

**Good scientific practice
for scientific qualification reports and theses
in physics**

Recommendations of the Konferenz der Fachbereiche Physik

www.kfp-physik.de

18th May 2016

Foreword

For several years now, a discussion has been taking place not only among scientists but also in the general public, as to which scientific and ethical standards should form a basis for scientific reports and theses.

The Konferenz der Fachbereiche Physik (KFP) welcomes this discussion. However, this discourse on standards is more complex than most of the examples of obvious scientific malpractice suggest. Scientific and ethical standards are based on general principles. They can, however, be accentuated differently from subject to subject and, in the course of time, also be altered.

An adequate assessment of breaches of conduct with regard to good scientific practice within the framework of reports and theses requires that the rules practiced at the time at which the report or thesis was authored within the particular subject in question are known. Subject-related issues may arise in physics, for example from the common and desirable collaboration in teams or the usual practice of rapidly publishing research results in order to participate in the scientific discourse.

The KFP thus regards it as important to record the current standards expected for a scientific report or thesis in order to be regarded as conforming with the regulations of “good scientific practice”. The present paper is based on the general document issued by the Allgemeiner Fakultätentag, the Fakultätentage as well as the Deutscher Hochschulverband ¹ and focusses on the specific situation within physics in Germany. It is more detailed and therefore complements the existing recommendations of that document. In addition, the rules and regulations of the Deutsche Forschungsgemeinschaft² and the recommendations of the Hochschulrektorenkonferenz³ have also been taken into account.

The recommendations to be found here apply to bachelor, master and doctoral theses, and are also applicable to “Habilitation”-theses. They are also appropriate for reports that have to be made during the undergraduate course of study, such as reports on practicals, in order that students obtain the correct orientation at the earliest possible point within their studies, and develop a critical view of possible problems. The academic requirements to be fulfilled for each of these types of reports differ considerably. From the point of view of good scientific practice, however, they should in principle all be handled in the same fashion. Note that other additional criteria may exist for the publication in scientific journals and for the execution of other scientific projects.

This paper presents the current general set of accepted standards for the preparation and writing of scientific qualifying reports and theses in physics. They do not necessarily represent an ideal. In some cases, it is still contentious as to which standards should be attained.

Qualifying reports and theses are always subject to the regulations of the applicable ordinances of each university, and these can be more detailed or, in some aspects, even in contradiction to the guidelines listed here. For example, it may be prohibited to publish research results before the qualifying report has been submitted. Furthermore, regulations laid down by third parties

that provide funding or other regulations for the publication of research results may also be relevant.

These recommendations should be made available to persons involved in preparing qualifying reports and theses, possibly after making suitable adjustments pursuant to the local environments. In this fashion, it should enable one to determine even after considerable time what exactly had constituted the rules of scientific practice at the time of submission of the qualifying report or thesis. At the same time, it appears sensible to discuss in which fashion some rules, which purposely have been kept vague, can be made more precise. For scientific qualifying reports or theses, at present there is no general consensus on, for example, how long, by whom, and in which form experimental or numerical data as well as the associated software should be kept.

The most important goal of these recommendations is to provide an orientation for all those involved with the production and evaluation of scientific qualifying reports and theses in physics. Moreover, this paper should provide a contribution to the debate on the further development of scientific and ethic standards.

References:

1. *Gute wissenschaftliche Praxis für das Verfassen wissenschaftlicher Qualifikationsarbeiten*, Gemeinsames Positionspapier des Allgemeinen Fakultätentags (AFT), der Fakultätentage und des Deutschen Hochschulverbands (DHV) vom 9. Juli 2012.
(www.hochschulverband.de/cms1/uploads/media/Gute_wiss._Praxis_Fakultaetentage_01.pdf)
2. *Sicherung guter wissenschaftlicher Praxis*, Deutsche Forschungsgemeinschaft, Wiley-VCH, Weinheim, 2013.
(www.dfg.de/download/pdf/dfg_im_profil/reden_stellungnahmen/download/empfehlung_wiss_praxis_1310.pdf)
3. *Gute wissenschaftliche Praxis an deutschen Hochschulen*, Empfehlung der 14. Mitgliederversammlung der Hochschulrektorenkonferenz am 14. Mai 2013.
(www.hrk.de/uploads/tx_szconvention/Empfehlung_GutewissenschaftlichePraxis_14052013_02.pdf)

Good scientific practice for scientific qualifying reports and theses in physics

The criteria listed here for good scientific practice in conjunction with qualifying reports and theses draws on two aspects of scientific work, the processes of obtaining new physical insights as well as the representation of the results. Utilizing the rules of good scientific practice is an important goal of learning within undergraduate and graduate studies, in particular in constructing bachelor and master theses, but also already relevant at an earlier stage, for example, during the undergraduate practical experiments. The authors themselves are responsible for upholding the rules and regulations of good scientific practice. They are guided by their supervisors, who advise in such a way as to see that the rules of good scientific practice are upheld.

