

A SET OF QUASI-EASY LECTURES ON QUANTUM MATERIALS

Fulvio PARMIGIANI

University of Trieste and University of Cologne

Abstract

The condensed matter physics of the present days and its future scenarios has its roots in issues that emerged in the years between the two world wars of the last century when a long file of unsolved mysteries. The main problems involved magnetism, transport properties and superconductivity.

If we are looking for a definition of quantum materials in a condensation of a few words or adjectives probably we can limit ourselves to all materials whose macroscopic properties cannot be derive in the frame of semi-classical particles and low-level quantum-mechanics. These are materials that present strong electronic correlations or an electronic order, i.e. magnetic or superconducting orders, or materials whose electronic properties have topological constrains or band structure anomalies like Dirac-electron systems (graphene and topological insulators) or systems whose collective properties are governed by quantum behavior. The fingerprints that qualify a quantum material, are some material properties with no counterpart in the classical or semi-classical physical world, such as the quantum entanglement, quantum fluctuations, boundary states that dependent on the topology of the electronic states etc. In these last two decades the study and research of quantum materials has proved to be a subject that not only revolutionized the very idea of condensed matter physics. Nowadays we can envision a scenario beyond traditional quantum materials such as unconventional superconductors, heavy fermions, and multiferroics, where these properties can arise along with mathematical and quantum mechanical fundamental behavior such as topology and entangled quantum states. This landscape comprises, topological quantum matter, low-dimensional materials, van der Waals heterostructures, Majorana fermions materials etc..

In this set of Lectures, we aim to introduce the students to this fascinating and largely unexplored world having in mind that all what is possible to do is not more than a snapshot of the history, concepts, theory models and experiments at the origin of the most recent developments in the field of quantum materials. Although, the topic is very challenging both conceptually and formally theoretically every effort will be made to illustrate the physics of quantum materials especially from the phenomenological point of view.

The intent is to open a door to this universe that in so many ways represents an important part of future physics. It would already be an achievement if the student would find himself at the end of these lectures with a wealth of questions and curiosities that are worth investigating if not exploring.

PhD Course

Martedì 23 aprile 2024

Martedì 7 maggio 2024

Martedì 14 maggio 2024

Martedì 21 maggio 2024

Sala Riunioni S4, ore 10.00

via Garzetta 48, Brescia



UNIVERSITÀ
CATTOLICA
del Sacro Cuore