Resolving the Spin Structure of Magnetic Topological Crystal NdSb using Inelastic Neutron Scattering

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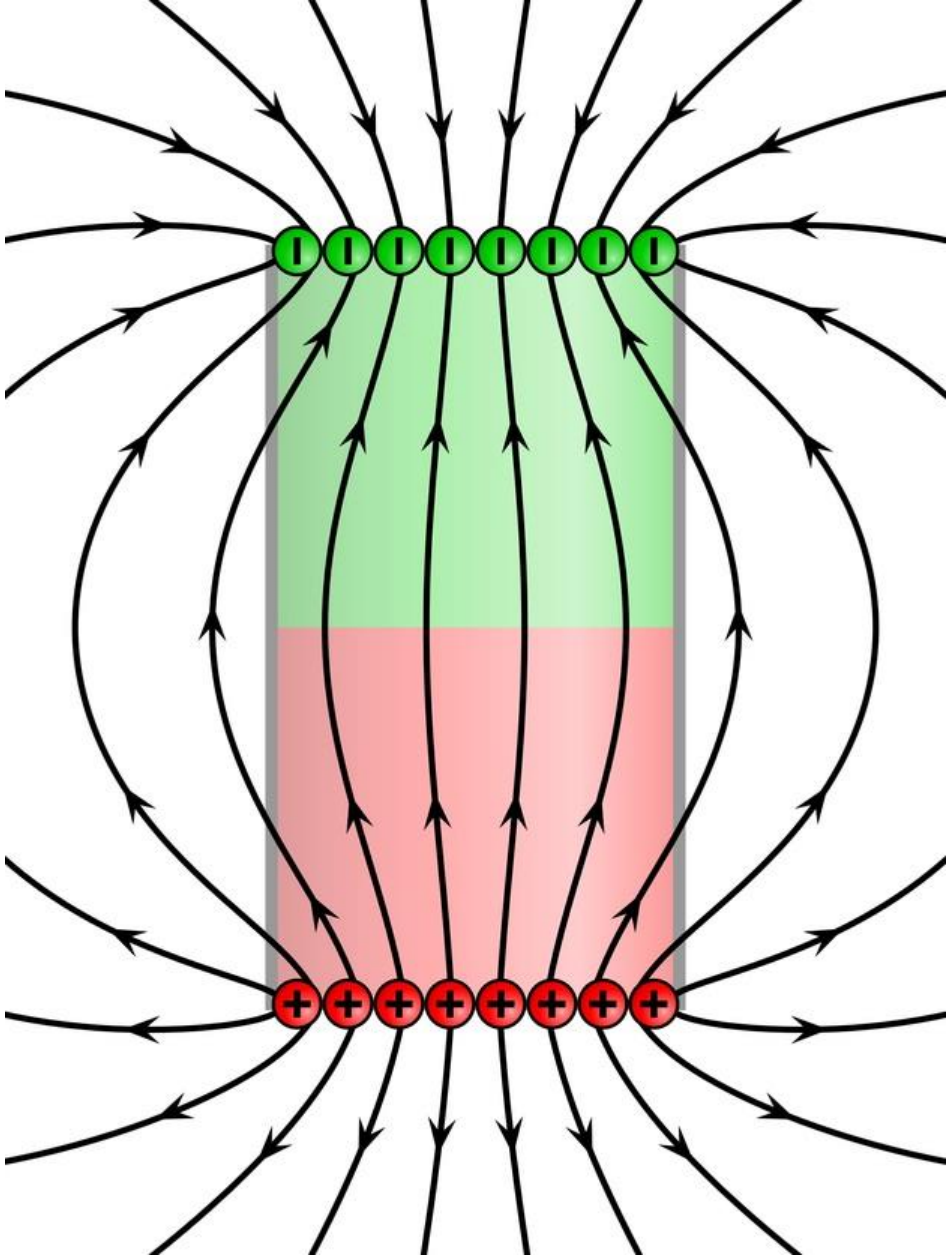
Outline

- Background
- Procedure & Instruments
- Data Analysis
- Conclusion

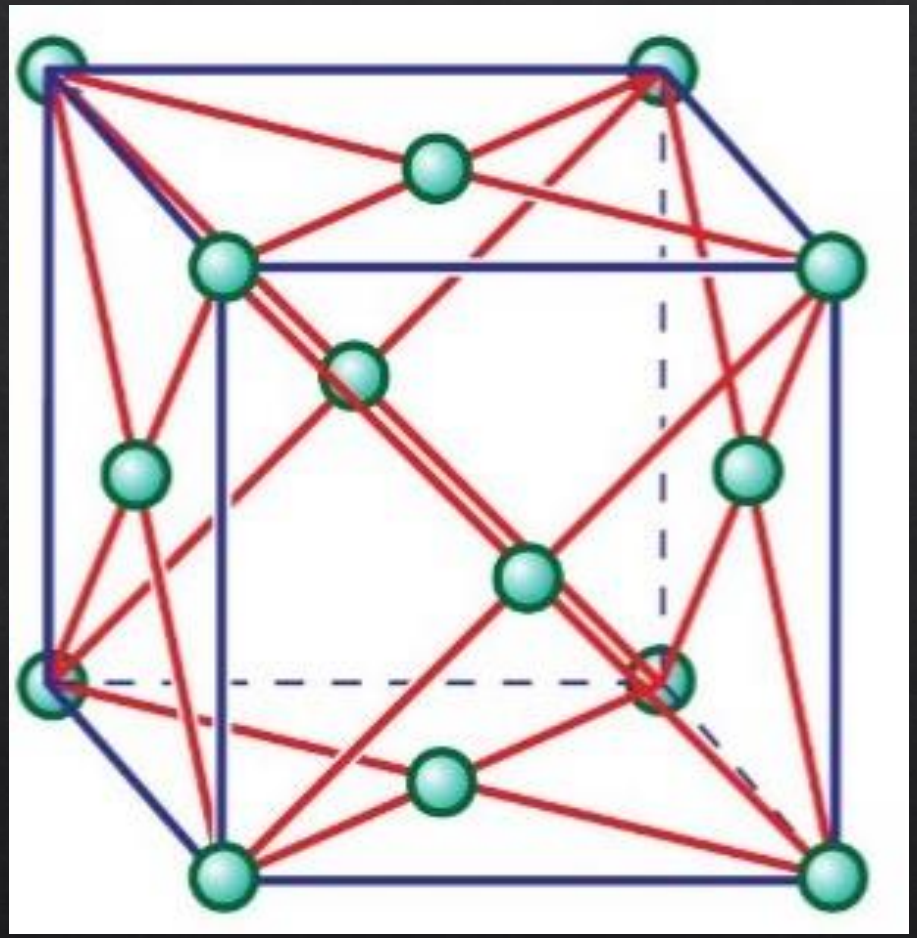
Background

- NdSb and NdBi
  - Topological insulator
- Studied LaBi
- Looking at ***magnetic*** rare earth ions



https://static.sciencelearn.org.nz/images/images/000/003/407/embed/ART_Introducing_magnetism_MagneticFieldDiagram.jpg?1674170731

