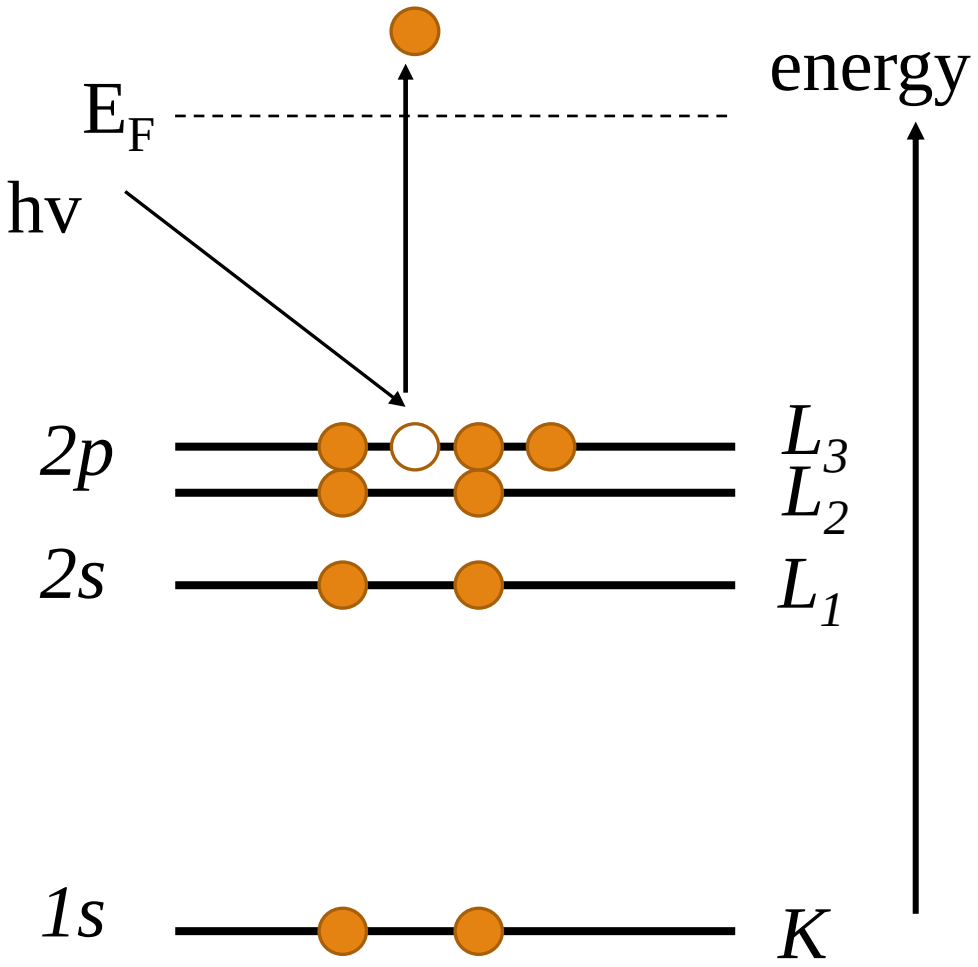
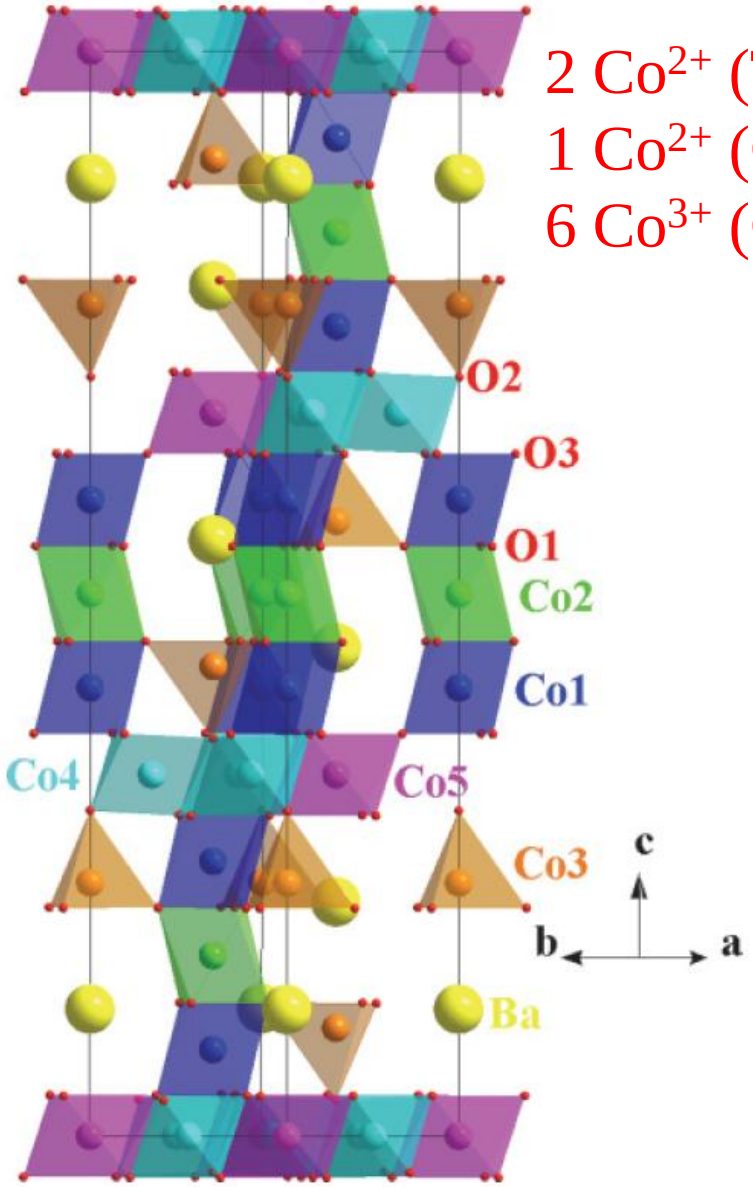
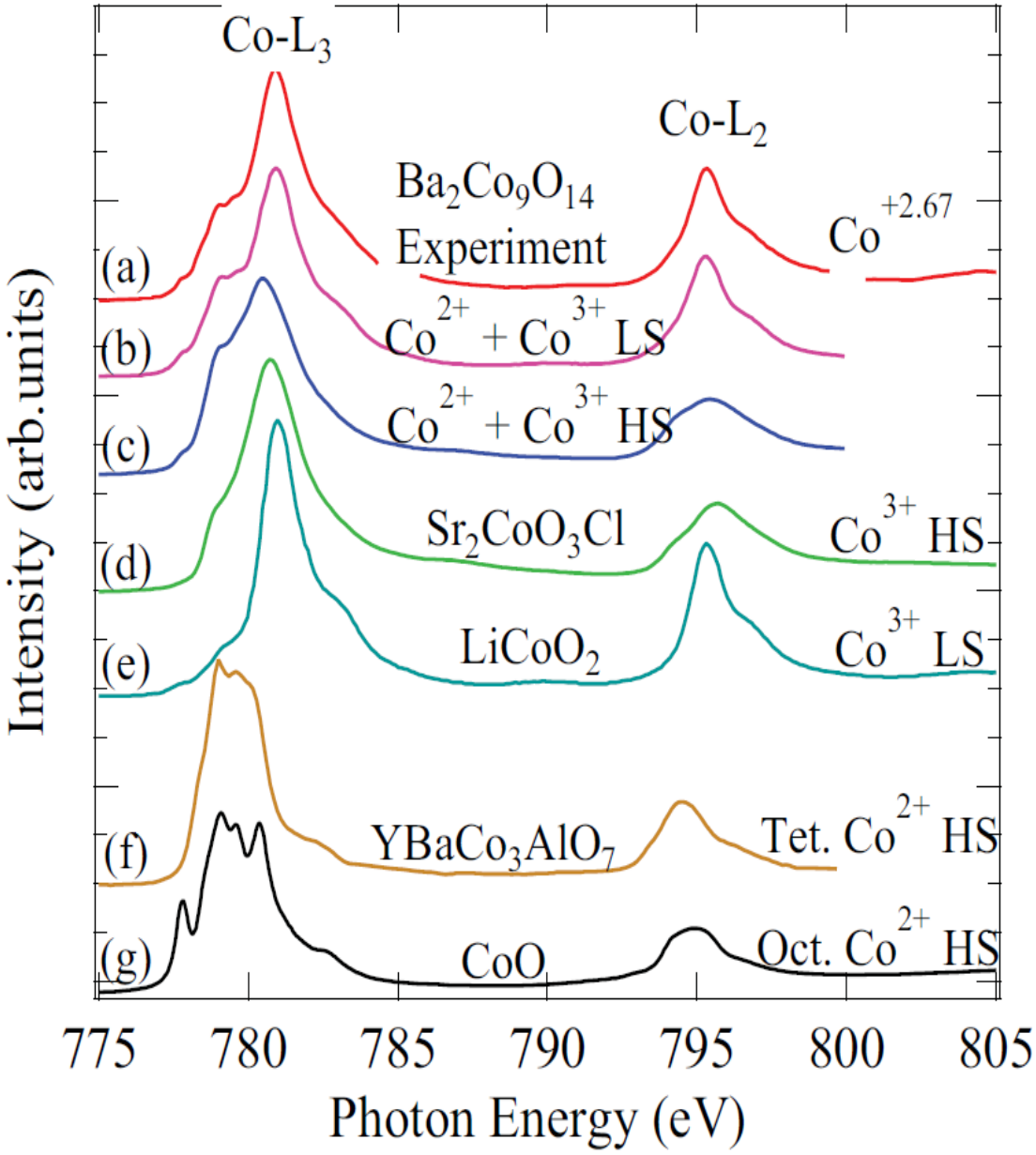
X-ray Absorption Spectroscopy (XAS)



