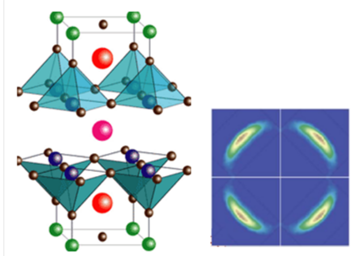
SCIENCES SORBONNE UNIVERSITÉ

MASTER
Physique fondamentale et applications

SMNO nanomat master

M2 – SMNO-nanomat – AdvCMP

Title	Advanced Condensed Matter Physics (AdvCMP)	
	Apogée code: MU5PYM11 **Number of credits:** 6 **Teaching hours:** 36h courses, 14h tutorial or project	

Lecturers	William SACKS (coordinator) IMPMC – Office 22-23 – 403 william.sacks@sorbonne-universite.fr	Matteo CALANDRA INSP – Office 22-32 – 211 matteo.calandra@insp.upmc.fr

Objective	To gain knowledge of advanced physical properties of materials and their theoretical base. To study both the phonon and the electronic degrees of freedom and, going beyond the independent electron concept, investigate in detail a number of challenging condensed phases such as superconductivity, charge density waves, vortex states, etc. The most important experimental tools, in particular the vibrational and the electronic spectroscopies will be discussed.
Content	W. Sacks • Landau theory of second order phase transitions • Electronic structure using Green's functions • Correlated electrons revisited: the Hubbard model, the t-J model • Collective states in remarkable materials: Superconductivity, vortex states, Josephson effects • Relevant theories: Ginsburg-Landau, London and BCS theories • The cuprate superconductors • Important experimental techniques, photoemission, NMR, and tunneling M. Calandra • The Born-Oppenheimer approximation • Dynamical matrix and harmonic approximation • Link with vibrational spectroscopies (semi-conductors, metals, superconductors) • Charge density waves, • Anharmonic properties of solids • Thermal transport 3-4 tutorials will be proposed in which the students, guided by their professors, will consider numerical solutions to advanced theories treated in the lecture course. For example, solutions of the Ginsburg-Landau and the BCS equations of superconductivity, etc.
Prerequisites	- A good working knowledge of solid-state physics (Ashcroft & Mermin or Kittel level). - Quantum mechanics at the Masters 1 level. - Motivation to explore the most challenging states of matter and their theoretical concepts.
Examination	Final grade will be based on homework assignement(s), tutorial work and one final examination.