



## Solid state physics (*winter term 2015/2016*)

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### Exercise sheet 10

#### Magnetism

##### Exercise 1: Diamagnetic susceptibility

The wave function of hydrogen atom in the ground state (1s) yields:

$$\Psi = \frac{1}{\sqrt{\pi a_0^3}} e^{\frac{-r}{a_0}}, \quad a_0 = \pi r^2 / m e^2$$

Calculate the molar diamagnetic susceptibility of atomic hydrogen ( $\text{cm}^3/\text{mol}$ )

##### Exercise 2: Two level system

Calculate the mean magnetic moment (magnetization per particle) of a system with total moment  $J=1/2$ , caused by the application of an external magnetic field  $B_0$ . Calculate the heat capacity of the system at constant  $B$ . How does the heat capacity change as a function of temperature? (Plot)

Hint: use the equation of mean magnetic moment derived in class and sum over  $m_j$ .

### Exercise 3: 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 of Fe and Ni?

Please return on 27/01/2016