

A  $\text{Sc}^{2+}$  ion has one electron in the 3d shell. It is in an anisotropic crystal, the crystal field potential acting on the 3d electron at the  $\text{Sc}^{2+}$  site can be expressed as  $V = A \cdot \tilde{l}_z$ .

- What are the lowest orbital states of the Sc ion if  $A > 0$  and if  $A < 0$  ?

The spin orbit coupling  $\lambda \tilde{l} \cdot \tilde{s}$  is much smaller than the crystal field energy.

- When this is included, what are the approximate ground states for the cases  $A > 0$  and  $A < 0$  ?
- Discuss the influence on these states of a small magnetic field along the z-axis and perpendicular to it. Comment on the temperature dependence of the magnetic susceptibility for all the cases.

Consider two interacting spin-1/2 particles. For this the proper quantum numbers are  $S=0$  (singlet) and  $S=1$  (triplet). The singlet and triplet states are separated in energy by an amount  $\Delta$  which can be negative (triplet ground state) or positive (singlet ground state). Derive the temperature dependent magnetic susceptibility for this system.