THE EUROPEAN SCHOOL ON MAGNETISM

Concept tests

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Peer instruction for active learning

https://youtu.be/Z9orbxoRofI

THE EUROPEAN SCHOOL ON MAGNETISM

The H field
Spontaneous magnetisation
Direct exchange

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To increase the field far away from a permanent magnet I can increase:

A (purple) : magnetisation at constant volume

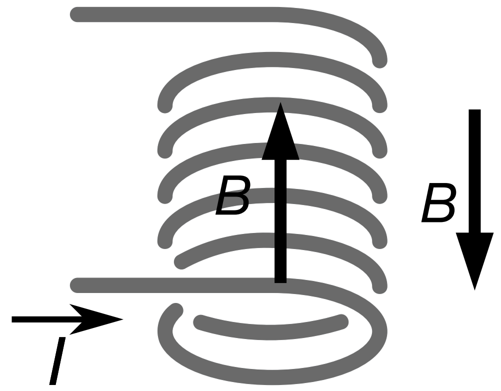
B (blue) : volume at constant moment

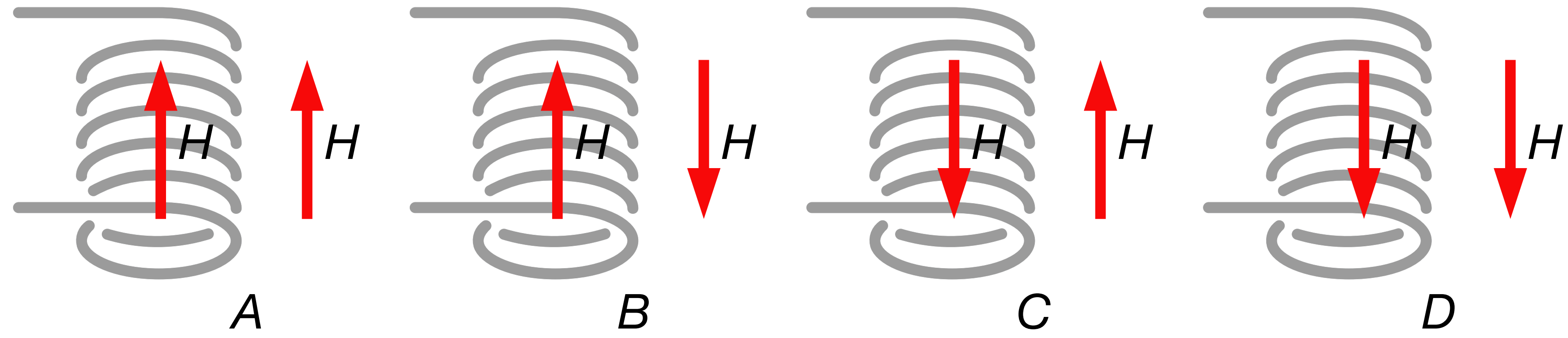
C (green) : moment at constant magnetisation

D (orange) : magnetisation at constant moment

Multiple answers possible

R

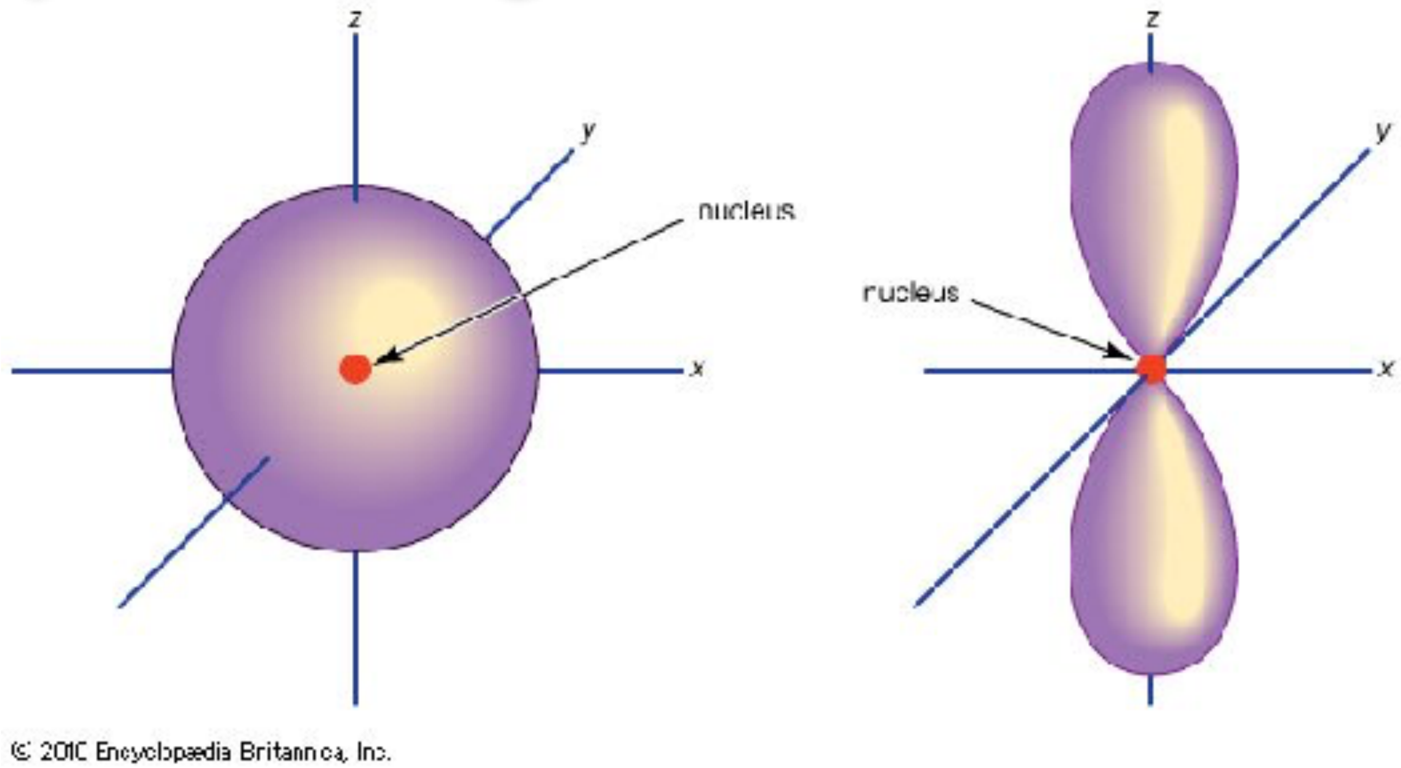




(purple) (blue) (green) (orange)

