

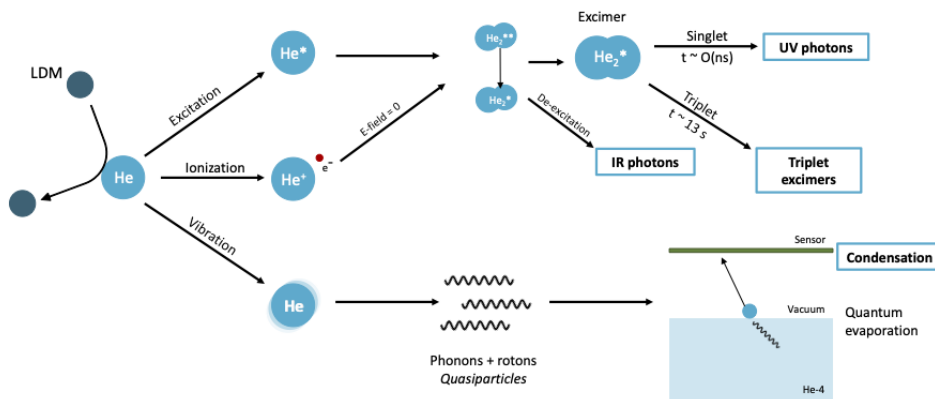
Exercises for Modern Experimental Physics III (Experimental Particle and Astroparticle Physics) Summer term 2024

Exercise sheet Nr. 4

To be worked on until 27.06.2024

DELIGHT (Direct search Experiment for Light dark matter, <https://delight.kit.edu/>) [1] is an upcoming direct detection dark matter experiment using a novel approach to probe the thus far uncharted low mass dark matter parameter space.

To be able to detect signals from potential dark matter in the sub-GeV domain, a sophisticated experimental setup is necessary. The active detector volume consists of superfluid ^4He , which when excited releases its energy via quasiparticles, photons and excited molecules. By precisely measuring these energies, light dark matter (LDM) signals can be distinguished from the recoil background.



For the precise determination of these energies magnetic microcalorimeters (MMCs) are utilized in the experiment [2]. The principle is that an absorption of energy causes the temperature of the sensor to increase, which in turn changes the magnetization of the sensor. This change in magnetization can then be measured by

a superconducting quantum interference device (SQUID), leading to an unprecedented energy resolution in this energy regime. However, before the MMCs can be deployed in the experiment they need to be calibrated first with a proper source, which will be the assignment of this exercise sheet.

The specific tasks for this exercise sheet are again provided by a Jupyter Notebook, which you can find at the usual location: https://gitlab.etp.kit.edu/Lehre/modexp3_forstudents. For this exercise it is sufficient to use the standard `Datenanalyse` container on the jupytermachine.

Exercise 1: Theoretical Model (3 points)

Exercise 2: Traces (3 points)

Exercise 3: Event Selection (4 points)

Exercise 4: Time Correction (5 points)

Exercise 5: Energy Calibration (5 points)

References

- [1] B. von Krosigk et al., “DELIGHT: A Direct search Experiment for Light dark matter with superfluid helium”, *SciPost Phys. Proc.* **12** (2023) 016, [arXiv:2209.10950](https://arxiv.org/abs/2209.10950). doi:10.21468/SciPostPhysProc.12.016.
- [2] M. Krantz, F. Toschi, B. Maier et al., “Magnetic microcalorimeter with paramagnetic temperature sensors and integrated dc-SQUID readout for high-resolution x-ray emission spectroscopy”, *Appl. Phys. Lett.* **124** (2024), no. 3, 032601, [arXiv:2310.08698](https://arxiv.org/abs/2310.08698). doi:10.1063/5.0180903.



Fachschaft Physik, jDPG und Mentoren
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Einfach vorbeikommen!

Physiker*innen im Beruf

Montag 24. Juni 2024
ab 17:30 im Gaede-Hörsaal

*Elevator Pitches & Get-Together
in entspannter Atmosphäre*

