-Origin of Van Vleck magnetism?
-Why do we still have a degeneracy of the multiplet since we have filled te e- in the boxes?
-Will you discuss the gyromagnetic ratio for band magnetism, where the apparent g_J takes crazy values?
-Different ferrimagnetic ordering, antiferromagnetic ordering. Is it important for applications?

-Origin of Van Vleck magnetism?

Energy: $$\mathcal{H}_B = \boxed{\mu_B(\vec{L}+2\vec{S}).\vec{B}} + \boxed{\frac{e^2}{8m_e}\sum_i(\vec{B}\times\vec{r}_i)^2}$$

$$\boxed{\begin{aligned}\Delta E_n = {} & \mu_B \mathbf{H}\cdot\langle n|\mathbf{L}+g_0\mathbf{S}|n\rangle + \sum_{n'\neq n}\frac{|\langle n|\mu_B\mathbf{H}\cdot(\mathbf{L}+g_0\mathbf{S})|n'\rangle|^2}{E_n-E_n'} \\ & + \frac{e^2}{8mc^2}H^2\left\langle n\left|\sum_i(x_i^2+y_i^2)\right|n\right\rangle\end{aligned}}$$

$$\Delta E_0 = \frac{e^2}{8mc^2}H^2\left\langle 0\left|\sum_i(x_i^2+y_i^2)\right|0\right\rangle - \sum_n\frac{|\langle 0|\mu_B\mathbf{H}\cdot(\mathbf{L}+g_0\mathbf{S})|n\rangle|^2}{E_n-E_0} \tag{31.31}$$

$$\chi = -\frac{N}{V}\frac{\partial^2 E_0}{\partial H^2} = -\frac{N}{V}\left[\frac{e^2}{4mc^2}\left\langle 0\left|\sum_i (x_i^2 + y_i^2)\right|0\right\rangle + 2\mu_B^2 \sum_n \frac{|\langle 0|(\mathbf{L}_z + g_0 \mathbf{S}_z)|n\rangle|^2}{E_n - E_0}\right]$$

Van Vleck paramagnetism → Another source of paramagnetism (2nd order perturbation theory, mixing with excited states)

weak positive and temperature independent

plays a role for electric shell 1 e- of being hafl filled like Eu3+.

-Why do we still have a degeneracy of the multiplet since we have filled the e- in the boxes?

Example of unfilled shell

Tb^{3+} is $4f^8$, 8 electrons to put in 14 boxes ($\ell = 3$)

m_ℓ	-3	-2	-1	0	1	2	3
$m_s = \frac{1}{2}$	$\uparrow$	$\uparrow$	$\uparrow$	$\uparrow$	$\uparrow$	$\uparrow$	$\uparrow$
$m_s = -\frac{1}{2}$	$\downarrow$						

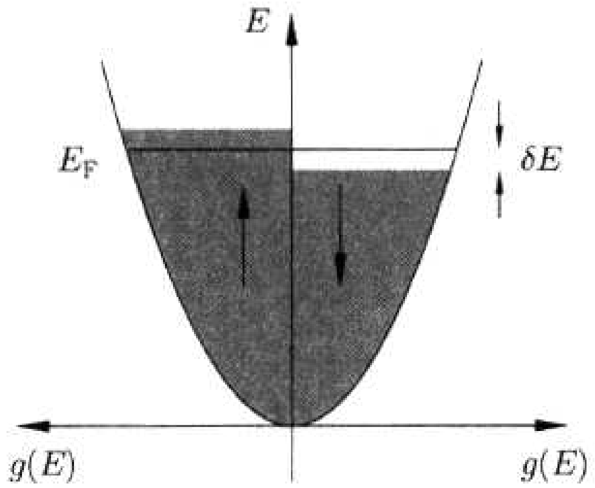
With this method, one identifies actually only one orbital of the ground state, the one for which M_S=S and M_L=L.

