

**On the Doctorate in Physics at German Universities
A Study by the Deutsche Physikalische Gesellschaft
(German Physical Society)
March 2007**

**Zur Promotion im Fach Physik an deutschen Universitäten
Eine Studie der Deutschen Physikalischen Gesellschaft e. V.
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In September 2007 the Deutsche Physikalische Gesellschaft (DPG) presented a study on the doctorate in Physics at German universities (“Zur Promotion im Fach Physik an deutschen Universitäten”). In view of the radical changes in the higher education system brought about by the implementation of the Bologna Process decisions, the DPG undertook to describe the importance of the doctorate in Physics and the conditions under which doctorates in Physics arise at German universities. On the basis of this study the DPG drew up salient points regarded as essential to the doctorate in Physics.

Since the Conference of European Ministers responsible for Higher Education in Berlin in 2003, the doctorate has been described in the Bologna communiqués as a “third cycle” of academic education. The DPG and the Conference of the Departments of Physics at German Universities (Konferenz der Fachbereiche Physik, KFP) – as well as the Natural and Engineering Sciences in Germany – have viewed this classification with concern and repeatedly pointed out that in Germany and especially in the Natural and Engineering Sciences the doctorate is understood not as a third cycle of higher education but as the first phase of independent scientific professional activity, in which PhD candidates conduct their own research work.

The following summary prefaced the study, which is available only in German, and is presented here translated into English. The complete text of the study can be downloaded from http://www.dpg-physik.de/static/info/promotion_2007.pdf.

Summary

The Bologna Process to create a European Higher Education Area (EHEA) has initiated radical reforms of higher education courses in Germany. It is the intention of the European Ministers of Higher Education for the doctorate to be now also integrated in the Bologna Process, as a “Third Cycle” of higher education. Associated with this is the call for “structured doctorate courses” to be set up.

From the point of view of those concerned, the young people who after their studies are aiming for a doctorate, the faculties offering doctorates and future employers, it is regrettable that this was stipulated on a political level without there having been a public debate on it beforehand. Moreover, flying in the face of facts, the assumption in the political comments and in the wording of the rules for implementing them is that there is only *the one* doctorate irrespective of the field, and that this doctorate must be reformed everywhere in accordance with the same rules. In reality, however, a broad spectrum of suitably different forms of doctorate has developed in line with the specific characteristics and requirements of professional practice of the individual fields, from Natural and Engineering Sciences through Medicine to the Arts.

A reform aimed at improving the doctorate procedure and increasing efficiency in relation to achieving the objectives associated with the doctorate in the respective subjects must take into consideration the specificities of the individual subjects. At the outset, therefore, there has to be a subject-specific analysis of the objectives pursued with the doctorate and a study of how these can be best achieved.

The DPG's aim with this study is to contribute to this discussion, which for reasons of diligence and responsibility for German science is absolutely indispensable, by analysing the doctorate from the viewpoint of physics as a science and Physics as an academic subject on the basis of its expertise. The framework for reforms of the doctorate in Physics should be defined on the basis of such a detailed stocktaking, and concrete salient points formulated that it is imperative to include in those reforms.

The starting point of the study is a detailed description of the procedure that leads to a doctorate in Physics. This entails discussing the admission requirements, the typical progression of the doctorate phase, the publication of the research results and the actual examination procedure right through to the conferring of the academic title *doctor rerum naturalium* (*Dr. rer. nat.*). This stocktaking is essential for the discussion, to enable the pros and cons of the current system of the doctorate to be assessed only by appraising the subject specificities.

The results of the study are as follows:

1) The purpose of the doctorate is to acquire a key qualification for working as a physicist. That is the ability to be professional and independent under considerable stress of performance and competition. To acquire this qualification, the doctoral candidate is set the task of working on a challenging, modern topic at the cutting edge of research. Working under risky conditions, entering new territory, having sole responsibility not under abstract conditions but under the real conditions of one's own subject are skills that have to be developed during the doctorate. Without them neither academic life nor industry and business can manage.