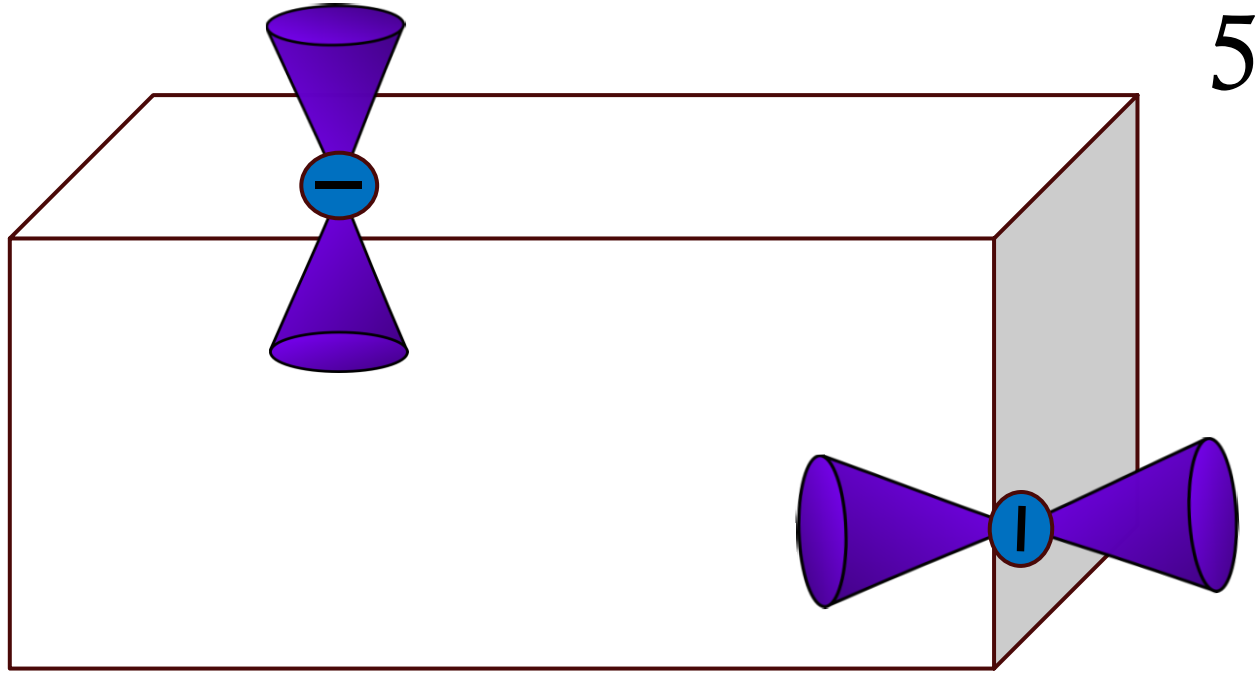
Face-Centered-Cubic

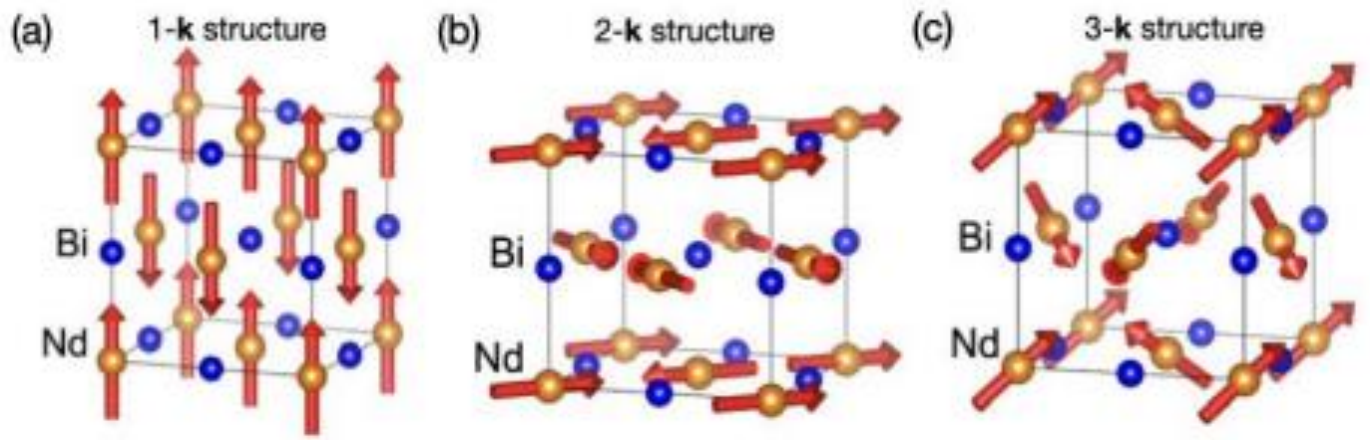


https://cdn1.byjus.com/wp-content/uploads/2016/10/Types-of-Unit-Cell-700x325.png

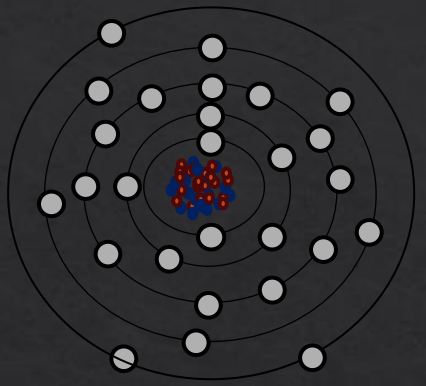
Background

- Photon-like Electrons
- Project Motivation:
  - **Standardize understanding of NdSb magnetic surface states**



