PHYS-511 **Electron spectroscopy**

Dil Hugo

| Cursus | Sem. | Type |
|---|---|---|
| Ing.-phys | MA1, MA3 | Opt. |
| Physicien | MA1, MA3 | Opt. |

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| Language of teaching | English |
| Credits | 4 |
| Session | Winter |
| Semester | Fall |
| Exam | Oral |
| Workload | 120h |
| Weeks | 14 |
| **Hours** | **4 weekly** |
| Courses | 2 weekly |
| Exercises | 2 weekly |
| **Number of positions** | |

## Summary

Series of lectures covering the use of electron spectroscopy for the study of the electronic and atomic structure of surfaces, nanostructures, and quantum materials. Special attention is given to various forms of photoelectron spectroscopy and to spin detection.

## Content

1. Technical considerations: sources, detectors, energy filters and analysis, vacuum
2. Diffraction based techniques: LEED-(IV), RHEED, surface reconstructions, thin film growth, interlayer spacing and structure determination
3. Energy loss techniques: Auger, EELS, chemical analysis, collective excitations and quasiparticles
4. Local probe techniques: STM, STS, IETS, nanostructures, atomic and molecular excitations
5. Photoelectron spectroscopy: XPS, ARPES, band structure measurements, correlated materials, spectral function, buried interfaces, crystal symmetry, collective excitations
6. Time-resolved photoelectron spectroscopy: unoccupied states, relaxation dynamics, attosecond streaking
7. Spin-resolved photoelectron spectroscopy: detection methods, SARPES, topological materials, spin interference, determination of quantum time scales

## Keywords

Electronic structure, quantum matter, spin, topology, spin-orbit interaction

## Learning Prerequisites

### Important concepts to start the course

This course requires an understanding of the basic concepts of solid state physics such as crystal structures, band structures, orbital compositions, and phonons. Solid state physics I and II are strongly recommended.

## Learning Outcomes

By the end of the course, the student must be able to:

- Interpret experimental data sets in terms of observables
- Compare different experimental methods and decide which is best for a given problem
- Decide which is best for a given problem
- Explain the sources of spin polarisation for photoelectrons
- Analyze scientific literature using electron spectroscopy

## Teaching methods

The course is composed of 2 hours of ex cathedra lecture and 2 hours of exercises and discussion. The exercise sessions will contain data analysis and student presentations

### Expected student activities

The students are expected to read the bibliographical resources to prepare or follow the scientific presentations

### Assessment methods

The course grading is composed of an oral exam counting for 70% of the grade, a 45 minute topical presentation during class counting for 20% of the grade, and data analysis and discussion participation counting for 10% of the grade.

### Resources

#### Bibliography

Textbooks covering part of the course:
Hüfner, Stephan: Photoelectron Spectroscopy, Springer ISBN 978-3-662-09280-4 (in library)
Suga, Shigemasa: Photoelectron Spectrocopy, Springer ISBN : 3-642-37530-8 (ebook in library)

#### Notes/Handbook

various lecture notes will be provided during the cours