2) Accordingly the PhD candidates' activity has to be assessed in relation to three categories. (i) The acquisition of new experiences, improving one's **ongoing learning process**, as occurs in every serious professional activity. (ii) Of particular importance to physics

are the **contributions to scientific research** (“*scientific output*”). These are considerable; it is assumed that the majority of the results of research in the field of physics in Germany are based on the work of candidates for a doctor’s degree. (iii) Both professional personality development and a substantial contribution to performing the teaching duties of the universities benefit from **the doctoral candidates’ involvement in the university teaching** by supervising practicals and seminars.

3) Reforms must be guided by this triad. Too much emphasis on one of these aspects of the doctorate is detrimental to the other two. Regarding the doctorate as a “Third Cycle” of higher education lays too much emphasis on the aspect of the students’ ongoing learning process along the lines of a school model. The study rejects this as totally inappropriate, for it ignores the fact that the focus of the doctorate is not on the scholastic elements, but precisely on independence and scientific and organisational self-responsibility, also from the responsibility that scientific output as a key factor of the German economy must not be jeopardised, which is essentially interlinked with doctoral theses. Physics research is conducted in an environment of international competition, in which the pioneering works required for a doctorate can only be achieved by focusing intensely on the particular field of work.

4) And an analysis of the activity and remuneration models of the PhD candidates in Physics shows that it is not at all a “Third Cycle” of higher education. On the contrary, in terms of the stipulations of the new higher education laws in Germany, with their diploma or master’s degree the doctoral candidates possess a *full professional qualification*, and in their doctoral work are basically pursuing a professional activity. This is particularly evident from the fact that in the majority of cases they are remunerated under time-limited contracts of employment for work in research and teaching and *not* for writing a doctoral thesis. At the recently set up graduate schools and graduate colleges there are also financing models in the form of doctoral scholarships. However, in these cases, too, the scientific work is the number one priority. Without exception the models set up in Physics strive to increase the research work to which the other elements of the graduate school / graduate college have to contribute.

5) Based on its analyses of the objectives of the doctorate in Physics and the efficiency in achieving these objectives, the study reaches the conclusion that models of “structured doctorates” have to be rejected if the time “structures” and additional subject “structures” they introduce result in the doctorate being made too school-like.

6) The general professional qualification is the task of study. If this is to be cut with the idea of streamlining the study there, then it cannot be the task of the doctorate to catch up on it here. This also puts tight limits on the furnishing of what are termed key qualifications during the work towards the doctorate. This study also takes a critical view of stays abroad during the doctorate period unless their primary purpose is to advance the research work. This is not to undervalue the aspect of personality development in any way: but stays abroad justified solely by personality development belong to the bachelor’s or master’s study or in the post-doctorate phase.

7) The study rates the introduction of graduate schools and graduate colleges as positive, provided contrary to the name adopted from American English they are set up not as

“schools” but as centres for increasing efficiency in achieving the predominantly scientific aims of the doctorate. Graduate schools and graduate colleges can result in improved social identification for the graduates and effectively promote exchange among the PhD candidates. Particularly when specific interdisciplinary topics are dealt with in parallel doctoral theses in one location they can also provide teaching, if the disciplinary qualification acquired during studies is not sufficient for the successful elaboration of the topic.

8) However, graduate schools must not represent the only way to the doctorate. It must still be possible to pursue a doctor’s degree through dissertations that are on autonomous topics and therefore not the subject of a graduate model, purely and simply because innovative topics generally only come into physics in this way. Moreover, the majority of research in Germany is carried out at extra-university research institutes, and university research conducted with large-scale equipment in Germany or other countries is not easily compatible with the obligation to attend a graduate school or graduate college. The same applies to doctoral work done in industrial firms under the simultaneous supervision of industrial and university scientists. Making such ways to the doctorate harder by obliging the PhD candidates to attend graduate schools and graduate colleges as a precondition for being admitted to the doctorate would jeopardise these models of co-operation that are so desirable both for young physicists and for science and business.

