



## Advanced Labwork in Astronomy and Astrophysics – Guidelines

These guidelines help you to successfully complete the advanced lab course. **Please read them carefully in advance and follow them!**

The central website for the course is <http://uni-tuebingen.de/en/4203>. It comprises the schedule, the protocol status, and detailed instructions for each experiment.

Each student has to conduct five experiments to successfully complete the course. The certificates are not printed, but digitally reported to the Prüfungsamt.

Students of the specialized course in Astronomy and Astrophysics have to carry out at least three experiments of the section Astronomy and at least one experiment of the section Computational Physics. Within the section Astronomy *Photometry and Spectroscopy* is obligatory.

Students of Master Astro and Particle Physics have to carry out at least three experiments of the sections Astronomy and Computational Physics and at least one experiment of the section Nuclear Physics.

### Preparation

**It is absolutely mandatory that you read and understand the instructions before lab day in order to be prepared for each experiment.** If you do not understand parts of the instructions, contact the tutor for clarification. You can use the given references to textbooks or publications to foster your knowledge of the subject.

**Some instructions comprise tasks for preparation that you have to solve before lab day and present during the introduction session.**

### Lab day

Before starting the experiment, one to two hours are reserved for an introductory session with the tutor. In this session, you will discuss theory and background of the experiment and present your results of the preparation tasks. **If it turns out that you are not sufficiently prepared, the tutor is obliged to exclude you from the experiment leading to a fail.**

Be sure to take detailed notes during lab day, especially of the measurements. You will need this information for the protocol.

If you cannot attend the experiment, contact the tutor and the other group members timely. If you do not show up on lab day, please hand in a doctor's certificate.

### Protocols

A protocol for each conducted experiment has to be written and sent to the specific tutor.

As a general guideline, consider the purpose of a protocol as to make the experiment and its results understandable to an outside person who has not read the instructions. Therefore, you need to explain the underlying theory to a level of detail that is necessary to understand the conducted experimental and analysis procedures and the results. **Stay tightly at the experiment as it was carried out. A protocol is not a list of facts and not an excerpt of the instructions, but gives a concise, comprehensive and comprehensible explanation of the experiment.**

The original measurement data have to be included in the protocol. If you provide only an electronic submission of the protocol, add scans of the original data sheets.

**Use external material only sparsely in the protocol, e.g. figures or tables, and always reference the source. This is also true for textual citations even in case you alter or rearrange the text.**

A standard protocol should contain the following sections and not exceed the page limits:

1. Abstract (max. 1/2 page).
2. Theory: A short overview over the most important points of the experiment, including the answers to the questions (max. 2 to 3 pages plus questions).
3. For each experimental part:
  - a) Description of setup and of experiment execution (1 to 3 sentences each).
  - b) Tabulated measurement results.
  - c) Analysis and graphs (including detailed calculation, giving all formulae and values with units used).
  - d) Discussion of result (1 to 3 sentences).
4. Conclusions (max. 1/2 page)
5. References: List all sources
6. Appendix: Your original notes

It is not allowed to

- use arbitrary data or data from other groups,
- use text or graphs from other groups,
- use text or graphs from publications, instructions, or the internet (e.g. Wikipedia) without correct citations.

**Any infringement against these points is fraud or plagiarism<sup>1</sup> and leads to a fail (or worse).**

### **Error Analysis**

Special care has to be taken for the error analysis: Each measurement has an error that has to be known in order to interpret the data correctly. A complete error analysis of the measured data is crucial and part of an experiment protocol (where explicitly requested in the instructions or by your tutor). A complete introduction into the propagation of errors is over the scope of these guidelines, please consult standard textbooks or Wikipedia<sup>2</sup>.

### **Deadlines**

**The deadline for handing in a protocol is four weeks after you have conducted the corresponding experiment. The deadline for corrected protocols (two times maximum) is two weeks after you have received the annotations by the tutor.** If you do not hand in the protocols in time or if the second correction is still significantly wrong or incomplete, the specific experiment is considered as failed. **However, even a quite substandard first submission might directly lead to a fail!**

Requests for deadline extensions are handled centrally by the lab course organizer and can be granted only if a doctor's certificate is presented.

### **Failed experiments**

If you have failed one or more experiment(s), you have the opportunity to complete the course in the following term. If the failed experiment was elective, you have to conduct a different one. If the failed experiment was obligatory, you have to conduct it again.

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<sup>1</sup>What is plagiarism: <https://libguides.sjsu.edu/plagiarism/home-page>

<sup>2</sup>Error propagation, see [http://ipl.physics.harvard.edu/wp-uploads/2013/03/PS3\\_Error\\_Propagation\\_sp13.pdf](http://ipl.physics.harvard.edu/wp-uploads/2013/03/PS3_Error_Propagation_sp13.pdf) and [https://en.wikipedia.org/wiki/Propagation\\_of\\_uncertainty](https://en.wikipedia.org/wiki/Propagation_of_uncertainty)