

Physics with neutrons (PH2053)

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Lecture 01

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MLZ is a cooperation between

Feedback more than welcome!

Lectures:

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starting 2nd of November

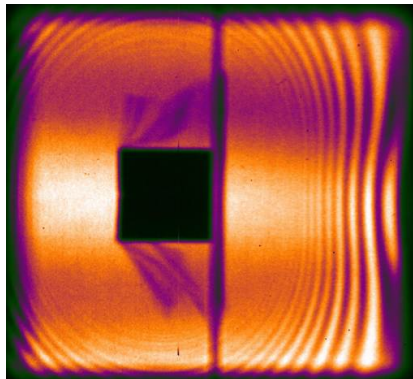
Website: <https://wiki.mlz-garching.de>

Oral exam, 5 CP – continuation in summer term!

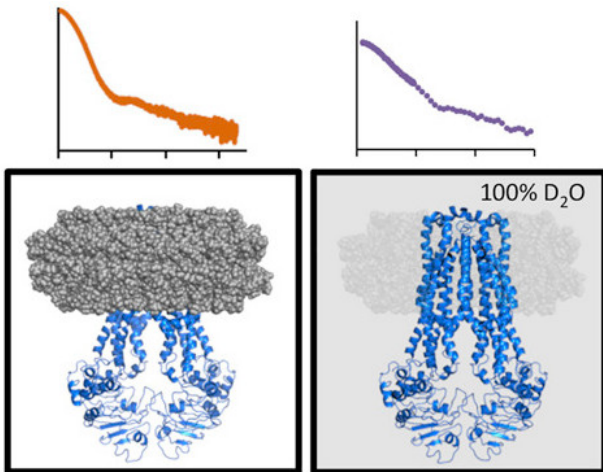
Making the invisible visible



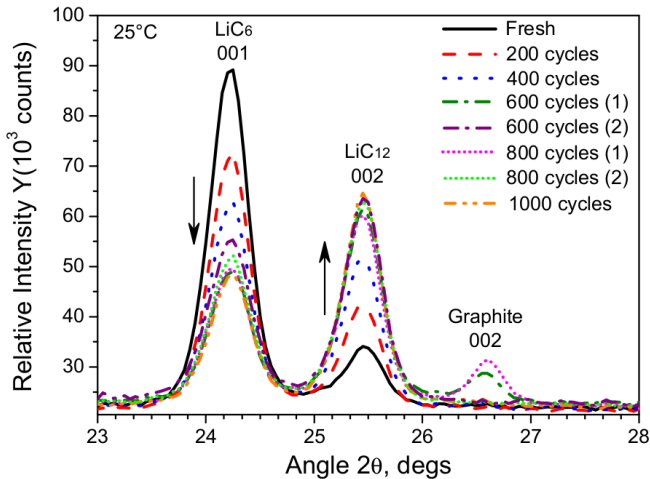
Making the invisible visible



also nanostructures



and even atoms!



Topics in the winter term

- Neutron/x-ray generation
- Neutron/x-ray absorption: radiography / tomography
- Neutron absorption: nuclear reactions
- Scattering theory
- Single crystal
- Powder
- Disorder – up to the liquid
- «large» structures in the bulk
- «large» structures at interfaces

Seminars

- Listen:
Neutrons in science and industry
Mondays 14:30–15:30, HS 3
e. g. next week: Valeria Rondelli (Milano)
Structural complexity and surface interactions in
biomembranes: a biophysical approach
- Talk:
Methods and Experiments in Neutron Scattering
P. Böni, C. Morkel, S. Mühlbauer
Kick-Off Meeting 24.10.2018, 9:00, Room PH2224

Seminar: Goals and motivation

- Acquire detailed knowledge in neutron scattering and its applications in the field of solid state physics or soft matter
- Working into a scientific topic under guidance and with the help of related literature
- Introduction into modern techniques used in neutron scattering
- Presentation of a comprehensible (!) talk about a scientific topic in front of your fellow students
- Last but not least: Certificate for presentation and presentation: 4 ECTS points