$Ba_2Co_9O_{12}$

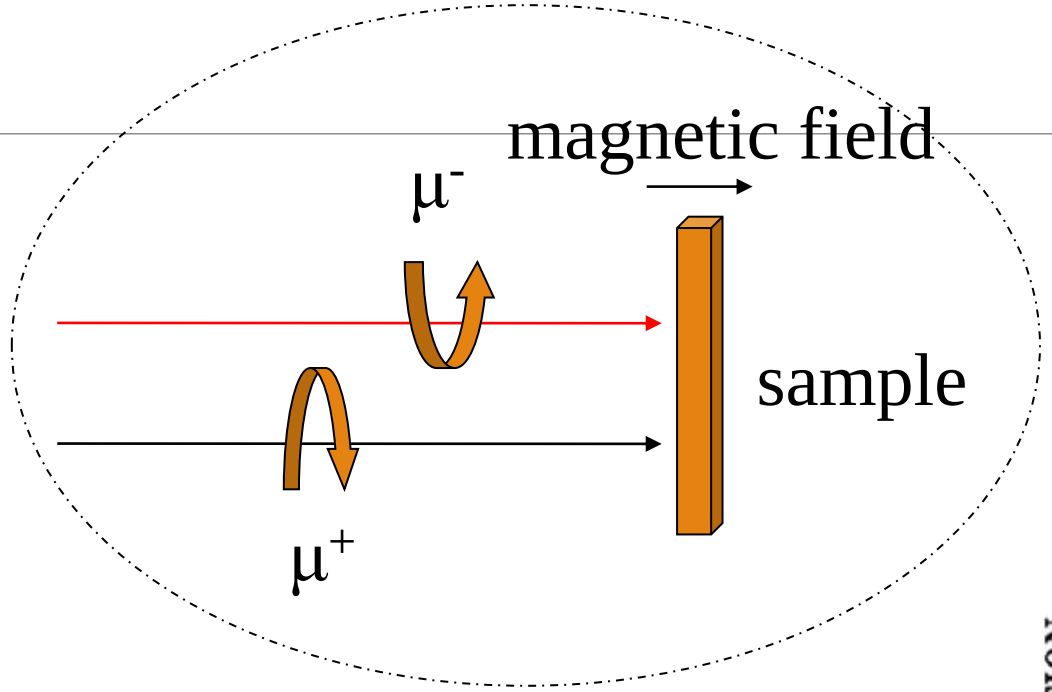


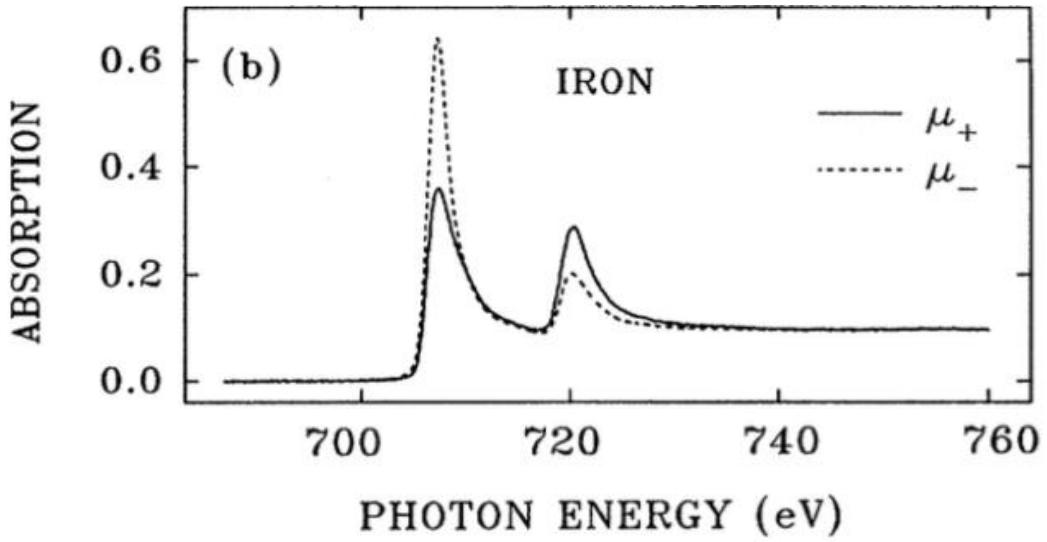
2 Co^{2+} (Tet.)
1 Co^{2+} (Oct.)
6 Co^{3+} (Oct.)