A

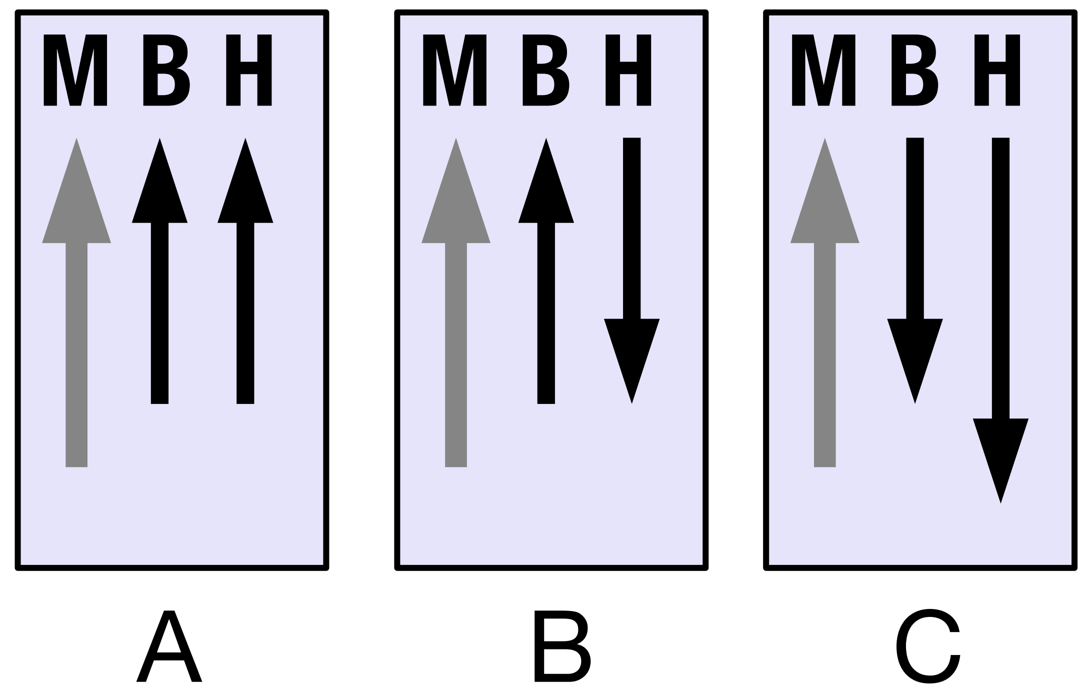
Probability of finding the electron in the nucleus



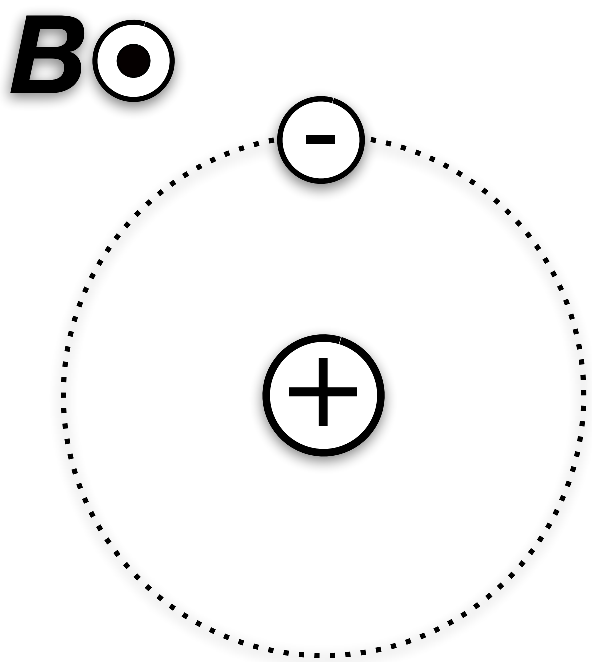
A (purple) :	0	0
B (blue) :	0	Minimum
C (green) :	Maximum	0
D (orange) :	Maximum	Minimum

Uniformly magnetised bar magnet

$$\mathbf{B}=\mu_0(\mathbf{H}+\mathbf{M})$$



(purple) (blue) (green)



H-atom

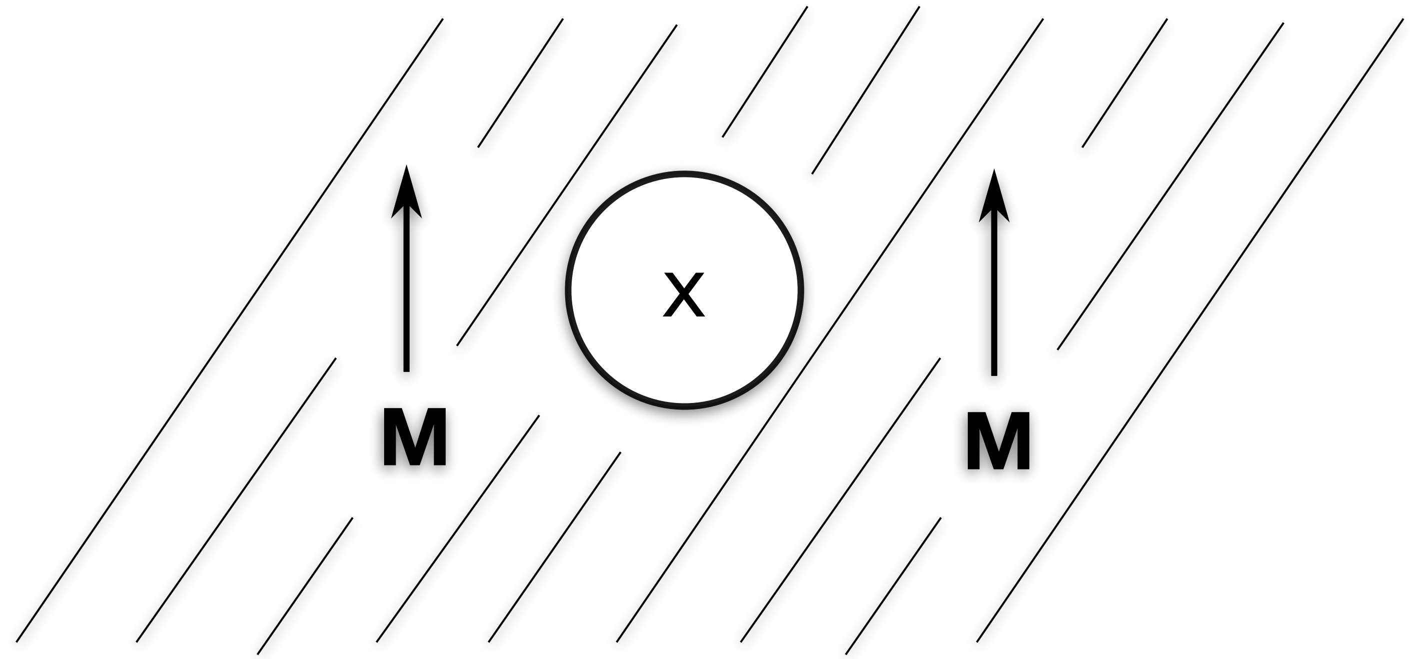
orbital moment

A (red) ⊙ (pointing at you)

