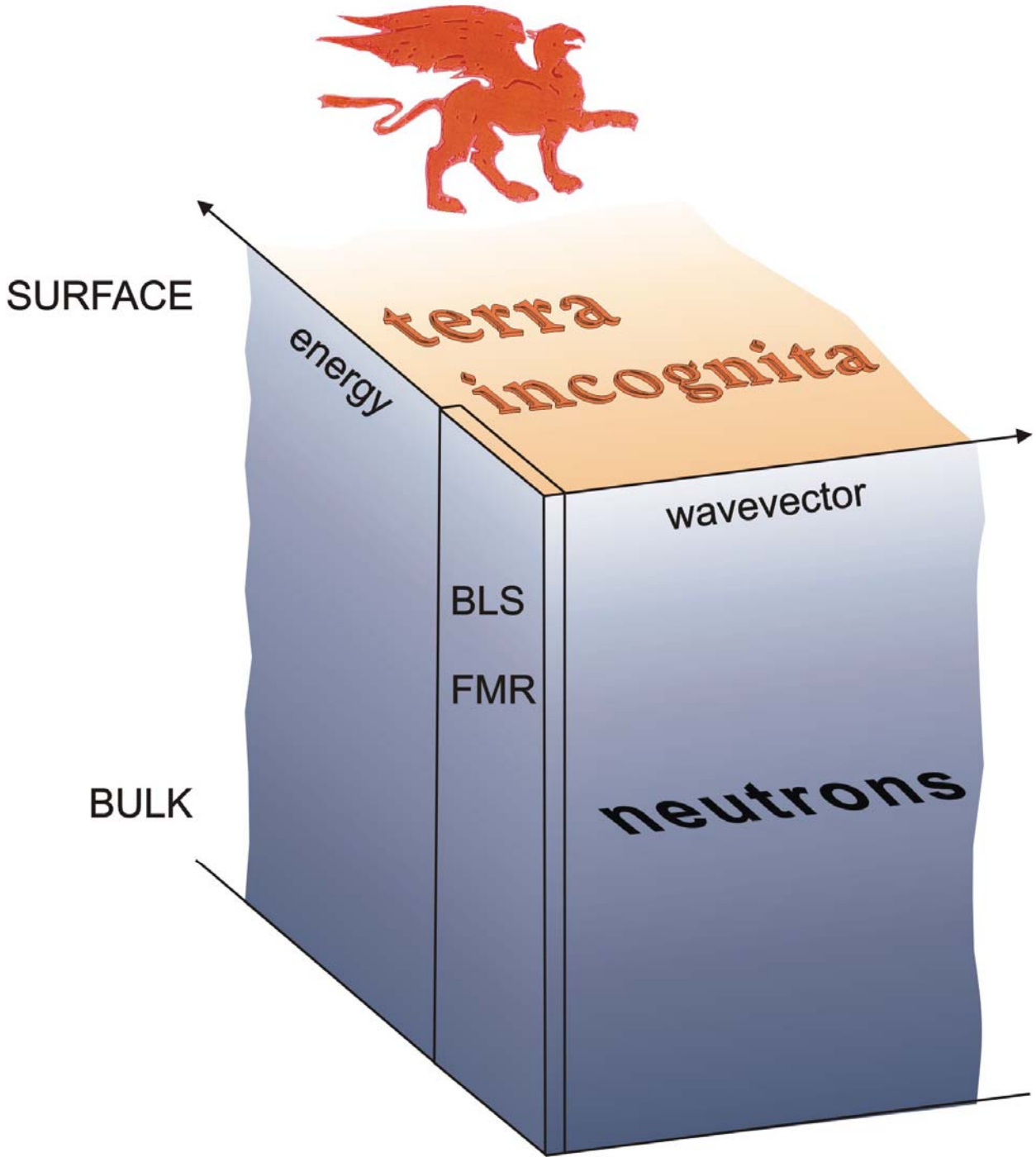
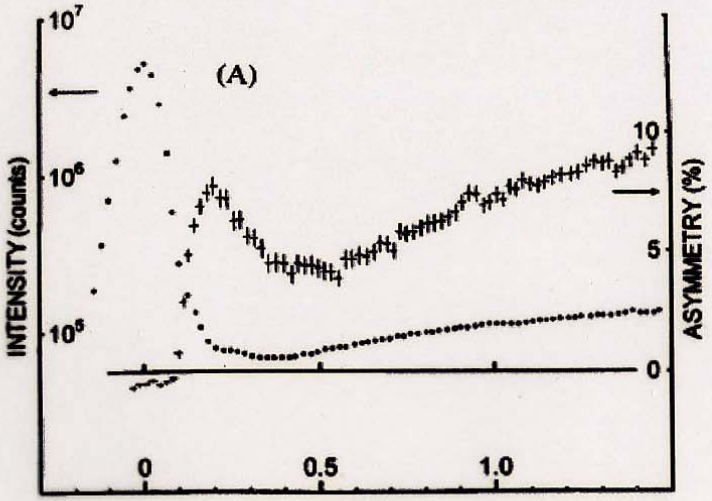