J.-G. Cheng *et al.*, Phys. Rev. B **85**, 094424 (2012)

X-ray Magnetic Circular Dichroism (XMCD)

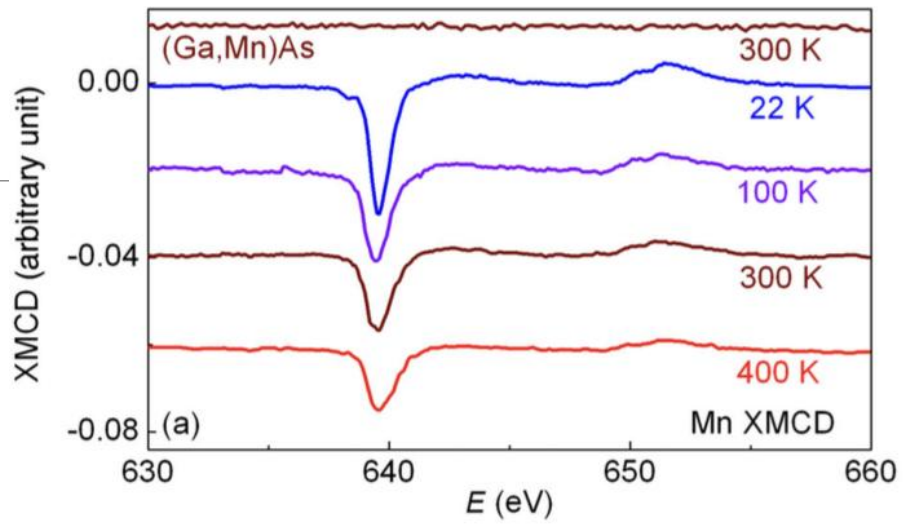


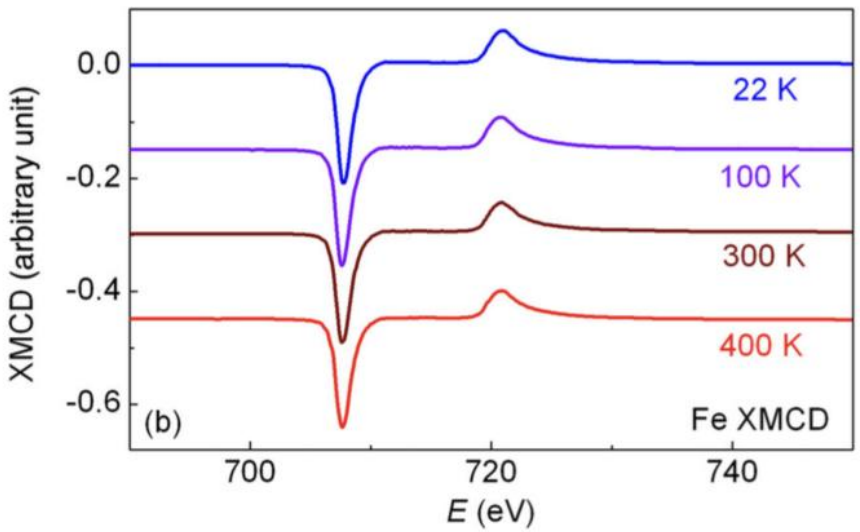


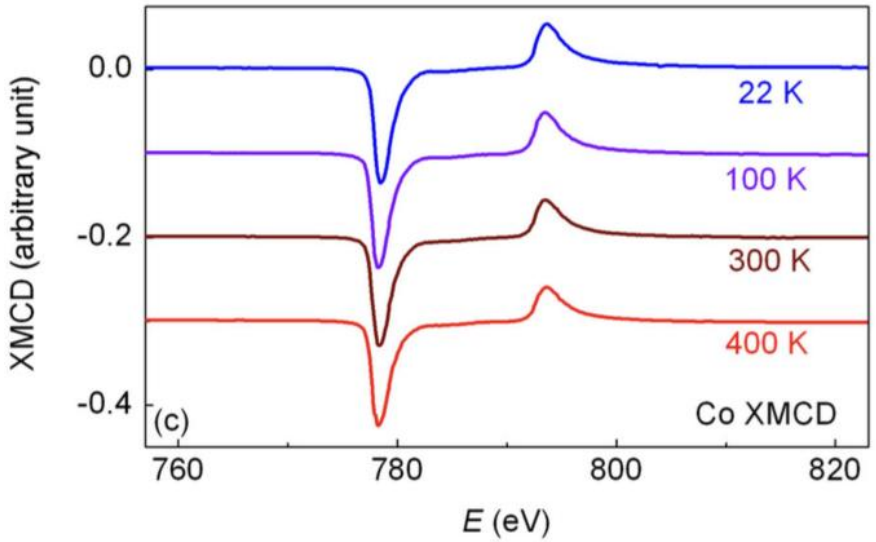
C. T. Chen *et al.*, Phys. Rev. Lett. **75**, 152 (1995).

