Student Handbook
2011–2012

Graduate Program in Physics
The University of Pavia

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Coordinator of the
Graduate School in Physics

Contents

Chapter 1
Introduction

Welcome to the University of Pavia Department(s) of Physics Graduate Program. The purpose of this handbook [1] is to provide you with a summary of the important information you will need as you make your way through the graduate curriculum, carry out your research and complete your thesis. The faculty and the Coordinator of Graduate Studies (CGS) encourage you to feel free to communicate frequently and freely with them, and to collaborate with your fellow students in learning the vast amount of material that you need to acquire in reaching the forefront of research. This handbook provides also an unofficial summary of some of the administrative requirements you will have to fulfill. If you encounter any errors or have any questions, please do not hesitate to contact the CGS. For more detailed administrative information please refer to the Graduate School Offices of the University of Pavia: (Via Ferrata, 1 - Pavia, opening hours: 9.30-12.00 from Monday to Friday- Fax: 0382 985996)

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[1] In order to be of help to the graduate student entering our internationalization program, the structure of this handbook is modeled on similar handbooks adopted by various graduate schools in the States, *e.g.* The University of Texas, Yale University, The University of California, Berkeley. The adaptation is not always straightforward due to the many differences between our graduate school system and the graduate program in the States.

1.1 Graduate Student Representative

Each three years, the graduate students elect a representative, who is a non-voting member of the Graduate School Committee. Responsibilities include: attending grad student events or otherwise being available to listen to fellow student concerns, attending meetings of the Graduate Committee, and bringing concerns to the attention of the Committee. Current representative:

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Chapter 3
Academic Requirements

3.1 Academic Requirements Overview

3.1.1 Course Requirements

4 Term Advanced Courses; 1 National (International) School on a topical research area of interest; Physics Colloquia; (Attendance on the Colloquia and Courses is compulsory for all graduate students).

Advanced Courses 4 from the following:

- 1.Teor Electromagnetic Theory
- 2.Teor Relativistic Quantum Field Theory
- 3.Teor Statistical Field Theory
- 4.Teor Quantum Information Science
- 5.Teor Selected Topics in Quantum Mechanics
- 6.Teor Strong Interactions
- 7.Teor Nuclear Structure
- 8.Teor Electroweak and QCD Field Theories
- 9.Teor SPECIAL TOPICS COURSE: Spacetime Structure, Cosmology, and Quantum Field Theory
- 10.Teor Econophysics
- 11.Teor Advanced Theory of Solids
- 12.Teor SPECIAL TOPICS COURSE: Photonics
- 13.Teor Open Quantum Systems
- 14.Teor SPECIAL TOPICS COURSE: Biophysics on Neural Signaling
- 1.Exp Imaging for Biomedical Applications
- 2.Exp SPECIAL TOPICS COURSE: Ionizing Radiation and Biological Structures: Theory and Applications
- 3.Exp Spectroscopies in Condensed Matter Physics
- 4.Exp Microscopic and Spectroscopic Characterization of Materials

- 5.Exp Magnetic Resonance Techniques in Solid State Physics
- 6.Exp Strongly Correlated Systems in Condensed Matter Physics
- 7.Exp Experimental Particle Physics
- 8.Exp Experimental Nuclear Physics
- 9.Exp Radiation and Particle Detection
- 10.Exp Information and Data Analysis
- 11.Exp Neutrino Phenomenology and Astroparticle Physics

3.1.2 Special Topics Courses

In the above list there are a number of *SPECIAL TOPICS COURSES*, these are courses including an intensive educational program, one to two weeks long, providing experience in specialized research techniques with lecture and laboratory courses in topics of current high interest. The 2012 Special Topics Courses are:

- Spacetime Structure, Cosmology, and Quantum Field Theory

Under the terms of a grant from the Cariplo Foundation, three distinguished scientist (T. Buchert, K. Fredhenhagen, R. Littlejohn) will lecture on themes ranging from Dark energy and Cosmology, (T. Buchert), Quantum Field Theory, (K. Fredhenhagen), Dynamical systems (R. Littlejohn). Lectures will be colloquium style and open to a general audience of graduate students.