SURFACE
energy
terra
incognita
wavevector
BLS
FMR
BULK
neutrons

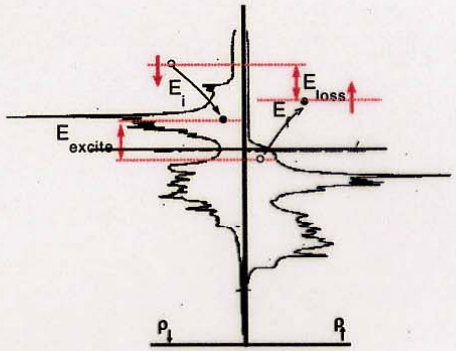
Signature of Spin-Waves by SPEELS

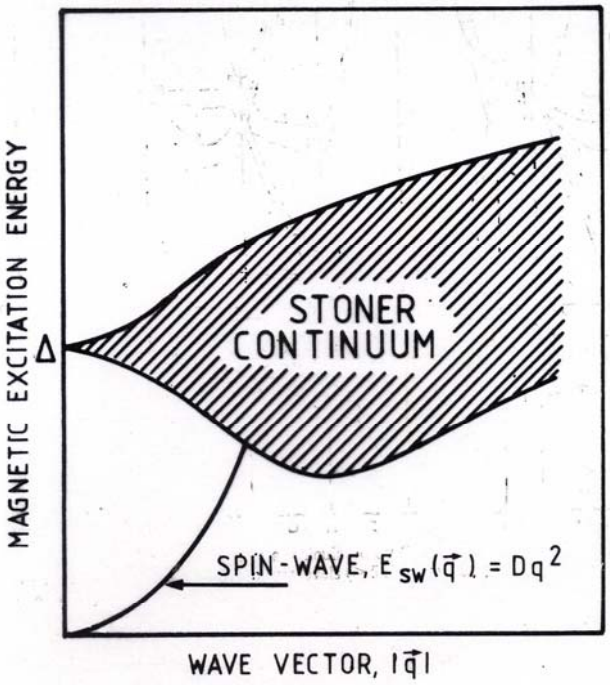
VOLUME 82, NUMBER 12 PHYSICAL REVIEW LETTERS 22 MARCH 1999

Spin Wave Signature in the Spin Polarized Electron Energy Loss Spectrum of Ultrathin Fe Films: Theory and Experiment

