

École Doctorale de Physique et Chimie-Physique 2017

Exploiting Strong Light-Matter Interactions and Quantum Coherence In Physics, Biophysics and Chemistry

Shannon Whitlock (IPCMS), whitlock@ipcms.unistra.fr
Jérémy Léonard (IPCMS), jeremie.leonard@ipcms.unistra.fr
Cyriaque Genet (ISIS), genet@unistra.fr

What determines the amazingly versatile optoelectronic properties of semiconductors, or the conversion of light into chemical energy in biological light harvesting? At a fundamental level we know quantum mechanics provides the laws which govern these types of behaviour, but it is not clear to what extent truly quantum effects survive in the warm and noisy environment of real materials or molecules. For example, in photosynthesis, it is hotly debated whether nature may harness quantum effects to transport energy between molecules in a coherent wavelike fashion rather than by a series of random hops, in some cases, achieving close to 100% efficiency.

In this interactive lecture series we explore how strong light-matter interactions and quantum coherence can influence fundamental processes arising in non-equilibrium physics, biophysics and chemistry. Particular focus is placed on cutting-edge research which explores the interplay between light, electronic and vibrational degrees of freedom to radically modify and even enhance said processes. We review how these effects can be studied in natural and synthetic quantum systems, including organic molecules, ultracold quantum matter and in semiconductor materials. By finding the ingredients responsible for achieving strong light-matter interactions and enhancing coherence, especially in the presence of noise, we predict breakthroughs in understanding how quantum effects arise in unexpected places, potentially inspiring the next generation of functional materials.

Main topics:

- Elementary light-matter interactions
- Collective light-matter interactions in ensembles
- Coherence effects in molecular dynamics
- Hot topic 1: Experimental quantum simulation of transport ultracold atoms
- Hot topic 2: Engineering vibrational coherence in organic molecules
- Hot topic 3: Strong light-matter coupling in semiconductors
- Panel discussion

Dates: 02, 05, 09, 12, 16 and 19 October 2017. The lectures will start from 15:00 to 17:00 except for the first and last lecture which will end at 18:00. Total course duration 14 hours

Place: 02, 12, 16 & 19 October: Auditorium of IPCMS - 23 rue du Loess.

05, 09 October will take place in room 70 of IPCMS - 23 rue du Loess