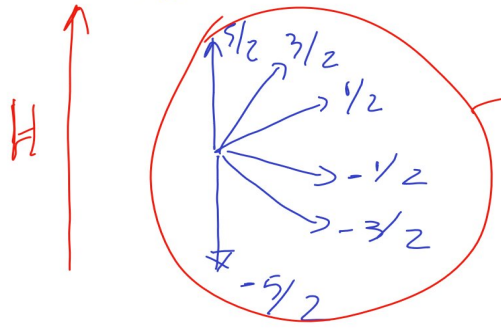
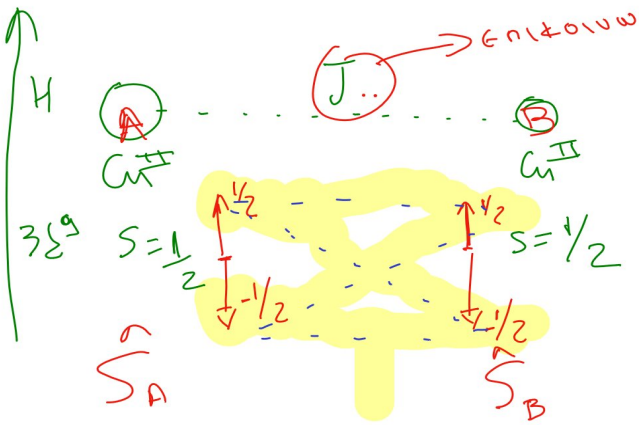
$\dot{e} \Longrightarrow$ spin $\pm 1/2$ $\quad \boxed{2S+1}$

spin $5/2$ $\quad M_n^{II}$ 5 αντ. e $\quad 2\cdot\frac{5}{2}+1 = 6$



→ Zeeman

$\hat{S}$



$$\hat{H} = -2\hat{J}\hat{S}_A\hat{S}_B \quad (1)$$

$$\hat{S}_T = \hat{S}_A + \hat{S}_B \quad (2)$$

$$\hat{a}^2 = a\cdot(a+1)$$

$$\hat{S}_T = \hat{S}_A + \hat{S}_B \Longrightarrow \hat{S}_T^2 = (\hat{S}_A + \hat{S}_B)^2 \ (2) \Longrightarrow$$

$$S_T\cdot(S_T+1) = \hat{S}_A^2 + \hat{S}_B^2 + 2\hat{S}_A\hat{S}_B \Longrightarrow$$

$$S_T\cdot(S_T+1) = S_A\cdot(S_A+1) + S_B(S_B+1) + 2\,\hat{S}_A\hat{S}_B$$

$$2\hat{S}_A\hat{S}_B = S_T(S_T+1) - S_A(S_A+1) - S_B(S_B+1) \quad S_A = S_B = S$$

$$\boxed{2\hat{S}_A\hat{S}_B = S_T(S_T+1) - 2S(S+1)}$$

$$H = -J\cdot\left[S_T(S_T+1) - 2S(S+1)\right]$$

$Cu^{2}\uparrow \quad Cu^{1/2}\uparrow$

$S_T = 1, 0$

$$E_{S_T=0} = -J\cdot\left[0\cdot(0+1) - 2\cdot 1/2\cdot(1/2+1)\right] \Longrightarrow$$

$$E_{S_T=0} = +\frac{3J}{2}$$

+1J

$$E_{S_T=1} = -J\cdot\left[1\cdot(1+1) - 2\cdot 1/2\,(1/2+1)\right] \Longrightarrow$$

↑↑ in T↓

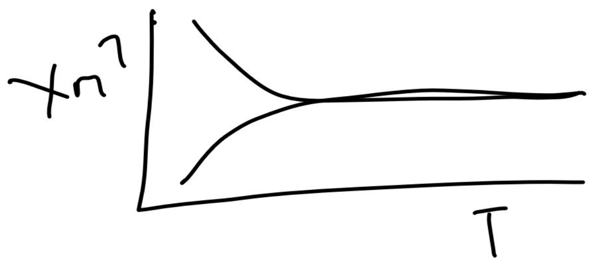
$$E_{S_T=1} = -J\cdot\left[2 - 3/2\right] \Longrightarrow E_{S_T=1} = -\frac{J}{2}$$

