Joint CQSE & NCTS Special Seminar

2024
Oct. 7, Friday

Time: Oct. 7, 2024, 14:20~15:30 pm
Title: Probing high-pressure superconductivity with quantum sensors
Speaker: Prof. Jean-François Roch (Director of Quantum-Saclay, the interdisciplinary center of the University Paris-Saclay)
Place: NCTS Physics Lecture Hall, 4F, Chee-Chun Leung Cosmology Hall, NTU
Online:
https://nationaltaiwanuniversity-zbh.my.webex.com/nationaltaiwanuniversity-zbh.my/j.php?MTID=m70f494fd71a9064a34559afbf55102f3

Abstract:

Pressure is a key parameter in condensed matter to modify chemical bounds and material structure. Pressure also enhances the quantum properties that arise from electronic interactions, such as superconductivity. The workhorse of high-pressure investigations in condensed matter physics is the diamond anvil cell (DAC) where the pressurized sample is confined inside a drilled metallic gasket squeezed by two opposing diamond anvils. However, the confinement of the sample in the tiny dimension of the diamond anvil cell makes the implementation of any non-optical sensing technique both highly challenging and hardly reproducible.

Over the last years, we developed integrated quantum sensing systems that perform in situ measurements of quantum materials in a pressurized diamond anvil cell. This is realized by engineering a thin layer of optically active spin defects centers directly into the tip of a diamond anvil. Our choice is the nitrogen-vacancy (NV) color center that can be fabricated by nitrogen implantation using a focused ion beam that we specifically developed for this task. Using the magnetic field sensitivity of the NV center layer, we directly observed the Meissner effect associated to high-pressure superconducting materials such as a mercury-doped cuprate. Most importantly, we demonstrated that the NV center's sensing efficiency remains robust up to megabar, i.e. hundred of gigapascals equivalent to a million of atmospheres. that the stress applied to the point defect remains hydrostatic in order to preserve its symmetry inside the diamond lattice that determines the quantum eigenstates on which the sensing capabilities are based.

Biography:

Jean-François Roch is the director of Quantum-Saclay, the interdisciplinary center of the University Paris-Saclay dedicated to the academic and industrial development of quantum technologies. He is a professor of physics at Ecole Normale Supérieure Paris-Saclay, where he leads a research team focusing on the use of diamond point defects. He is a senior member of the Institut Universitaire de France and an Overseas Fellow at Churchill College, University of Cambridge.