- Photonics

This is and advanced course on photonics and nanophysics offered every two years. Typical arguments include: nanophotonic systems and methods, quantum effects in radiation-matter interaction, non-linear optics. For the year 2011/12 most of the course is a special topic course offered with the Marie Curie ITN PROPHET workshop *Theory and modelling in Photonics*, (see http://fisicavolta.unipv.it/prophet.htm). The course will deal with theoretical background and modelling methods in: quantum dot mode-locked laser for communications applications, photovoltaic cells and photonic structures, mid-infrared lasers for gas sensing, optical coherence tomography. The program will include tutorial-like talks, training on communication skills, students presentations.

- Biophysics on Neural Signaling

The course is offered under the aegis of a collaboration between our graduate school and the graduate school in physiology and neuroscience. The computational problems that are solved by networks of neurons, from roughly 100 cells in a small worm to 100 billion in humans provide a number of challenging problems to physicists. Careful study of the natural context for these tasks leads to new mathematical formulations and physical modeling of the problems that brains are solving, and these theoretical approaches in turn suggest new experiments to characterize neurons and networks. This interplay between theory and experiment is the central

theme of this course. The course will start from a description of the biomolecular structure of the neuronal membrane and will provide a biophysical interpretation of the processes generating electrical activity in neurons and synapses. The target is to illustrate how neurons generate information codes and how these are processed in complex neuronal networks. Topics will include: 1) Biophysical phenomena in the neuronal membrane, 2) Information in spike trains, 3) Principles of signal processing in neuronal networks.

- Ionizing Radiation and Biological Structures: Theory and Applications

This is an advanced course on the interaction between biological structures and ionizing radiation offered every two years. For the year 20111/12 the course will be integrated with the special topic course *Modeling radiation effects from initial physical events*, (Pavia, May 28-June 8, 2012), dedicated to learning modeling approaches and techniques in radiation biophysics and radiobiology research, from basic mechanisms to applications.

3.1.3 Additional Elective Courses

Students are strongly encouraged to attend the elective course

- 16.Teor Soft Skills for Graduate Students

This course does not belong to the course requirements but you are strongly advised to attend it. Arguments range from writing techniques for filing a proper grant request, to developing presentation skills for seminars and the like.

3.1.4 Grades

Pavia Graduate School grade format: *Honors (H); High Pass (HP); Pass (P); Fail (F)*

- For good academic standing the Graduate School strongly recommends a High Pass average.

3.1.5 Qualifying Seminars

At the end of the first and second academic year (typically around mid October) students are requested to make a presentation, in a public forum, of a topical research argument. See subsection 3.3.5 for details.

3.2 Typical Time Line for Academic Requirements

Year 1:

- Choice of Thesis advisor
- Written presentation of Thesis Prospectus and plan of studies to Graduate School Committee
- Start dissertation research
- 2 required advanced courses
- National (International) School on a topical research area of interest
- Physics Colloquia
- Qualifying Seminar (October)
- Written Performance Report for monitoring the student's research progress and academic performance

Year 2:

- Continue dissertation research
- 2 required advanced courses
- Physics Colloquia
- Qualifying Seminar (October)
- Written Performance Report for monitoring the student's research progress and academic performance

Year 3:

- Physics Colloquia
- Continue dissertation research and prepare dissertation draft
- Submission of written dissertation draft
- Reader's reports due after submission
- Admission to Candidacy, including written Thesis report and relation on the student's research and overall academic performance to Graduate School Committee (October)
- Thesis Defense and oral examination by an external nominated committee
- Award of degree

3.3 First and Second Years

This section concerns more detailed information on the various academic requirements listed above.

3.3.1 Choosing an Adviser

Contrary to what happens in many research institutions abroad, where graduate studies have a time span of 5-6 years, here in Italy the typical time line for graduate studies is three years (with a possibility of a Petition for an Extension for 6 months or one year. However, such an extension is not covered by a corresponding extension of the Ph.D. grant). Thus, it is best thought to start exploring possible dissertation advisors as soon as possible. An advisor from a department other than Physics can be chosen in consultation with Coordinator and the Graduate School Committee, provided the dissertation topic is deemed suitable for a physics PhD. It is up to you to seek out faculty and talk to them no later than your first term (i.e., by January) to discuss your interest and possibilities for collaborating. It is also important that you explore more than one subfield of physics with respect to the particular one you are fond of. There is indeed the possibility that the field of physics and the adviser you are interested in will have no opening available at the time you are ready to begin research.

3.3.2 Preparing a thesis prospectus and plan of studies

Soon after the beginning of the Graduate School Academic Year, (say between mid December and not later than January 20), each graduate student produces a thesis prospectus and plan of studies. The prospectus must be submitted to the Graduate Registrar, Mrs. Anna Rita Mangia, and it must be approved by the Graduate School Committee.