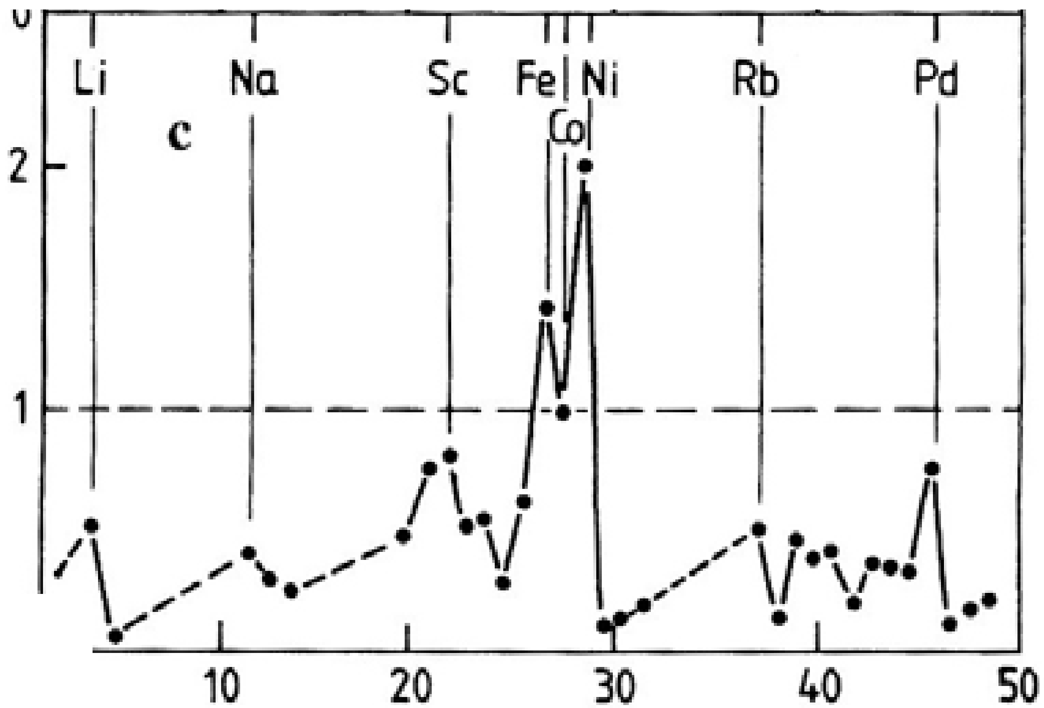
-Will you discuss the gyromagnetic ratio for band magnetism, where the apparent g_J takes crazy values?

Reformulated as: why do we have values of magnetization per atom which are non integral value as in the case of localized magnetism In ferromagnetic metals (Co, Ni, Fe)? Ex. 2.2 μ_B/Fe

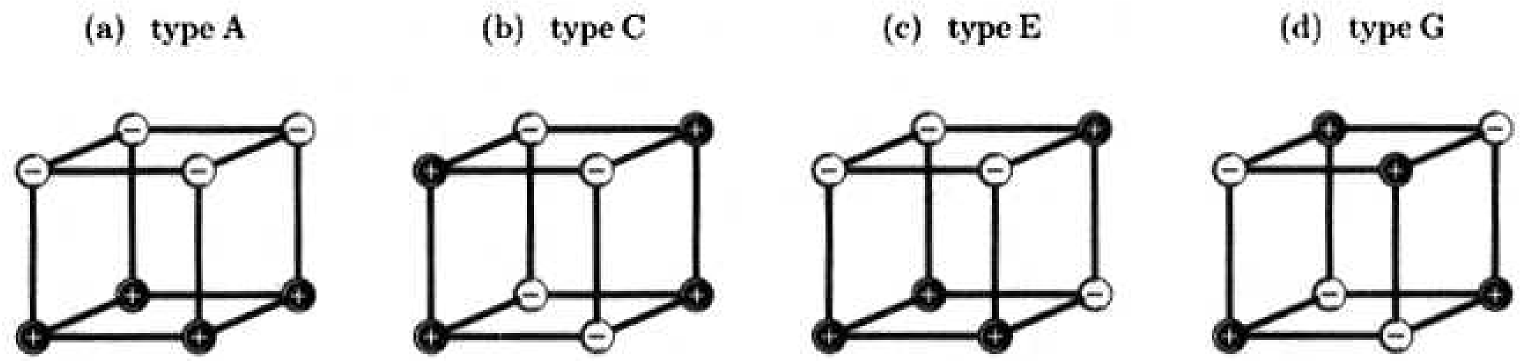
A spin-dependent electron interaction
Spontaneously spin-split bands:
Stoner criterion

$$UN(E_F) \geq 1$$





-Different ferrimagnetic ordering, antiferromagnetic ordering.
Is it important for applications?



Exchange bias