UCL Université catholique de Louvain

LMAPR2015

2010-2011

Physics of Nanostructures

5.0 credits	37.5 h + 22.5 h	1q

Teacher(s) :	Charlier Jean-Christophe (coordinator) ; Gonze Xavier ; Piraux Luc ;
Language :	Anglais
Place of the course	Louvain-la-Neuve
Main themes :	The course is divided in three parts. In the first part, the geometric and electronic aspects of clusters and nanowires are studied. Then, we cover carbon nanotubes and associated concepts. Finally, we examine systems for spintronics applications.
Aims :	In this course, the major concepts relevant for the physics of systems structured at the nanometer level are introduced, and several kinds of such systems are thoroughly investigated : carbon nanotubes ; systems for spintronics applications ; clusters ; nanowires. At the end of their classes, students are expected to be able : 1. To describe the main characteristics and properties of nanometer-structured systems : geometrical aspects, electronic aspects, optical aspects, chemical aspects, transport properties (especially spin transport). 2. To use simple models representing the properties of such systems ; 3. To present numerous applications, and to follow the state-of-the-art concerning the physical properties of nanostructures. *The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled "Programmes/courses offering this Teaching Unit".*
Content :	Part 1: Geometric and electronic structure of clusters and nanowires. 1.1. Introduction (Scale and size laws, experimental aspects of cluster physics, nanoobjects) 1.2. Electronic structure of nanostructures (Periodic systems and finite systems at one dimension, how to understand the electronic structure of nanosystems at two and three dimensions) 1.3. Clusters (Rare gases clusters : geometrical factors ; metallic clusters : electronic factors ; semiconductors clusters ; ionic and molecular clusters) 1.4. Semiconductor and metallic nanowires. (Sensitivity of the conductance of semiconducting nanowires, monoatomic wires) Partie 2 : Carbon Nanostructures 2.1. Synthesis and growth mechanisms for fullerenes, carbon nanotubes and graphene (Low-temperature synthesis techniques, high-temperature synthesis techniques, in situ diagnostics, nucleation and growth mechanisms from computer simulation approaches) 2.2. Structural properties (helicities, multi- and single-wall, defects, bundles, junctions, tips, ...) and experimental characterization (electron microscopy, diffraction, EELS, STM, resonant Raman, fluorescence, optical absorption,...) 2.3. Electronic and transport properties of fullerenes, carbon nanotubes and graphene (Electronic structure, excitonic effects, 1D and 2D transport, spintronics, superconductivity, optoelectronics, field emission,...) 2.4. Mechanical and chemical properties of fullerenes, carbon nanotubes and graphene (Manipulation at the nanoscale, composite materials, macroscopic assemblies, chemical doping, filling, functionalization, heterostructures...) 2.5. Thermal and optical properties of fullerenes, carbon nanotubes and graphene 2.6. Applications (Electronic - transistors, flat screen, electrodes,...; Electromechanical - actuators - NEMS, Bio-chemistry applications - Nano-sensors, Energy storage, ...) Part 3 : Spin electronics 3.1 Spin electronics : concepts, effects and materials

	3.2 Giant magnétoresistance : principle, CIP and CPP geometries, spin accumulation 3.3 Tunnel magnetoresistance : principle, magnetic tunnel junctions 3.4 Magnetic nanowires : synthesis methods, spin dependent magnetotransport 3.5 New routes in spin electronics : spin transfer, spin electronics and semiconductors, molecular spintronics 3.6 Applications and prospects Méthodes : Plenary lectures, project-based learning.
Other infos :	MAPR 1491 (Complements of Physics) or a similar course. MAPR 1492 (Material Physics) or a similar course.
Cycle and year of study :	> Master [120] in Physics > Master [120] in Chemical and Materials Engineering > Master [120] in Electrical Engineering > Master [120] in Electro-mechanical Engineering > Master [120] in Physical Engineering
Faculty or entity in charge:	FYKI