The Thesis (Research) Prospectus should be viewed as a preliminary statement of what the student proposes to do in his or her dissertation and not as an unalterable commitment. The appropriate form and typical content of a prospectus inevitably vary from field to field. However a prospectus should always contain the following information:

- Student's name, Adviser's name, date.
- A statement of the topic of the dissertation and an explanation of its importance.
- What in general might one expect to learn from the dissertation that it is not known, understood, or appreciated.
- A concise (even schematic) review of what has been done on the topic in the past.
- How will the proposed dissertation differ from or expand upon previous work
- A basic bibliography appended to this section would be appreciated.
- A statement of where most of the work will be carried out: e.g. In the laboratory of a particular faculty member; In an international laboratory (e.g. CERN); As part of an international collaboration with a specific part of the research program carried out abroad.

This part of the research prospectus should be long enough to include essential information for the proposed topics but not overly long. It should be written in a manner comprehensible to people who are not experts in your particular subfield. Four to five pages, including figures and bibliography, should be appropriate in most cases.

The plan of studies lists the courses selected by the student-see the following subsection for details.

3.3.3 Course requirements and suggested sequencing

To complete a student's undergraduate training in classical and quantum physics, students are required to take 4 graduate courses. These latter (see the list in section 3.1) are typically one-term classroom courses (to be held in the spring term), with exams administered by the lecturer of the course in question. Most graduate courses will have a lecture or seminar component. The topics of many graduate courses may vary from term to term, however our system does not permit students to repeat a course with a change in topic. Moreover, it is foolish to attend courses you have already covered elsewhere; this does not advance your skills. Two courses must be completed in the first year of graduate study and the remaining two in the second year. In both cases the final exams must be registered, with satisfactory grades (High Pass on average over the first two years is strongly advised in order to get a good record when admitted to candidacy), not later than October the 15th or you will be not permitted to register for the next term.

To gain the maximum benefits from the courses our Graduate School offers it is important that students do not see each course in isolation from the other courses or research training they are taking. Responsibility lies with each student (and their adviser) to think about what research they wish to conduct, what methods might be amenable; their own methodological competency, and therefore which courses to attend. Ideally this task will be facilitated by integration with discipline-specific courses in the Physics departments and through reading and discussion. Graduate Students should take a broad view of the courses and the opportunities they offer. Their purpose is to give students an awareness of, and experience in using a wide range of research methods and concepts in Physics. This is not solely to support the development for a PhD.

3.3.4 Course enrollment procedures

Note that, according to Graduate School rules, a particular course in the list 3.1.1 is offered if and only if at least 3 students declare an intention to audit it, (this enrollment threshold can be reduced to 2 upon approval of the Graduate School Committe

and of the lecturer of the course in question). An Audit requires regular attendance and any other obligations as stated by the course instructor. If these requirements are not met, the audit will be removed from the students record at the instructors request. It is the student's responsibility to collaborate with her/his fellow students in reaching a rapid decision on course offering. It is up to you to be proactive in seeking out fellow students wishing to audit the particular course you are interested in so as to reach the offering threshold. For assistance in enrolling in courses, students are advised to contact their graduate student representative who will prepare the Graduate Audit Form and bring it to the attention of the Graduate School Committee by the enrollment deadline for the term, (mid December).

3.3.5 Qualifying seminars

The development of seminar presentation skills is regarded as an integral part of the graduate training program for a Physics PhD at Pavia University. These presentation skills are essential to student's future success as a teacher and researcher. Thus, at the end of the first and second year (October), students are requested to make a Powerpoint (or similar) presentation, in a public forum, of a topical research argument. The format of the presentation should be a talk that lasts 30 minutes (25+5 for questions). The goal of this public presentation is primarily for the students to practice communicating in a public setting, and to receive feedback about how to improve their presentation abilities. To administer and grade the qualifying seminars an ad hoc committee will be established by the Coordinator of the Graduate School. After the public presentation, the coordinator will prepare a brief report of the committee's assessment of the student's presentation, and present this to the student and Graduate School Committe.
The grading will indicate performance according to the following scheme:

ACHIEVEMENT of a PASSING SCORE on the appropriate subject area:

- Appropriate mastery of Subject Area Knowledge

QUALITY of PRESENTATION according to:

(i) QUALITY of CONTENT:

- Was the mastery of the subject adequate?
- Was the message clear and accessible?
- Was the message appropriate to audience?
- Was the amount of material appropriate?