~~−J~~

exc. state

$\Longrightarrow 2J$

gs



$$\chi_M T = C\cdot\frac{\sum S_T\cdot(S_T+1)\cdot(2S_T+1)\cdot e^{-E_{S_T}/kT}}{\sum (2S_T+1)\cdot e^{-E_S/kT}}$$

$C \Downarrow$ no. S

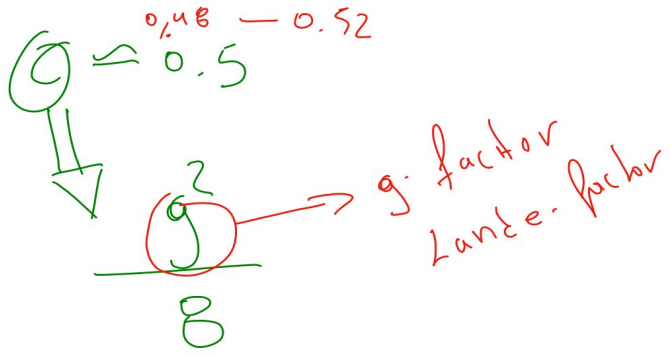
Van Vleck

$$\chi_M T = C_{\text{no. S}}\cdot\frac{0\cdot(0+1)\cdot(2\cdot 0+1)\cdot e^{-3J/2kT} + 1\cdot(1+1)\cdot(2\cdot 1+1)\cdot e^{J/2kT}}{(2\cdot 0+1)\cdot e^{-3J/2kT} + (2\cdot 1+1)\,e^{J/2kT}}$$

6 … 3

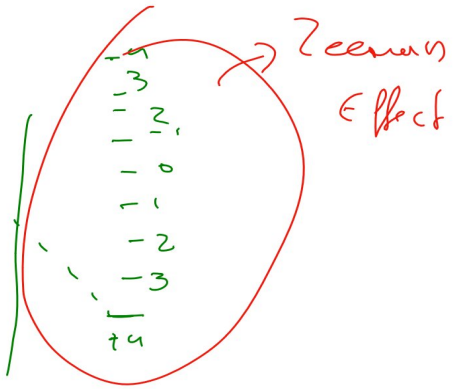
$$\chi_m = C \cdot \frac{6 e^{\frac{J}{2kT}}}{e^{-\frac{3J}{2kT}} + 3 e^{\frac{J}{2kT}}}$$

$n \cdot 0.5$



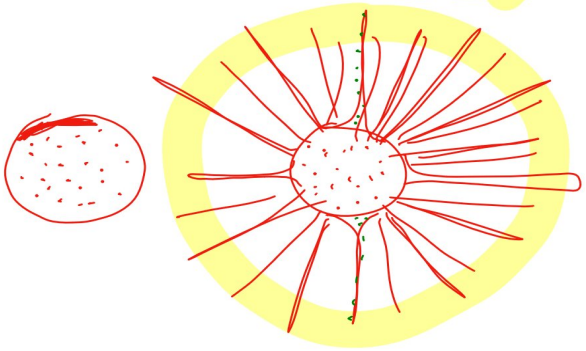
$\xi^{\frac{5}{2}}$ $\xi^{\frac{3}{2}}$ $\xi^{\frac{1}{2}}$