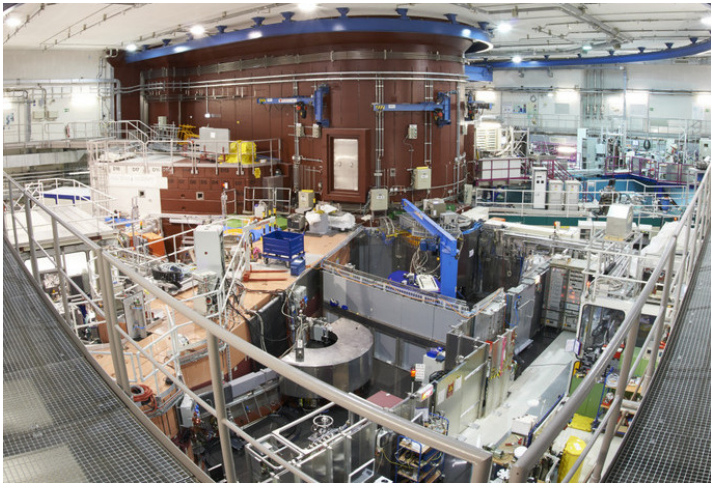
Seminar: Examples for topics

- Neutron sources
- Neutron optics
- Scattering by disorder
- Flux line lattices in superconductors
- Reflectometry with neutrons, heterostructures
- Quasielastic neutron scattering: TOF-technique, spinecho
- Lattice dynamics
- Magnetic structures, magnetic excitations
- Larmor techniques (MIEZE, NSE, NRSE, diffraction)
- 3D-Polarisation analysis, MuPad
- Extreme conditions
- Ultra cold neutrons (life time, dipole, gravitation)

Other lectures (= not this lecture)

- Reactor physics PH2050
- Particle physics with neutrons PH2066
- Physics with positrons PH2075
- Advanced materials analysis with synchrotron radiation PH2134

Reactor tour 5.11.



Literature

- D. Sivia
Elementary Scattering Theory
- G. L. Squires
Introduction to the Theory of Thermal Neutron Scattering
- S. W. Lovesey
Theory of neutron scattering from condensed matter
- B. T. M. Willis & C. J. Carlile
Experimental Neutron Scattering

The probes

Photon (x-ray)

- W. C. Röntgen 1895
- no electrical charge
- quite weakly interacting
- spin 1, no magnetic dipole
- 8 keV correspond to 1.54 \AA

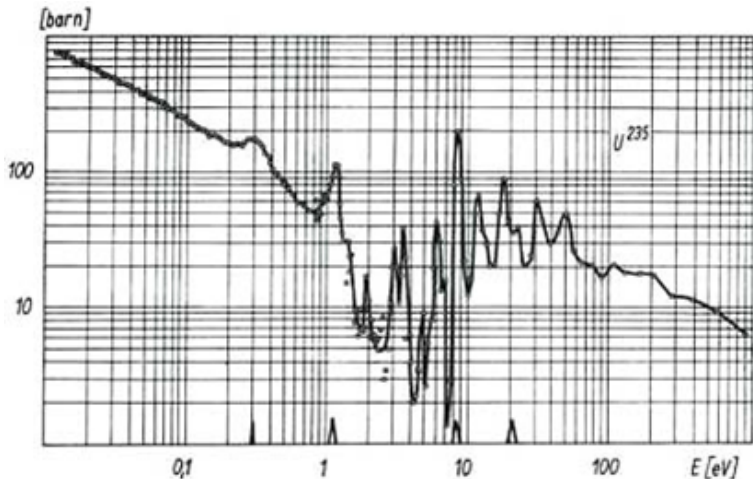
Neutron

- J. Chadwick 1932
- no electrical charge
- very weakly interacting
- spin $1/2$, magnetic dipole
- 25 meV correspond to 1.8 \AA

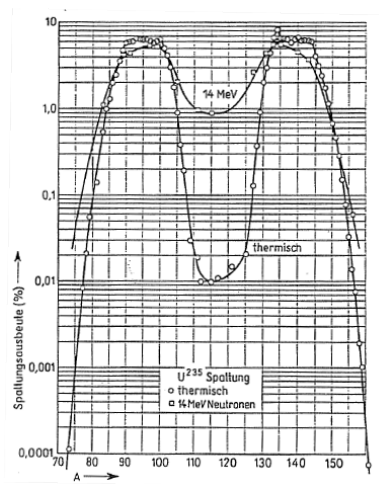
Neutron generation

- spallation: $\text{GeV } p + \text{heavy nucleus} \rightarrow \text{MeV } n$
- stripping: e. g. $\text{MeV } d + \text{Be} \rightarrow \text{MeV } n$
- fission: $\text{meV } n + {}^{235}\text{U} \rightarrow \text{MeV } n$

Neutron absorption cross section of ^{235}U



Fission reaction products



Neutron moderation