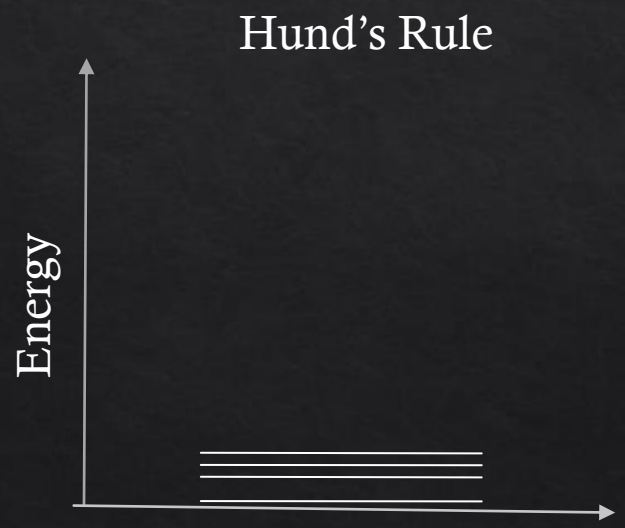


Hund's Rule



$$J = L - S = 9/2$$

$$2J + 1 = 10$$



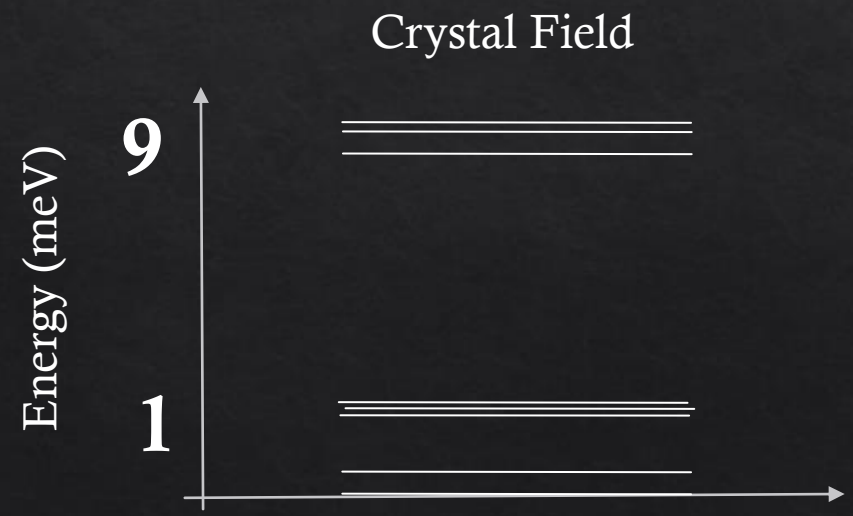
S

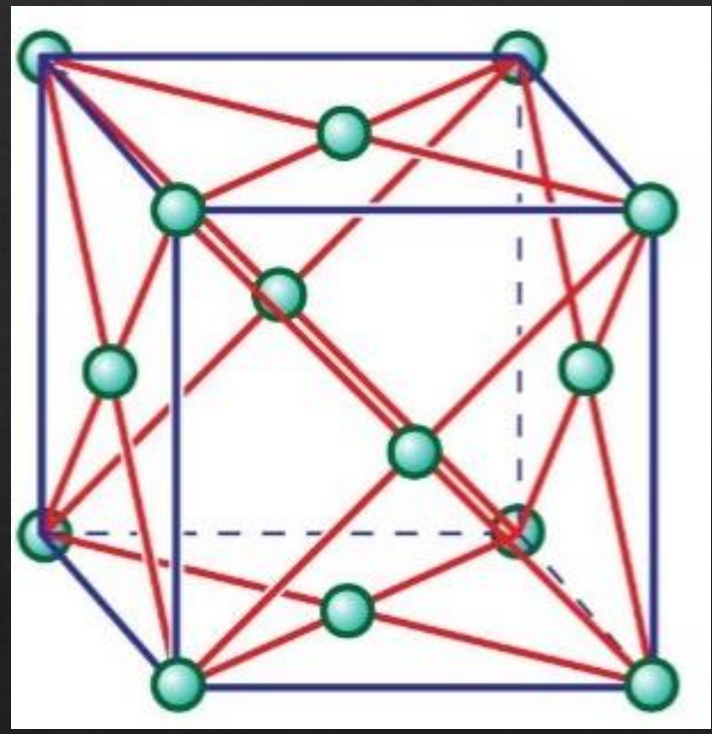
L

	+1/2	-1/2
+3	X	
+2	X	
+1	X	
0		
-1		
-2		
-3		

Crystal Field

$$H_{CEF} = -\frac{e}{4pi\epsilon_0}\sum_i \frac{q_i}{|\vec{r} - \vec{R}_i|}$$



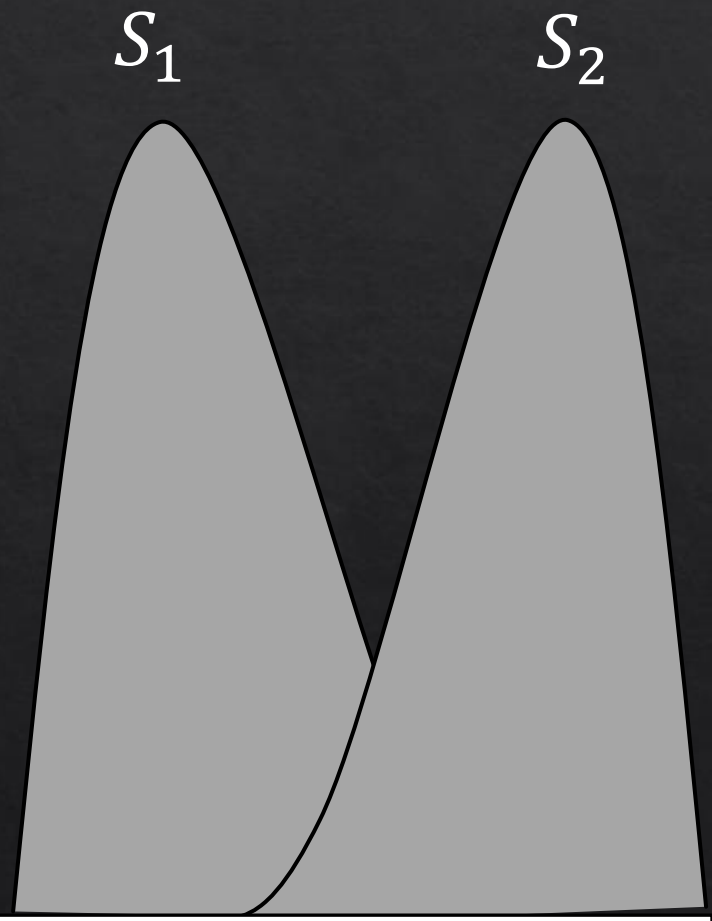


https://cdn.britannica.com/37/1537-050-BBA36198/crystal-structures.jpg

Exchange Interactions

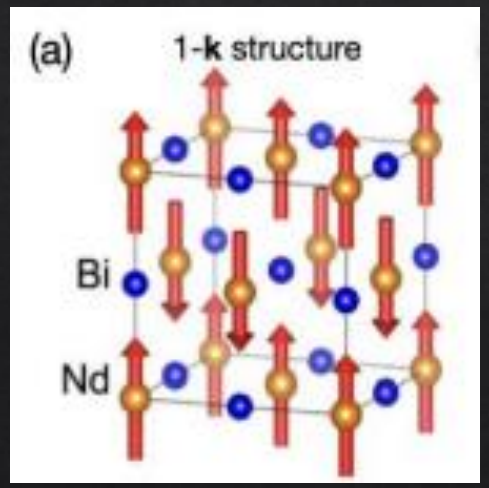
Exchange Interactions

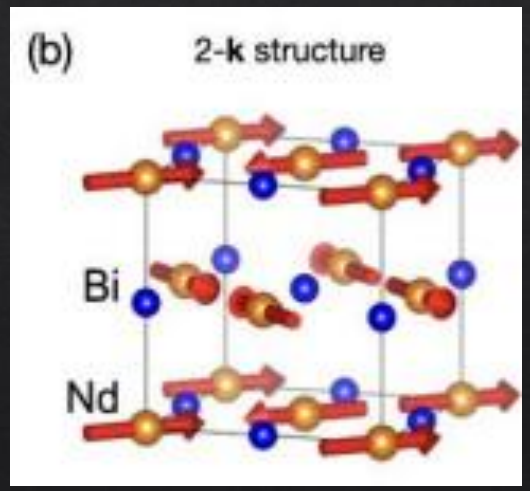
$$H_{exch} = -J\vec{S}_1 \cdot \vec{S}_2$$

