

## Solid State Physics for Nano

SS 2019

### Exercise sheet 6

### Magnetism

#### Exercise 1: two level system

Calculate the mean magnetic moment (magnetization per particle) of a system with total angular momentum  $J=1/2$ , caused by application of an external magnetic field  $B_0$ . Calculate the heat capacity of the system at constant B field and evaluate its function of temperature.

#### Exercise 2: Hund rules

Apply Hund rules and find the ground state of  $\text{Eu}^{1+}$ ,  $\text{Eu}^{2+}$  and  $\text{Eu}^{3+}$  and discuss the consequences for the magnetic moment. Which electronic configuration is responsible for the magnetism in Fe and Ni.

#### Exercise 3: Magnon dispersion

Show that the dispersion relation for antiferromagnetic magnons is  $\hbar\omega \propto |ka|$  instead of  $\hbar\omega \propto |ka|^2$  in ferromagnetic case. Hint: define a set of two differential equations for  $dS^x/dt$  and  $dS^y/dt$  for both sub lattices (similar to the approach for phonons of a two atomic chain)