

Advanced theory of solids

PhD in Physics, year 2022/2023 – proposed programme

Responsible: Lucio Andreani

The course will deal with elementary excitations in solids, focusing on surface plasmon polaritons and exciton-polaritons, on radiation-matter interaction at the nanoscale, and on effects related to chirality. It will start from the basics, covering until recent research developments.

Module 1 (Lucio Andreani, 12 hours): Introduction to metamaterials. Macroscopic electrodynamics, dielectric function, Drude and Lorentz model, Born-Kuhn model for chiral media. Examples: electrodynamics of aluminium; optical activity and circular dichroism. Surface plasmon polaritons, length scales, plasmonic waveguides. Localized surface plasmons, Mie theory, scattering and resonances, field enhancement, SERS. Chiroptical spectroscopies and chirality of light.

Module 2 (Lucio Andreani, 6 hours): Excitons and polaritons in 3D, excitons and polaritons in 2D, planar microcavities, cavity polaritons. Excitons-photon coupling in 0D: Purcell effect, strong coupling.

Module 3 (Dario Gerace, 6 hours): Polariton nonlinearities. Quantum polaritonics. Intersubband polaritons. Strong and ultra-strong coupling.

We hope to start in the second half of January and to exploit until the end of February for all or most of the lectures. A few seminars will be organized after finishing the lectures.