

Advancing Quantum Mechanics with Mathematics and Statistics



March 7 - June 10, 2022

Scientific Overview

Quantum mechanics is the fundamental theory of fields and matter and it is arguably the most successful and widely applicable theory in the history of physics. Quantum mechanics is widely used today to describe low and high energy phenomena. This includes studying molecules and solids throughout biology, chemistry and physics, and even the determination of constitutive relations in engineered mesoscale structures.

The aim of this program is to pave the way towards practical and error-controlled quantum-mechanical calculations with tens of thousands (or even millions) of quantum particles. This IPAM program is based on the premise that by systematically analyzing the structure and topology of Hilbert spaces of different systems and methods, as an interdisciplinary community we can overcome the bottlenecks of existing approximations, and move towards quantum multiscale methods based on Hilbert space embedding, model order reduction, and complementary mathematical and statistical techniques. This program will bring together physicists, mathematicians, chemists, engineers, and computer scientists interested in pushing the boundaries of theory and methods based on quantum mechanics.

Long Program Schedule

- Opening Day. March 7, 2022.
- Advancing Quantum Mechanics with Mathematics and Statistics Tutorials : March 8-11, 2022.
- Workshop I: Multiscale Approaches in Quantum Mechanics : March 28 - April 1, 2022.
- Workshop II: Model Reduction in Quantum Mechanics : April 11-15, 2022.
- Workshop III: Large-Scale Certified Numerical Methods in Quantum Mechanics : May 2-6, 2022.
- Workshop IV: Monte Carlo and Machine Learning Approaches in Quantum Mechanics : May 23-27, 2022.
- Culminating Workshop at Lake Arrowhead. June 5-10, 2022.

Organizers

Eric Cances (École Nationale des Ponts-et-Chaussées), **Maria J. Esteban** (CNRS and Univ. Paris-Dauphine), **Giulia Galli** (Univ. Chicago), **Lin Lin** (UC Berkeley), **Alejandro Rodriguez** (Princeton), **Alexandre Tkatchenko** (Univ. Luxembourg)

Participation

This long program will involve senior and junior researchers from several communities relevant to this program. You may apply for financial support to participate in the entire fourteen-week program, or a portion of it. We prefer participants who stay for the entire program. Applications will be accepted through November 29, 2021, but offers may be made up to one year before the start date. We urge you to apply early. Mathematicians and scientists at all levels who are interested in this area of research are encouraged to apply for funding. Supporting the careers of women and minority researchers is an important component of IPAM's mission and we welcome their applications. More information and an application is available online.

