



# A EUROPEAN SPECIFICATION FOR PHYSICS DOCTORAL PROGRAMMES

EPS Publications 2011



European Physical Society  
more than ideas

# **A EUROPEAN SPECIFICATION FOR PHYSICS DOCTORAL PROGRAMMES**

Submitted to the European Physical Society by

**Prof. Dr. Hendrik Ferdinande**  
UGent- Proeftuinstraat 86  
BE-9000 Gent, Belgium

hendrik.ferdinande@ugent.be

**Keywords:**

Bologna Process  
European Higher Education Area (EHEA)  
European Specification  
Physics doctor degree

Copyright © 2011 by the European Physical Society. All rights reserved. This information may be freely used and copied for non-commercial purposes, provided that acknowledgment is given to the specification group for the physics doctorate and to the copyright of the European Physical Society.

For ordering information, please, contact [info@eps.org](mailto:info@eps.org) or write to:

**European Physical Society**  
6 rue des Frères Lumière  
FR-68200 Mulhouse, France  
Tel: +33 389 32 94 40  
Fax: +33 389 32 94 49  
Web: [www.eps.org](http://www.eps.org)

A free electronic version of this report is available through [www.eps.org](http://www.eps.org)

This project has been funded with support from the *Lifelong Learning Programme* of the *Education and Culture DG* of the European Commission (Ref. Assoc-Educ-SAOG2-12). This publication reflects the views of the authors and the Commission cannot be held responsible for any use which may be made of the information contained therein.

# A EUROPEAN SPECIFICATION FOR PHYSICS DOCTORAL PROGRAMMES

## ▶ CONTENTS

02	Keywords
03	Table of contents
04	Preface
05	Physics doctoral programmes
05	1 - Introduction
05	2 - Programme structure & delivery
07	3 - Physics
08	4 - Physics doctoral discipline competences
09	5 - Physics doctoral generic competences
10	References
11	Annex: membership of the doctoral specification group

## ► PREFACE

The **European Physical Society (EPS)** is a European-wide professional association with 41 national member societies. The EPS supports the Bologna Process and provides with a series of *specifications* a means to describe the characteristics of the physics study programmes in a European dimension. This series of brochures covers the bachelor or first-cycle or EQF level 6, master or second-cycle or EQF level 7 and doctorate or third-cycle level or EQF level 8, as one of the three priorities in the *Bologna Process* [EC09a].

The brochures also represent general expectations about the standards for the award of qualifications at the given level and articulate the attributes and capabilities – *i.e.* the learning outcomes - that those possessing such qualifications should be able to demonstrate. These qualifications are in agreement with the *European Qualifications Framework (EQF)* [EC09b]. National statements and guidelines [DP07, IM07, KF05, LM07, MS04 and QA11] have already been established in some countries, and have been very influential in designing these specifications. The European doctoral level or EQF level 8 corresponds to the UNESCO level ISCED 6 [UN06]

The present *EPS specification* refers to the physics doctoral degree in a European perspective. **Specifications are used for a variety of purposes.** Primarily, they are an important external source of reference for higher education institutions (HEIs) when new programmes are being designed and developed or doctoral programmes provisioned. They provide general guidance for articulating the learning and research outcomes associated with the programme but are not detailed descriptions of a core or model concept. Specifications provide for variety and flexibility in the design of programmes and encourage innovation within an agreed overall national, regional or institutional framework.

Specifications also provide support to institutions in pursuit of **internal quality assurance**. They enable the learning outcomes specified for a particular programme to be reviewed and evaluated against agreed general expectations.

Finally, specifications are among a variety of **external reference points** that may be drawn upon for the purpose of external review. Reviewers should not use specifications as a crude checklist for these purposes however. Rather, they should consider them in conjunction with the relevant programme descriptions, the institutions' own internal evaluation documentation, in order to arrive at a rounded judgment based on a broad range of evidence.

The present physics doctoral specification has been undertaken by a **European group of physics higher education specialists** (see Annex 1). The group's work has been funded with support from the European Commission [EC07] and was facilitated by the European Physical Society, which publishes and distributes these documents. The present document went through a full consultation and validation process with the wider European academic community and the stakeholder groups.

In due course the specification will be **revised** to reflect developments in physics (and astronomy) and the experiences of institutions and others who are working with it. The EPS will initiate revision and will make arrangements for any necessary modifications to the description in collaboration with the European physics community.