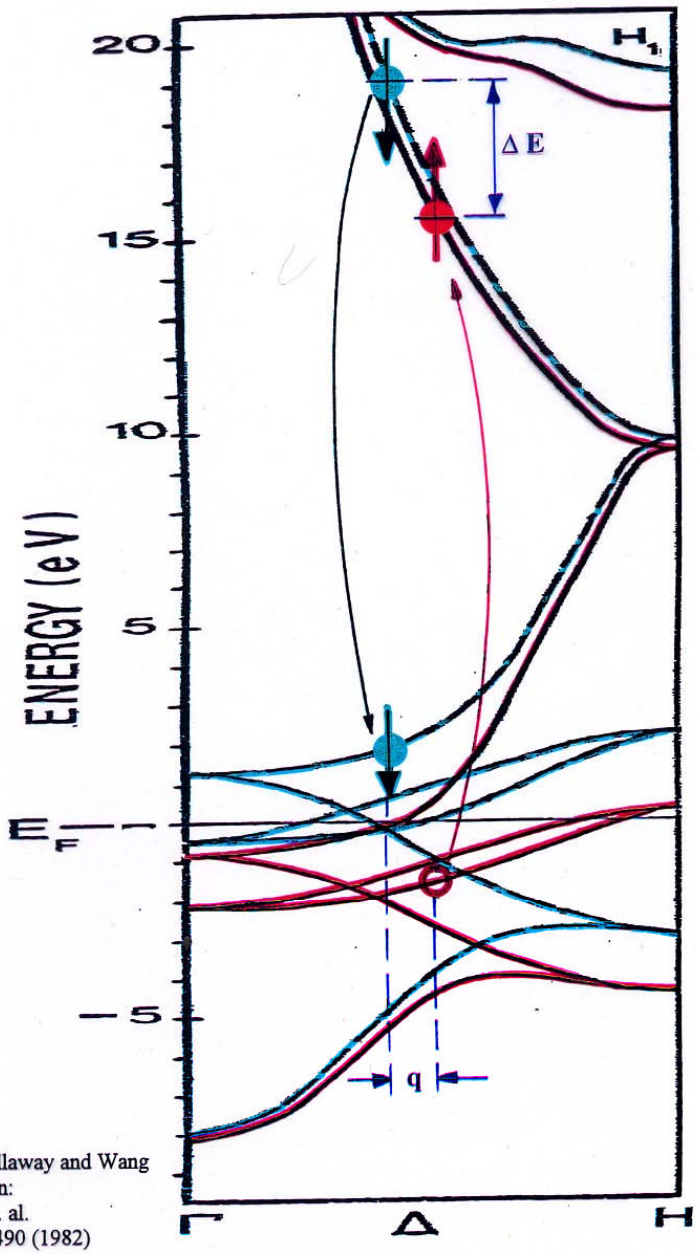
M. Plihal,[1] D. L. Mills,[2] and J. Kirschner[3]






MAGNETIC EXCITATION ENERGY
Δ
STONER CONTINUUM
SPIN-WAVE, $E_{sw}(\vec{q}) = Dq^2$
WAVE VECTOR, $|\vec{q}|$

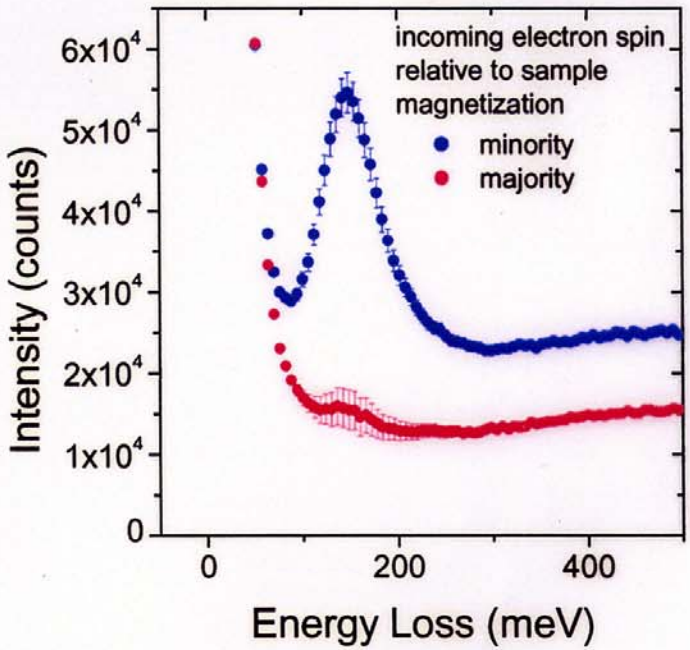
bulk Fe along <100>



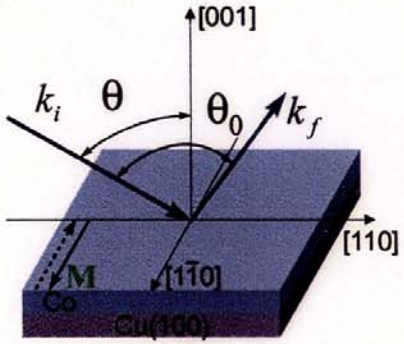
data by Callaway and Wang
published in:
Colavita et. al.
PRB 25, 2490 (1982)

SPEEL- Spectra: 8 ML Co/Cu(100)

$E_0 = 6.5$ eV ; $\theta = 67.5°$; $\theta_0 = 90°$; $\Delta K_{\parallel} = -0.71 Å^{-1}$



