Quantization of conductance in nanowires

PHYS-E0411 Advanced Physics Laboratory

Supplementary information

Teaching assistant: Marie-Melody Volard
email: marie-melody.volard@aalto.fi

Spring 2021

Contents

1 Exercise layout

You can find below further details on the running of this exercise and description of the available material. This should mostly be repeat of what was communicated to you before. The next 2 sections provided further explanation on the different assignment and their **detailed** marking scheme. The last section focuses on issues and extensions.

Like the rest of this course the experiment is shown in the video available in MyCourses. Please read the 'laboratory-instructions' **before** watching the video. The instruction include a summary of the theory required to understand the experiment. The theory is derived from the solution of the Schrödinger equation for 'a particle in an infinite square well'. Students are assumed to have come across this derivation before and is widely available in all undergraduate level quantum mechanics books. However, if you are unfamiliar with this derivation do not hesitate to contact me and I will go through it in more details. My contact informations can be found on the cover page of this document. Once you have familiarised yourself with the instructions please watch the video of the experiment. Some additional documents mentioned in the video are also available in MyCourses such as: picture of the gold wires, the Rigol and Digilent oscilloscope, documentation of the Rigol oscilloscope, and screen capture of the Digilent software with voltage steps visible. Again feel free to contact me if you have any questions about any of the provided material. Once you reviewed all the material you can choose whether you would like to be graded on this exercise or not and which type of assignment you wish to hand in (report or lomake). There are slots for 5 reports and 10 lomake for this exercise, with registration being on a first come, first served basis. If you chose to complete an assignment, 15 cvs files each containing data for 1 trace will be sent to you along with a pdf containing results of the calibration section and further hints for the exercises.

2 Lomake

This assignment requires you to answer questions 7, 8, 12, 13 and 14 of the laboratory instruction and can be found on MyCourses (word document). You have **3 weeks** to perform the data analysis and answer the questions. Please submit the lomake along with required graphs either on MyCourses or via email as pdf or word documents. The lomake is graded out 5, with points being distributed as follows:

- All questions have been answered **0.5pts EXTRA**

- Answering questions 7, 8 and 12 correctly **1pt** (error in question 7 and/or 8 will only be deducted once)

- Error analysis **1pt** (**0.5pts** for 7&8 each)

- Discussion **1pt** (**0.5pts** for 13 & 14 each)

- Physical quantities on the graph's axis are given, complete with units **1pt**

- Appropriate choice of bin number, width and centering for Q14 **1pt**

Please note the extra 0.5 points for answering all questions! This will only be given to compensate a lost mark in numerical questions or error calculation (question 7, 8 and 12) or if an attempt at discussing results in Q13 and 14 is made. If you encounter any issues with the data analysis or require further explanation feel free to drop me an email. Also note that the assignment suggests to use MatLab however any program you feel most comfortable using is fine as well. Note that I will only be able to answers questions for data analysis made in Python or Matlab.

3 Report

This assignment requires you to answers **ALL** the questions provided in the laboratory instruction (including prerequisite questions). You have **3 weeks** to hand in a first version of the report and a further **1 week** for the 2nd version. Please submit the report as a pdf via MyCourses or email. The report is graded out of 10, with points being distributed as follow:

• All questions were answered (**1pt EXTRA**)

• Answering questions 7, 8 and 12 correctly **1pt** (error in question 7 and/or 8 will only be deducted once)

• Discussion **2pts***

• Error analysis **2pts** (**0.5pts** for 7&8 each and discussion on error **1pt**)**

• Language **1pt** (mistakes are authorised but should be scarce, overall the text should be easy to read and understand)

• Structure **1pt** (Introduction, Theory, Set-up/method, results and conclusion each in their own sections)

• Referencing **1pt** (3-7 relevant and correct references)

• Physical quantities on the graph's axis are given, complete with units **1pt**

• Appropriate choice of bin number, width and centering for Q14 **1pt**

* From theory what would be the expected result? Do the results match the expected? If not why not? Can you think of any improvement?

** Is the error a reasonable value? What are the main source of error you can think about (some are given in the video)? Can these error be reduce in any way?

Please note the extra 1 point for answering all questions! This will only be given to compensate a lost mark in numerical questions or error calculation (question 7, 8 and 12) or if an attempt at discussing results (Q13&14) and/or error is made. If you encounter any issues with the data analysis or require further explanation feel free to drop me an email. Also note that

the assignment suggests to use MatLab however any program you feel most comfortable using is fine as well. Note that I will only be able to answers questions for data analysis made in Python or Matlab.

4 Issues and extension

As previously mentioned you can contact me at any point with any questions you may have regrading the material and/or assignments. Regarding the assignments: given the unusual arrangement of this course due to the corona virus I would be lenient and give a couple of extra days to hand in an assignment **only** if you give a reasonable explanation **before** the due date of the assignment. These include: issues understanding the theory and/or questions, difficulties with MatLab or equivalent, delay in receiving an answer to a question asked to me, personal circumstances etc... Longer extension can also be given but require the approval of the course coordinator and a doctor note.