A **Glossary** of key terms in higher education can be found in [CE11, EU09a, and VI07].

# ► PHYSICS DOCTORAL PROGRAMMES

## 1 - Introduction

**1.1** The present *specification for physics doctoral programmes* characterises a European-wide view of the competences and achievements that graduates of physics doctoral degrees should have acquired through their studies, training and research activities. There exists a wide range of programmes delivering such degrees reflecting the varying aspects of physics and different national perspectives, traditions and educational policy imperatives. However, there is wide agreement across Europe of what constitutes the essentials of what should be included in a third degree in physics. However, doctoral education has a particular place in the European Research Area (ERA) and the European Higher Education Area (EHEA). It rests on the *practice of research*, which makes it fundamentally different from the first and second cycles. In some institutions of some European countries doctoral degrees are a fairly recent development inspired by the Bologna Process. Physics departments and national physical societies might welcome some guidance on what such degrees should try to achieve. This document builds on extensive work carried out over recent years by the physics group in the *TUNING* project [TU09a] and over a longer period by the *EUPEN* group of physics departments [Fe05] both of which have done a great deal to establish European-wide consensus on the essentials of physics degree programmes. While this work has been vital in order to establish a European wide consensus, some parts of the present text rely on the document published by the QAA in the UK [QA11], on the German Study [DP07] and on the *Salzburg II Recommendations* produced by the EUA [EU10] from which they have been directly taken. Practically all of the global recommendations on graduate education, known as the Banff Principles [Ba07], also appear in the *Salzburg II Recommendations*.

**1.2** Physics is a *major discipline* in the EHEA with over 100 000 full-time equivalent students registered on undergraduate HE programmes. Physics graduates play a major role in the EU economy. However, the importance of physics is not restricted to the provision of professional scientists and technologists. It is also an essential part of our understanding of all aspects of nature and the principles and methods which allow us to understand the universe. As such it has wide and deep cultural dimensions and its study is of universal value. It forms the foundation of many of the sciences and their applications. Physics is also an important backbone for new advances in technology, which constitutes an important factor in the development and economy of our society.

**1.3** The doctoral degree acquired its modern status as the highest research degree during the 19<sup>th</sup> century in Germany, where according to the *Humboldtian tradition* the doctoral candidate followed a form of ‘apprenticeship’.

**1.4** ‘The doctorate is distinctive because it is about creating new knowledge or applying existing knowledge in a new way; this is the key characteristic that differentiates it from first and second cycle degrees’ [QA11].

**1.5** ‘Whereas until the late 20<sup>th</sup> and early 21<sup>st</sup> centuries the purpose of acquiring a doctorate (in several countries) was (mostly) for entry to the academic profession, nowadays many doctoral candidates have no intention of pursuing an academic role. Instead, many go on to a diversity jobs in both public and private sectors, and they often bring their research skills to bear in their own professional context. Some doctoral candidates study at doctoral level purely as a personal challenge, or for interest, with no ‘career’ relevance’ [QA11].

## 2 - Programme structure and delivery

**2.1** Physics is a *hierarchical* discipline that requires an ordered and structural acquisition of knowledge as well as a prolonged period of study to assimilate its concepts and coherence. It is a subject which relies on experiment and observation as the source of our knowledge of the physical universe but which complements this with theoretical constructs based on a fairly small number of all embracing principles and laws often expressed and developed using mathematics. Practical skills have to be developed alongside an appreciation of the link between theory and experiment.

In the *TUNING* methodology [TU09a], the use of learning outcomes and competences is necessary in order to make programmes student-centred and output-oriented. This approach requires that the key knowledge and skills that a graduate needs to achieve during the learning process should be taken into account in developing the programme.

**2.2** In 2004 the *Joint Quality Initiative* [JQ04] developed the following descriptors, known as the *Dublin Descriptors* (based on Bloom's [Bl56] Taxonomy), to determine when young researchers in their learning process would have attained the doctoral level:

'Qualifications that signify completion of the third cycle are awarded to candidates who:

- have demonstrated a systematic understanding of a field of study and mastery of the skills and methods of research associated with that field;
- have demonstrated the ability to conceive, design, implement and adapt a substantial process of research with scholarly integrity;
- have made a contribution through original research that extends the frontier of knowledge by developing a substantial body of work, some of which merits national or international refereed publication;

- are capable of critical analysis, evaluation and synthesis of new and complex ideas;
- can communicate with their peers, the larger scholarly community and with society in general about their areas of expertise;
- can be expected to be able to promote, within academic and professional contexts, technological, social or cultural advancement in a knowledge based society.'

