**Scientific Mission**

HYSPEC will be a world class inelastic-scattering instrument with neutron polarization analysis capabilities, making it unique among the instruments being installed at the SNS. This instrument will meet the challenge posed for neutron inelastic spectroscopy in a wide range of science applications, including complex alloys (high Tc superconductors, spin valves, and photonic switches), nanosize magnetic molecules (spintronics and quantum computing), functional materials (superconducting cuprates and colossal magnetoresistance), strongly correlated electron systems, and quantum magnetism.

**CAPABILITIES**

- Desire to measure lattice and spin dynamics in small single crystals.

- Need high flux at sample position.

- Low background.

**Science Needs**

- Polarized neutrons

- Sophisticated and/or extreme sample environment

**Polarized Neutrons**

**Examples of Inelastic Polarized Neutron Studies**

- CWRR Material Li_{2}Cu_{2}MnO_{3}

- Frustrated Heusler (B. Khaykovich & G. Shirane).

- Measured at zone boundary (0.5,0.5,2) The red data points are phonon + magnon scattering while the open data points are phonon only.

**Magnetic Field**

**Polynomial Models of Neutrons**

**Examples of Inelastic Polarized Neutron Studies**

- CWRR Material Li_{2}Cu_{2}MnO_{3}

- Frustrated Heusler (B. Khaykovich & G. Shirane).

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**PROPOSED PROJECTS FROM HYSPEC IDT MEMBERS**

- Spin Dynamics in Nanostructures (J. J. Rhyne, LANL)

- Nanoscale Features of Functional Materials (V. Kryukhlin, Rutgers University)

- Anomalous Phonon Behavior (S. Shapiro, G. Shirane, BNL)

- Complex Phases in Intermetallics (C. Stassis, R. McQueeney, Iowa State University)

- Correlated Phases in Many-Electron Systems (A. Zheludev, G. Shirane, ORNL)


- High-Tc Superconductors (L.-P. Regnault, IEEE, Tranquada, BNL)

- New Transition Metal Oxides (M. Greven Stanford University)

- Quantum Critical Points (R. Osborn, ANL)

- Geometrically Frustrated Magnets (B. Gaulin, McMaster University, J. Gardner, BNL)

- Quantum Spin Systems (A. Zheludev, ORNL)

- Colossal Magnetoresistance Materials (J. Fernandez-Saca, M. Hagen, ORNL)

**FLUX AND RESOLUTION**

The flux at the sample position (in non-polarized mode), obtained from Monte Carlo simulations, for two different monochromator-sample distances (LMM=35, 43m) is shown in the figure below as function of the incident energy.

**Example of Inelastic Polarized Neutron Analysis**

**POLARIZATION ANALYZERS**

- The incident beam polarization is defined by the use of Heusler crystals (see Focusing Crystal Optics).

For the beam scattered from the sample we need to analyze how many neutrons are scattered with each spin state over a wide angular range (0° to 170°) in the horizontal and over a broad range of energies (10–60 meV). This does not necessarily have to be done with a single device, but could be done with a combination of devices. We are currently evaluating possible devices, two of which are shown in the panels on the right.

- **Polarizing Supermirror Benders**

- **Polarized 3He Gas Cells**

The neutron absorption cross-section of 3He is highly spin dependent. This is a barrier of neutron passage through a gas of nuclear spin polarized. The one neutron polarization is selectively absorbed. Methods for polarizing the gas cells exist, although they are highly sensitive to the magnetic field environment around them. Such a cell could cover an energy range 30–60 meV, while a combination of devices could also be used to split the neutron spin states. An array of such supermirror benders would be highly effective for E = 25 meV.

**Polarizing Supermirror Benders**

**Polarized 3He Gas Cells**

**Flux at the sample position (in non-polarized mode), obtained from Monte Carlo simulations, for two different monochromator-sample distances**

**HYSPEC PARAMETERS**

- **Beamline:** 14B
- **Monochromator:** Cryogenic coupled HG moderator
- **Moderator-Monochromator distance:** 32 m
- **Monochromator-sample distance:** 1.4-1.8 m
- **Sample-detector distance:** 4.5 m
- **Incident energy range:** 3.5 meV < Ei < 90 meV
- **Incident energy resolution:** ΔEi/Ei = 1.5%
- **Final energy resolution:** χ = 5–6%
- **Wavevector transfer range:** 0.1 Å⁻¹ < Q < 8 Å⁻¹
- **Beam size:** 150mm x 40mm
- **Beam size at sample:** 2cm by 2cm
- **Sample area:** There is a large area around the sample for specialized and/or bulky sample environment equipment.

**Brookhaven National Laboratory is managed by Brookhaven Science Associates for the U.S. Department of Energy. For more information on HYSPEC please see the website http://neutrons.phy.bnl.gov/CNS/hyspec/index.htm**