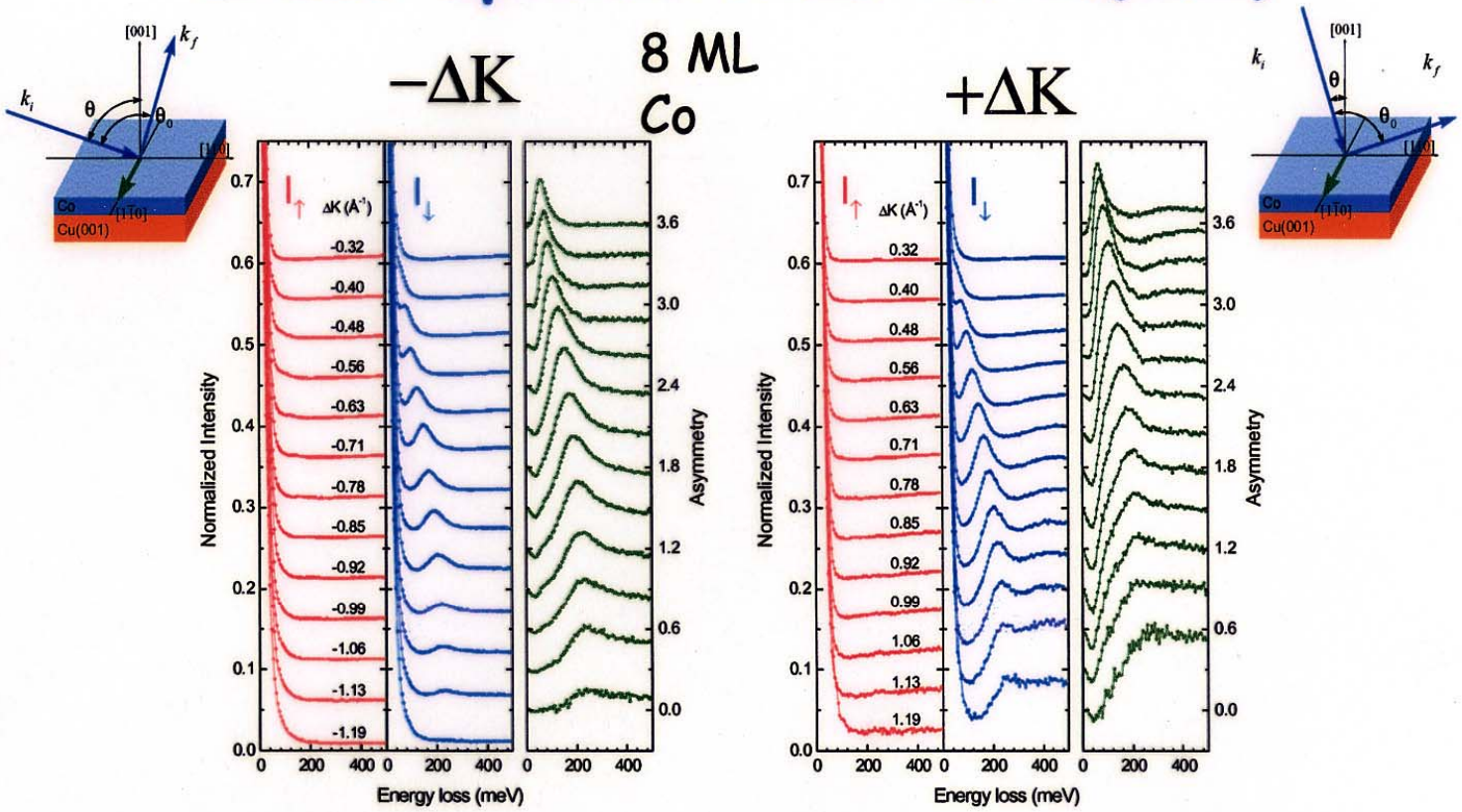
Scattering Geometry



Corrected for the incomplete polarization of the incoming electron beam

Spin polarization of the incoming beam ~0.81± 0.1

SPEEL Spectra from Co/Cu(001)