(ii) QUALITY of SLIDES:

- Were the slides clear and readable?
- Were the slides balanced, not crowded?
- Were the slides nice to see, creative?

(iii) QUALITY of DELIVERY:

- Was the speech clear and the use of English approprate?
- Were the timing and the speed of the presentation ok?
- Was there an attempt to interact with the audience?
- Was the seminar enjoyable and engaging?

For the first year presentation students are strongly advised to select an argument distinct from their dissertation research topic. Alternatively (but strongly discouraged) the presentation can be related to the topic of the dissertation if it is a comprehensible and concise review of the state of the art of the dissertation research field. In particular what has been done on the topic in the past, and how will the proposed dissertation differ from or expand upon previous work.

The second year presentation is basically a dissertation progress report: a brief review of the field prior to the thesis research to provide context, a presentation of the goals and motivations of the thesis research, a description of the dissertation research progress.

Both presentations MUST be given in English: if you are not able to speak and write English fluently, you will find it very difficult to carry out your research, or write publications. You are strongly encouraged to take advantage of the English course opportunities available through our University system.

3.3.6 Taking courses outside the Physics department(s)

At the discretion of the CGS and with the approval of the Graduate School Committee it is possible to replace one (and only one) of the required four Term Advanced courses listed in 3.1.1 with either a course taken from the *Laurea Magistrale in Physics* or with a graduate course carried out in another (Italian) Graduate School who has signed an Academic Requirements Exchange Agreement with our Graduate School.

Laurea Magistrale courses are admitted only if they were not taken while registered as a Laurea magistrale student.

In occasional circumstances, a student can take one Graduate course in a qualified research center abroad. If the student is under a co-tutorship international agreement between our Graduate School and a Graduate School in Physics in Europe then all Term Advanced Courses can be taken abroad. In this latter case, a course certification and the corresponding grade must be submitted to the CGS and to the Graduate Registrar, (Mrs. Anna Rita Mangia).

3.3.7 Grades

The grades assigned in the Graduate School are:

- H = Honors
- HP = High Pass
- P = Pass
- F = Fail

The Graduate School strongly suggests a grade point average of HP for a student to remain in good standing.

3.3.8 Schools and Conferences

Top research institutions often organize international (traineeships) conferences on advanced research topics which provide a rich and active environment for learning and doing Physics. The traineeships generally last 1-2 weeks and offer talented university graduates an intensive learning experience under the assistance of leading scientists. Our academic program requires that graduate students must attend one National or International School of their choice during their graduate studies. Typically this is done in the first year, but it can be postponed to the second year. Financial support will be partially provided by the Graduate program (typically up to 400-500 Euro) and by research group grants.

During the Academic Year 2011/12 our Departments will host the *Italian School on Magnetism*. This is a National School, held under the auspices of the Italian Association of Magnetism (AIMagn), intended for graduate students and post-doctoral fellows in the early stages of vision research or planning to enter the field of magnetism and nanomagnetism. Students are presented with a comprehensive overview of current research areas and approaches that will help to broaden their understanding of this area. The School will be held in February 5-10, 2012 at the Physics Department A. Volta. Details can be found at the school website: http://nmrphysics.unipv.it/magnetschool

3.3.9 Research progress and academic Performance Report

Towards the end of the first and second academic year, (and not later than October 15), each graduate student produces a year report. This includes a review of her/his academic performance, a description of progress to date in the research project and a discussion of future work. The report, endorsed by the student's adviser, is read by the members of the Graduate School Committee, which in turn recommends to the Graduate School Offices of the University whether the student should be

permitted to register for the next academic year. The report should also include a list of publications in preparation or already published (classified into: peer-reviewed journals/ proceedings, etc.). Participation of the students in summer schools and conferences that are relevant to their research topics. Thus, the issues to be addressed within the Report are:

- results of the project
- first steps / next steps within the project
- problems / setbacks encountered and possible solutions
- lectures and courses taken
- conferences attended / upcoming conferences
- publications in preparation / already published

The Report must be submitted to the Graduate Registrar, (Mrs. Anna Rita Mangia).

3.3.10 Physics Colloquia

Pavia Physics Graduate School Colloquia are held in Room A102 Aula Giulotto at 4:00 p.m. (every two) Thursday during the Fall and Spring semesters unless otherwise announced.