In their 2007 London Summit the 'Bologna' ministers insisted on the use of learning outcomes in curriculum design and student-centred pedagogy (see also [TU09a]). In the '*Tuning 3<sup>rd</sup> cycle studies in Physics*' document [TU07] it is emphasised that the term 'research outcomes' would be appropriate rather than 'learning outcomes'.

**2.3** 'The modern doctorate is at its core determined by an interplay between professional research experience and personal development' [LE10].

**2.4** 'Doctoral education is, by nature, an individual experience; even if a doctoral candidate is part of a cohort, which is becoming increasingly common, each person's route to the degree is different and takes account of several factors, including:

- the individual's experience (academic and life) before enrolling on the doctorate
- the university at which the candidate is studying
- the (doctoral) school or department in which the candidate is based
- the candidate's relationship with the supervisor
- the candidate's relationship with peers' [QA11].

**2.5** 'Applying *e.g.* the *European Credit Transfer and Accumulation System* (ECTS) [EC09c] developed for cohorts of students in the first and second cycles is not a necessary precondition for establishing successful doctoral programmes. Some universities consider credits useful for the taught components of doctoral education, especially in cross-institutional (joint)

doctoral programmes. ECTS credits, however, do not make sense when measuring the research component or its associated dissemination outputs. Applied wrongly, rigid credit requirements can be detrimental to the development of independent research professionals. High-quality doctoral education needs a stimulating research environment driven by research enthusiasm, curiosity and creativity, not motivated by the collection of credits. [EU10]

**2.6** A recent study [Ke11] investigated 155 investigated physics doctoral programmes from 24 countries; it showed that the vast majority have duration of *three to four years* (full time; part-time candidates take up normally twice as long). Only in exceptional cases [e.g. Ph09] is the duration condensed to two and half years, when the bachelor and the master programme may also be condensed. According to a DPG Study [DP07] such an offer should be reserved for the most-talented and able candidates. In the case where candidates transfer directly from the bachelor to the doctorate, they should be provided with an intensive programme of study to develop knowledge and skills equivalent to the master's level.

**2.7** 'Universities as institutions need to *assume responsibility for ensuring* that the doctoral programmes and research training they offer are designed to meet new challenges and include appropriate professional career development opportunities.' [EU10]

**2.8** 'Physics doctoral programmes should seek to *achieve critical mass* and should draw on different types of innovative practice being introduced in universities across Europe, bearing in mind that different solutions may be appropriate to different contexts and in particular across larger and smaller European countries. The promotion of innovative structures [is particularly needed] to meet the challenge of interdisciplinary training and the development of transferable skills. These range from graduate schools in major universities to international, national and regional collaborations between universities.' [EU10]

**2.9** A possible sensitive but clear and succinct tool for transparency and recognition can be found in the *Tuning Guide* [Lo10] to formulating degree programmes. The degree profile template and related guidelines set out in that guide booklet constitute such a tool.

**2.10** The *European Charter for Researchers and a Code of Conduct for the Recruitment of Researchers* give individual researchers the same rights and obligations wherever they work throughout the EU. This should help counter the fact that research careers in Europe are fragmented at local, regional, national or sectoral level [EC05]. Acceptance of these guidelines would be an important stimulus towards Europe-wide mobility of researchers.

### 3 - Physics

**3.1** 'Physics is concerned with the quantitative observation, understanding and prediction of *natural phenomena* and the *behaviour of human-made systems*. It deals with profound questions about the nature of the universe and with some of the most important practical, environmental and technological issues of our time. Its scope is broad and involves mathematics and theory, measurement, *i.e.* quantitative experimentation and observations, computing, technology, materials and information theory. Ideas and techniques from physics also drive developments in related disciplines including chemistry, computing, engineering, materials science, mathematics, medicine and the life sciences, meteorology and statistics' [QA08].

**3.2** 'Physics is both *an experimental and a theoretical* discipline that is continuously evolving. It is deeply rooted in the idea that even complex systems can be understood by identifying a few key quantities such as energy and momentum, and the universal principles that govern them. Part of the appeal of physics is that there are relatively few such principles and that

these apply throughout science and not just in physics. The laws of mechanics are a good example; deduced by Newton after studying observations of planetary motion, they govern systems familiar from everyday life as well as many of the phenomena observed in the movement of stars and galaxies' [QA08].