1. Obtaining scientific results

As a prerequisite for obtaining a scientific qualification, the candidate must provide proof of his/her capability to perform appropriate scientific research. In physics this is usually provided through work done in collaboration within a research project, or, at the latest during doctoral studies, through independently carrying out a research project.

Thus, before addressing the standards required for the presentation of scientific results, the question of standards that should be adhered with regard to the actual process of performing research must be addressed.

1.1. Dealing with data

Physical insights are often gained through experimental or numerical data. The process in which this data is obtained and the way the data are handled is thus of central importance. Good scientific practice starts already with the design of an experiment or numerical evaluations. These must be designed such as not a priori to exclude or suppress “unwanted” results.

Scientific research includes providing an understandable description of the methods used and the results obtained so that these can be reproduced. Scientific research must include a readiness to call the results into question. Facts and arguments that shed doubt on a working hypothesis may not be ignored.

In any case, it is inadmissible to falsify data, i.e. to manipulate data or fraudulently place data in another context in order to render these compatible to a desired result. It is regarded as particularly grossly fraudulent to invent or to suppress relevant data.

The process of preparation, analysis and interpretation of data, in order to deduce physical results from primary data generated experimentally or numerically must be clearly laid out. Here, different techniques such as filtering and smoothing can be used. If data points or sets of data are weighted differently or in fact completely disregarded, this must be scientifically justifiable and must be documented accordingly.

1.2. Documentation

Scientifically generated primary data, together with the processes associated with them for further evaluation (including e.g. parameters of the experiment or the computer programs used) must be documented and archived, so that a reconstruction of the scientific results presented in the qualification report or thesis is possible. In which form this should occur is at present not clearly regulated, and can probably not be done generally for all fields within physics; aspects that may play a role here include the sometimes extremely large volume of data that may be generated in specific experiments or the regulations laid down within large collaborations. At the beginning of a project, the persons involved (authors, supervisors, institution) should agree on the practices for documentation and long-term archiving.

1.3. Combined work within a team

Physics research projects are often performed within teams, and in some fields of physics large research teams are unavoidable. Thus, within the framework of a physics qualification report or thesis, often the capacity for teamwork is an important characteristic. At the same time, such a qualification report or thesis has to be presented as the author's own work. This can lead to rather difficult circumstances. In complex projects such as doctoral theses, it may not always be possible to separate out the individual contributions from each of the persons involved. For this reason, it is strongly recommended that the contributions towards the progress made on the project be documented at regular intervals. This is the responsibility of all persons involved.

1.4. Aspects of supervision

With the exception of „Habilitation“ theses, physics qualification reports and theses are usually performed under the supervision of an advisor or an advisory team. For reports and theses that are performed at the undergraduate or master level, it is the responsibility of the supervisor to convey knowledge and aid the student in developing the necessary capabilities. At the latest, at the doctoral level, the role of the supervisor shifts to being more of that of a mentor, who acts as a knowledgeable discussion partner, and who can point out problems and possible perspectives. In Germany it is common practice that the supervisor of a report or thesis also acts as an examiner for the same, and provides an evaluation thereof. Often undergraduates, master and doctoral students not only work closely with some supervisor, but also work on an explicit project of this supervisor. In most cases, this occurs without friction. However, in some cases it can become problematic that the supervisor is, at the same time, the discussion partner, the boss, and later the referee and examiner. In view of this, it is recommended that an ombudsperson be named or that a council be established to handle cases where conflict arises. This is currently not the case everywhere.

1.5. External influences¹

Qualification reports and theses in physics are sometimes performed together with companies that may have a commercial interest in the results of a research project. Often the results generated – sometimes the project itself – underlie specific confidentiality or non-disclosure agreements, for which the legal status may be complex. With a view to performing scientific qualification reports or theses, it should at least be guaranteed that the supervisor at the university is comprehensively informed about the concept that is to be followed and is constantly informed about the progress of the project and in such detail that he/she can make a well-substantiated evaluation of the contribution made by the undergraduate, master or doctoral student.

2. Presentation of scientific results

In physics, it is customary to publish scientific results first in peer-reviewed journals. Scientific qualification reports or theses can therefore often be the place in which the results are not published for the first time, but which provide an extended presentation of these published results. For the publication in peer-reviewed journals, there are usually specific regulations set down by the publishers.

In certain cases, in particular for “Habilitation” theses a cumulative thesis may be acceptable. Such a thesis form will mainly consist of already existing publications. As a rule, though, the main results obtained during the qualifying phase must be written up again in the qualifying thesis or report, even if they have already been published.