B (blue) ⊗ (pointing from you)

C (green) 0

D



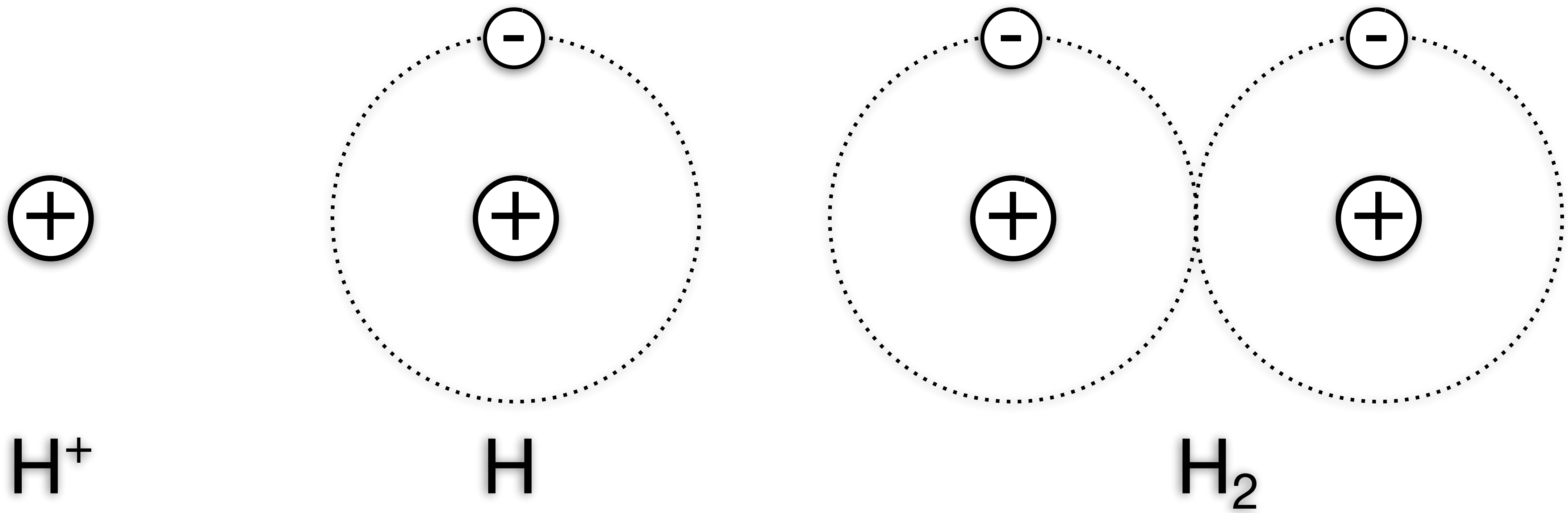
Hole in a permanent magnet with magnetisation $\boldsymbol{M}$

A (purple) : $\boldsymbol{H}$ in $\boldsymbol{x}$ is parallel to $\boldsymbol{M}$

B (blue) : $\boldsymbol{H}$ in $\boldsymbol{x}$ is anti-parallel to $\boldsymbol{M}$

C (green) : $H = 0$

C



A (purple) : $m_{H^+} \geq m_H$

B (blue) : $m_{H^+} \geq m_{H_2}$

C (green) : $m_H \geq m_{H_2}$

Hunds rule:

Mn: [Ar] $3d^5$ $4s^2$

Fe: [Ar] $3d^6$ $4s^2$

Co: [Ar] $3d^7$ $4s^2$

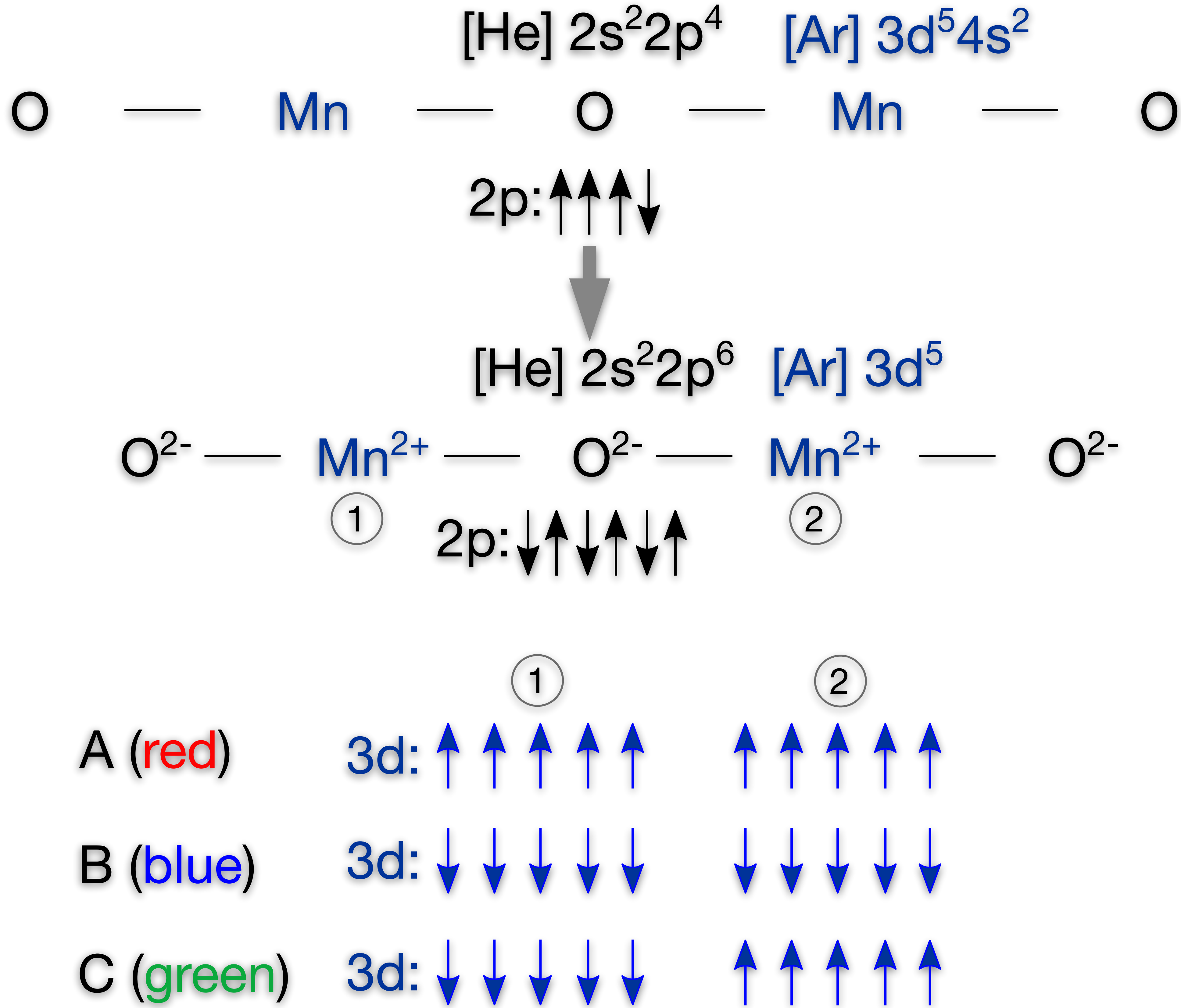
Ionized Fe:

