

Title:	<i>Chirality: from physics to chemistry and living matter</i>
Coordinator	L. Andreani
Lecturers:	A. Andreani, A. Bacchetta, M. Cococcioni, D. Rebuzzi, G. Zanoni (Chemistry Department)
Duration:	24h
CFU:	4 CFU
Period:	January - June 2025
Content:	<p>This course aims at introducing the main concepts and phenomena related to chirality from different perspectives, providing an interdisciplinary view of this widespread and fascinating manifestation of symmetry breaking. The course is organised in 4 modules and is directed to PhD students in Physics, Chemistry and related areas.</p> <p>Module 1: Chirality in fundamental interactions and particle physics Teachers: Alessandro Bacchetta, Daniela Rebuzzi Topics: Chirality as operator acting on Dirac's spinors, Dirac equation, Weyl equation, difference between chirality and helicity, Parity violation, the Standard Model as a chiral theory.</p> <p>Module 2: Chirality in macroscopic electrodynamics and optics Teacher: Lucio Andreani Topics: Macroscopic electrodynamics, constitutive relations for non-chiral and chiral media, gyrotropy tensor and chirality parameter, chiroptical phenomena (optical activity, circular dichroism, light-matter interaction), examples. Possibly: superchiral light, reciprocity vs nonreciprocity, Faraday effect, experimental measurement of chirality parameter.</p> <p>Module 3: Chirality in matter (solids & molecules) Teacher: Matteo Cococcioni Topics: macroscopic and microscopic chirality in matter; symmetries (and lack thereof): time-reversal, mirror and inversion. Energy bands in solids; Berry phase and Chern number; anomalous velocity; quantum-anomalous- and quantum-spin-Hall effects in topological insulators; Dirac and Weyl semimetals; chiral anomalies. Structural and particle chirality: the spin-orbit coupling.</p> <p>Module 4: Chirality in chemistry, biochemistry and life sciences Teacher: Giuseppe Zanoni Topics: Chirality in the living system, from amino acids and sugar, to proteins, DNA and more. Importance of chirality in drug discovery and drug design. Molecular chirality, from stereogenic center to stereogenic plane. Quantum physics on molecular chirality and origin of biomolecular chirality.</p>