Study programme P4F3A Physics of Condensed Matter and Materials Research

Annotation

The programme prepares specialists qualified for independent activity in basic and applied research in the field of physical properties of condensed matter and materials. The students gain broad knowledge of relevant theoretical approaches (quantum theory, thermodynamic and statistical physics) and of their employment in theoretical and experimental physics of condensed matter, and become familiar with up-to-date experimental methods and technological procedures. Beside the basic education common for the whole study programme, the student gain a deep knowledge according to the dissertation topic and to the choice of optional specialized courses. This pattern guarantees that the graduate has an overview of the whole field at the current level of the knowledge and is an expert in the chosen specialty.

Board of the doctoral programme

Members of the board: `http://mff.cuni.cz/phd/or/p4f3` .

Cooperating institutes

- Institute of Physics, CAS
  Na Slovance 2, 182 21 Praha 8
  `http://www.fzu.cz/`

- Institute of Photonics and Electronics, CAS
  Chaberská 57, 182 51 Praha 8
  `http://www.ufe.cz/`

- Nuclear Physics Institute, CAS
  Husinec – Řež č. p. 130, PSČ 250 68
  `http://www.ujf.cas.cz/`

- Institute of Macromolecular Chemistry, CAS
  Heyrovského nám. 2, 162 06 Praha 6
  `http://www.imc.cas.cz/`

- Institute of Thermomechanics, CAS
  Dolejškova 1402/5, 182 00 Praha 8
  `http://www.it.cas.cz/`

Homepage of the board

`http://krystal.karlov.mff.cuni.cz/f3`

Available topics of the dissertation

Topics are listed in SIS at `http://mff.cuni.cz/phd/temata/p4f3` .

Selected topics for the preliminary admission procedure

`https://www.mff.cuni.cz/en/physicsphd/f3/` .

Courses and other requirements for the course of doctoral study

In agreement with the supervisor, the student enrolls the compulsory lecture courses of the corresponding Master's programme if he/she has not completed these or analogous courses during his/her Master study.

During the doctoral study, the student passes the compulsory courses and according the topic of his/her dissertation chooses the elective courses and eventually other optional courses according the recommendation of his/her supervisor. He/she participates in regular seminars.

Compulsory courses

Code	Subject	Winter	Summer
NBCM083	**Selected Topics on Quantum Theory**	2/1 C+Ex	—
NFPL088	**Methods of Statistical Physics**	2/1 C+Ex	—
NFPL085	**Electronic Theory of Solids**	—	2/0 Ex
NFPL087	**Seminar on Solving Physical Problems**	—	0/2 C
NFPL086	**Experimental Methods in Condensed Matter Physics**	2/2 Ex	—

Elective courses

Code	Subject	Winter	Summer
NFPL082	*Magnetism and Electronic Structure of Metallic Systems*	2/0 Ex	—
NFPL120	*Modern Problems in Physics of Materials*	2/0 Ex	—
NFPL063	*Advanced Quantum Theory with Applications in Condensed Matter Physics*	—	2/1 Ex
NFPL093	*Selected Topics on Magnetic Resonance Theory and Methodology*	2/0 Ex	—
NFPL128	*Selected Topics on Positron Annihilation Spectroscopy*	—	1/1 C+Ex
NFPL178	*Superfluidity and Bose-Einstein Condensation*	—	2/1 C+Ex
NFPL195	*Selected Topics on Low Temperature Physics*	—	2/0 Ex
NFPL066	*Advanced Methods and Contemporary Topics on Structure Analysis*	2/0 C	—

Requirements for the course of doctoral studies

1) A pre-requisite for the enrollment for the doctoral exam is a completion of all compulsory courses listed in the table, one course from the table of elective courses, and participation in two seminars (two times one semester). The student is also obliged to give a lecture at WDS (Week of Doctoral Students).

2) The student regularly attends other seminars (in total number of 4 semesters during the study) and under the circumstances, he/she attends a suitable summer or winter school.

3) According the supervisor advice, the student can enroll for other proper elective or optional courses.

4) During all the study, the student works intensively on a solution of the dissertation tasks, presents his/her results at seminars and scientific conferences and participates in preparation of scientific publications. According to the directions of the supervisor, the student is involved in an international cooperation.

Requirements for the doctoral exam

Wider focused questions are asked with the aim to test the ability of the student to be oriented in the given issue. The exam consists of three parts: I — Broader background, II — Advanced parts of the field, III — Specialization. The student is asked one question from each part.

I. Broader background

I.1. Quantum-mechanical description of atoms and condensed matter
I.2. Many-particle systems
I.3. Electronic states in atom and condensed matter
I.4. Interaction of quantum system with electromagnetic radiation
I.5. Classical and quantum statistical ensembles
I.6. Thermodynamic quantities
I.7. Ideal, classical, and quantum gases
I.8. Fermions and bosons at low temperatures
I.9. Phase transitions
I.10. Non-equilibrium processes in condensed matter

II. . Advanced parts

II.1. Structure and microstructure of condensed systems
II.2. Phonons
II.3. Electronic and atomic structure and interactions in condensed systems
II.4. Metals and semiconductors
II.5. Dielectrics and ferroelectrics
II.6. Magnetism
II.7. Physics of condensed systems at low temperatures, superconductivity, superfluidity

III. Specialization

Questions from the subject of the specialization will be proposed by the supervisor. The Commission selects one of at least three issues proposed.

Recommended literature

Abragam, A.: **Principles of Nuclear Magnetism.** *Clarendon Press, 1983.*

Ashcroft, N. W., Mermin, N. D.: **Solid State Physics.** *Sounders Coll. Publishing, Philadelphia, 1988.*

Barbara, B., Gignoux, D., Vettier, C.: **Lectures on Modern Magnetism.** *Springer–Verlag, Berlin, 1988.*

Buschow, K. H. J., Cahn, R. W., Flemings, M. C., Ilschner, B., Kramer, E. J., Mahajan, S.: **The Encyclopedia of Materials: Science and Technology.** *Pergamon Press, Oxford, 2001.*

Cahn, E. W., Lifshin, E.: **Concise Encyclopedia of Materials Characterization.** *Pergamon Press, Oxford, 1993.*

Giacovazzo G. et al.: **Fundamentals of Crystallography**, 2nd ed., *IUCr, Oxford Science Publications, Oxford 2002.*

Ibach, H., Luth, H.: **Solid–State Physics.** *Springer–Verlag, Berlin, 1991.*

Kittel, C.: **Introduction to Solid State Physics**, 8th ed. *John WileySons, 2005.*

F.Pobell, F.: **Matter and Methods at Low Temperatures**, *2007.* ISBN 978-3-540-46360-3

Reed R.C.: **The Superalloys Fundamentals and Applications**, *Cambridge, UK, 2006.*

Slichter, C. P.: **Principles of Magnetic Resonance.** *Springer Series in Solid-State Sciences book series (SSSOL, volume 1), 3rd edition, 1989.*

Smallman, R.E., Bishop, R.J.: **Modern Physical Metallurgy**, *Butterworth-Heinemann, Oxford, UK, 1999.*

Tilley, D.R., Tilley, J.: **Superfluidity and Superconductivity**, 3rd ed., *IoP Publishing, 1990.*

Ziman, J. M.: **Principles of the Theory of Solids.** *Cambridge University Press, Cambridge, 1965.*