A (purple) Fe^{2+}: [Ar] $3d^4$ $4s^2$

B (blue) Fe^{2+}: [Ar] $3d^5$ $4s^1$

C (green) Fe^{2+}: [Ar] $3d^6$ $4s^0$

D (orange) None of the above


[He] 2s²2p⁴
[Ar] 3d⁵4s²
O — Mn — O — Mn — O
2p: ↑↑↑↓
[He] 2s²2p⁶
[Ar] 3d⁵
O2- — Mn2+ — O2- — Mn2+ — O2-
1
2p: ↓↑↓↑↓↑
2
1
2
A (red) 3d: ↑↑↑↑↑ ↑↑↑↑↑
B (blue) 3d: ↓↓↓↓↓ ↓↓↓↓↓
C (green) 3d: ↓↓↓↓↓ ↑↑↑↑↑

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Anti-ferro and ferri-magnetism
Anisotropy - phenomenological
Anisotropy - pair model

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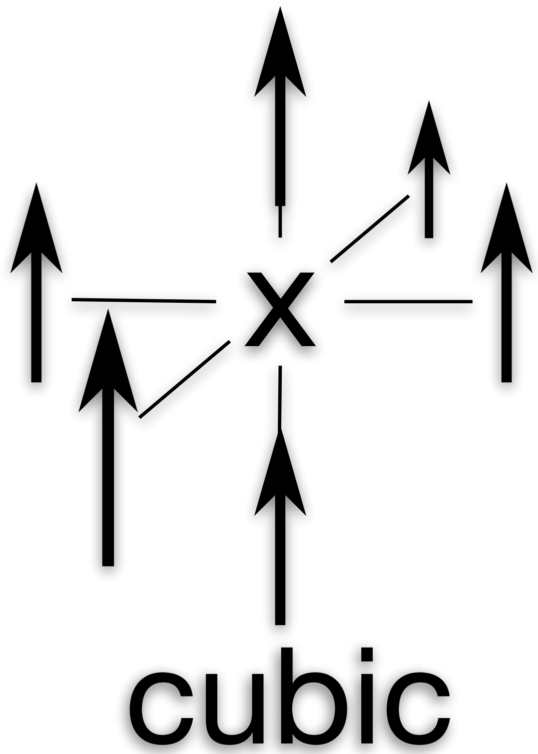
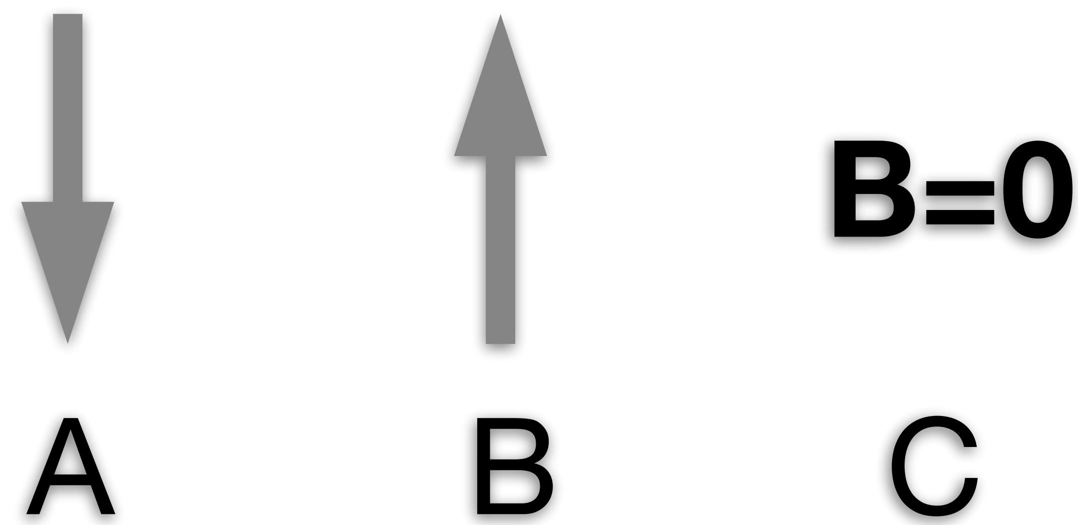


B in x:

