Outline

- Magnetic scattering
- Neutron diffraction
- Magnetic properties of neutron
- Advantages and Disadvantages
- Why neutron scattering is important
- Application of Neutron diffraction

MAGNETIC SCATTERING

- Neutron process a spin and associated magnetic moment , magnetic interaction between neutron and atomic electrons which is responsible for magnetic properties of moments may be expected .
- Thus a neutron can be scattered by interaction of its magnetic moment with the atomic or ionic magnetic moment of the sample atom.
- This type of scattering is generally referred to as magnetic scattering .

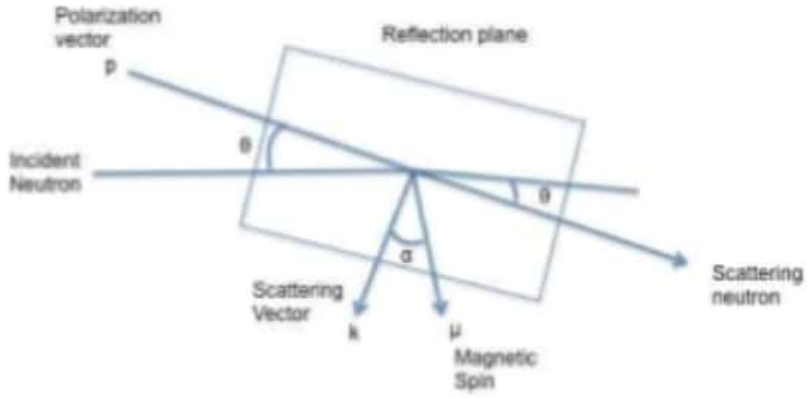
- Scattering diffracting of neutrons is caused by two effects.

I. Nuclear scattering due to interaction of neutrons with atomic nuclei
II. Magnetic scattering due to interaction of the magnetic moment of neutron with permagnet magnetic of atoms or ions.

- The magnetic moment of atoms in a paramagnetic crystal are arranged at random in the absence of external magnetic field hence magnetic scattering of neutron by such a crystal is also random.

NEUTRON DIFFRACTION

- Neutron diffraction is the application of neutron scattering to the determination of the atomic /or magnetic structure of a material: A sample to be examined is placed in a beam of thermal, hot or cold neutrons to obtain a diffraction pattern that provides information of the structure ...



MAGNETIC PROPERTIES OF NEUTRON

- The spin of an electron is approximately 1000 times larger than the magnetic moment of a neutron.
- The magnetic moment of the neutron is sufficiently large to give rise to an interaction with unpaired electrons in magnetic atoms.
- In compound containing elements of the first transition series in the periodic table (Iron, Cobalt and Nickel) the 3d shell contains unpaired electrons.
- The magnetic field created by these unpaired electrons in the sample interact with the neutron magnetic moment to give magnetic scattering.

WHY NEUTRON SCATTERING IS IMPORTANT?

Neutrons have No Charge!

- Highly penetrating
- Nondestructive
- Can be used in extremes

Neutrons probe Nuclei!

- Light atom sensitive
- Sensitive to isotopic substitution

Neutrons have a Magnetic Moment!

- Magnetic structure
- Fluctuations
- Magnetic materials

Neutrons have Spin!

- Polarized beams
- Atomic orientation
- Coherent and incoherent scattering

TYPES OF NEUTRON

ELASTIC SCATTERING

- no energy transfer to/from sample
- crystal structure ,atomic correlation in liquid /glass

INELASTIC SCATTERING

- energy transfer to/from sample
- Measurement of lattice vibration (phonons),atomic diffusion , molecular modes.

ADVANTAGES

- **Mass**: Momentum transfer around interatomic distance
- **Zero charge**: highly penetrating: measure bulk properties, can benefit from large samples, extreme sample environment (high/low temperature, magnetic field, pressure...)
- **Spin:** polarization is possible
- **Magnetic dipole moment:** Neutrons interact with unpaired electrons. Magnetic structure and spin excitations can be studied

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DISADVANTAGES

- Low brilliance of sources: low intensity or resolution, large samples, statistical noise.
- Penetrating: background hard to control, need large samples
- Some elements (B, Cd, Gd,..) strongly absorb
- Neutral: hard to manipulate, accelerate, detect, etc

APPLICATION OF NEUTRON DIFFRACTION

- Used for determination of structure
- Locating Light atoms
- Heavy atoms that absorb x-ray strongly
- Similar atomic no /Isotopes
- Magnetic properties
- Single crystal studies analysis