Lecture 16: Ferromagnetism and Antiferromagnetism

Lecture 17: Spin-Flop Transition and Neutron Scattering

The ferromagnetic and antiferromagnetic orders are described and the behavior of their spin susceptibility is contrasted. The ferromagnetic Heisenberg model has a simple ground state and first excited state which involves the propagation of a single spin flip, giving rise to the spin wave dispersion.

Reading: Ashcroft and Mermin, Chapter 33

The Holstein-Primakoff transformation is introduced and applied to the antiferromagnetic case to derive the spin wave spectrum in the presence of a uniaxial anisotropy term and an external magnetic field. It is seen that the spin wave gap due to anisotropy closes by the application of a magnetic field. The effect is explained as a spin-flop transition. The effect of thermal and zero point fluctuations of spin waves on the sublattice magnetization is discussed.

Reading: Kittel, *Quantum Theory of Solids*, Chapter 4

The measurement of the magnetic correlation function using neutron scattering is discussed in some detail, following Kittel, *Quantum Theory of Solids*, Chapter 19.