Our Physics Colloquia host distinguished guest speakers who highlight the forefront of ongoing research in Physics and in related fields with a one-hour presentation addressed to a general audience of graduate students. This is particularly important for first-year graduate students and let them sample the type of research they might be involved in during graduate school. For those with more definite ideas about the research they are carrying out, this gives them an excellent opportunity to sample the various research opportunities for future jobs and to talk directly with leading scientists.

Attendance on the Colloquia is compulsory for all graduate students.

3.4 Third Year and Beyond

3.4.1 Admission to candidacy

The graduate school requires all students to be admitted to candidacy by the end of the third year. Students who have completed their course requirements with satisfactory grades, pass the qualifying seminars, and have submitted an acceptable dissertation final draft are recommended for admission to candidacy. The time line for admission to candidacy is the following:

- By September 15 students must submit a final draft of their dissertation which is sent, for peer review, to an outside reader selected by the Graduate School Committee. The outside reader must be someone outside of Pavia University who has had no involvement with the student's research and who can be completely objective in his/her evaluation of the dissertation. The outside reader is usually selected by the dissertation supervisor and approved by the Graduate School Committee. Usually the supervisor must be proactive in suggesting and contacting the reader.
- By October 15 the outside reader must submit a written report on the dissertation draft. After the report, the Graduate School Committee may ask the student to make some changes in the dissertation. These changes must be made before submission of the definitive version of the dissertation.
- By October 15 students must submit a Research and Academic Performance Report reviewing the work done during the three years of graduate school. This report should include a succinct description of: (i) Research work; (ii) Academic performance; (iii) Complete list of publications in preparation or already published (classified into: peer-reviewed journals/ proceedings, etc.); (iv) Participation to summer schools and conferences (classified into: national/international conferences, workshops, (traineeships) schools); (v) Talks given (classified into: invited talks to conferences and workshops, contributed talks, posters; invited talks to other universities etc.). This Report must be submitted to the Graduate Registrar, (Mrs. Anna Rita Mangia).
- On the basis of the outside referee report and of the Research and Academic Performance Report, the Graduate School Coordinator will prepare a brief report of the committee's assessment of the student's graduate career and present this to the student and to the Graduate school Offices for the Admission to Candidacy.
- By October 31 student admitted to candidacy must submit the definitive version of their dissertation and the Admission to the Dissertation Defense Form (this latter obtained from the University Graduate School Offices).
- Typically the Graduate School Offices require four bound copies of the dissertation-One for the Science Library, three for the members of the Defense Committee. Two electronic copies on a CD are required for the national record of graduate school dissertations.
- The Graduate School has very specific rules about the preparation of the dissertation, so students should obtain a Dissertation Packet from the Science Library.

3.4.2 Forming a dissertation defense committee

The University of Pavia requires a 3-member faculty committee for the dissertation defense and must be approved by the Graduate School Committee. Typically, the Dissertation Committee should be made up by one tenured faculty member of the Physics Department of the University of Pavia and by two outside members who are tenured faculty outside of Pavia who have had no involvement with the student's research and who can be completely objective in their evaluation of the student's dis-

sertation defense. Both the student's adviser, the members of the Graduate School Committe, and the outside reader cannot enter the make-up of the committee.

These rules are superseded when the dissertation defense is under the aegis of an international co-tutorship agreement between our graduate school and a graduate school abroad.

3.4.3 Dissertation defense

Once the Defense Committee is chosen and approved by the Graduate School Committee, it is the Pavia Faculty member's responsibility to set the date, time and place for the defense at a time convenient to all members of the Committee, (the Graduate School Committee strongly encourages the selection of a date between mid January and the end of February). Copies of the dissertation should be given to the Defense Committee member at least a month in advance. The dissertation defense shall consist of two consecutive parts. The first part will consist of an oral presentation of approximatively 45-60 minutes in length, in the style of a research seminar. An official announcement will appear in the departmental Seminar Notices. The second part will consist of detailed questioning of the candidate by the Defense Committee. Both parts shall be open to anyone interested.

3.5 Administrative Issues

3.5.1 Petitioning for Extension

A student wishing to extend his/her registration beyond the original three years terminal date must file a Petition for an Extension to the Graduate School Committee (and then to the offices). A dissertation Progress Report must also be completed along with a letter to the Graduate School Committee stating the reasons for needing an extension. The extension can be requested only once and for 6 months or 1 year. Note that the extension is not covered by the Graduate Study Grant.