2.00 2,05 2,1

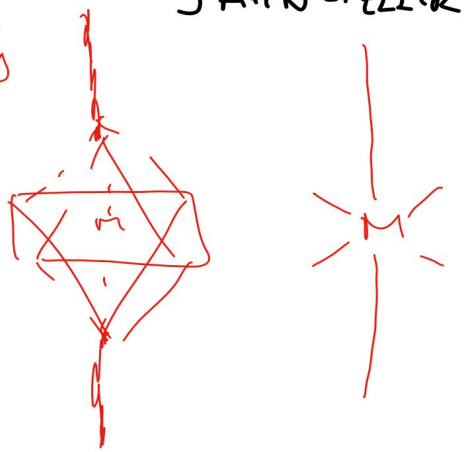


π.χ. $S = 4$ $\quad 2S+1 \Longrightarrow 9$

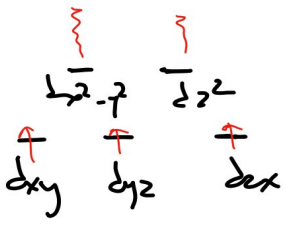
D: μαγνητική ανισοτροπία : ZFS zero field splitting

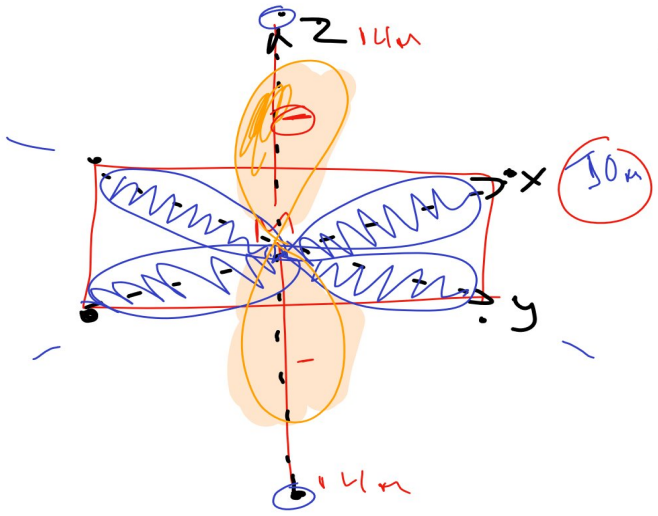


JAHN-TELLER



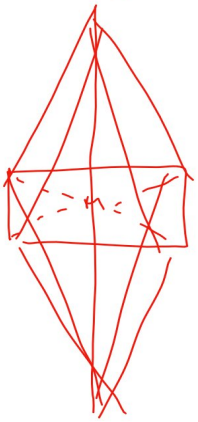
$Mn^{III}: 3d^4$



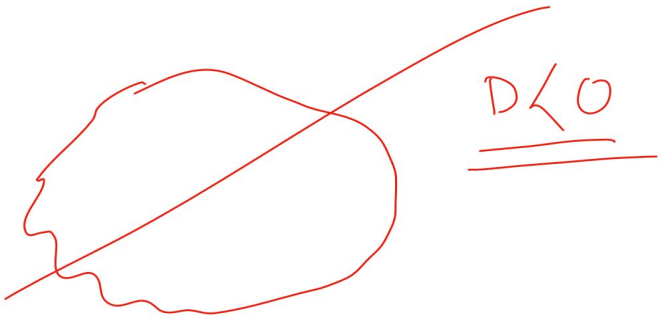


Εστω $\xi_{z^2} \rightarrow 1e^-$

$\xi_{x^2-y^2} \rightarrow 0e^-$



anisotropic



D<0

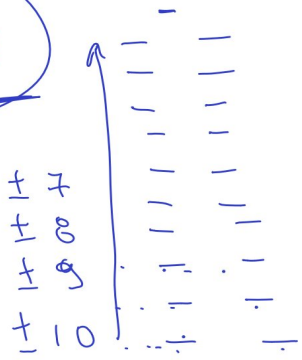
---

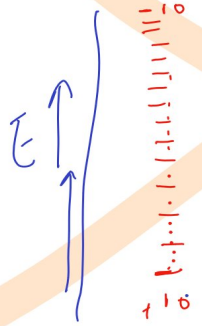
n | S

2S+1

S=10 → 21 προσανατολισμοί.

