FRM II
Forschungs-Neutronenquelle
Heinz Maier-Leibnitz

Physics with Neutrons I

Lecture: Prof. Dr. Winfried Petry
Exercises: Dr. Zach Evenson

email: zachary.evenson@frm2.tum.de

WS 2017/2018

Literature

Textbooks - all available in the TUM Physics Department Library

- G. L. Squires
Introduction to the Theory of Thermal Neutron Scattering, Cambridge University Press, Cambridge (1978), also Dover Publications, New York (1996).

- S. W. Lovesey
Theory of Neutron Scattering from Condensed Matter I, II, Oxford University Press, Oxford (1984).

- A. Furrer, J. Mesot, T. Strässle
Neutron Scattering in Condensed Matter Physics, World Scientific, Singapore (2009).

Literature

Internet resources

- Roger Pynn
Neutron scattering: A primer, Los Alamos Neutron Science Center
https://www.ncnr.nist.gov/summerschool/ss16/pdf/NeutronScatteringPrimer.pdf

- Michael Leitner (TUM)
Lecture script: Physics with neutrons
https://homepage.univie.ac.at/michael.leitner/skriptum_neutronphysics.pdf

Exercises

Exercises begin on **Friday, 17.11.17**
Meeting place: Room C.3202 (Container Building)
Meeting time: 12 - 14 Uhr

Student Seminar

Methods and Experiments in Neutron Scattering
Organized by Sebastian Mühlbauer and Christoph Morkel

Preliminary meeting on **25.10.17 at 9:15 Uhr**
Meet in **Room 2224**

Further inquiries: `Sebastian.Muehlbauer@frm2.tum.de`

Employment opportunity!

Work student on the time-of-flight-spectrometer TOFTOF
Up to 9 hr/week

We offer:

- Challenging and engaging working environment
- Direct access to state-of-the-art neutron scattering instruments
- Opportunity to develop professional working skills
- Possibility for Master's thesis

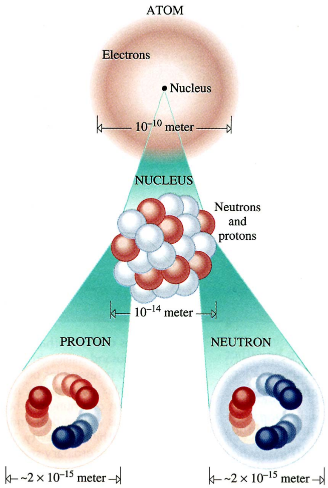
You have:

- Background in programming (C and/or Python)
- Interest in neutron scattering in solid-state materials

Are you interested?

Zachary.Evenson@frm2.tum.de

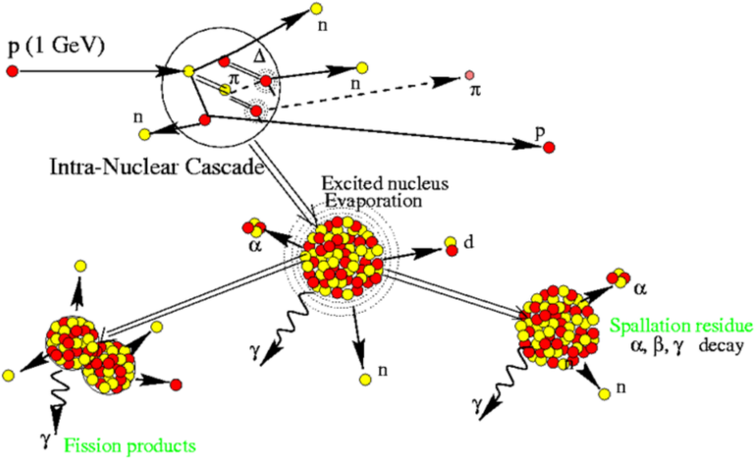
The atomic nucleus



Summary: Characteristics of different neutron sources

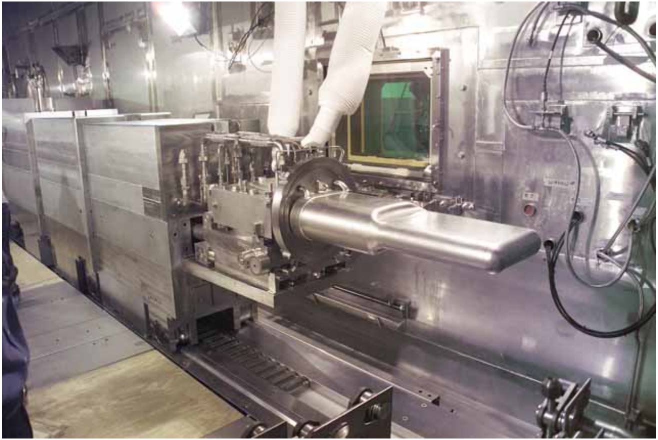
Reaction	Neutron rate	Heat deposition [MeV/n]	Source strength [n/s]
Spontaneous fission ^{252}Cf	3.75 n/fission	100	$2 \cdot 10^{12}$ g-1
^{9}Be (d,n) (15 meV)	$1.2 \cdot 10^{-2}$ n/d	1200	$8 \cdot 10^{13}$ mA^{-1}
^{3}H(d,n) (0.2 MeV)	$8 \cdot 10^{-5}$ n/d	2500	$5 \cdot 10^{11}$ mA^{-1}
Photo production W(e,n)(35 MeV)	$1.7 \cdot 10^{-2}$ n/e^-	2000	$4 \cdot 10^{14}$
spallation 1.33 GeV p on Hg	28 n/p	20	10^{18}
^{235}U fission	~1 n/fission	200	$2 \cdot 10^{18}$