3.5.2 Travel

Graduate students wishing to attend meetings, conferences, etc. must ask permission to the Graduate School Committee, (forms are available from the Graduate Registrar Mrs. Anna Rita Mangia). There are very important considerations against traveling

for official reasons without asking permission to the School. Typically it may imply a failure in coverage for health and hospitalization insurance.

3.5.3 Financial matters

Under certain circumstances, besides the graduate scholarship, extra-mural money may be available to graduate students. The sources of this extra financing inevitably may vary case by case, and it may be subjected to both administrative and academic constraints. According to the Rules and Regulation of the University of Pavia, the basic administrative constraint is that the gross extra-mural salary should not exceed the salary associated with the graduate scholarship (for students winner of a graduate scholarship), or twice the graduate scholarship salary (for students without a graduate scholarship grant). The students should inquire with the Coordinator of Graduate Studies (and the offices) to make certain they are complying with these constraints, and in any case they must ask permission to the Graduate School Committee.

3.5.4 Leave of absence

Students who need to interrupt their study temporarily may request a leave of absence. There are two types of leave, personal and medical. Students facing any type of personal or health difficulties are strongly encouraged to consult with the Coordinator of Graduate Studies.

3.6 Internationalization

3.6.1 International student issues

If you are an international student, the Office of Graduate Studies of our University offers an international student service, and can be of help with questions regarding your visa and other issues that pertain to your status as an international student at Pavia.

3.6.2 Exchange programs

Our graduate school has a rich exchange program with many graduate schools worldwide. Here is an updated list:

- University of Colorado, Boulder, U.S.A.
- University of Washington, Seattle, U.S.A.
- Iowa State University, Ames, U.S.A.
- Jagiellonian University, Crakow, Poland
- Purdue University, West Lafayette, U.S.A.
- University of California, Santa Barbara, U.S.A.
- University of California, Berkeley, U.S.A.
- University of California, Santa Cruz, U.S.A.
- State University of New York, Stony Brook, U.S.A.
- University of Houston, Houston, U.S.A.
- Texas Tech University, Lubbock, U.S.A.

There is an international agreement among our graduate school and these Universities. Students from both sides may ask to enter into this international program and obtain, besides their Ph.D degree, a specific Diploma: The International Certificate of Graduate Studies.

With Universities in France or Germany we often have a co-tutorship program leading to a Ph.D degree recognized by the graduate schools involved, (e.g. the most recent such a co-tutorship agreement has been with the Université de la Méditerranée (Aix-Marseille II)).

Under these international programs students may spend up to 18 months abroad (with a 50% an upgrade of their monthly salary). The interested students should inquire with the Coordinator of Graduate Studies to explore the possibilities for entering such an international program.

Chapter 4
Advanced Courses

4.1 Courses

In this section we shall briefly illustrate the advanced courses offered by the Graduate School in Physics. Note that most courses are offered each two year, thus in the following list each course has a status tagging figure: OFFERED if the course in question can be activated this academic year; NOT OFFERED if the course will be activated the next Academic Year (2012/2013).

The courses also have a Coordinator(s) tagging. The coordinator is the faculty member the graduate student have to contact for further details on the structure of the course; He also has the responsibility of the organization of the course by coordinating the various instructors and the special topics seminars that may constitute an essential part of the course.

Note that a particular course in the list is offered if and only if at least 3 students declare an intention to audit it, (this enrollment threshold can be reduced to 2 upon approval of the Graduate School Committe and of the lecturer of the course in question). It is the student's responsibility to collaborate with her/his fellow students in reaching a rapid decision on course offering. It is up to you to be proactive in seeking out fellow students wishing to audit the particular course you are interested in so as to reach the offering threshold.

For assistance in enrolling in courses, students are advised to contact their graduate student representative who will prepare the Graduate Audit Form and bring it to the attention of the Graduate School Committee by the enrollment deadline for the term, (mid December).

4.1.1 Electromagnetic Theory

This is and advanced course in Classical Electrodynamics. Topics will include the theory of radiation and applications of synchrotron radiation both in laboratory and in astrophysics. In order to be activated the course requires that at least three students are willing to audit it.

- Coordinator: M. Bornatici
- Instructors: M. Bornatici
- Status: OFFERED

4.1.2 Relativistic Quantum Field Theory

This is an advanced course in quantum field theory tailored on those students interested in theoretical high energy physics. Arguments range from methods in relativistic quantum field theory to particle physics phenomenology.