9) The possibility created by the revised form of courses of study in Germany of going directly from the bachelor’s degree to the doctor’s degree without acquiring the master’s degree (“fast track”), is criticised by the study. It must remain the exclusive preserve of specially gifted outstanding students. Suitability for this route must be proven by corresponding achievements *before* a student is admitted onto such a course. In graduate schools that lead directly from the bachelor’s degree to the doctor’s degree, before the actual doctorate phase specially qualified students acquire the knowledge and skills equivalent to a master’s degree in a one-year crash course before the actual doctorate phase. Unlike the normal doctorate, such courses have to be accredited. The study rejects doctorate courses on which students who do not belong to this elite group and because of their inadequate qualification are supposed to be “brought up to scratch” for the doctorate through “coaching”.

10) The following additional salient points are essential for the doctorate in Physics, and it is therefore imperative they are considered, regardless of the particular doctorate model pursued:

- The fundamental admission requirement for the doctorate is a master’s qualification. Only in exceptional cases can specially talented applicants without a master’s degree or diploma be admitted to the doctorate after passing a procedure to ascertain their suitability.
- In general the doctorate should be completed in three to three-and-a-half years, to give the PhD candidates good chances of starting a career in business or science.
- A doctorate committee should monitor the doctorate from the beginning of the research activity until the completion of the examination, and must be regularly informed by the PhD candidates and their supervisors of the progress of their work.
- The doctorate is supervised by *one* member of the faculty responsible with expertise in the particular specialist field. The study rejects collective responsibility because it can-

not ensure faultless supervision. Usually the doctorate is under a research project conducted by the supervisor, who thus has a genuine interest in the swift progress and success of the work.

- Additional courses can be appropriate to a limited extent, especially when interdisciplinary research projects require specialist knowledge that is not part of the higher education in the PhD candidates' specialist discipline. In general, courses in the doctorate phase are to be kept to a minimum to enable the candidate to dedicate himself/herself to the extremely tough requirements of the actual research work. The courses must be organised in such a way that as far as possible PhD candidates with jobs outside the university (e.g. in industry or at extra-university research institutes) can also attend them.
- The study basically advises against courses in General Physics, since they can only be conducted at the expense of the time available for research. A number of so-called key qualifications or soft skills are automatically acquired in Physics in connection with the research work. Doctoral and working group seminars as well as presentations at scientific conferences promote communication skills and the use of presentation techniques; working with specialist literature and writing scientific papers develops English language skills. As in most cases doctorate work is done under research projects, the PhD candidates gain insights into applying for, planning and reporting on projects.

The DPG appeals to those responsible in politics, in the ministries and in the universities, to proceed when reforming the doctorate and redrafting the doctor's degree regulations of the universities in Physics with the diligence that one of the most important instruments for preserving the outstanding position of German research throughout the world deserves. The DPG appeals to the physicists in universities and extra-university institutions to stand up for an appropriate high quality of the doctorate in Physics, in assuming their responsibility for their specialist field, for high quality of teaching and education and of scientific research.

*The **Deutsche Physikalische Gesellschaft** (German Physical Society, DPG) with a tradition extending back to 1845 is the oldest physical society in the world, as well as being the largest with about 60,000 members.*

The DPG sees itself as the forum and mouthpiece for physics and is a non-profit organisation that does not pursue financial interests. It supports the sharing of ideas and thoughts within the scientific community, fosters physics teaching and would also like to open a window to physics for all those with a healthy curiosity.

The DPG brings together professors, students and teachers, those working in industry and those who are simply interested in physics as such, as well as science journalists and patent agents. At present the DPG counts nine Nobel Prize winners in its ranks. The Society has always had world-famous members, including Albert Einstein, Hermann von Helmholtz and Max Planck as former DPG Presidents for example.

The DPG is funded primarily by membership fees. It also receives financial support for its activities from state and national sources, as well as non-profit organisations. The DPG co-operates on a particularly close scale with the Wilhelm and Else Heraeus Foundation.