition or on the so-called quantum measurement problem.

The objective of the proposed training and following PhD work is to gain insight into the reasons that make it hard to observe quantum effects at macroscopic scales. The fact that quantum theory is seemingly unnecessary in the macroscopic domain favors the idea that it is a theory describing microscopic phenomena exclusively. However, there is nothing in the theory itself that prevents it to apply to large systems. We intend to investigate two different approaches to resolving this paradox. The first one consists in deriving effective quantum-to-classical transitions within quantum theory. In this framework, we will not only focus on decoherence which is widely accepted as one of the fundamental problems limiting the ability of macro systems to maintain quantum properties but we will also explore the problem of the measurement precision, i.e. the requirement on the precision of the measurement that is needed to reveal the quantum nature of macroscopic systems. The second approach is to look for post-quantum theories having both quantum and classical theories as asymptotic limits. Here we intend to develop realistic experimental proposals to test explicit collapse models stating that a massive object in a superposition of two distinct positions inevitably collapses due to the gravitational field. These projects are all realized in close collaboration with leading experimental groups.

For more information, do send an email to nicolas.sangouard@unibas.ch. We can also invite you at Basel for a day or so — for you to have a closer look at our research activities.

Ce stage pourra-t-il se prolonger en thèse ? *Possibility of a PhD* **? : YES**

Si oui, financement de thèse envisagé/ *financial support for the PhD***: EU or Suiss fundings**

Lasers, Optique, Matière	**X**	Lumière, Matière, Interactions	**X**
Plasmas : de l'espace au laboratoire			