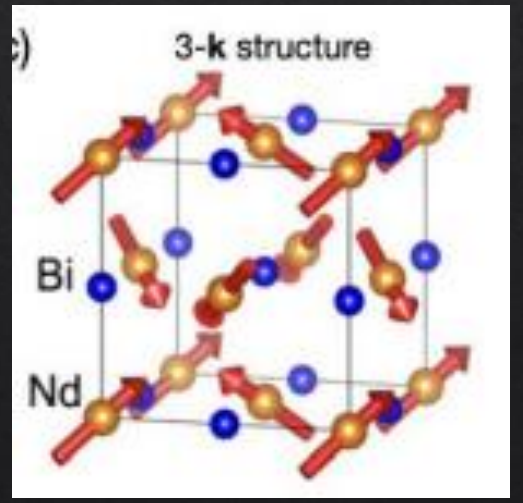


Resolving NdSb Spin Structure

- Why doesn't diffraction work?
  - FCC Lattice Symmetry
- Inelastic Scattering



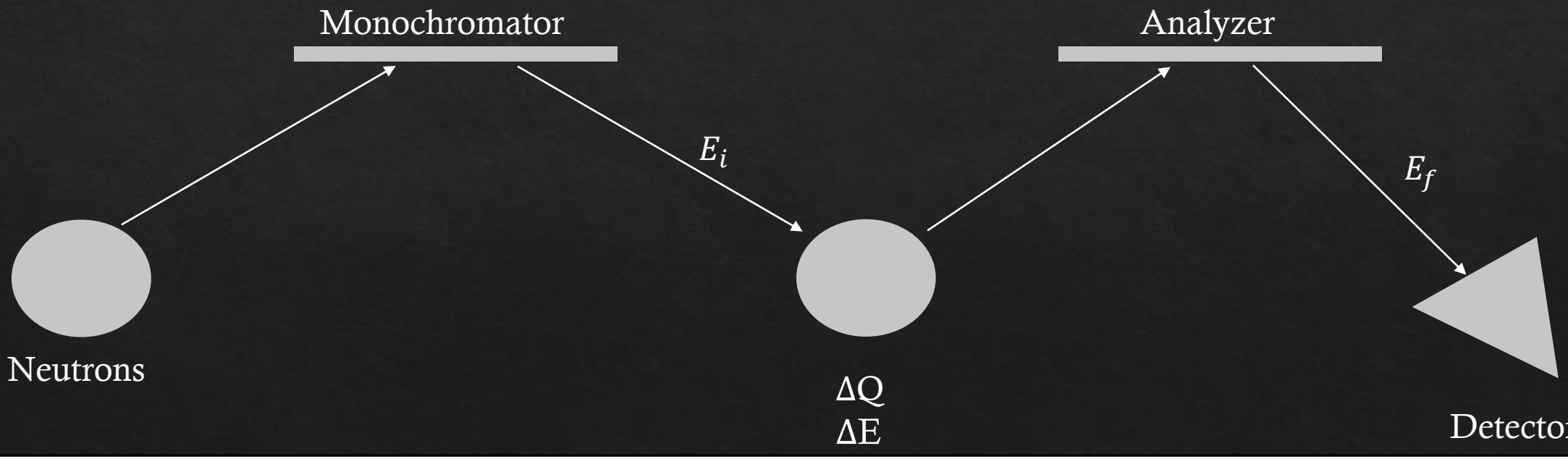




Data Collection

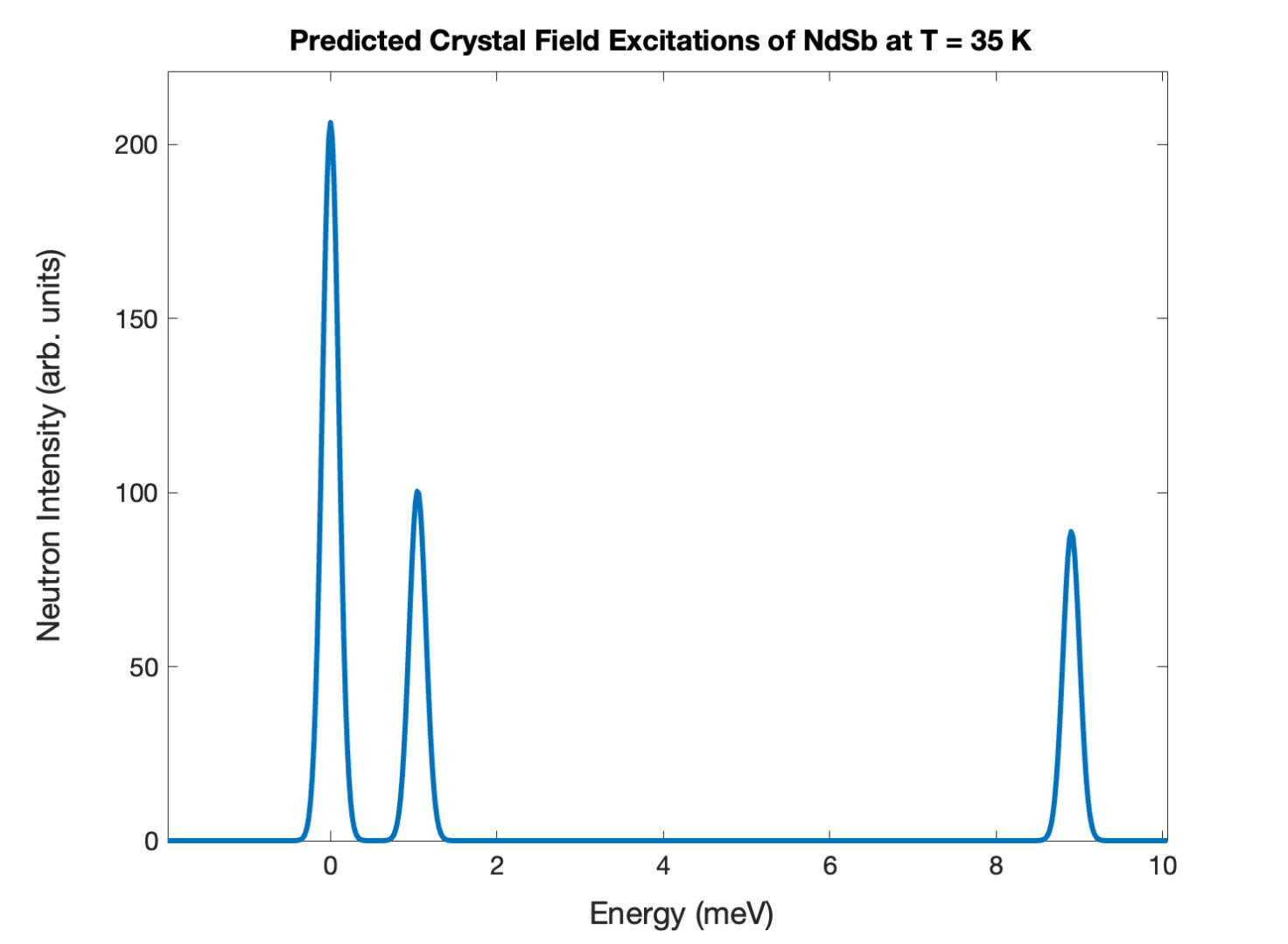
- Inelastic Scattering
- **T**riple **AX**is Spectrometer
- **C**old **T**riple **AX**is Spectrometer

https://neutrons.ornl.gov/sites/default/files/styles/page_width_1240w/public/HB-3.png?itok=SpSBoFAs