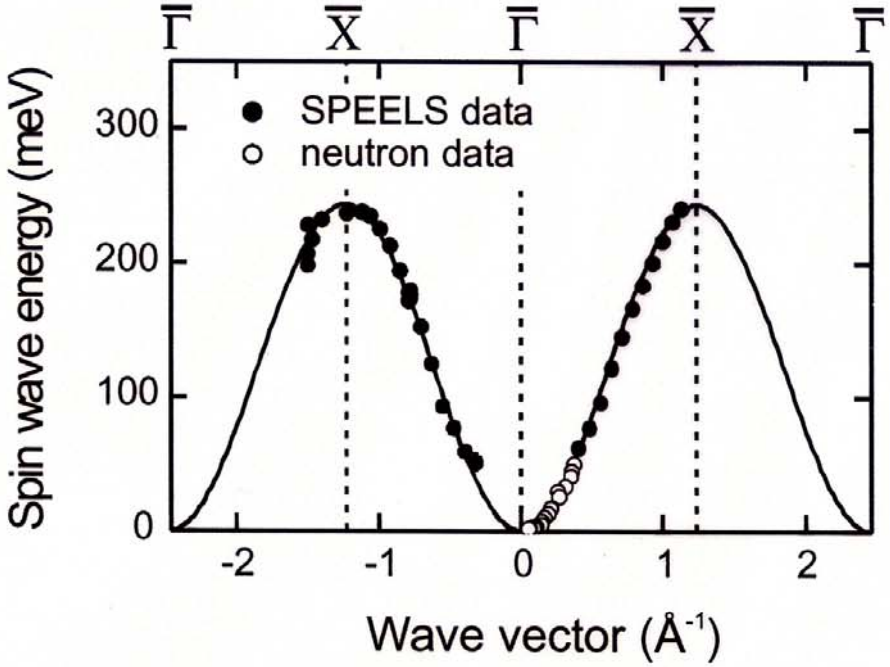
$E_0 = 6.5$ eV

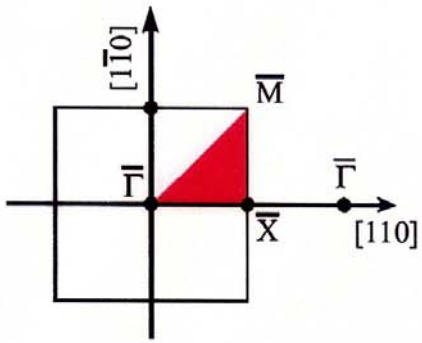
$P = 0.79 \pm 0.09$

intensities corrected for the incomplete polarization and normalized to the diffuse elastic peak,

asymmetries corrected for the incomplete polarization

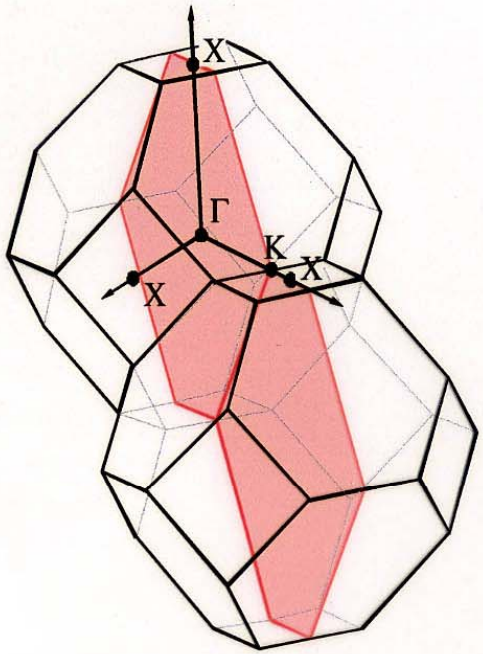
Spin wave dispersion curve for 8 ML Co/Cu(001)

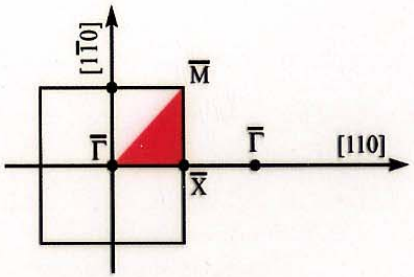




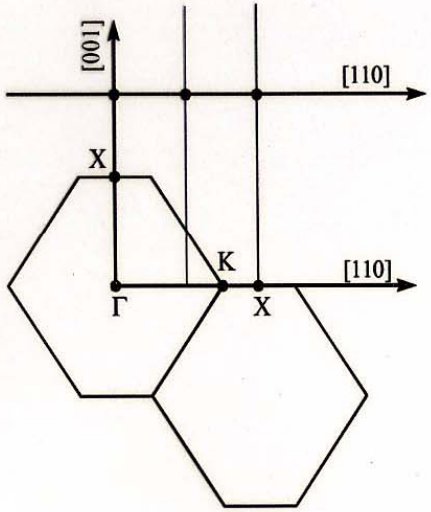
neutron data (fcc Co(8% Fe) alloy):
R. N. Sinclair and B. N. Brockhouse, Phys. Rev. **120**, 1638 (1960) .