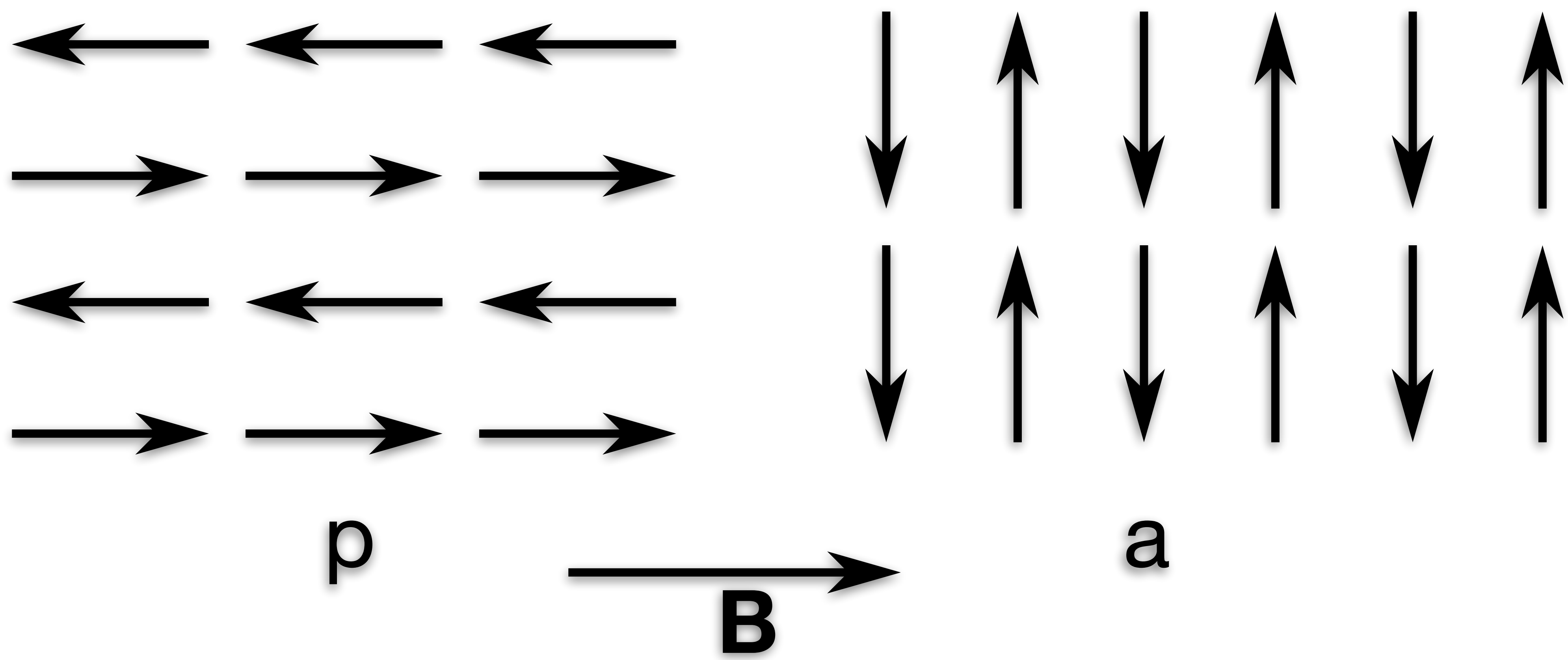


A (purple) : down

B (blue) : up

C (green) : zero

D (orange) : None of the above



A (purple) : $E_p > E_a$

B (blue) : $E_p < E_a$

C (green) : $E_p = E_a$

J

Mn: [Ar] $3d^5$ $4s^2$ is not a ferromagnet because:

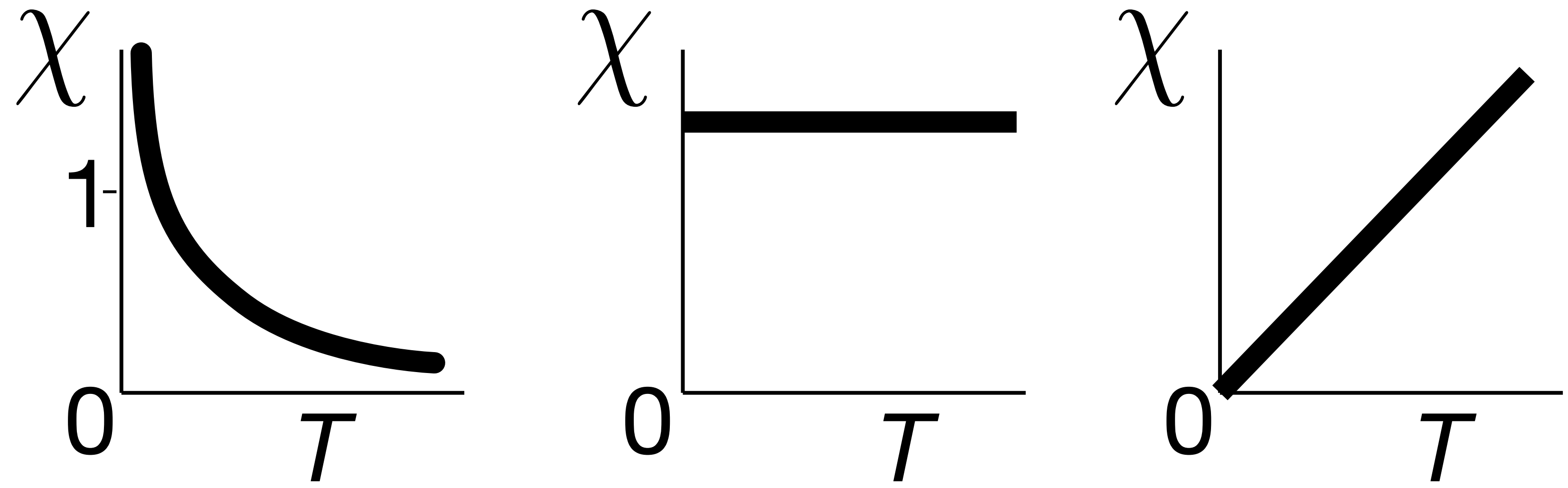
A (purple) : Mn has a half filled d-shell

