INTERNATIONAL SOLVAY INSTITUTES BRUSSELS

SOLVAY COLLOQUIUM

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Universal Matter-Wave Interferometry

Quantum mechanics is celebrating its centenary, commemorating de Broglie's matter wave hypothesis, Heisenberg's matrix mechanics, Schrödinger's wave equation and many other fundamental achievements. Confirmed by countless experiments, quantum theory has since become the foundation of a vast range of technologies. Yet, we still struggle to grasp the meaning of the quantum wave function, the interpretation of its formalism and its implications for the nature of reality. This talk will illustrate the conundrum by exploring how quantum superpositions and extended wave functions of massive objects can be prepared in states that appear forbidden from the perspective of our macroscopic everyday world.

I will discuss the experimental conditions, realizations and applications of matter-wave interferometry which we have extended across diverse material classes and ever-increasing mass scales: from C60 molecules to vitamins and polypeptides, molecular clusters, and metal nanoparticles containing thousands of atoms in a single delocalized body. In all cases, we confirm that quantum superpositions can be realized, in stark contradiction to a classical world view that assumes massive bodies travelling along well-defined trajectories. Our experiments have grown from 'Schrödinger kittens' to mesoscopic cats and I will highlight the next steps on this journey.

Pushing quantum superpositions to even larger masses and complexity demands substantial advances in quantum state preparation. I will present our recent progress in cooling optically trapped dielectric nanorotors, with masses in the gigadalton range. Preparing these systems in their quantum ground state of libration now enables unprecedented control over their rotational quantum states and spatial alignment, paving the way for new matter-wave experiments in rotational phase space.

While our primary aim is to explore the boundary between quantum and classical phenomena, the tools and methods developed for matter-wave interference also open new avenues for quantum sensing. They allow us to probe tiny forces and torques, with applications in physical chemistry, biomolecular physics and materials science.

Tuesday 24 Februay 2026 at 4:00 P.M.

COFFEE AND TEA WILL BE SERVED AT 3:45 P.M IN FRONT OF THE SOLVAY ROOM

UNIVERSITÉ LIBRE DE BRUXELLES
CAMPUS PLAINE - BOULEVARD DE LA PLAINE
ACCESS 2 - 1050 BRUSSELS
Quartier Jaune - Building N.O. - 5th Floor - Solvay Room