Brillouin zone of an fcc crystal





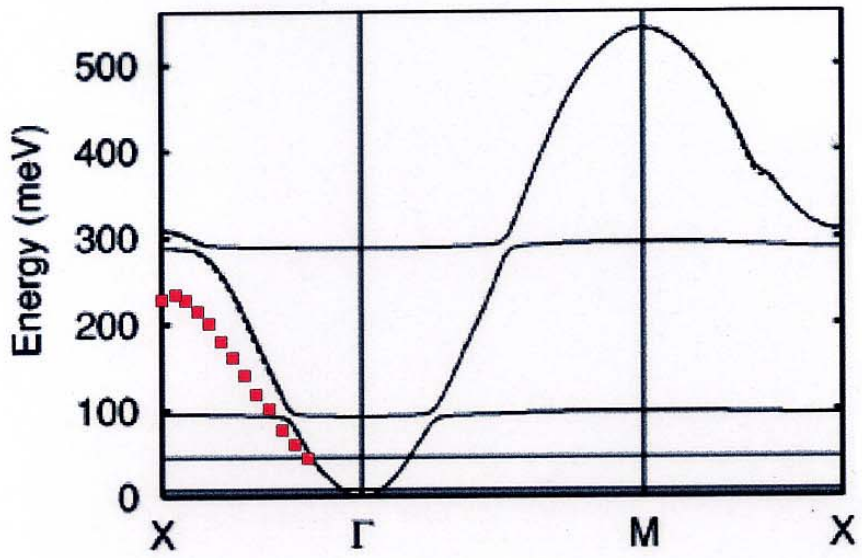
Surface Brillouin zone



cut through the
bulk Brillouin zone

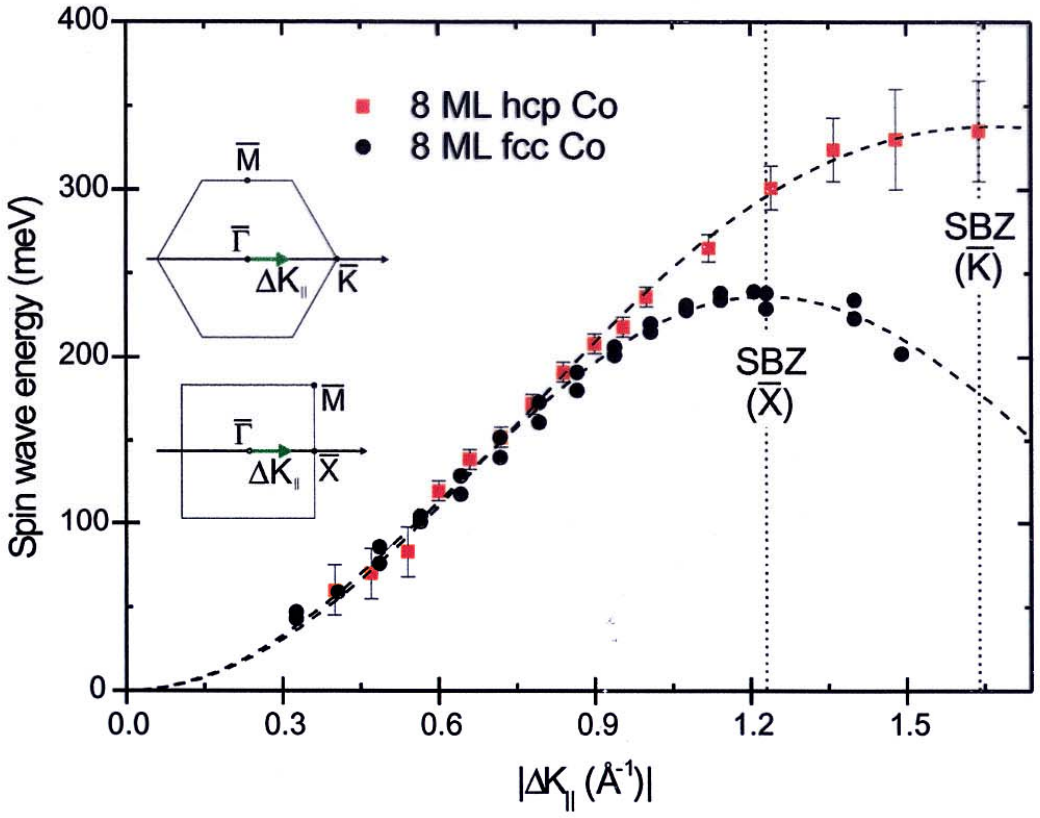
Comparison with *ab initio* calculations

