ICFO

THEORY LECTURE SERIES

EUGENE DEMLER

January 09, 2023 to January 12, 2023
10:00 to 13:00
Blue Lecture Room and Seminar Room

The lectures will be given by **Prof. Dr. Eugene Demler**
Full Professor of Physics at Institute for Theoretical Physics | ETH Zurich ?

With the following **schedule**:
Monday, January 9, 11-13 SMR
Tuesday , January 10, 10-12, BLR
Wednesday, January 11, 10-12, SMR
Thursday, January 12, 10-12, BLR

Lecture I
Monday, January 9, 11-13, SMR
Title
Waveguide quantum electrodynamics with many-body electron system
Abstract
In this talk, I will discuss the applications of cavity electrodynamics for controlling many-body electron systems. The focus will be on achieving strong coupling between cavities and collective excitations of interacting electrons at Terahertz and IR frequencies. As a specific example I will consider a cavity platform based on a two dimensional electronic material encapsulated by a planar cavity consisting of ultrathin polar van der Waals crystals. I will also discuss how metallic mirrors sandwiching a paraelectric material can modify the transition into the ferroelectric state. Finally, I will review a general question of theoretically describing ultrastrong coupling waveguide QED. I will present a novel approach to this problem based on a non-perturbative unitary transformation that entangles photons and matter excitations. In this new frame of reference, the factorization between light and matter becomes exact for infinite interaction strength and an accurate effective model can be derived for all interaction strengths.

Lecture II
Tuesday, January 10, 10-12, BLR
Title
Optical responses of photoexcited materials: from parametric amplification to photoinduced superconductivity

Abstract

Optical drives at terahertz and mid-infrared frequencies in quantum materials are commonly used to explore nonlinear dynamics of interacting many-body systems. Recent experiments have demonstrated several surprising optical properties of transient states induced by driving, including the appearance of photo-induced edges in the reflectivity, enhancement of reflectivity, and even light amplification. I will show that many of these unusual properties can be understood from the general perspective of reflectivity from Floquet materials, in which pump-induced oscillations of a collective mode lead to parametric generation of excitation pairs. This analysis predicts a universal phase diagram of drive induced features in reflectivity, which evidence a competition between driving and dissipation. I will argue that this mechanism explains several recent experimental observations, including photoinduced superconductivity in the pseudogap phase of high Tc cuprates.

Lecture III

Wednesday, January 11, 10-12, SMR

Title

Quantum simulators: from the Fermi Hubbard model to quantum assisted NMR inference

Abstract

I will discuss recent progress of optical lattice emulators of the Fermi Hubbard model, specifically the new availability of snapshots of many-body states with single particle resolution. I will review new insights from these experiments on the properties of doped Mott insulators, including the demonstration of magnetically mediated pairing. I will also present the idea of using quantum simulators to perform inference of NMR spectra for biological molecules. I will review a recent experimental realization of this algorithm on a quantum computer using trapped ions. Prospects for scaling this approach to solving practically relevant problems will be discussed.

Lecture IV

Thursday, January 12, 10-12, BLR

Title

Single-spin qubit magnetic spectroscopy of the correlated states of electrons

Abstract

A single-spin qubit placed near the surface of a material acquires an additional contribution to its relaxation rate due to magnetic noise created by the low energy excitations of the electron system. I will discuss how this noise can be used to investigate different types of electronic states, including superconductors, , ferro- and antiferromagnetic insulators, and spin liquid states.

Participation is open to all ICFOnians

We strongly encourage you to attend the lectures in person.
If you are unable to attend the lectures in person, here is the link to attend them online:

Join **Zoom** Meeting
https://us06web.zoom.us/j/88237842408?pwd=MWw0QTlpbmc5enZuRFBDcmFpcFZlQT09

Meeting ID: 882 3784 2408
Passcode: 628037

Please, note: Due to room availability, the lectures will be held in different rooms, as indicated in this email.
Hosted by: Maciej Lewenstein; Antonio Acin; Darrick Chang; Leticia Tarruell