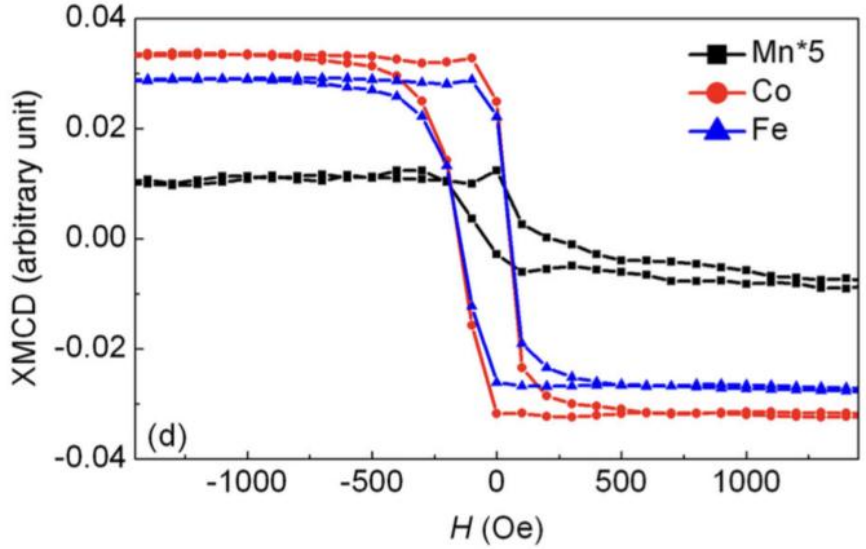
Element Selective

$Co_2FeAl/(Ga,Mn)As$







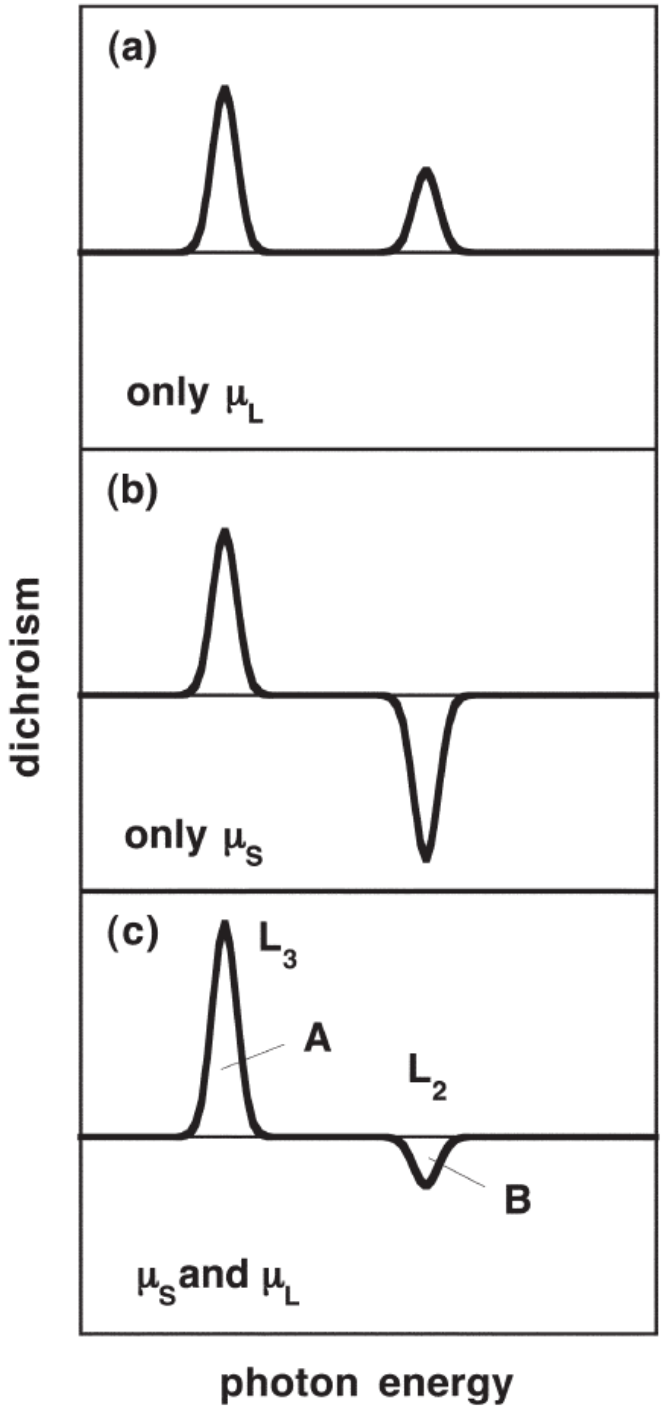


S. H. Nie *et al.*, Phys. Rev. Lett. **111**, 027203 (2013).

Orbital and spin moment

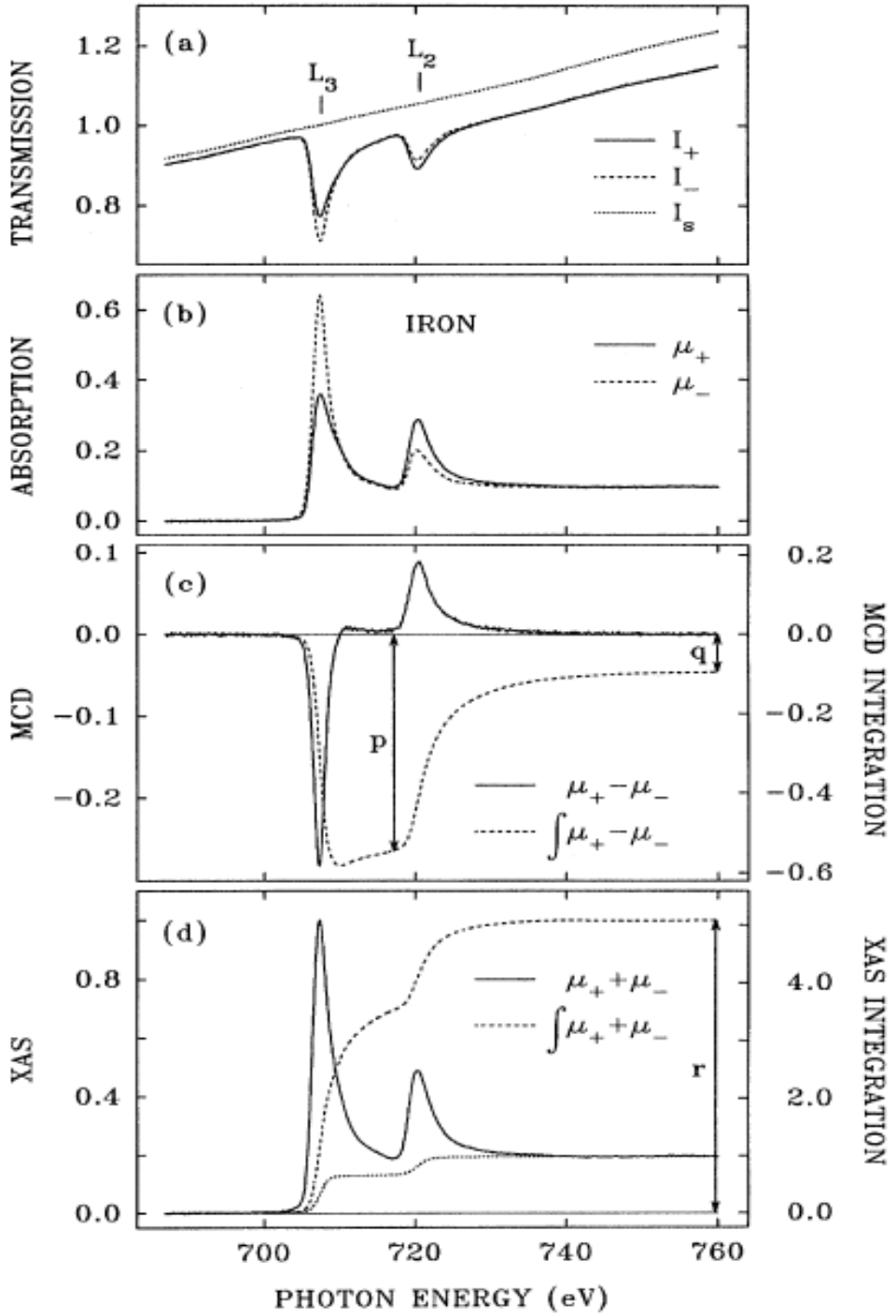
L_3: J = L+S = 1+1/2

L_2: J = L-S = 1-1/2



W. Kuch, Phys. Scr. **2004,** 89 (2004)

XMCD sum rules



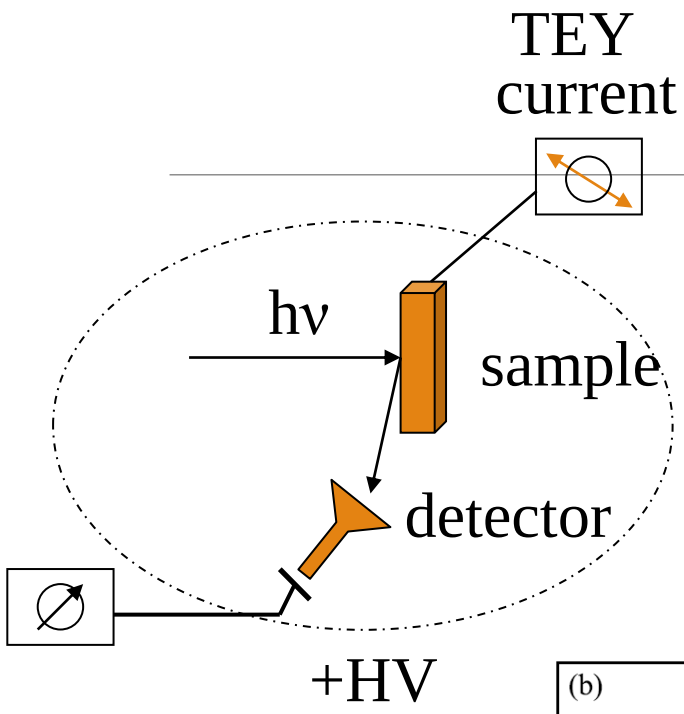