Spallation


p (1 GeV)
n
Δ
π
n
π
n
p
Intra-Nuclear Cascade
Excited nucleus
Evaporation
α
d
α
Spallation residue
α, β, γ decay
γ
n
γ
n
γ
Fission products

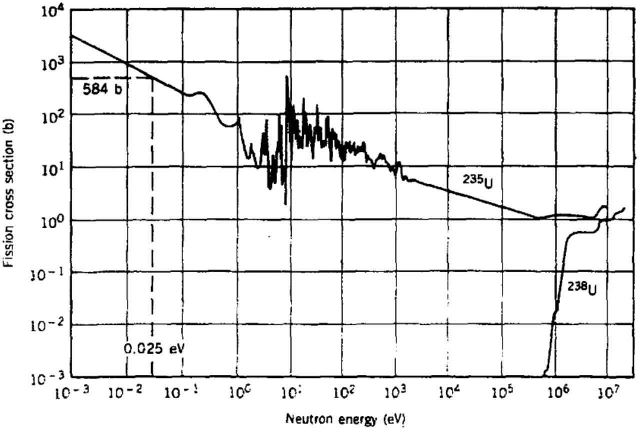
Liquid Hg target

Spallation Neutron Source (SNS), Oak Ridge, USA

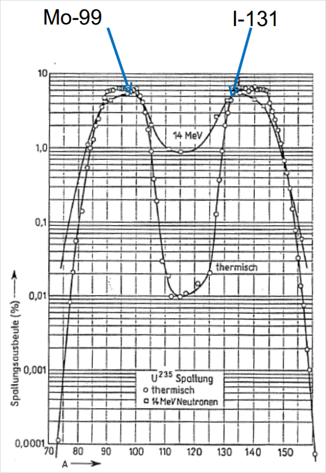


Probability for fission

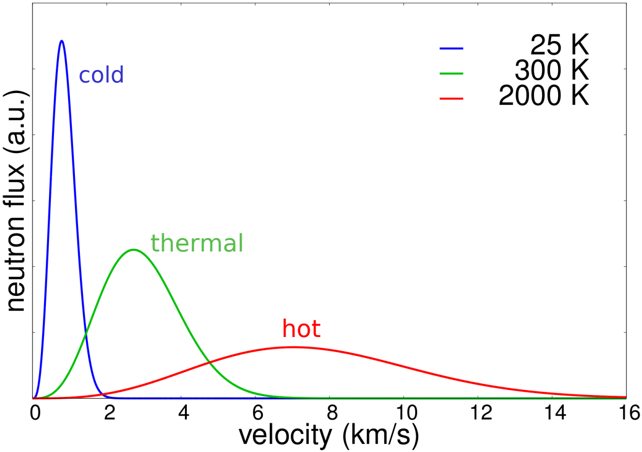
Neutron-induced fission cross-sections [Krane, *Introductory Nuclear Physics*]



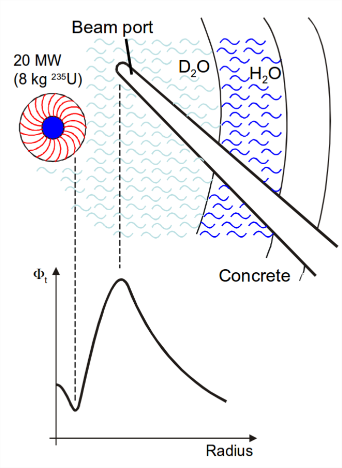
Mass distribution of fission products from ^{235}U



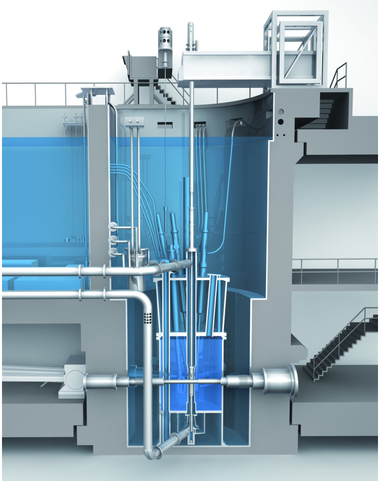
Maxwellian velocity distribution of moderated neutrons



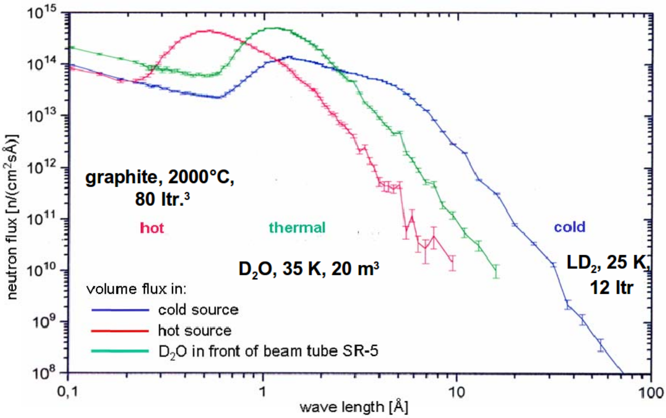
Principle of a high-performance fission neutron source



FRM-II core cross-section



Spectral distribution of neutrons FRM-II



- under-moderated cold source provides also short wavelength $\lambda \geq 1$ Å
- on the expense of intensity at very long wavelength $\lambda \geq 15$ Å