- Coordinator: F. Piccinini
- Instructors: F. Piccinini, G. Montagna, Seminars
- Status: OFFERED

4.1.3 Statistical Field Theory

This is an advanced course in statistical mechanics. The program typically offers arguments ranging from phase transitions, critical field theory, renormalization group theory.

- Coordinator(s): B. Pasquini, M. Guagnelli
- Instructors: B. Pasquini, M. Guagnelli, Seminars
- Status: NOT OFFERED

4.1.4 Quantum Information Science

This is an advanced course in quantum information science.

- Coordinator: M. D'Ariano
- Instructors: M. D'Ariano, C. Machiavello
- Status: NOT OFFERED

4.1.5 Selected Topics in Quantum Mechanics

This is an advanced course on selected arguments in quantum mechanics.

- Coordinator: M. D'Ariano
- Instructors: M. D'Ariano, C. Machiavello
- Status: OFFERED

4.1.6 Strong Interactions

This is an advanced course in hadronic physics emphasizing applications in Astrophysics.

- Coordinator: M. Radici
- Instructors: M. Radici, A. Bacchetta, B. Pasquini, Seminars
- Status: OFFERED

4.1.7 Nuclear Structure

This is an advanced course in nuclear theory. Typical topics are: nuclear models, nuclear force, nuclear reaction and electromagnetic probes.

- Coordinator(s): C. Giusti, F.D. Pacati
- Instructors: C. Giusti, F. D. Pacati
- Status: OFFERED

4.1.8 Electroweak and QCD field theories

This is an advanced course on the Standard Model and beyond. Topics will include: neutrino oscillations, introduction to supersymmetry, technicolor, comparison with recent experimental data.

- Coordinator: O. Nicrosini
- Instructors: O. Nicrosini, G. Montagna, F. Piccinini, Seminars
- Status: OFFERED

4.1.9 Spacetime structure, Cosmology, and Quantum Field Theory

This is and advanced course on the interplay between general relativity and quantum field theory. The argument discussed range from QFT on curved spacetimes to the analysis of the different approaches to quantum gravity. For the Academic year 2011/12, three distinguished scientist (T. Buchert, K. Fredhenhagen, R. Littlejohn) will lecture on themes ranging from Dark energy and Cosmology, (T. Buchert); Quantum Field Theory, (K. Fredhenhagen); Dynamical systems (R. Littlejohn). Lectures will be colloquium style and open to a general audience of graduate students.

- Coordinator(s): M. Carfora, C. Dappiaggi
- Instructors: M. Carfora, C. Dappiaggi, A. Marzuoli, T. Buchert, K. Fredhenhagen, R. Littlejohn, Seminars
- Status: OFFERED

4.1.10 Econophysics

This is an advanced course dealing with methods of theoretical physics applied to economy.

- Coordinator: G. Montagna
- Instructors: G. Montagna, Seminars
- Status: NOT OFFERED

4.1.11 Advanced Theory of Solids

This is an advanced course on solid state theory. Arguments include: elementary excitations (plasmons, polaritons,...), advanced quantum treatment of electronic systems and the like.

- Coordinator: L.C. Andreani
- Instructors: L.C. Andreani, Seminars
- Status: NOT OFFERED

4.1.12 Photonics

This is and advanced course on photonics and nanophysics. Arguments include: nanophotonic systems and methods, quantum effects in radiation-matter interaction, non-linear optics. For the year 2011/12 most of the course is a special topic course

offered with the Marie Curie ITN PROPHET workshop *Theory and modelling in Photonics*, (see http://fisicavolta.unipv.it/prophet.htm).

- Coordinator: L.C. Andreani
- Instructors: L.C. Andreani
- Status: OFFERED

4.1.13 Soft Skills for Graduate Students

This course does not belong to the course requirements but you are strongly advised to attend it. Arguments range from writing techniques for filing a proper grant request, to developing presentation skills for seminars and the like.

- Coordinator: A. Bacchetta
- Instructors: A. Bacchetta
- Status: OFFERED

4.1.14 Open Quantum Systems

This is an advanced course on the analysis of analytical and numerical techniques for the study of interacting quantum systems.