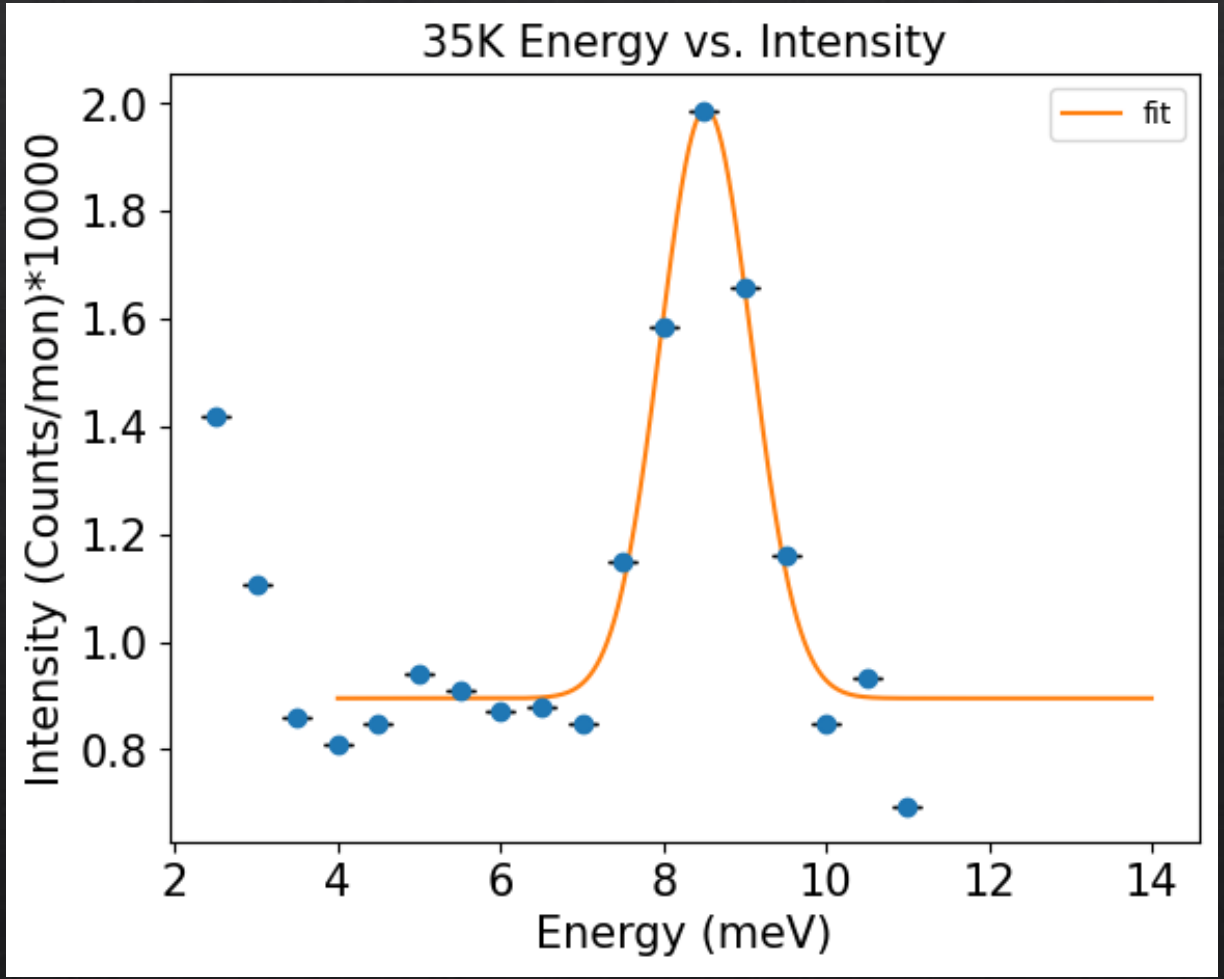


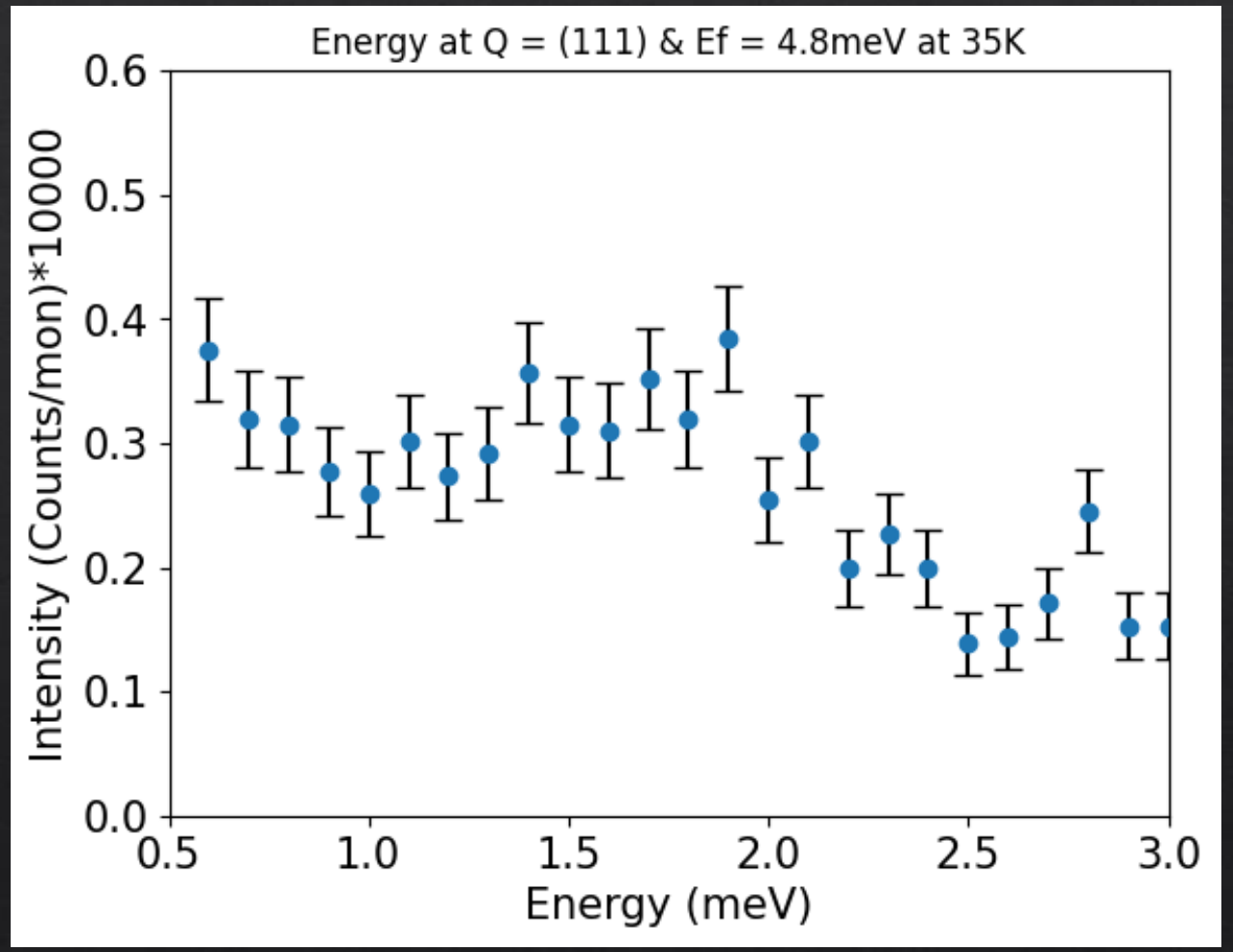
Data Analysis

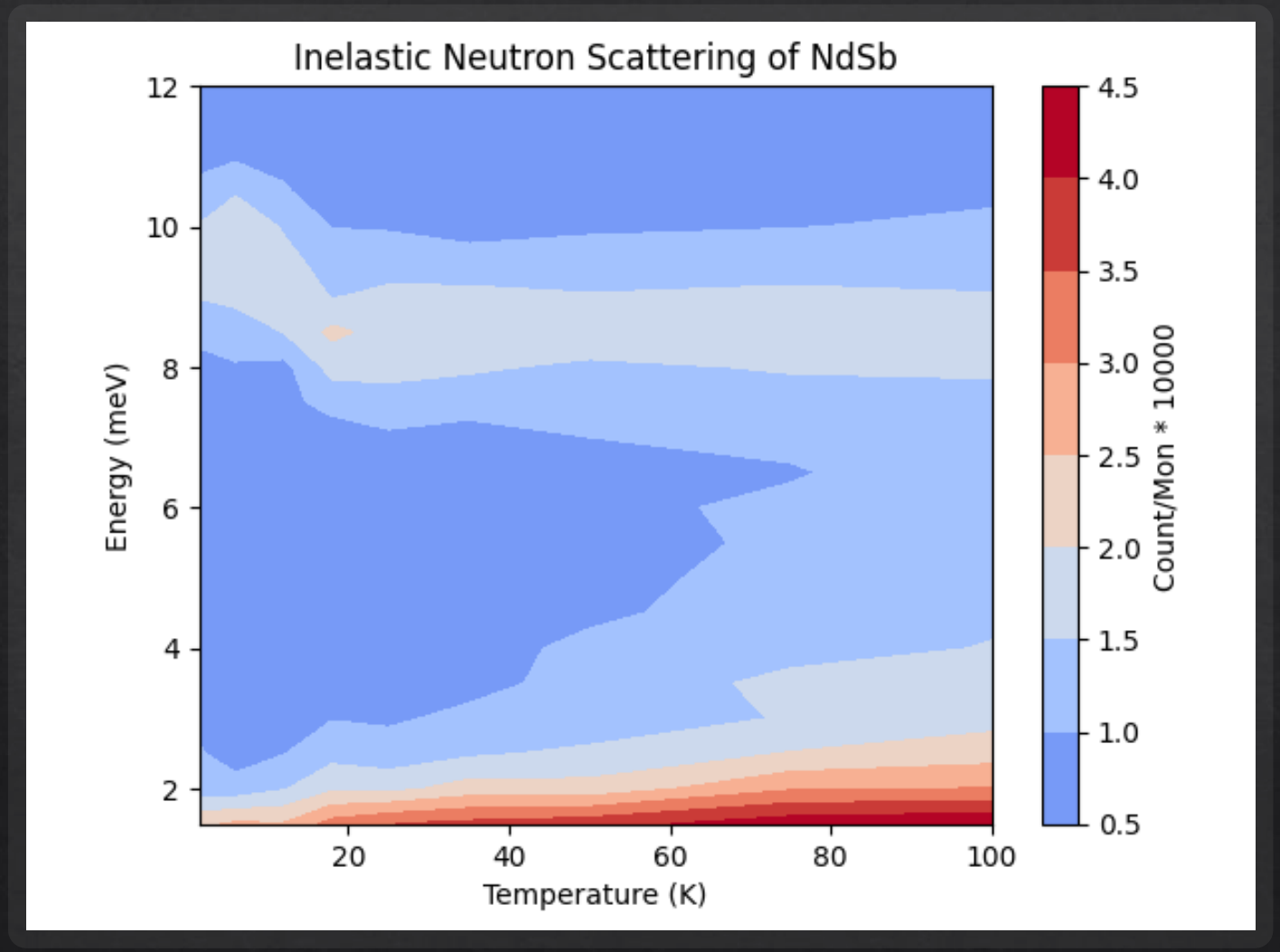
Predicted CFE Data