$$m_{\text{orb}} = -\frac{4\int_{L_3+L_2}(\mu_+ - \mu_-)\,d\omega}{3\int_{L_3+L_2}(\mu_+ + \mu_-)\,d\omega}(10 - n_{3d}), \quad (1)$$

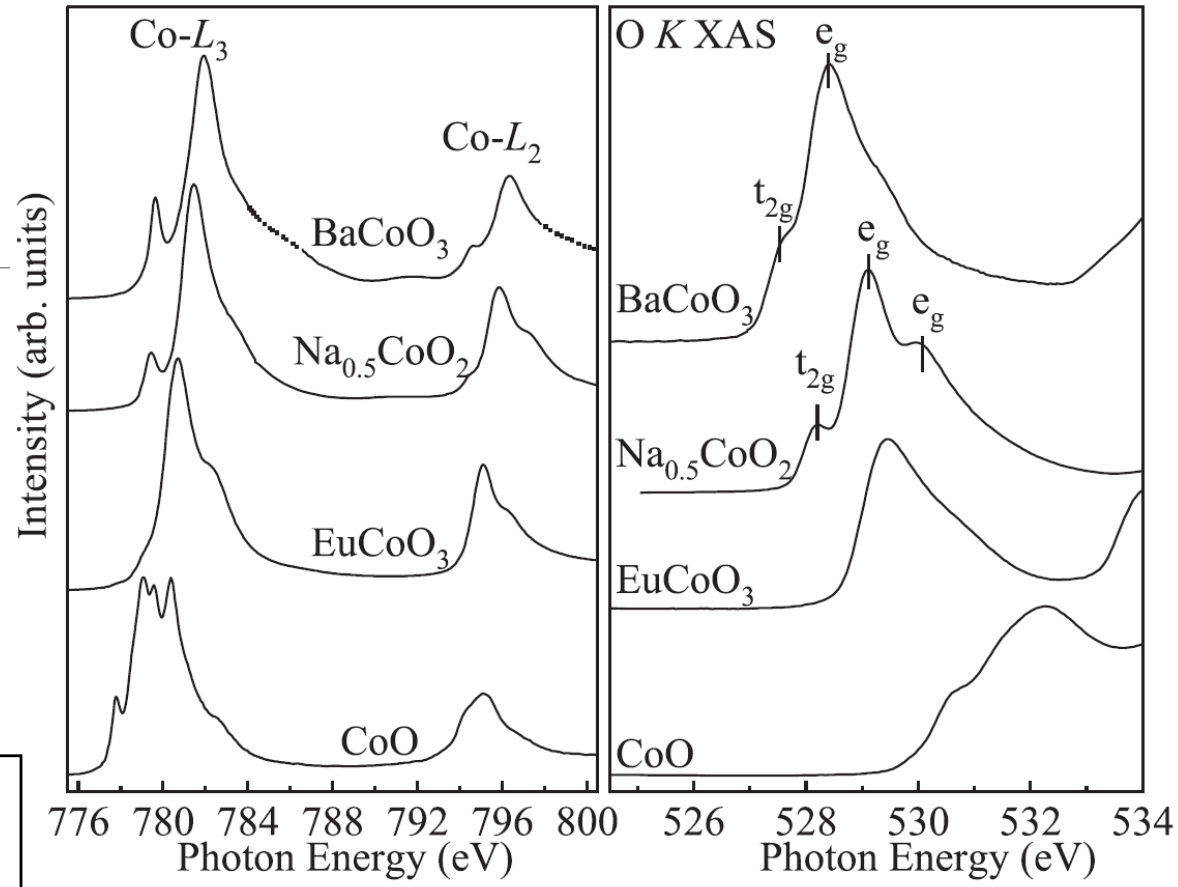
$$m_{\text{spin}} = -\frac{6\int_{L_3}(\mu_+ - \mu_-)\,d\omega - 4\int_{L_3+L_2}(\mu_+ - \mu_-)\,d\omega}{\int_{L_3+L_2}(\mu_+ + \mu_-)\,d\omega} \times (10 - n_{3d})\left(1 + \frac{7\langle T_z\rangle}{2\langle S_z\rangle}\right)^{-1}, \quad (2)$$

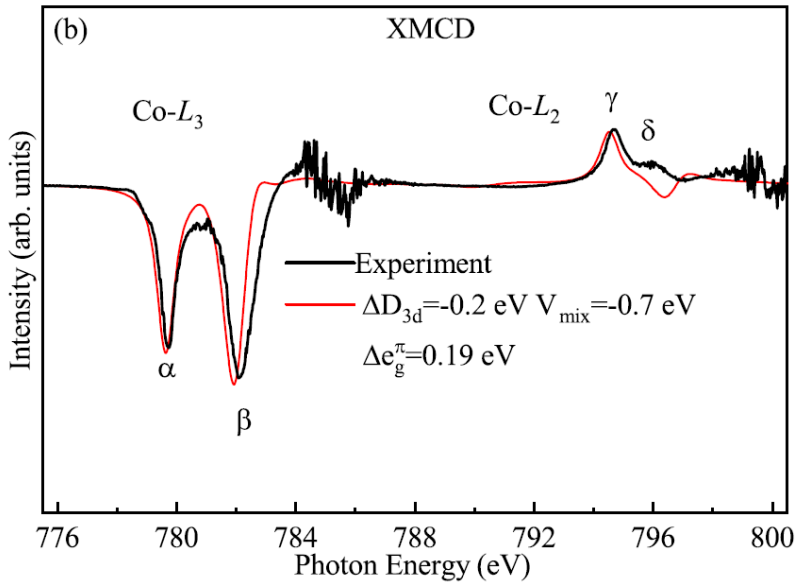
One can estimate the spin and orbital moments.

