Spinwave Calculations

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Significance

• Underlying assumptions
• Colossal magneto-resistant materials
• Multiferroics
Crystal Lattice

- Lattice structure
  - Repeated unit cell
- Space groups
  - Symmetry
Electron Spin

- Pauli exclusion principle
- Coulomb repulsion
- Magnetic order
- Spin angular momentum
  - Operators: \( \{S_x, S_y, S_z\} \)
Spinwaves

- Magnetic moments
  - Ferromagnet
  - Paramagnet
- Small deviation along moments
- Causes
Spinwave Energy Hamiltonian

\[ H = \sum_{i,j} S_i J_{i,j} S_{n,j} + \sum_i S_i A_i S_i + B \sum_i g_i S_i \]

- **1\text{st} Term:**
  - Exchange spin interactions

- **2\text{nd} Term:**
  - Anisotropic interactions

- **3\text{rd} Term:**
  - Applied magnetic field
SpinW (Paul Scherrer Institute)

- Invariance under rotations
- Common coordinate system
- Linear spin wave theory
- Holstein-Primakoff
- Fourier transform

- New spin operators
- Substitutions
- New Hamiltonian expression

- More substitutions
- Diagonalization
- Eigenvalues = spin wave energies

\[ H = \sum_{m_i n_j} \left\{ \sqrt{\frac{S_i}{2}} (\bar{u}_i^T b_{m_i} + u_{m_i}^T b_{m_i}^\dagger) + v_i^T (S_i - b_{m_i}^\dagger b_{m_i}) \right\} R_{m_i n_j} \left\{ \sqrt{\frac{S_j}{2}} (\bar{u}_j b_{n_j} + u_{n_j} b_{n_j}^\dagger) + v_j (S_j - b_{n_j}^\dagger b_{n_j}) \right\} \]
Future Actions

- ZeroMQ and Mathlab Engine API
- Future goals
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