- Coordinator: L. Maccone
- Instructors: L. Maccone
- Status: NOT OFFERED

4.1.15 Biophysics on Neural Signaling

The course is offered under the aegis of a collaboration between our graduate school and the graduate school in physiology and neuroscience. The computational problems that are solved by networks of neurons, from roughly 100 cells in a small worm to 100 billion in humans provide a number of challenging problems to physicists. Careful study of the natural context for these tasks leads to new mathematical formulations and physical modeling of the problems that brains are solving, and these theoretical approaches in turn suggest new experiments to characterize neurons and networks. This interplay between theory and experiment is the central theme of this course. The course will start from a description of the biomolecular structure of the neuronal membrane and will provide a biophysical interpretation of the processes generating electrical activity in neurons and synapses. The target is to illustrate how neurons generate information codes and how these are processed in complex neuronal networks. Topics will include: 1) Biophysical phenomena in the

neuronal membrane, 2) Information in spike trains, 3) Principles of signal processing in neuronal networks.

- Coordinator: E. D'Angelo
- Instructors: E. D'Angelo
- Status: OFFERED

4.1.16 Imaging for Biomedical Applications

This is an advanced course on imaging techniques applied to problems in biomedical physics.

- Coordinator: A. Ottolenghi
- Instructors: A. Ottolenghi
- Status: NOT OFFERED

4.1.17 Ionizing Radiations and Biological Structures: Theory and Applications

This is an advanced course on the interaction between biological structures and ionizing radiation. The course will be integrated with the special topic course *Modeling radiation effects from initial physical events*, (Pavia, May 28-June 8, 2012), dedicated to learning modeling approaches and techniques in radiation biophysics and radiobiology research, from basic mechanisms to applications.

- Coordinator: A. Ottolenghi
- Instructors: A. Ottolenghi
- Status: OFFERED

4.1.18 Spectroscopies in Condensed Matter Physics

This is an advanced course on spectroscopical techniques in condensed matter physics. Topics will include: (i) time resolved optical spectroscopies: techniques and experiments; (ii) Nuclear Magnetic Resonance and Nuclear Quadrupolar Resonance Spectroscopies.

- Coordinator: F. Marabelli
- Instructors: F. Marabelli, P. Carretta, M. Galli.
- Status: OFFERED

4.1.19 Microscopic and Spectroscopic characterization of materials

This is an advanced course in the physics of material structures.

- Coordinator: F. Marabelli
- Instructors: F. Marabelli
- Status: NOT OFFERED

4.1.20 Magnetic Resonance Techniques in Solid State Physics

This is an advanced course on magnetic resonace techniques in solid state physics.

- Coordinator: P. Carretta
- Instructors: P. Carretta
- Status: NOT OFFERED

4.1.21 Strongly Correlated Systems in Condensed Matter Physics

This is an advanced course on strongly correlated systems in condensed matter physics.

- Coordinator: P. Carretta
- Instructors: P. Carretta
- Status: NOT OFFERED

4.1.22 Experimental Particle Physics

This is an advanced course on modern particle physics with a particular attention to collider physics.

- Coordinator: C. Conta
- Instructors: C. Conta, Seminars
- Status: OFFERED

4.1.23 Experimental Nuclear Physics

This is an advanced course on experimental techniques in nuclear and subnuclear physics. The focus of the course is the study of the structure of the lightest hadrons (mesons,nucleons) in the non-perturbative QCD regime using electromagnetic and

hadronic probes. Topics covered will include: (i) overview of the existing theories of the hadronic structure: quark, chiral symmetry and lattice QCD models; (ii) baryon spectroscopy experiments using elecromagnetic probes; (iii) meson spectroscopy experiments using hadronic probes.

- Coordinator: P. Pedroni
- Instructors: P. Pedroni, Seminars
- Status: OFFERED

4.1.24 Radiation and Particle Detection

This is and advanced course on the Physics of particle detectors.

- Coordinator: M. Livan
- Instructors: M. Livan, Seminars
- Status: OFFERED

4.1.25 Information and data analysis

Advanced course on data analysis.

- Coordinator(s): A. Rotondi and A. Fontana
- Instructors: A. Rotondi, A. Fontana, Seminars
- Status: OFFERED

4.1.26 Neutrino phenomenology and astroparticle physics

An advanced course in astroparticle physics. Arguments include: cosmic rays physics, satellites and Earth based experiments, introduction to high energy neutrino physics, (in particular neutrino oscillations).

- Coordinator: P. W. Cattaneo
- Instructors: P. W. Cattaneo, Seminars
- Status: OFFERED

4.1.27 Courses in Astrophysics

These are advanced courses in astrophysics held at the University of Insubria. There is an agreement between our and their graduate school according to which our stu-

dents may audit one (and only one) of these courses as part of their academic requirements.