C. T. Chen *et al.*, Phys. Rev. Lett. **75**, 152 (1995).

XAS and XMCD

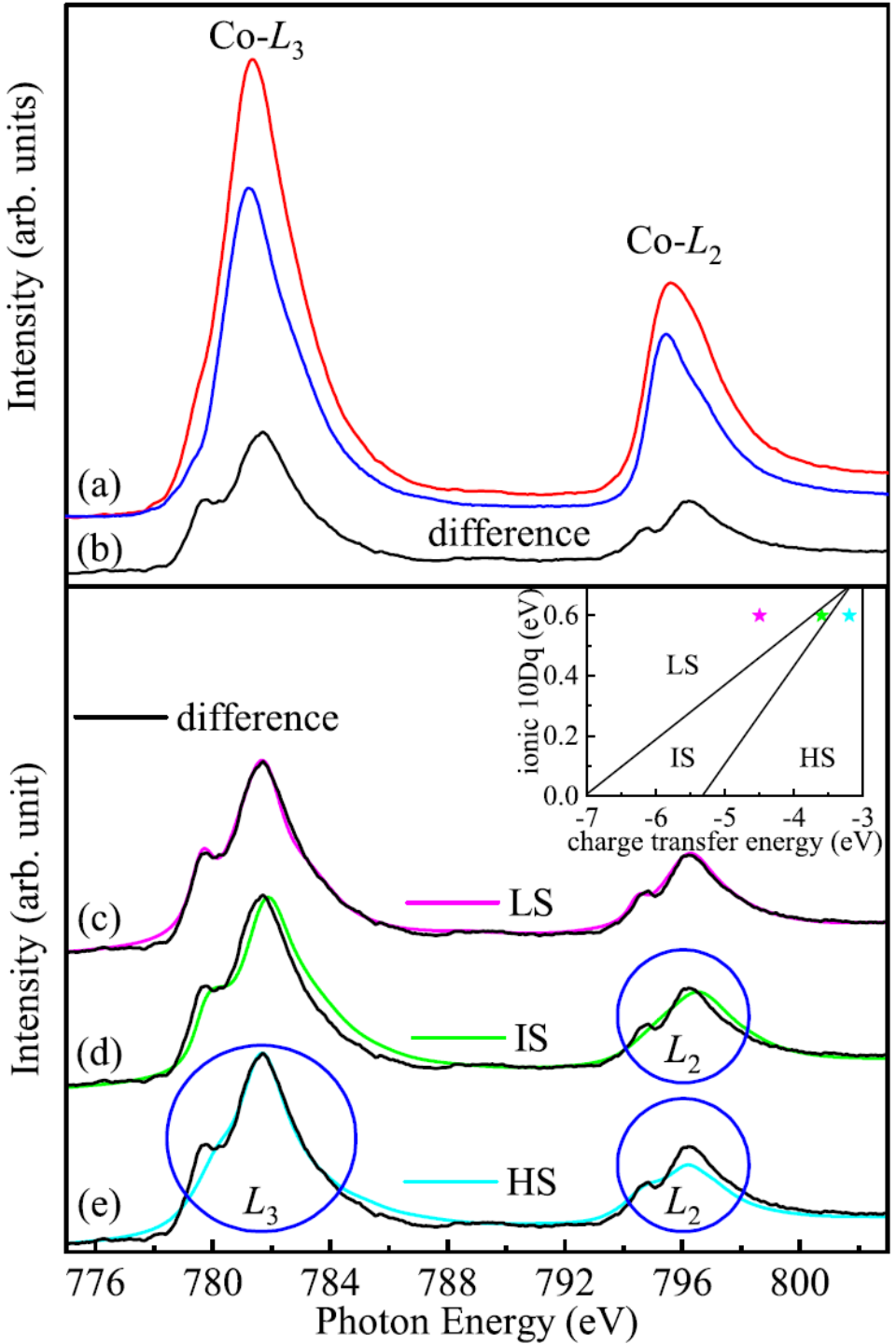


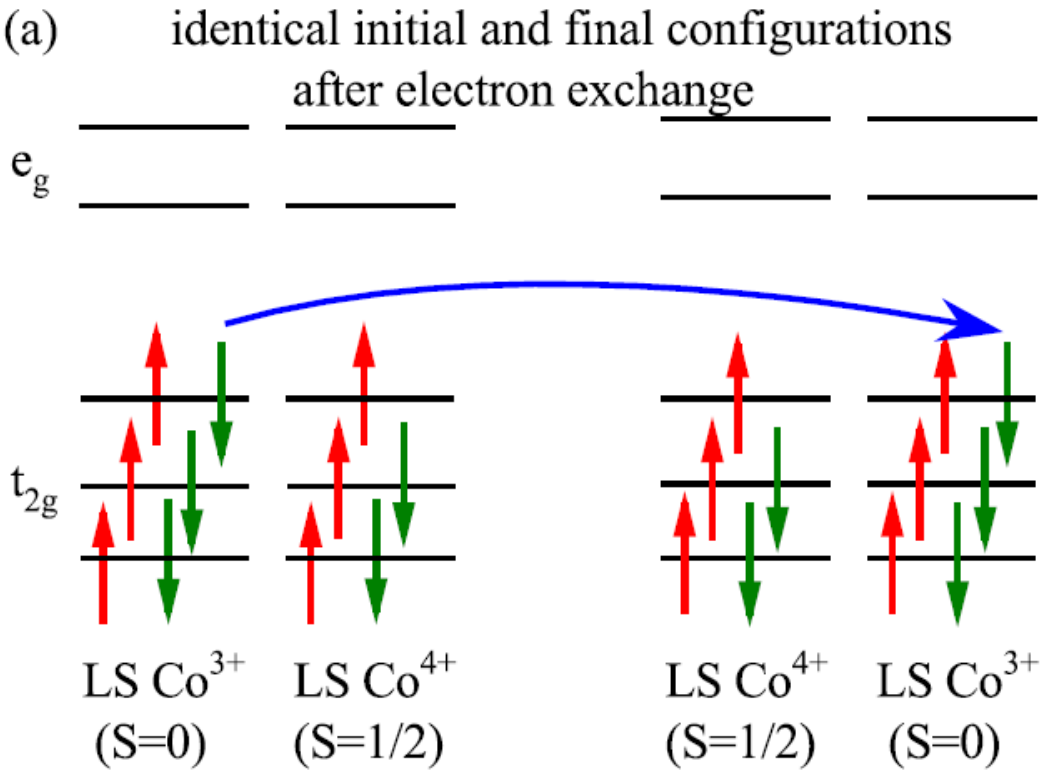




The short distance between Co atoms in the chain results in the reversal of energy levels and a finite orbital moment.