**3.3** Physics as an *experimental science*: 'The skills and methods used to make measurements are an integral part of physics. The final test of the validity of any theory is whether it agrees with experiment. Many important discoveries are made as a result of the development of some new experimental technique. For example, the techniques developed to liquefy helium subsequently led to the totally unexpected discovery of superconductivity, superfluidity and the whole field of low-temperature physics. Instruments developed originally in physics frequently find applications in other branches of science; for example, electromagnetic radiation emitted by electron accelerators, which were originally designed to study elementary particles, is now used to study the properties of materials in engineering, biology and medicine' [QA08]. Moreover, devices such as transistors and lasers, which were developed within basic physics research programmes, have revolutionised technology.

**3.4** 'In order to make quantitative predictions, physics uses *mathematical models*. The types of approximation used to find satisfactory models of experimental observations turn out to be very similar whether the underlying laws are those of classical physics, statistical mechanics or quantum theory. Typically, an idealised model of some phenomenon is established, the equations for the model are solved (often with further approximations) and the results compared with what is observed experimentally. Sometimes a model is applicable to very different circumstances. For example, the same statistical model that describes the behaviour of electrons in metals is equally valid for white dwarf stars.' [QA08]

**3.5** 'Studying physics at a university brings *benefits that last* a lifetime and knowledge and skills that are valuable outside the field of physics. Such benefits include a practical approach to problem solving, often using mathematical formulation and solution, the ability to reason clearly and to communicate complex ideas, IT and self-study skills, along with the pleasure and satisfaction that comes from being able to understand the latest discoveries in physics or natural science. After graduation, physicists work in a wide variety of employment, including research, development and education, in industry and academia and increasingly in areas such as business and finance, where they are sought for their analytical and synthetical approaches to the solution of problems.' [QA08]

## 4 - Physics doctoral discipline competences

**4.1** 'The core component of the physics doctoral training is the advancement of knowledge through original research. At the same time it is recognized that doctoral training must increasingly meet the needs of an employment market that is wider than academia.' 'Doctoral candidates<sup>1</sup> should be recognized as early-stage researchers – with commensurate rights – who make key contributions to the creation of new knowledge.' [EU10]

In order to obtain the doctorate degree physics doctoral candidates undertake research in a physics specialty, *e.g.* in one or more of the sub-fields:

- atomic and molecular physics
- nuclear or particle physics
- condensed matter physics
- physics of materials

<sup>1</sup> Throughout this document the term 'doctoral candidate' and not 'doctoral student' is used in order to emphasize her/his professional status. Only in a minority of cases in Europe this is not so clear. [Ke11]

- plasma physics
- physics of fluids
- optics / optical physics / laser physics
- fundamental quantum physics / quantum information
- mathematical and numerical methods in physics
- cosmology
- the structure, formation or evolution of stars and galaxies
- planetary systems
- high-energy phenomena in the universe

Alternatively, the research may be in an interdisciplinary areas, such as:

- biophysics
- medical physics
- geophysics or meteorology
- physics of nanostructures
- econophysics
- atmospheric or environmental physics.

Physics doctoral candidates develop an awareness of the highest scientific standards and of health and safety issues. They should learn to take responsibility for their research and develop the confidence to make independent decisions with a real research environment. Hence, their doctoral degree forms a complete professional qualification. [DP07]

**4.2** As physics is a quantitative field of study where the use and power of mathematics for *modelling* the physical world and *solving problems* is a primary factor, an appreciation of mathematical and theoretical methods is an essential part of a physics doctoral degree.

**4.3** Hence, the doctoral candidate's activities comprise three categories:

- Acquiring new experiences to improve *self-development*, an essential feature of professional activity;
- Contributions to research output;

- Substantial contributions to university training by *participation in university instruction* via practicals, tutorials and seminars. [DP07]

**4.4** The majority of doctoral studies are integrated in a doctoral programme or a doctoral school<sup>2</sup>. [Ke11]

**4.5** In most European countries physics doctoral candidates are only accepted when they possess a qualified physics master degree. [DP07] In the UK it is still possible to accept candidates with only a bachelor degree and in Germany there exists some 'fast track' programmes for especially-gifted students.

