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8.512 Theory of Solids II
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Lecture 14: Local Moment Magnetism

Lecture 15: Exchange Interactions

We begin with a discussion of the magnetism due to spins and Hund's rule in isolated ions.

Reading: Aschcroft and Mermin, Chapter 31.

Then the effect of the solid state is discussed by introducing the concept of crystal field splitting. For transition metals, the crystal field effect is stronger than the spin orbit effect and we work in the orbital angular momentum basis. On the other hand, for rare earths, the reverse is true and one works in the basis of J . We discuss the transition metal case in some detail, covering the Jahn-Teller theorem and the splitting of the d band into T_{2g} and E_g orbitals in a cubic crystal field. Then the spin orbit effect is introduced perturbatively, leading to the effective g tensor and anisotropy in the magnetic Hamiltonian. The exchange interactions between two magnetic ions is discussed as the Heisenberg exchange via the Hubbard model. Some examples of ferromagnetic and antiferromagnetic exchange are discussed. The concept of double exchange is illustrated by considering doping of LaMnO_3 by Sr substitution.