Y. Y. Chin *et al.*, Phys. Rev. B **100**, 205139 (2019).



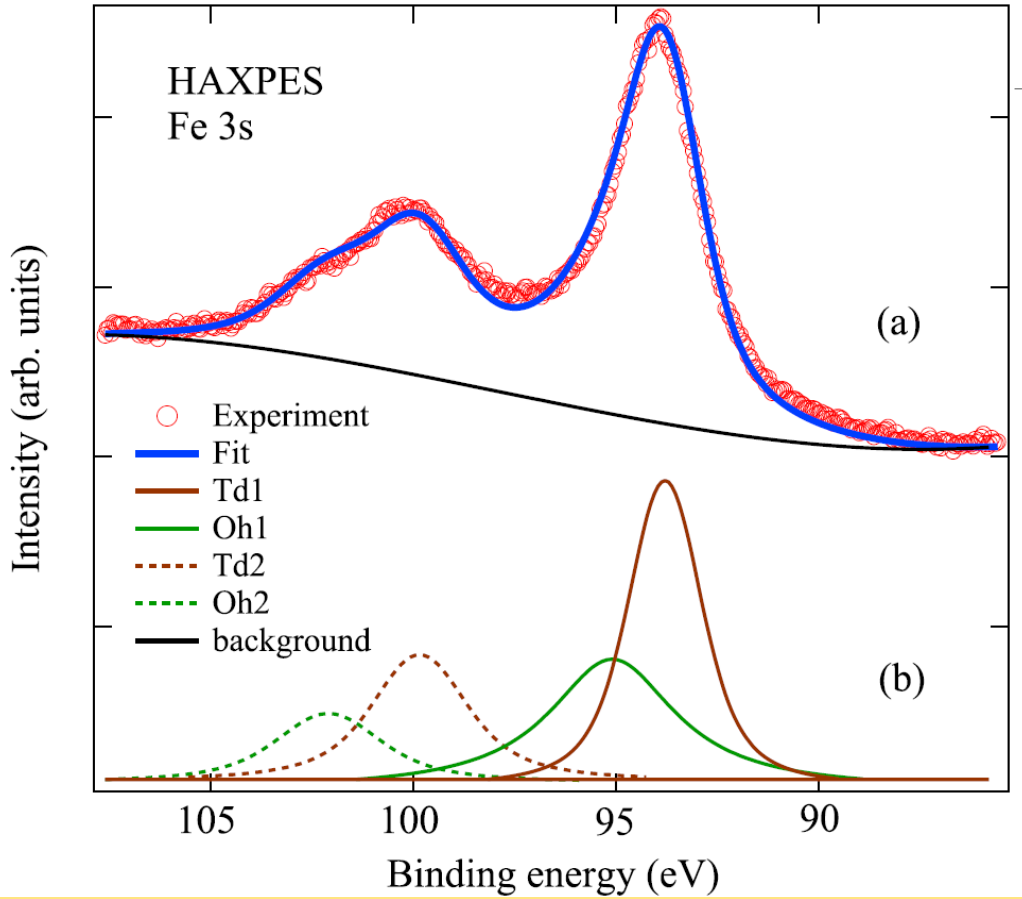


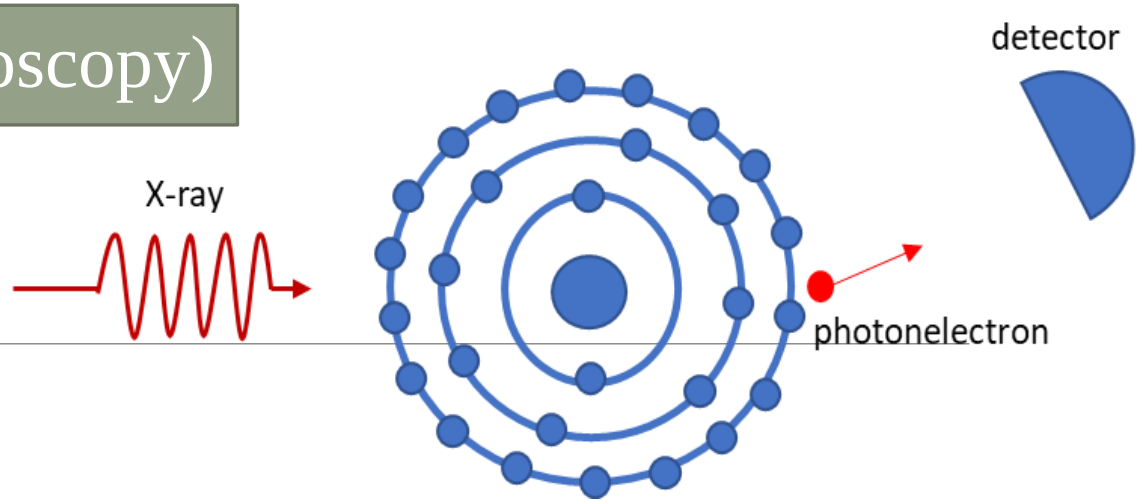
The line shape and energy position of Co in $YCu_3Co_4O_{12}$ indicates a low-spin (LS) Co^{3+} state in $YCu_3Co_4O_{12}$, leading to the insulating nature of $YCu_3Co_4O_{12}$. Introducing Co^{4+} through chemical doping is associated with the metallic properties observed in $CaCu_3Co_4O_{12}$.

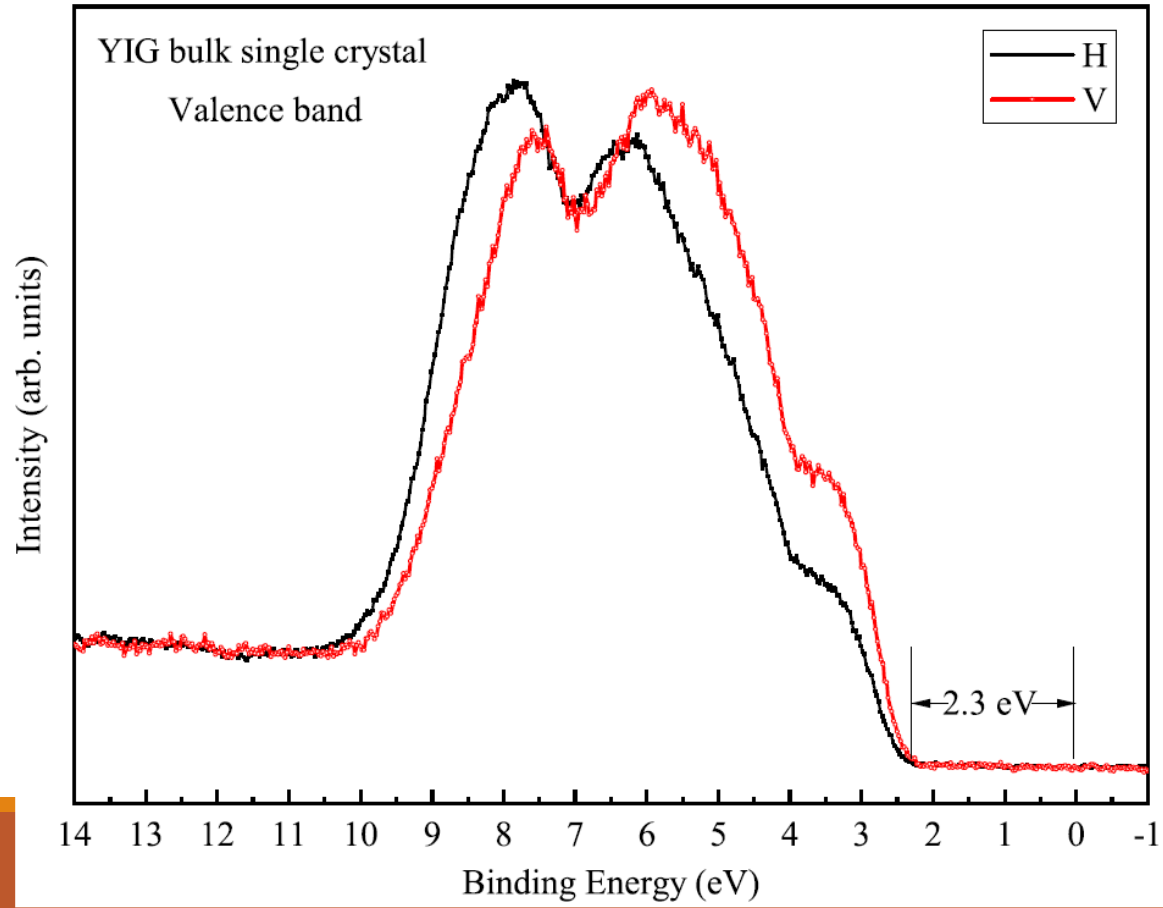
Y. Y. Chin *et al.*, Phys. Rev. B **103**, 115149 (2021).