**4.6** 'In respect of individual doctoral candidates, arrangements for supervision and assessment should be based on a transparent contractual framework of shared responsibilities between doctoral candidates, supervisors and the institution.' [EU10] The progress of the doctoral candidate's research should be monitored from the start of the research by the supervisor and/or by the director of the doctoral school, preferably via a (couple) of report(s). [DP07]

**4.7** 'The doctoral candidate has to submit a substantial body of original work for scrutiny, of which the volume is expected that which could be "reasonably produced" in the equivalent three years of independent study' [QA11]. 'Physics doctoral candidates are assessed on the basis of their thesis and by an oral examination (in the UK often called '*viva voce*' or '*viva*'). In the doctorate by publication(s) the candidate is normally examined on published material and a related commentary [*"often written in the mother tongue of the candidate"*], sometimes supported by a CV. The

<sup>2</sup> Throughout this document the term 'doctoral schools' is used as a generic term including graduate and/or research schools. Recently the term 'doctoral training centres' has become in use in the UK. This collection of published work is accompanied by a critical appraisal set within the context of the research. The compulsory oral examination/defence judges the candidate and the thesis using the same academic standards as for a conventional research degree programme.

oral examination follows the same patterns as for other doctorates.' In some countries the examination is in public and in others, in private.

4.8 'The outcome of their doctoral research must testify to the originality of the research and be suitable for dissemination within the scientific community. [EU10] The quality should normally be sufficient for the [acceptance for] publication of the research output/results in an internationally recognized journal. In many European countries the possibility exists for the candidate's thesis to consist entirely or largely of published work (which is reflected in the title in the UK for such theses: PhD by Publication or by Published Work) [QA11].

4.9 'Doctoral programmes should seek to offer geographical as well as interdisciplinary and intersectoral mobility and international collaboration within an integrated framework of co-operation between universities and other [e.g. industrial] partners.' [EU10]

## 5 - Physics doctoral generic competences

Many countries are seeing a shift from a closed model, in which the doctoral candidate has a single supervisor, to a more structured model where doctoral degrees are embedded within institutional structures that provide doctoral candidates with rights and responsibilities.

The burden of the administration for the training of physics doctoral generic competences is mostly taken care of in an institutional approach by the centralised administration of the 'doctoral school', which increases the efficiency of the research undertaken and stimulates networking between doctoral candidates (*cohort building*).

In a *competency model* we can distinguish between *three classes* of generic competences for a physics doctoral degree [TU09b, Fe05 and QA08]:

### ► Intellectual competence

Physics doctoral candidates constantly tackle open-ended problems, identify key issues and possess the ability to solve new, complex and non-standard problems by independent investigation and by systematic critical thinking and decision making. In this way they develop a facility for life long learning and a permanent engagement with the process of searching for new ideas and techniques.

### ► Competence in collaboration and communication

A physics doctoral programme should develop students' ability to communicate *in writing and orally* difficult ideas and complex information relevant to her/his domain in a clear and concise manner with colleagues and to lay people.

Since a mobile labour force with language competences is crucial for economic growth and better jobs, enabling European enterprises to compete effectively in the global marketplace, multilingualism contributes to personal development and reinforces social cohesion. Physics doctoral candidates are expected to have an oral and written knowledge of English, the *lingua franca* of physics and should develop this knowledge during their programme. Some knowledge of another global language could also be an asset.

Doctoral candidates should have developed the ability to work autonomously accepting responsibility in planning and managing projects, to use their initiative, to organise their activities, to meet deadlines, to aim for the highest quality standards and to interact constructively in a *multidisciplinary team*.

### ► Investigative

Students will have opportunities to develop their skills of independent investigation. Generally, students will have experience with extracting important information

from textbooks and other literature, with searching databases and with interacting with colleagues.

### ► Societal competence

Doctoral candidates should appreciate that to fabricate, falsify or misrepresent data or to commit

plagiarism constitutes *unethical* scientific behaviour. They should show culture awareness, be objective, unbiased and truthful in all aspects of their work, behave with professional integrity, integrate the societal consequences of new developments and respect for diversity in their work, and recognise the limits of their knowledge.