B (blue) : Mn oxidises too fast

C (green) : Mn is an anti-ferromagnet

D (orange) : Another reason

$$\chi = \left.\frac{dM}{dH}\right|_{H=0}$$



A (purple) : Para-, Ferro-, Anti-ferro

B (blue) : Anti-ferro-, Para-, Ferromagnetic

C (green) : Para-, Anti-ferro, Anti-ferro

D (orange) : Ferro-, Anti-ferro, Para

L

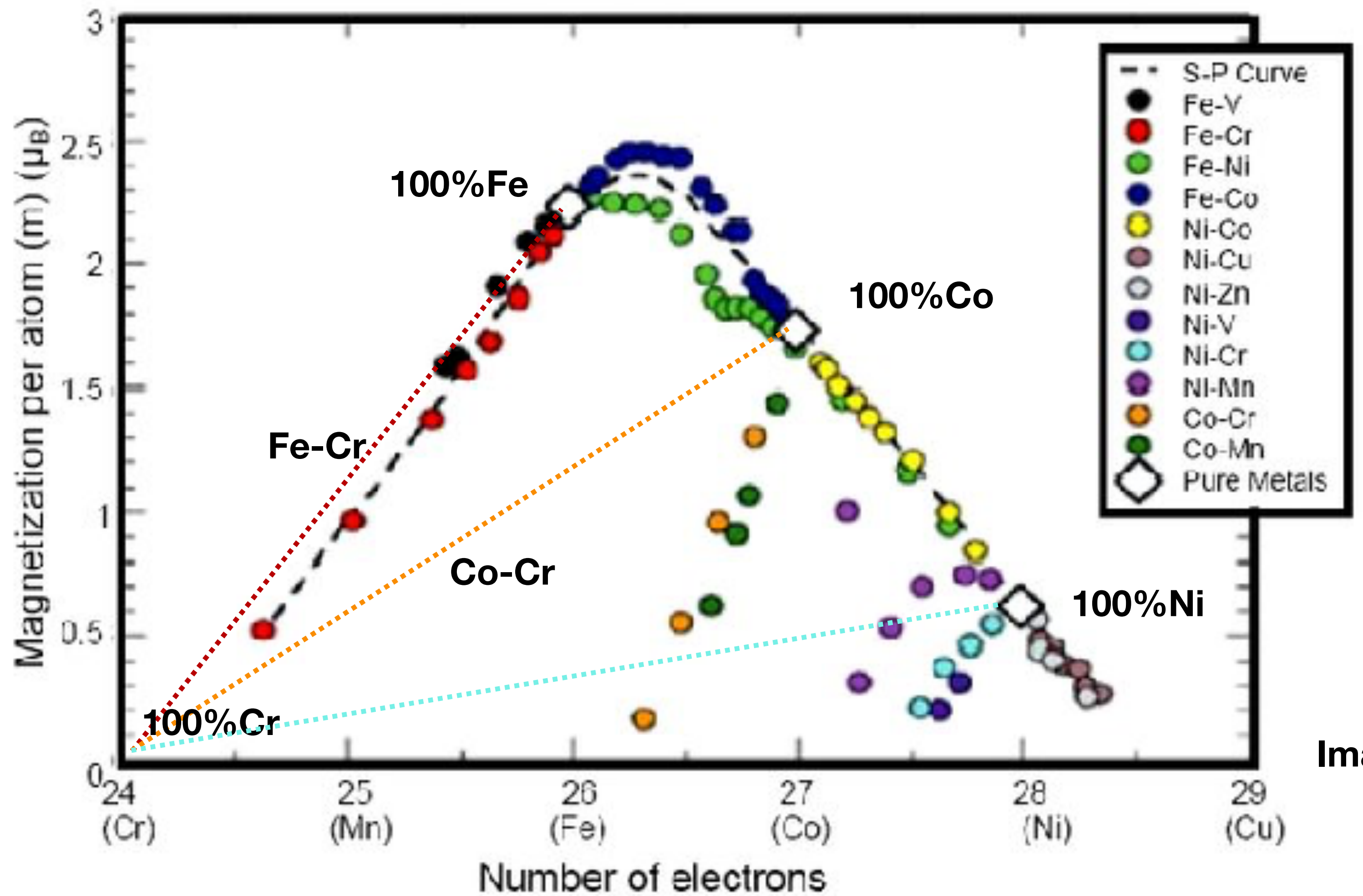


Image from Rajat Roy

Effect Cr on Fe different from Co and Ni because:

A (purple) : Cr chemically reacts with Ni, Co

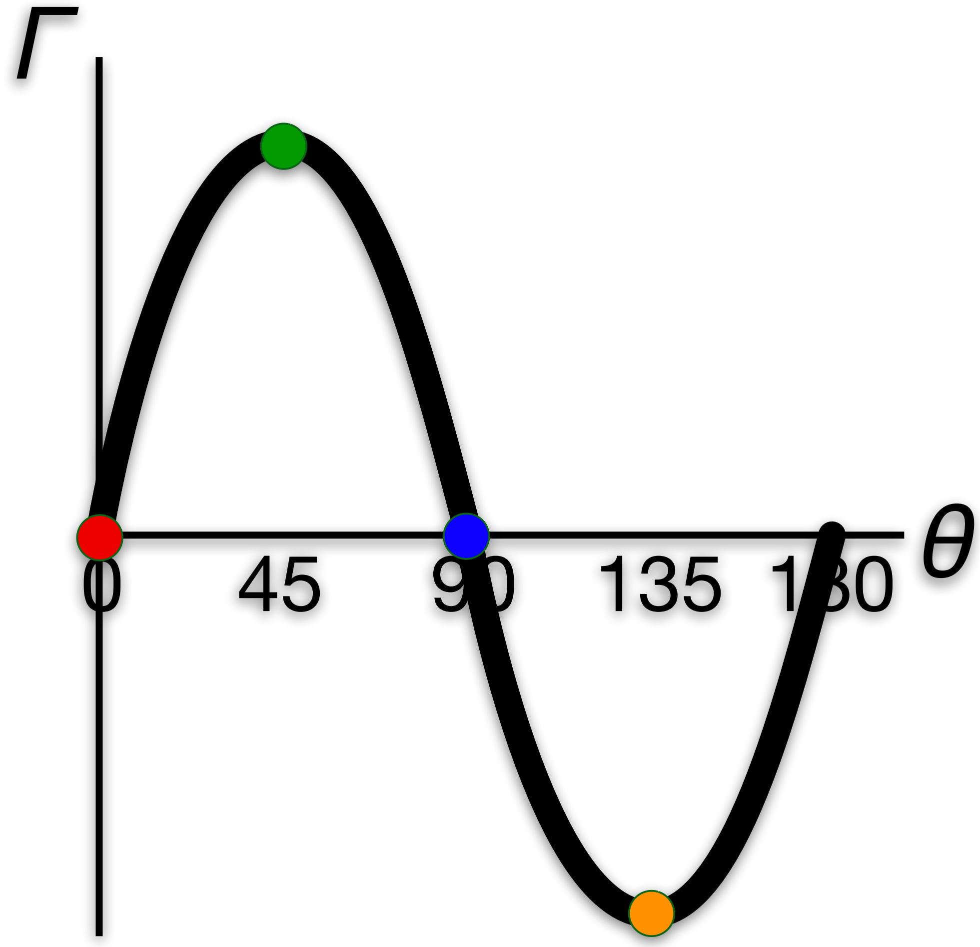
B (blue) : Cr couples anti-ferromagnetically