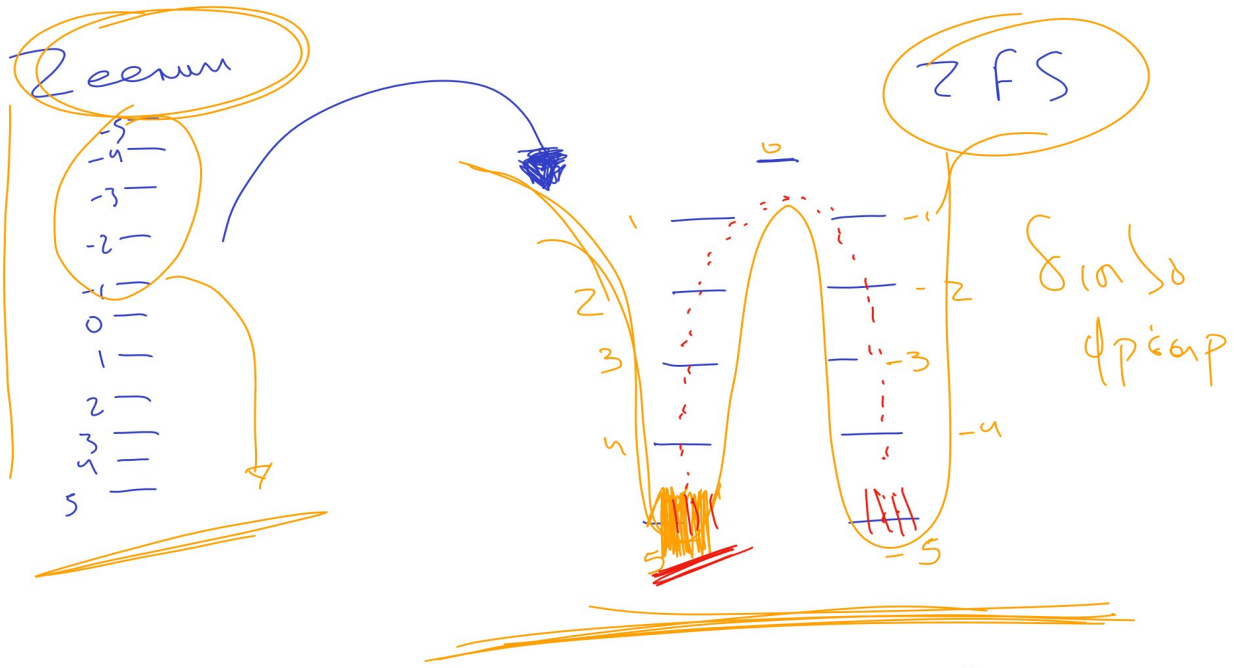
D<0

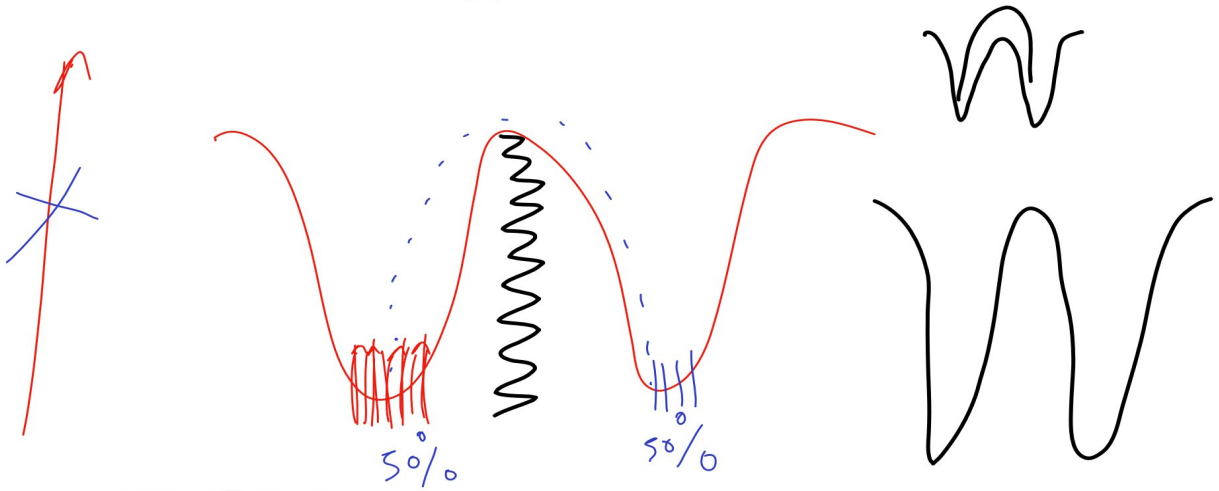




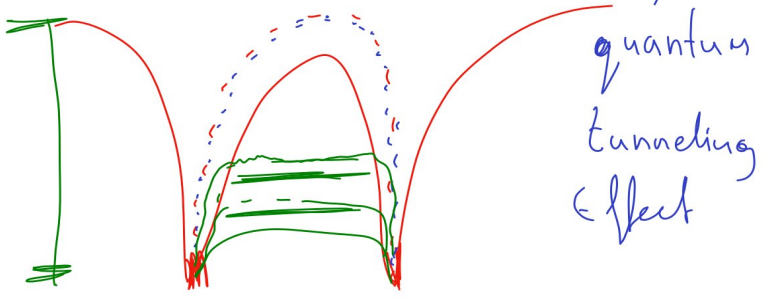
Zeeman Effect

ZFS.

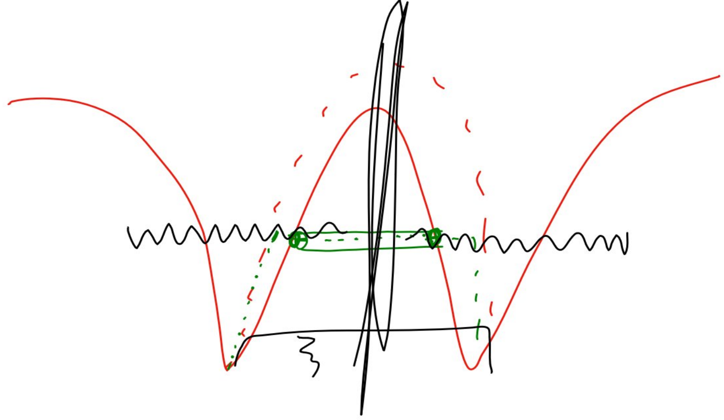


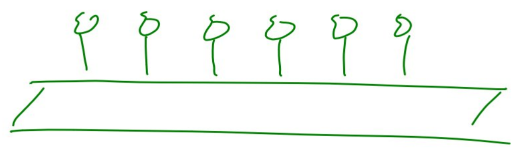


