DETECTORS *for* NEUTRON SCATTERING

Requirements, possible alternatives & international engagement

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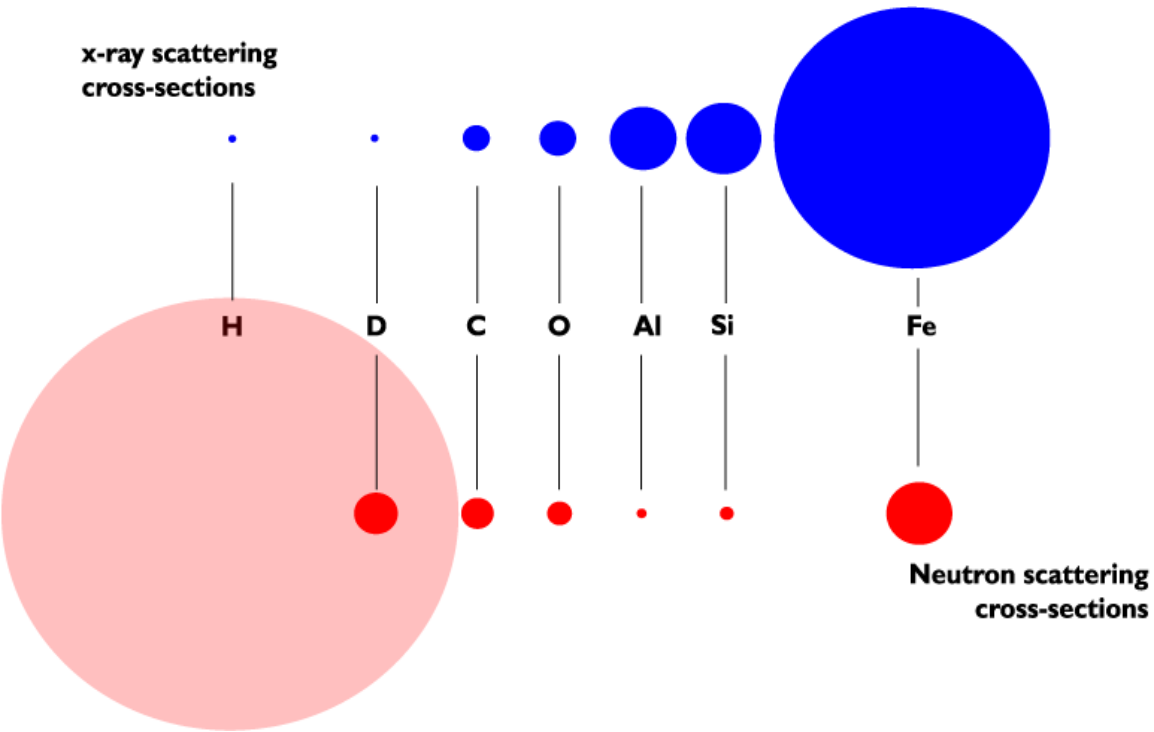
Seeing with neutrons…