## ► REFERENCES

- Ba07 'Banff Principles on Graduate Education', Banff, 2007
- BI56 B. Bloom *et al.* 'Taxonomy of Educational Objectives', Vol. 1, Longman, London, 1956
- CE11 CEDEFOP, 'Glossary/Glossaire: Quality in education and training/La qualité dans l'enseignement et la formation', European Centre for the Development of Vocational Training, Luxembourg, 2011
- CR02 'Criteri per la revisione del dottorato di ricerca', Conferenza dei Rettori delle Università Italiane (CRUI), Roma 2002 [www.cru.it/HomePage.aspx?ref=1695](http://www.cru.it/HomePage.aspx?ref=1695)
- DP07 Deutsche Physikalische Gesellschaft, 'Zur Promotion im Fach Physik an deutschen Universitäten', DPG, Bad Honnef, 2007. [www.dpg-physik.de/static/info/promotion\\_2007.pdf](http://www.dpg-physik.de/static/info/promotion_2007.pdf) [www.dpg-physik.de/veroeffentlichung/broschueren/studien/promotionsstudie\\_eng\\_2011.pdf](http://www.dpg-physik.de/veroeffentlichung/broschueren/studien/promotionsstudie_eng_2011.pdf) (Summary in English)
- EC05 European Commission, 'The European Charter for Researchers. The Code of Conduct for the Recruitment of Researchers', EUR 21620, DG Research, Unit D1, Brussels 2005
- EC07 E.C. Funding 'The implementation of the Bologna Process reforms into Physics Studies in Europe', by EPS, ref. ASSOC-EDUC-2007-12, European Commission, Brussels, 2007
- EC09a 'The Bologna Process - Towards the European Higher Education Area', European Commission, Brussels, 2009 [http://ec.europa.eu/education/higher-education/doc1290\\_en.htm](http://ec.europa.eu/education/higher-education/doc1290_en.htm) [www.ond.vlaanderen.be/hogeronderwijs/bologna/](http://www.ond.vlaanderen.be/hogeronderwijs/bologna/)
- EC09b 'The European Qualifications Framework (EQF)', European Commission, Brussels, 2009 [http://ec.europa.eu/education/lifelong-learning-policy/doc44\\_en.htm](http://ec.europa.eu/education/lifelong-learning-policy/doc44_en.htm) [www.ond.vlaanderen.be/hogeronderwijs/bologna/qf/qf.asp](http://www.ond.vlaanderen.be/hogeronderwijs/bologna/qf/qf.asp)
- EC09c 'European Credit Transfer and Accumulation System' (ECTS), European Commission, Brussels, 2009 [http://ec.europa.eu/education/lifelong-learning-policy/doc48\\_en.htm](http://ec.europa.eu/education/lifelong-learning-policy/doc48_en.htm)
- EN10 ENQA, 'Quality Assurance in Postgraduate Education', European Association for Quality Assurance in Higher Education, Helsinki 2010
- EU10 'Salzburg II Recommendations', European University Association (EUA), Brussels 2010
- Fe05 'Inquiries into European Higher Education in Physics', Vol. 1 to 7, ed. H. Ferdinande *et al.*, EUPEN, Gent, 1997/2005 [www.eupen.ugent.be](http://www.eupen.ugent.be)
- IM07 L-30, 'Classe delle lauree in Scienze e Tecnologie fisiche', Italian Ministry Decree, Roma, 2007 <http://beta.fisica.uniba.it/LinkClick.aspx?fileticket=aCFiQgVLOPs%3D&tabid=75&mid=408&language=it-IT>
- JQ04 'Shared 'Dublin' descriptors for Short Cycle, First Cycle, Second Cycle and Third Cycle Awards', Joint Quality Initiative, Dublin, 2004. [www.jointquality.nl/content/descriptors/CompletesetDublinDescriptors.doc](http://www.jointquality.nl/content/descriptors/CompletesetDublinDescriptors.doc)
- Ke11 Barbara M. Kehm & Bettina Alesi, 'The implementation of the Bologna Process into Physics Studies in Europe - The Doctoral Level', Project Report, INCHER Kassel, 2011
- KF05 'Empfehlungen der Konferenz der Fachbereiche Physik (KFP) zu Bachelor- und Master-Studiengängen in Physik', Konferenz der Fachbereiche Physik, Bad Honnef, 2005 [www.kfp-physik.de/dokument/Empfehlungen\\_Ba\\_Ma\\_Studium.pdf](http://www.kfp-physik.de/dokument/Empfehlungen_Ba_Ma_Studium.pdf)
- LE10 LERU, 'Doctoral degrees beyond 2010: Training talented researchers for society', League of European Research Universities, Leuven, 2010