HAXPES (hard X-ray photoelectron spectroscopy)

$$E_K = h\nu - E_B - \Phi$$





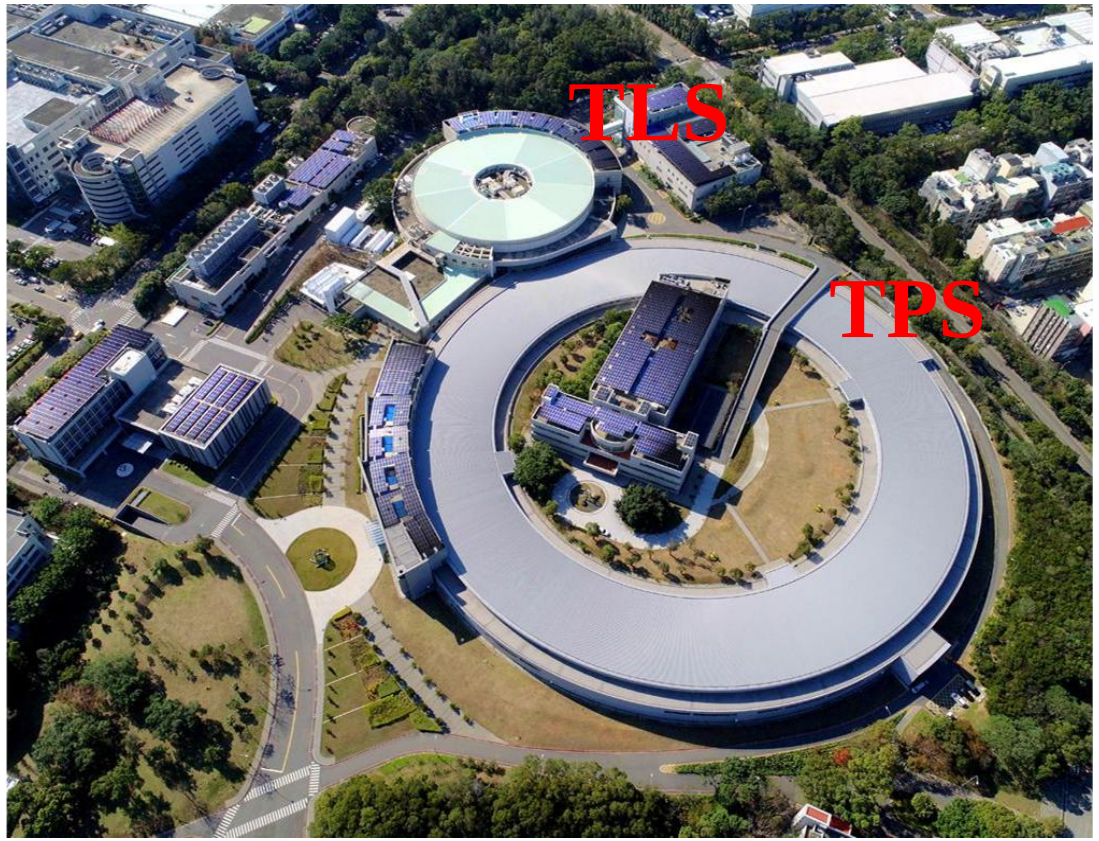


One can probe the density of states of electrons close to the Fermi level.

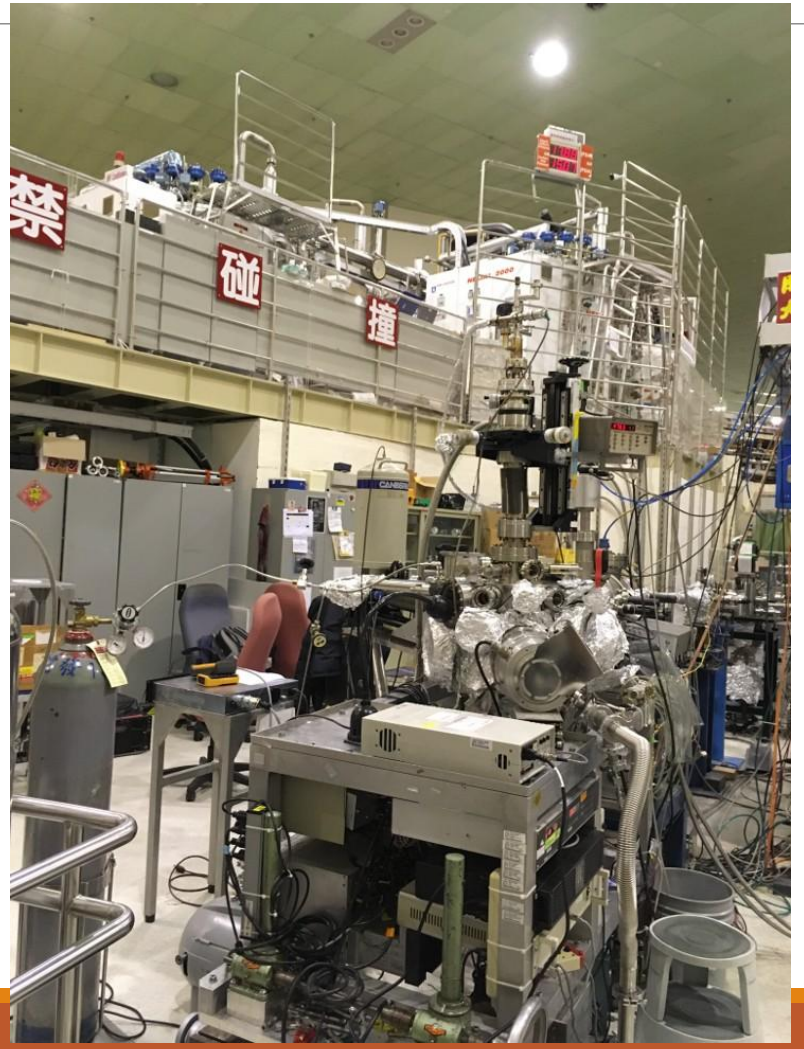
Y. Y. Chin *et al.*, Phys. Rev. B 99, 184407 (2019).

Synchrotron Radiation

National Synchrotron Radiation Research Center



TLS Beamline 11



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