interaction
strong & short-ranged

nuclear scattering
varies between isotopes

measurements
ΔE and Δp
magnetism

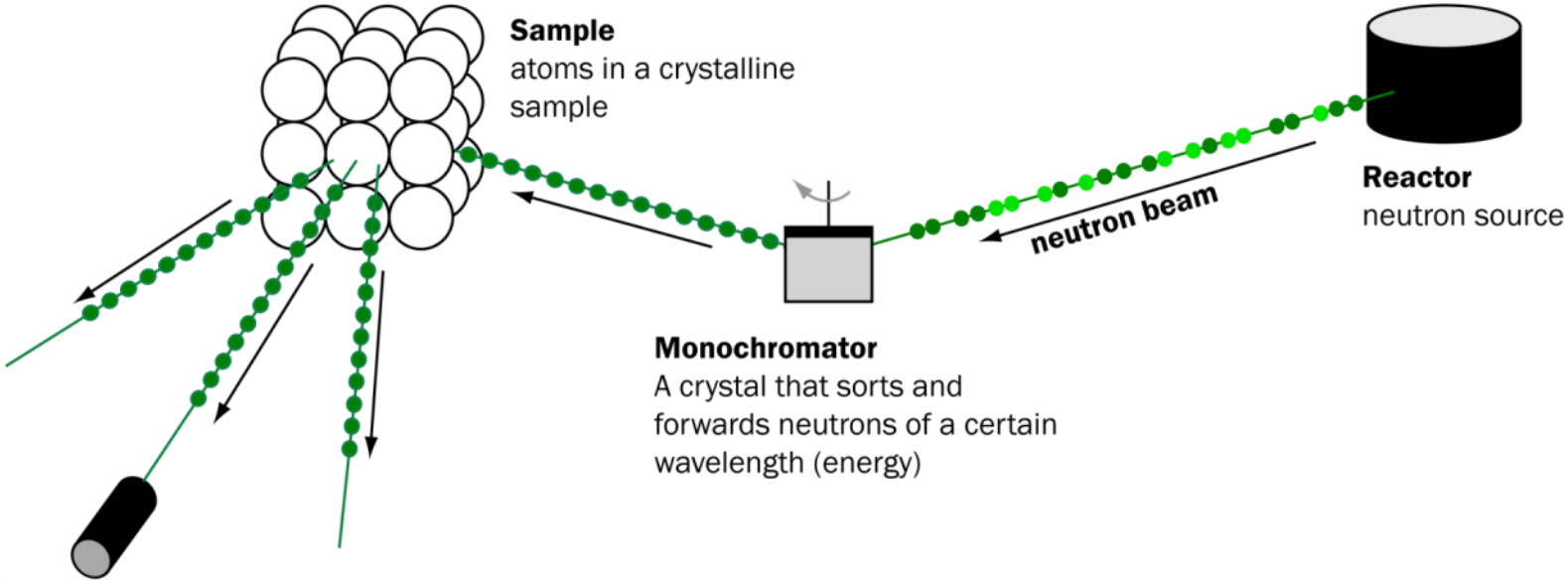
Thermal

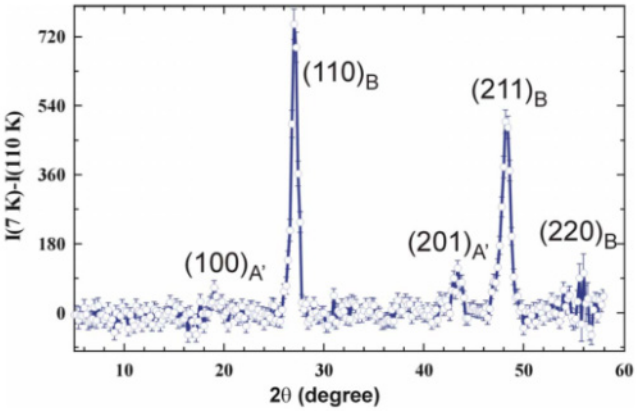
25 meV/300 K E comparable to thermal vibrations in a solid

Cold

2 meV/20 K longer $\lambda \rightarrow$ excellent probe of macromolecular structure and dynamics

When the neutrons collide with the atoms they change direction - they are scattered elastically.