…compared to 35 Kelvin Data

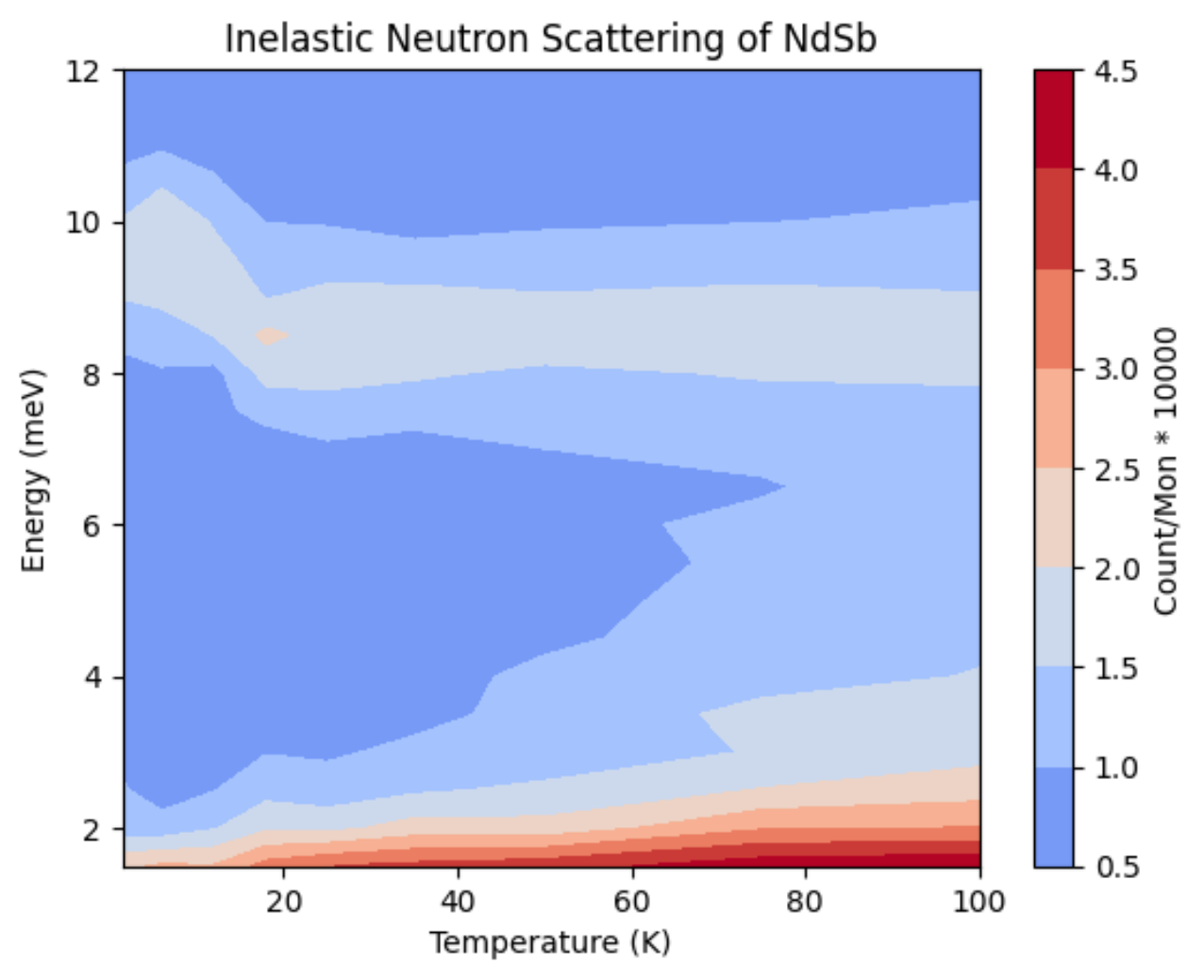


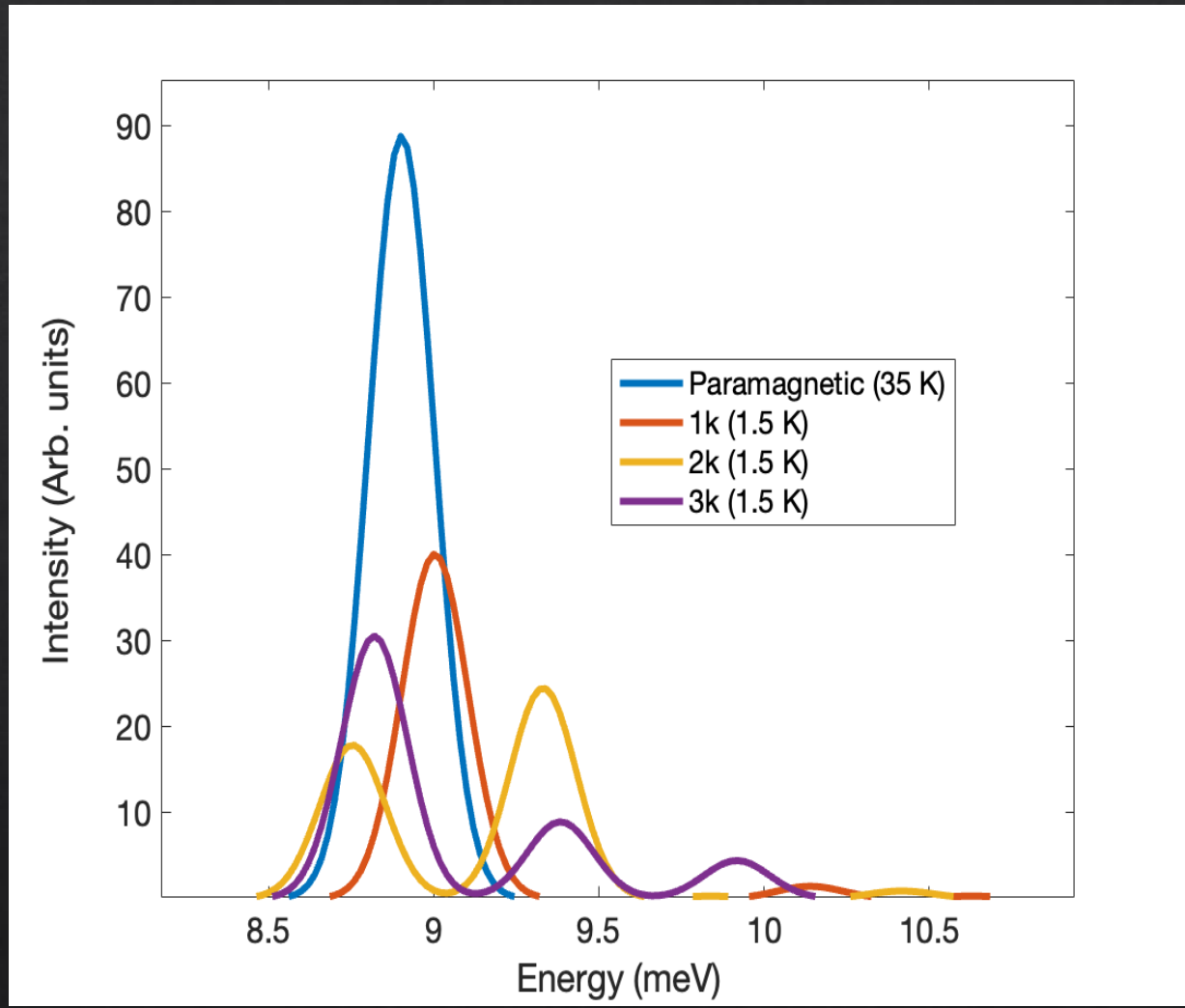




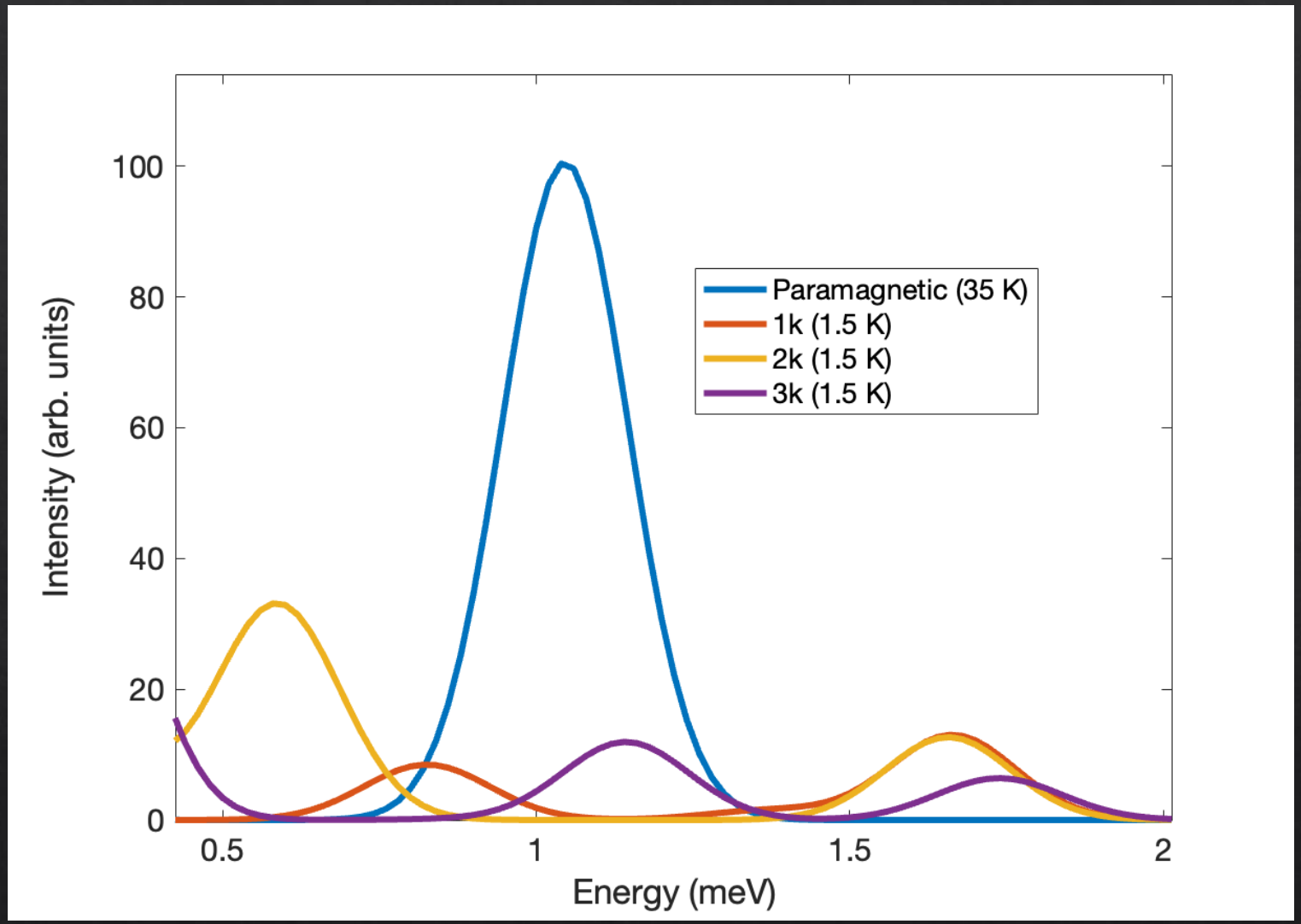
TAX
Contour Map