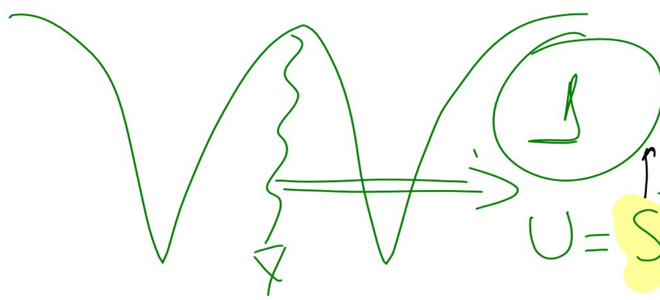
$$U = S^2 \cdot |D|$$



QTM
quantum
tunneling
effect





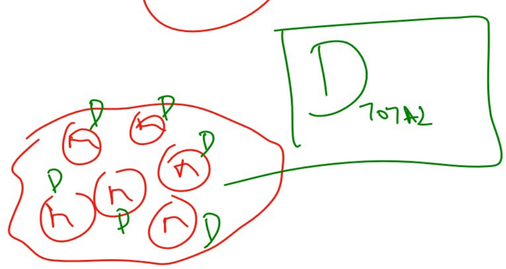


$U = S^2 \cdot |D|$

2

Grenoble

D



$U = 500\,K$

$S = 9$

$U = S^2 \cdot |D|$

$\Longrightarrow D =$

0,04