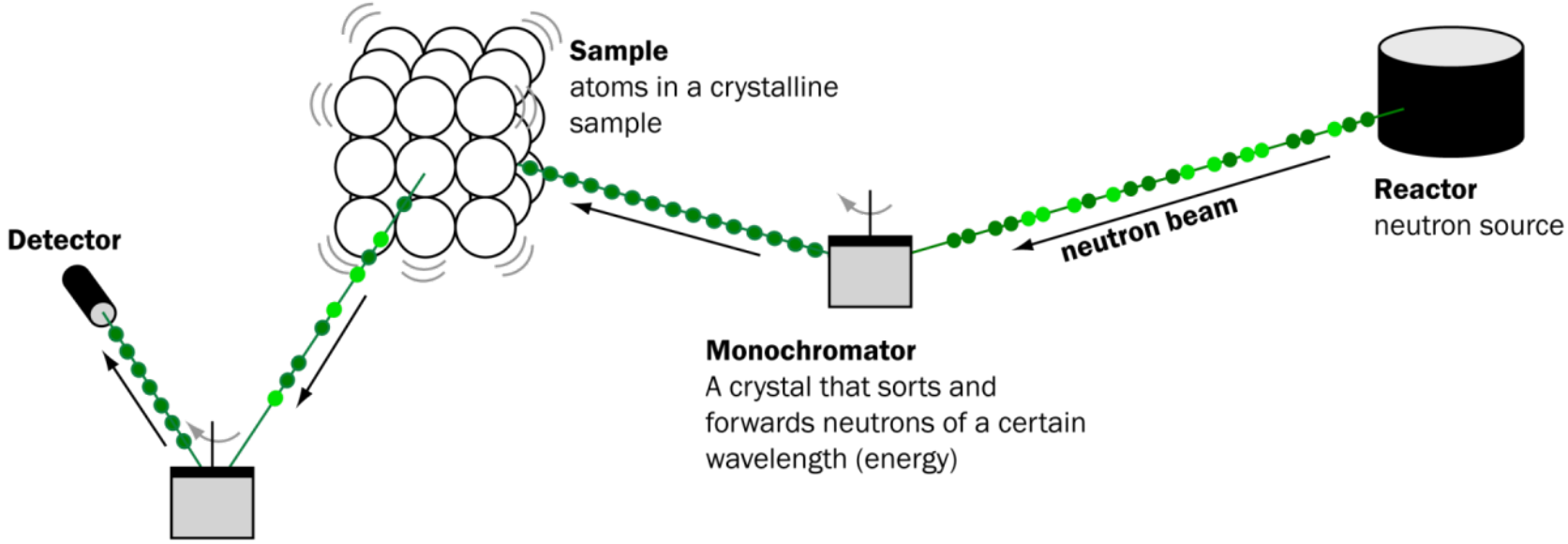




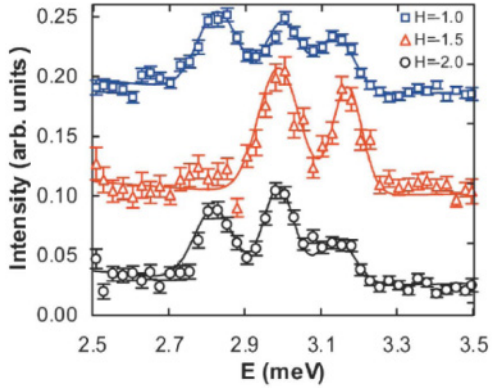
where are the atoms?

DIFFRACTION

When the neutrons collide with the atoms, they may gain or lose energy to the atoms (inelastic scattering).



Analyzer
A crystal that sorts and forwards to the detector neutrons that have exchanged energy with the sample by a specific amount



how are they moving?

SPECTROSCOPY

Neutron sources cost $ $

DETECT { *as many as you can* — *large area coverage*

as efficiently as you can — *high detection efficiency*

MINIMIZE **spurious** signals — *good gamma separation*

Inelastic neutron scattering instruments are the *most demanding*

small signals from *weak* scatterers

require background

\ /

low

International Neutron Facility Directors Meeting

Grenoble, Fr
March 5, 2010

*ESSS (Sweden) and PSI (Switzerland) not shown in photo but present at meeting.

The Helium-3 Supply Crisis – Alternative Techniques to Helium-3 based Detectors for Neutron Scattering Applications

The Institut Laue-Langevin in Grenoble, France invited the Directors of all the major neutron facilities in Europe, the US, Australia, Japan, and China to meet and discuss how to find solutions to such global problems as new detectors without helium-3, common software platforms for data reduction, and data policy.

At their meeting on 5 March, it was agreed to establish a joint programme with three development lines to develop alternative technologies for neutron detectors.

DEVELOPMENT LINES

Based on ZnS:^{6}LiF(Ag) or ZnS:$^{10}B_2O_3$(Ag) scintillators

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JCNS (Germany)
J-PARC (Japan)
NIST (US)
PSI (Switzerland)
SNS (US)
STFC (UK)
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Based on solid ^{10}B multilayers (large area detectors)

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BNC (Hungary)
ESSS (Sweden)
FRM II (Germany)
HZB (Germany)
ILL (France)
JINR (Russia)
SNS (US)
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$^{10}BF_3$ gas-filled detectors

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BNC (Hungary)
FRM II (Germany)
HZB (Germany)
ILL (France)
JINR (Russia)
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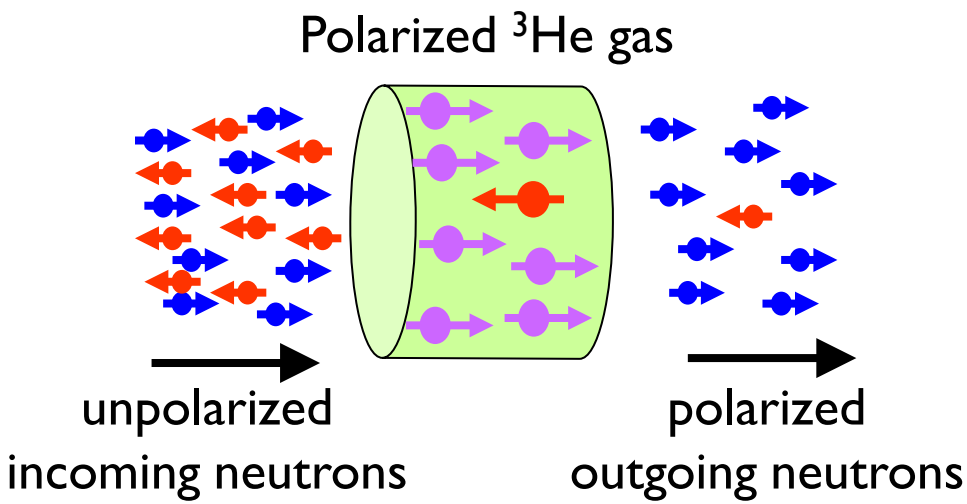
^{3}He *for* NEUTRON SPIN FILTERS

^{3}He is <u>not</u> consumed

^{3}He *for* NEUTRON SPIN FILTERS

Polarized ^{3}He gas preferentially absorbs one neutron spin state



Polarized neutrons provide detailed information on the spin structure present in solid state systems

^{3}He *for* CRYOGENICS