Intensity Peaks

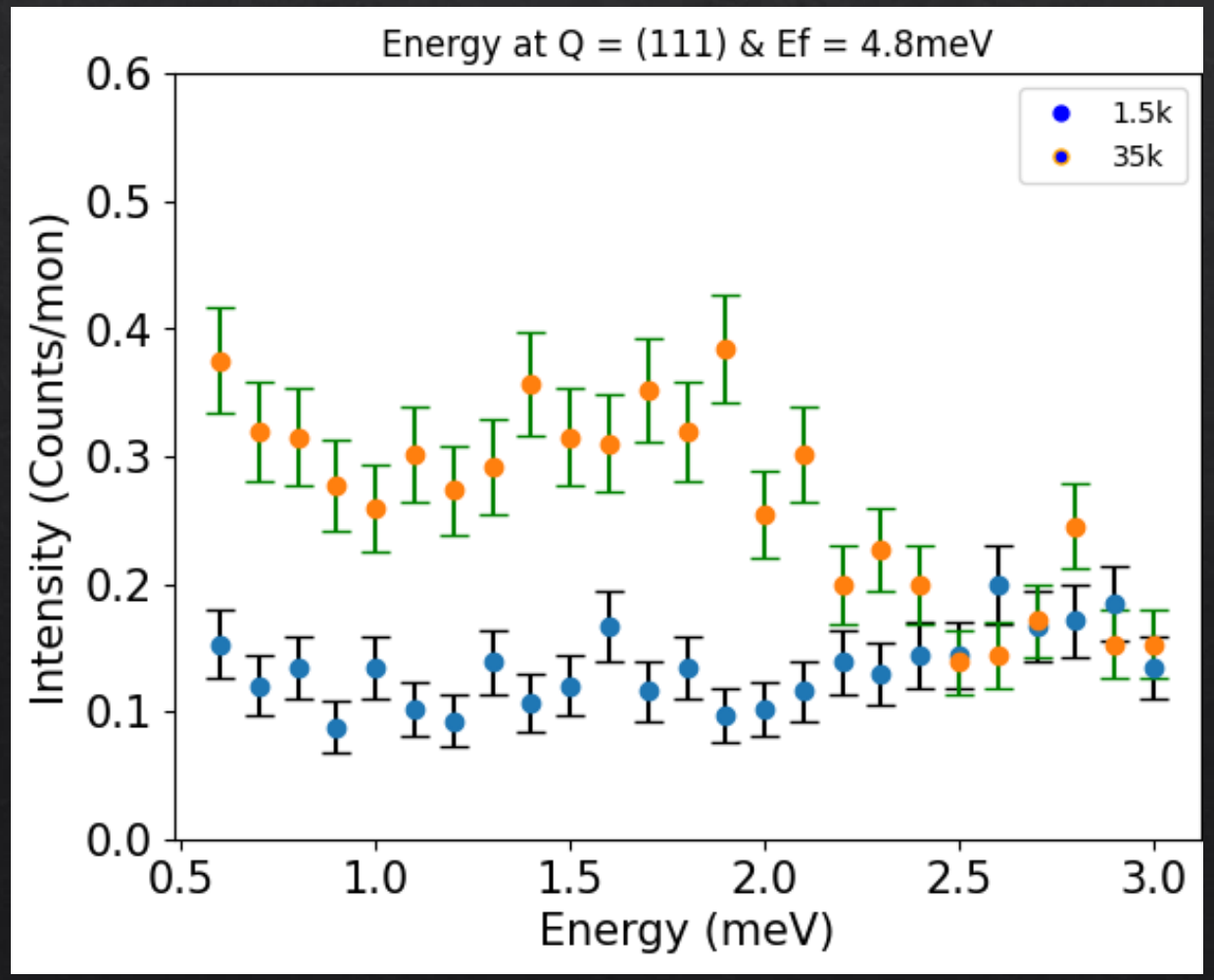


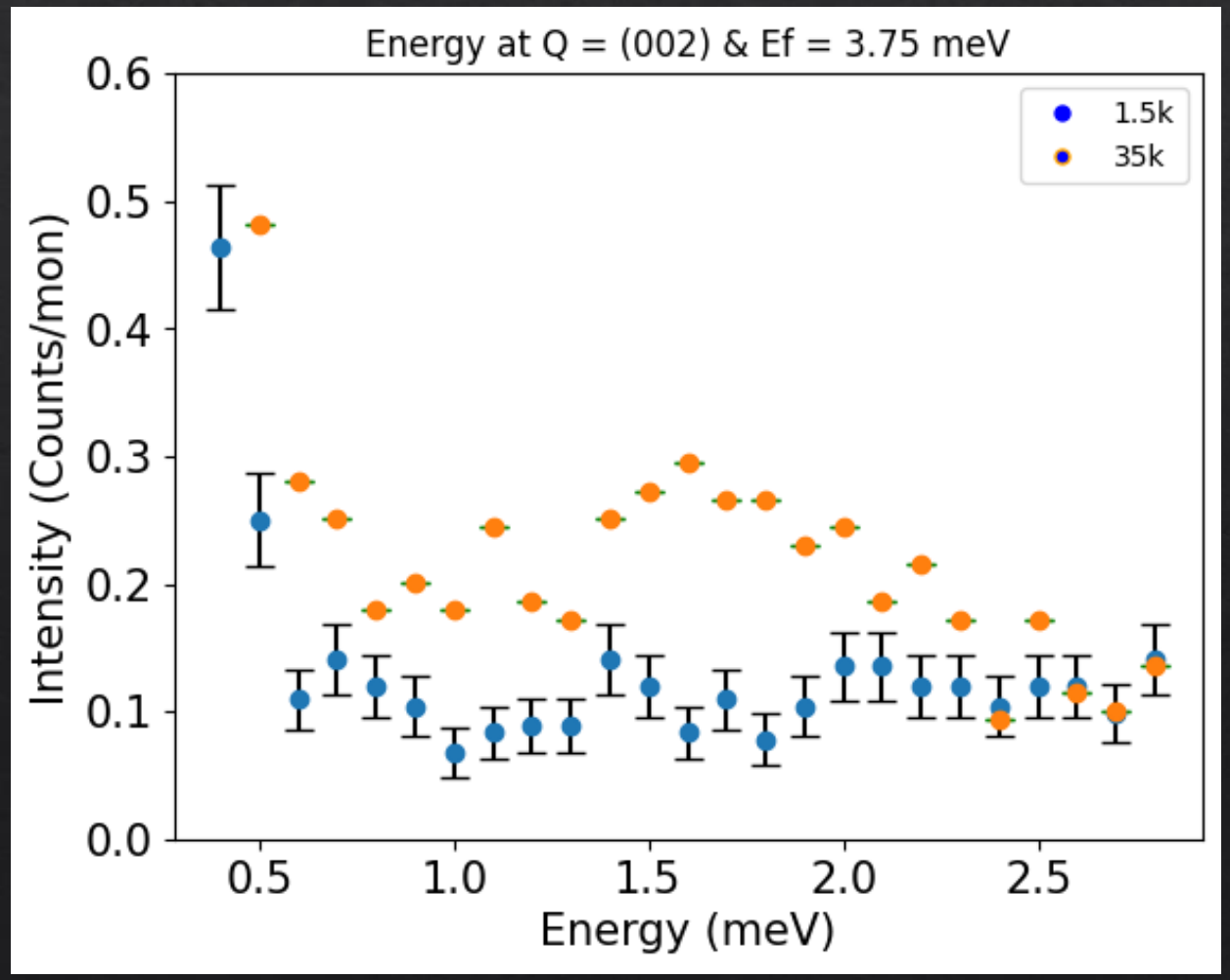


Predicted Exchange Interactions



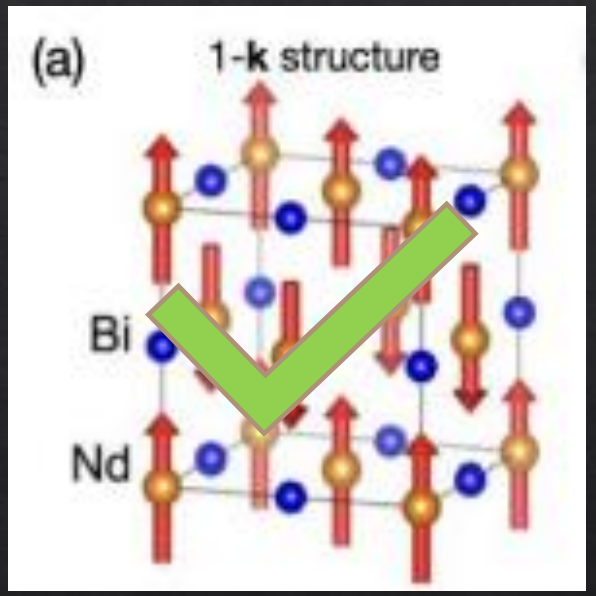
…compared to CTAX Data





Conclusion

- 1k Spin Structure
- Accurate Crystal Field Model



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Questions?