In general, not only the skill in obtaining results and the author’s general physics knowledge should come across; also the quality of the presentation of the results in such a thesis forms an essential criterion for the evaluation and decision to award the corresponding academic degree. A qualification report or thesis must conform to the standards of good scientific practice, which in different fields may differ somewhat. The following remarks thus pertain solely to the fields of physics.

2.1. Independent intellectual thought

A scientific qualification report or thesis must be an independently created intellectual accomplishment of the author. This precludes that the report or thesis is written, even in part, by a third party and is claimed as the work of the author, even if the third party agrees to this (ghostwriting).

¹ Cf. the paper on „Die Industriepromotion. Regeln guter wissenschaftlicher Praxis“ (Deutscher Hochschulverband, January, 20, 2016), www.hochschulverband.de/cms1/fileadmin/redaktion/download/pdf/resolutionen/Industriepromotion.pdf

At the same time, in physics it is part of the scientific discourse that parts of the qualification report or thesis are presented in advance to another person, e.g. to the supervisor, for critical commentary. Such commentary can refer to the interpretation of the scientific results themselves, the organization of the subject matter, or the chain of arguments within the report or thesis. For doctoral theses, the commentary should rather have the character of a collegial feedback. For reports and theses within undergraduate or master studies, it is also a duty of the supervisor to aid the student in developing the competences necessary for writing such a report or thesis. Within the development of the study program, this aspect should play a lesser role.

In particular, in cases in which qualification reports and theses are based on projects involving many people and which may have led to joint publications in scientific peer-reviewed journals, one may assume that the interpretation of the scientific results and the question of their adequate representation was duly discussed by all members of the project prior to publication in a qualification report or thesis. It is therefore difficult to define an abstract line beyond which such a document no longer can be seen as the result of independent research of the submitting author. Thus, for research performed within the framework of collaborations, it must explicitly be made clear what the individual contribution of the author is. In addition, it may occur that the author of a qualifying report or thesis concurrently participates in the supervision of another person's qualifying report or thesis. The results obtained thereby can be used by the author, if he/she provided a substantial contribution to obtaining these. In this case, it is important to reference the other qualification report or thesis and to clarify the contribution of the other person involved.

2.2. Embedding within the scientific context

In a qualification report or thesis it must be clearly recognizable what the original contribution of the author is, and where he/she draws on thoughts and results of others or refers to specialist's general knowledge. If portions written by other authors are included, either literally or paraphrased, or where ideas, concepts or results of others are utilized, these must be declared and referenced. This holds for the entire qualification report or thesis, including introductory sections.

It can happen that someone performs scientific research and obtains specific results, and then publishes these, not realizing that others have already done so. The author of a qualification report or thesis has, however, to have informed him/herself adequately about the scientific environment surrounding the project, and should do sufficient research to avoid such cases, as far as is possible.

In order to embed the research performed into its scientific context, scientific qualification reports or theses often contain parts in which specialist's general knowledge including descriptions entailing formulae or established experimental or theoretical techniques are presented. Usually in this case no special sources must be quoted, unless the author refers to some particularly original presentation or if specific passages are taken verbatim. What is considered as general knowledge of specialists would be the putative knowledge of scientists working in the field of the qualification report or thesis.

2.3. Own reports and texts

It is not uncommon that authors of physics qualification reports or theses have already published the results of their research in peer-reviewed journals or elsewhere. If this is the case, the authors must explicitly mention this in their report or thesis and provide references to the first instance of publication.

At the same time, it is usually not necessary to refer to this first instance of publication every time a statement or result is taken from it, even if small passages of text are quoted verbatim. For publications with several authors, however, this is only applicable to results or passages for which the author has made a substantial contribution. Should figures be taken from one's own publication, in as far as this is admissible through the copyright regulations, the first instance of publication must be cited in the figure caption.

2.4. External influences

It is part and parcel of an adequate representation of the research performed that all external factors be clarified, which may, in the view of an objective third party, throw doubt as to whether a completely independent scientific judgement was formed. Thus, it is particularly important that support obtained from a company or other stakeholders be clearly stated.

Referees of qualification reports or theses that are written in conjunction with a company must have full access to all relevant data, so that they are able to obtain their own complete picture of the scientific quality of the research that was performed. Regulations for this must be made before the project starts, and the legal department of the University in question should be involved in the process. It should also be kept in mind that doctoral theses must be made publically available.

The original German version of these recommendations was approved on 18th May 2016 in the General Meeting of the Konferenz der Fachbereiche Physik (KFP). It corresponds to the status of the discussion at this point in time and will be updated as necessary.