60165 - Physics of materials in big installations

Guía docente para el curso 2011 - 2012

Curso: 1, Semestre: 0, Créditos: 8.0

Información básica

Profesores

- **Juan Bartolome Sanjoaquin** barto@unizar.es
- **Luis Miguel García Vinuesa** luism@unizar.es
- **María Grazia Proietti Cecconi** proietti@unizar.es
- **José Fernando Bartolomé Usieto** bartolom@unizar.es
- **Jorge Serrano Gutierrez**

Recomendaciones para cursar esta asignatura

Actividades y fechas clave de la asignatura

- Matriculation from 21/07/2011 to 28/07/2011 and from 21/09/2011 to 06/10/2011
- First course date: 13/02/2012.
- Last course date: 8/06/2012.
- Examination period: 8-28/06/2012 and 1-14/09/2012. The date for the oral presentations (see below) will be chosen in this period, agreed by students and teachers.

Inicio

Resultados de aprendizaje que definen la asignatura

El estudiante, para superar esta asignatura, deberá demostrar los siguientes resultados...

1:

To be able to identify the microscopic probe and technique of choice needed to obtain a particular piece of information (structural, electronic or morphologic) on a material under study.

2:

To be able to understand and qualitatively analyze data obtained by the most usual techniques of neutron and synchrotron scattering, describing the main results and information obtainable from data.

3: To be able to conveniently present and defend a report about a real experiment or experimental proposal or detection technique (oral presentation), preferently related with his or her own research project.

Introducción

Breve presentación de la asignatura

In this course, students are introduced to the use and capabilities of experimental tools available in large facilities in the research area of condensed matter and materials physics, with an emphasis on neutron and synchrotron radiation techniques. The course is given during the second semester of the master and it does not require following any special curricular path. Nevertheless, it is advised to have a degree in physics or, at least, some previous knowledge of solid state physics, quantum mechanics and statistical physics.

Contexto y competencias

Sentido, contexto, relevancia y objetivos generales de la asignatura

La asignatura y sus resultados previstos responden a los siguientes planteamientos y objetivos:

Students are introduced in the techniques and capabilities that large facilities such as synchrotron and neutron sources offer in condensed matter and solid-state physics research. They learn the properties making of neutrons, photons, muons and alpha particles very useful probes in condensed matter and materials physics. Along the whole course strong emphasis is done on the complementarity between different probes, especially neutrons and photons from synchrotron rings. Therefore, they can describe how the realisation of neutron and synchrotron experiments in a given system does complement each other, bridging the path towards understanding of the physical phenomena. They can describe the theoretical as well as the experimental basis of the most typical experiments performed in large facilities, starting from the interaction between matter and probe to end with the physics of detection. They get in touch with the mechanisms of production of beams at a qualitative level. They get in touch with some outstanding experiments which has changed the paradigm of solid state physics research, like neutron diffraction (nuclear and magnetic) and neutron scattering by elementary excitations, x-ray absorption (including EXAFS and XANES), as well as newer experimental efforts like x-ray magnetic dichroism and inelastic scattering.

This course is recommended for students interested on materials physics, nanoscience, large facilities, etc...

Contexto y sentido de la asignatura en la titulación

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Al superar la asignatura, el estudiante será más competente para...

1:
Describe the main facilities used in materials physics research.

2:
Given a typical situation in any of the main areas of materials physics research, deeply analyze which kind of probe (neutron, photon, muon) would be helpful in that situation, and which kind of scattering experiment (elastic, inelastic, polarisation-dependent, image...) should be proposed.

3:
Describe how an experiment in a large facility is complementary to their *in-house* experiments.

4: Deeply analyze outstanding experiments in the fields of condensed matter and materials physcs carried out at large facilities around the world.

5:
Actually design an experiment in the referred fields selecting probe, detection technique, geometry, etc. according to the research main goal and experimental constraints.

6:
Defend reports of an experimental work in oral format.

Importancia de los resultados de aprendizaje que se obtienen en la asignatura:

The quest to observe, predict, and control the arrangements and motions of the particles that constitute condensed-matter systems is central to condensed matter and materials physics. The constituent particles span an enormous range of sizes—from electrons and atoms to macromolecules—and their motions span a correspondingly immense range of timescales. As a result, the experimental tools required to study them are extremely diverse and the role of tools such as synchrotron x-ray and neutron scattering, developed at large-scale national and international laboratory facilities has been gaining importance over the past decades. Good skills on understanding and treating these techniques will therefore enable the student to apply them in order to solve either scientific or technological problems.