C (green) : All of the above

D (orange) : None of the above

M

$\Gamma=-dE/d\theta$



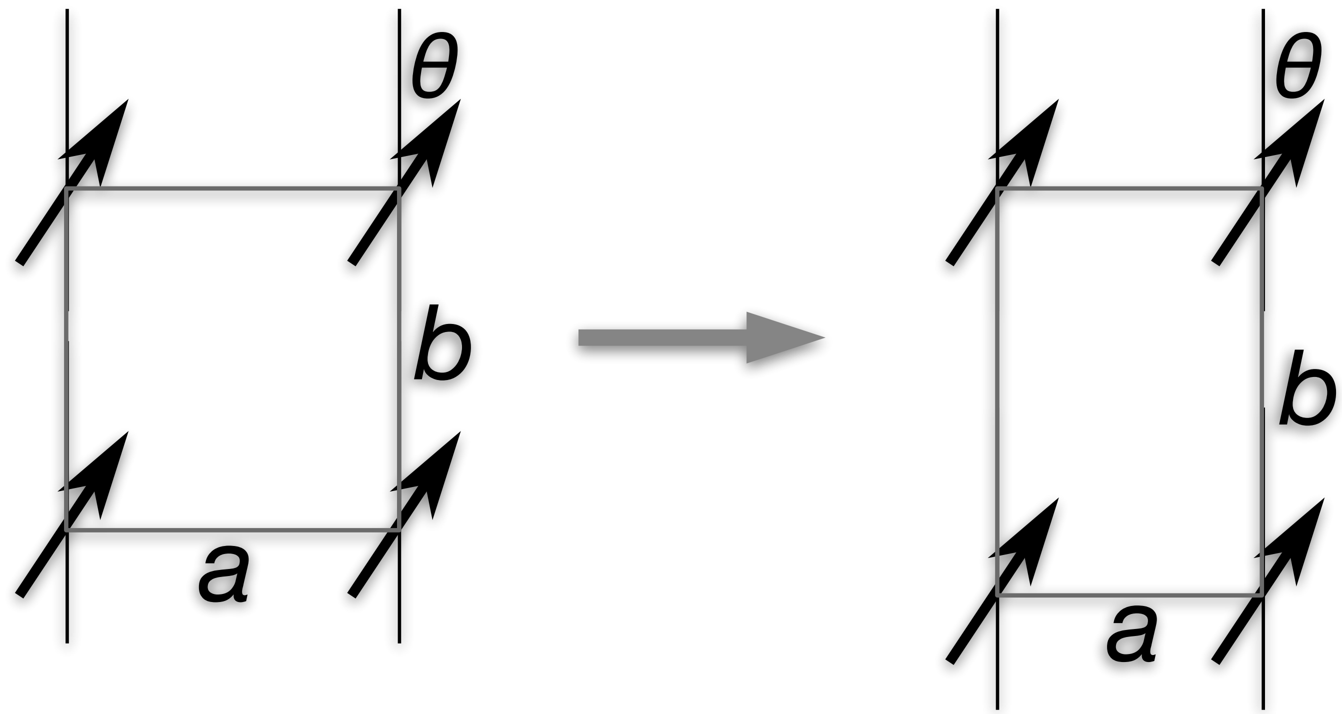
The easy axis is at $\theta=$

A (purple) : 0

B (blue) : 45

C (green) : 90

D (orange) : 135



$$E = K_{u1}\cos^2(\theta) + K_2\cos^2(2\theta)$$

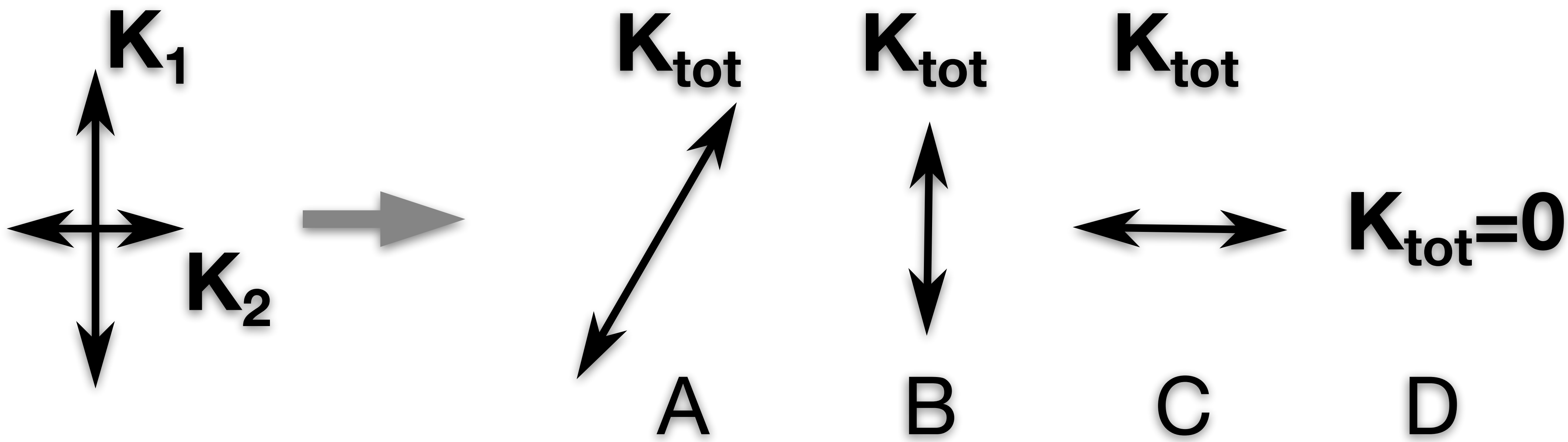
First b/a=1, if I increase b/a, then

A (purple) : K_{u1} increases

B (blue) : K_{u1} decreases

C (green) : $K_{u1} = 0$

o



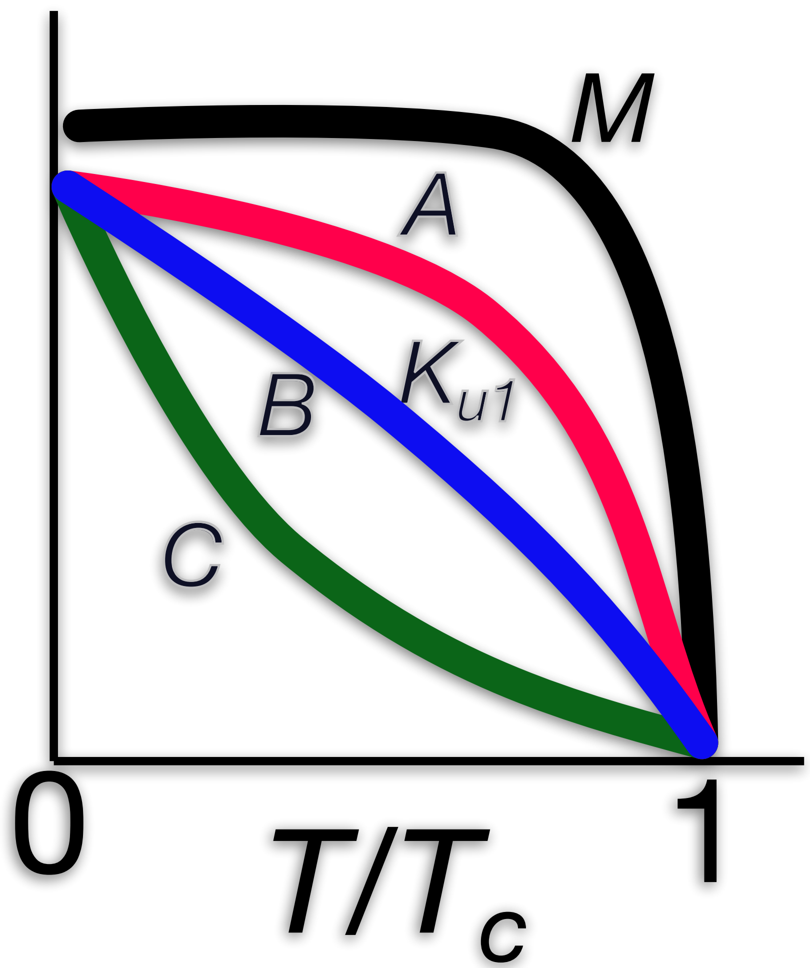
K_1, K_2 uni-axial

A (purple)

B (blue)

C (green)

D (orange)