- LM07 *'Regulations for Study Programmes in Physics'*, Lithuanian Ministry of Higher Education, Vilnius 2007
- Lo10 Jenneke Lokhoff *et al.*, *'A Tuning Guide to Formulating Degree Programme Profiles'*, CoRe & Tuning, Bilbao, Groningen, The Hague 2010
- MS04 *'La Physique en Licence'*, Rapport de perspective, Mission Scientifique Technique et Pédagogique, Ministère Éducation Nationale, Enseignement Supérieur Recherche, Paris, 2004.  
[www2.enseignementsup-recherche.gouv.fr/mstp/physique\\_licence\\_sfp\\_mstp.pdf](http://www2.enseignementsup-recherche.gouv.fr/mstp/physique_licence_sfp_mstp.pdf)
- Ph09 *'Physik mit integriertem Doktorandenkolleg'*, Friedrich-Alexander Universität Erlangen-Nürnberg, Universität Regensburg, Max-Planck-Forschungsgruppe für Optik, Information und Photonik, Erlangen-Nürnberg-Regensburg, 2009.  
[www.enb.physik.uni-erlangen.de/](http://www.enb.physik.uni-erlangen.de/)
- QA11 *'Doctoral degree characteristics'*, Quality Assurance Agency for Higher Education, Gloucester, 2011
- QA08 *'Physics, astronomy and astrophysics'*, Quality Assurance Agency for Higher Education, Gloucester, 2008
- [www.qaa.ac.uk/academicinfrastructure/benchmark/statements/Physics08.pdf](http://www.qaa.ac.uk/academicinfrastructure/benchmark/statements/Physics08.pdf)
- TU07 *'Tuning Educational Structures in Europe'*, Subject Area Physics, *'Third cycle studies in Physics'*, Deusto & Groningen, 2007.  
<http://tuning.unideusto.org/tuningeu/index.php?option=content&task=view&id=218&Itemid=242>
- TU09a *'Tuning Educational Structures in Europe'*, Deusto & Groningen, 2009.  
<http://tuning.unideusto.org/tuningeu/>
- TU09b *'Tuning Educational Structures in Europe'*, Subject Area Physics, Deusto & Groningen, 2009.  
<http://tuning.unideusto.org/tuningeu/index.php?option=content&task=view&id=31&Itemid=54>
- UN06 *'ISCED 1997 International Standard Classification of Education'*, Re-edition, UNESCO-UIS, Paris, 2006  
[www.uis.unesco.org](http://www.uis.unesco.org)
- VI07 Lazăr Vlăsceanu, Laura Grünberg & Dan Pârlea, *'Quality Assurance and Accreditation: A Glossary of Basic Terms and Definitions'*, UNESCO-CEPES, București 2007  
[http://www.cepes.ro/publications/pdf/Glossary\\_2nd.pdf](http://www.cepes.ro/publications/pdf/Glossary_2nd.pdf)

## ▶ ANNEX

### Membership of the doctoral specification group

**Hon. Ass. Prof. Hendrik Ferdinande (secretary)**

*Universiteit Gent (BE)*

EPS Executive Committee Member

**Professor em. Peter Main**

*University of Nottingham (UK)*

Director Education & Science

*Institute of Physics (IoP)*

**Professor Gerd Ulrich Nienhaus**

*Karlsruhe Institute of Technology [KIT] (DE)*

Spokesperson (until June 2011)

*Konferenz der Fachbereiche Physik (KFP)*

Executive Board Member (until April 2011)

*Deutsche Physikalische Gesellschaft (DPG)*

**Professor em. Urbaan Titulaer**

*Johannes-Kepler-Universität Linz (AT)*

EPS Physics Education Division Board Member

**Professor em. Friedrich Wagner (chair)**

*Ernst-Moritz-Arndt-Universität Greifswald (DE)*

EPS Past-president

The **European Physical Society (EPS)** is a not-for-profit representative organization whose purpose is to promote physics and physicists in Europe. Created in 1968, the EPS provides an international forum to discuss science and policy issues of interest to its members



European Physical Society

---

6, rue des Frères Lumière - 68200 Mulhouse - France  
tel: +33 389 32 94 42 • fax: +33 389 32 94 49  
website: [www.eps.org](http://www.eps.org)

---

---