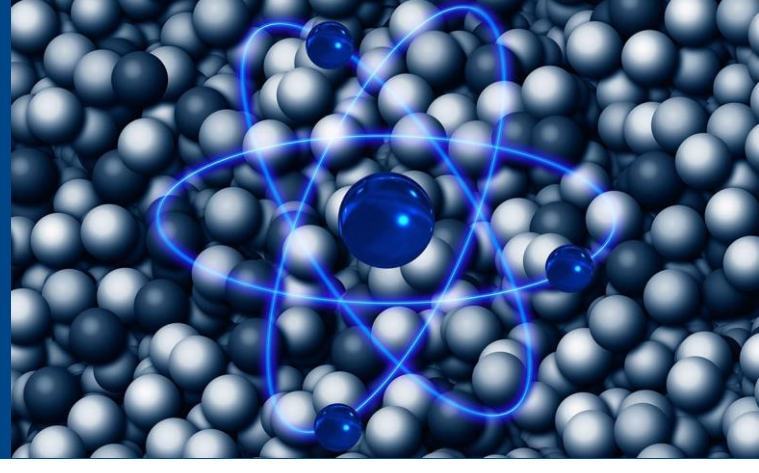
Lecture series on *Quantum Engineering* at University Paris-Saclay



Topological insulators and geometrical band theory

by Jean-Noël Fuchs (LPTMC, Jussieu)

&

Entangled structures in classical and quantum optics

by Antonio Zelaquett Khoury (Universidade Federal Fluminense, Niterói, RJ, Brasil)

Tuesday 8, 15, 22 and 29 January 2019 from 9:15 to 12:30

Amphithéâtre Blandin, LPS*

4th series of lectures organized by the IQUPS** network, open to Master students, PhD students, Post-docs, and researchers.
?? The ensemble of the two courses is eligible as "complément de formation initiale" for EDOM and EDPIF students.??

Attendance is free but registration is *mandatory* (by email to iqups@universite-paris-saclay.fr)

Program:	9h15-10h45	11h-12h30
January 8	J.-N. Fuchs	A. Zelaquett Khoury
January 12	A. Zelaquett Khoury	J.-N. Fuchs
January 15	J.-N. Fuchs	A. Zelaquett Khoury
January 22	A. Zelaquett Khoury	J.-N. Fuchs

Topological insulators and geometrical band theory (Jean-Noël Fuchs)

We will start by recalling some mathematical notions of topology by using historical examples in physics : topological defects in order parameters (notion of homotopy groups) and the Dirac magnetic monopole (notion of fiber bundles). Then, we will present geometrical band theory (i.e., Berry phases for Bloch electrons in crystals) and the integer quantum Hall effect (i.e., the Chern number also known as the Thouless-Kohmoto-Nightingale-den Nijs invariant) as a first example of a topological insulator. Next, we will study graphene in order to introduce Dirac fermions as possible excitations in condensed matter. From the massless case (gapless graphene), we will turn to the massive case (gapped graphene) by opening a gap in different ways : (1) via an inversion symmetry breaking (boron nitride, "trivial" Dirac insulator, quantum valley Hall effect) ; (2) via time-reversal symmetry breaking (Haldane's model, Chern topological insulator, anomalous quantum Hall effect) ; and (3) via a spin-orbit coupling that breaks no symmetry of the graphene layer (model of Kane and Mele, Z2 topological insulator, quantum spin Hall insulator).

Entangled structures in classical and quantum optics (Antonio Zelaquett Khoury)

Lecture 1: Optical vortices as entangled structures in classical optics
Lecture 2: Quantum-like simulations and the role of quantum inequalities
Lecture 3: Quantization of the electromagnetic field
Lecture 4: Vector beam quantization and the unified framework

- Laboratoire de Physique des Solides, bâtiment 510, université Paris-Sud (https://www.lps.u-psud.fr/)

** Ingénierie Quantique à l'Université Paris-Saclay (https://www.universite-paris-saclay.fr/fr/recherche/projet/iqups-ingenierie-quantique)