Uni-axial:

$E=K_{u1}\cos^2(\theta)$

Cubic:

$E=K_1\,(\alpha_1^2\alpha_2^2+\alpha_1^2\alpha_3^2+\alpha_2^2\alpha_3^2)$

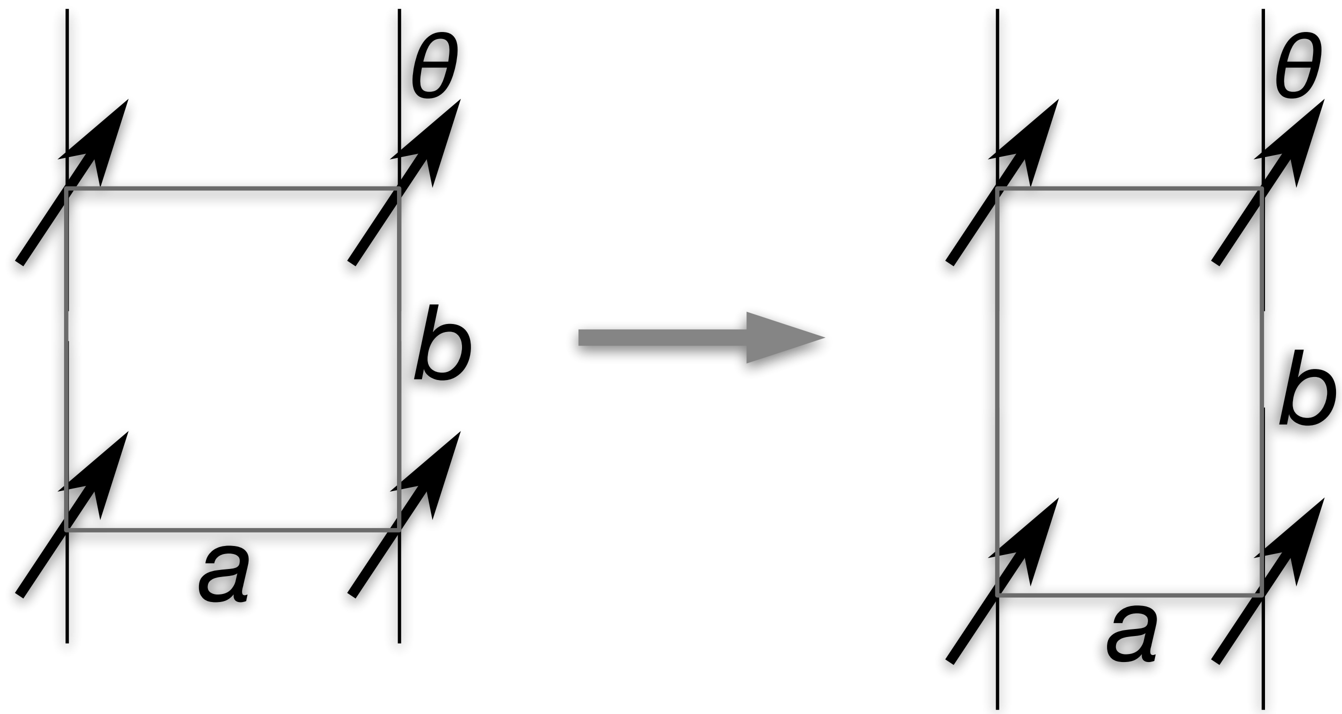
If T-dependence K_{u1} is as indicated, than K1

A (purple) : K_1 less T-dependent

B (blue) : K_1 same as K_{u1}

C (green) : K_1 more T-dependent

Q



$$E = K_{u1} \cos^2(\theta) + K_2 \cos^2(2\theta)$$

If I increase b/a, then

A (purple) : K_2 increases but $K_2 < 0$

B (blue) : K_2 increases ($K_2 > 0$ is ok)

C (green) : K_2 decreases but $K_2 > 0$

D (orange) : K_2 decreases ($K_2 < 0$ is ok)