Evaluación

Actividades de evaluación

El estudiante deberá demostrar que ha alcanzado los resultados de aprendizaje previstos mediante las siguientes actividades de evaluacion

1:
Evaluation of the progressive acquisition of competences along the course by

1. solving problems along the course in a continuous basis: a 30% of the final qualification mark will be derived from them.
2. Experimental data analysis and the corresponding “work reports”: 20% of the final qualification mark
3. developing and defending a guided project on one of the subjects dealt with along the course: 50% of the final qualification mark. The project should be presented in written format and defended in an oral presentation before 16th June 2012.

2:
Global examination

This global examination will be done in one of the two official calls, during the examination periods established by the Science Faculty of the University of Zaragoza. The global examination will have two sessions: theoretical and practical examination of the subject contents (50% of the final qualification) and individual oral defense of the guided project (50% of the final qualification). All the students have the right to do this global examination. For those having passed the course by the continuous evaluation procedure, this global examination is optional, and the best qualification obtained will prevail.

3:
Evaluation procedure for those students not attending the course

The evaluation in these cases is the same that for those students attending the course. All the relevant material is available on the web of the University of Zaragoza and the course can be followed in a non-presence basis. Problems and practical works should be solved and sent to the teachers to be evaluated along the course. Work at laboratory and submission and defense of the guided project should be done before 16th June 2012 in order to obtain a qualification by the continuous evaluation procedure. In other case, the student should go to the global examination in one of the two official calls, during the examination periods established by the Science Faculty of the University of Zaragoza.

Actividades y recursos

Presentación metodológica general

El proceso de aprendizaje que se ha diseñado para esta asignatura se basa en lo siguiente:

This course is organized mainly by theoretical lessons. In order to achieve the intended goals the strategy chosen by the teaching staff consists of using lectures for presenting to the students the basic knowledge required to face the problem solving and, conveniently intertwined, the case analysis – problem solving lessons for applying the previously acquired knowledge in different situations.

Actividades de aprendizaje programadas (Se incluye programa)

El programa que se ofrece al estudiante para ayudarle a lograr los resultados previstos comprende las siguientes actividades...

1:

Theoretical lessons for the acquisition of basic knowledge on large-facility experiments on condensed matter and materials physics. The summary of the covered contents and main bibliographic references is the following:

I: Introduction: Motivation and historic evolution of the use of Large Facilities in condensed matter and materials physics. Basic properties of the different probes: neutrons, x-rays, muons, alpha particles, etc. Production of beams: basic ideas about reactors and synchrotrons. Beamlines. Detectors.

II: Probe-matter interaction: neutrons. Theoretical basis of the neutron-matter interaction. Calculation of the differential neutron cross-section. Coherent and incoherent scattering. The Fermi pseudopotential. Elastic scattering of neutrons. Nuclear and magnetic neutron diffraction. Inelastic and quasielastic processes. Correlation functions.

III: Probe-matter interaction: photons. Theoretical basis of the photon-matter interaction. Electronic and magnetic x-ray scattering at first and second order of perturbations. One and two photon processes. Spin dependent scattering. Inelastic terms.

IV: Inelastic Scattering: neutrons. Inelastic and quasielastic scattering of neutrons. Three axes experiments, time-of-flight (TOF) and High Resolution.

V: X-ray absorption spectroscopies: XANES and EXAFS. Basic principles and general formalism of absorption. Experiments and data treatment. Examples: local structure determination; distances, coordination... electronic properties, chemical information. DAFS: a combination of EXAFS and x-ray diffraction.

VI: Polarized probes: Magnetism and synchrotron radiation. XMCD, XRMS and resonant magnetic reflectivity. Neutron Spin Echo, Polarisation Analysis (CRIOPAD) and polarised neutron reflectivity.

V: Small Angle Scattering: SANS, SANSPOL, SAXS y WAXS. Aplications to Nanoagregates and polymers.

VI: Ineslastic x-ray scattering: resonant and non-resonant IXS. Dynamic and magnetic excitations.

2:

Practical lessons for the acquisition of skills treating basic x-ray and neutron scattering data.

2 ECTS: development of a guided project chosen by the student among different subjects proposed at the beginning of the semester by the teachers, followed by periodical tutorial sessions, preparation of a report and oral dissertation for the main group.

3:

An oral report of about 20 minutes will be presented by the student. The subject may depend on the experience and research work of the student. This would deal with an actual experiment already realised or with the proposal of a future one, the detection procedures or a theoretical development extending some of the topics studied during the course. Although it is not the ideal case, an academic or bibliographic study would be acceptable if the research work of the student is not well suited to present a more realistic case. The dates of the examinations will be agreed by teachers and students and will take place during the examination period approved by the Science Faculty of the UZ.

4:

Visit to the ALBA synchrotron facilities: the date will be agreed by students and teachers, taking into account the availability of the ALBA facilities.

Planificación y calendario

Calendario de sesiones presenciales y presentación de trabajos

Referencias bibliográficas de la bibliografía recomendada