based on the adiabatic approximation



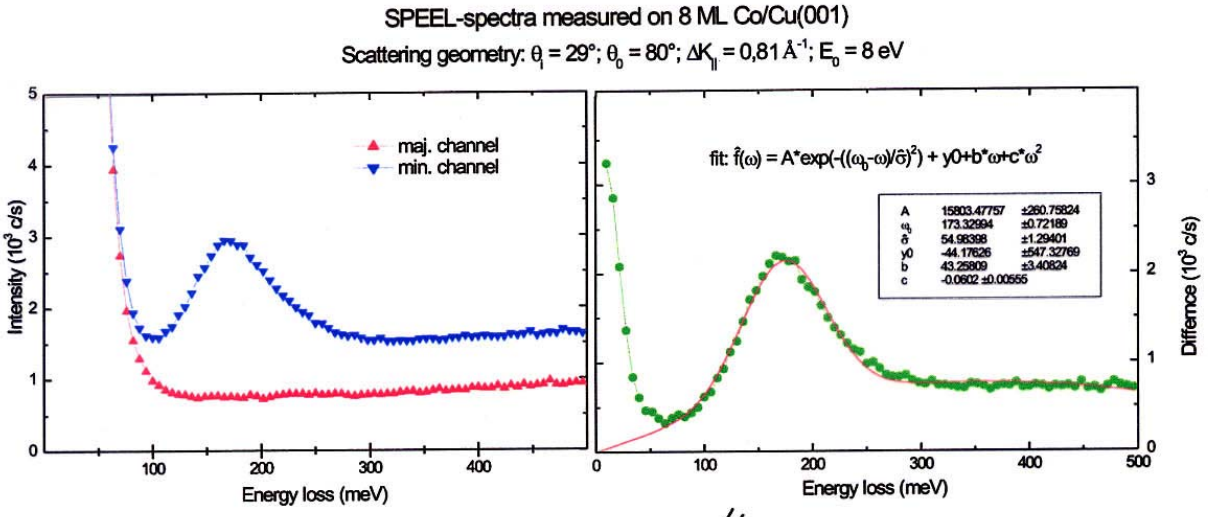
L. Udvardi, L. Szunyogh, K. Palotas, and P. Weinberger, Phys. Rev. B 68 (2003) 104436.

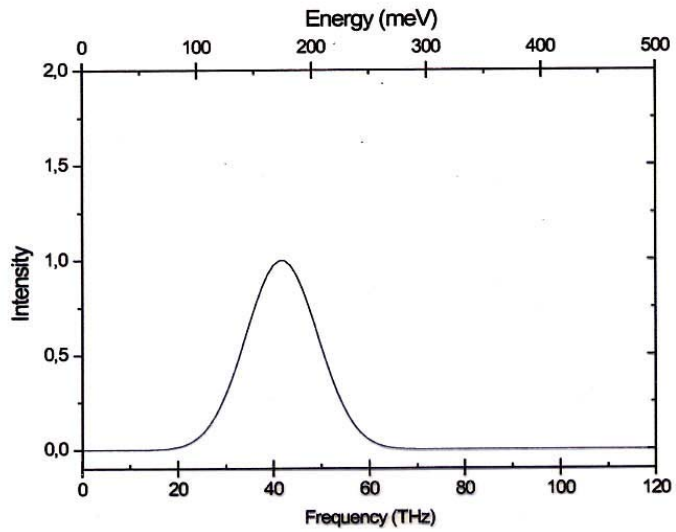
Dispersion for 8 ML fcc and hcp Co-films measured by SPEELS



Dashed lines:
Fits to the data by dispersions of the surface mode in a nearest neighbor Heisenberg model with
JS = 15±1 meV in both cases

Fourier transformation of SPEEL-spectra





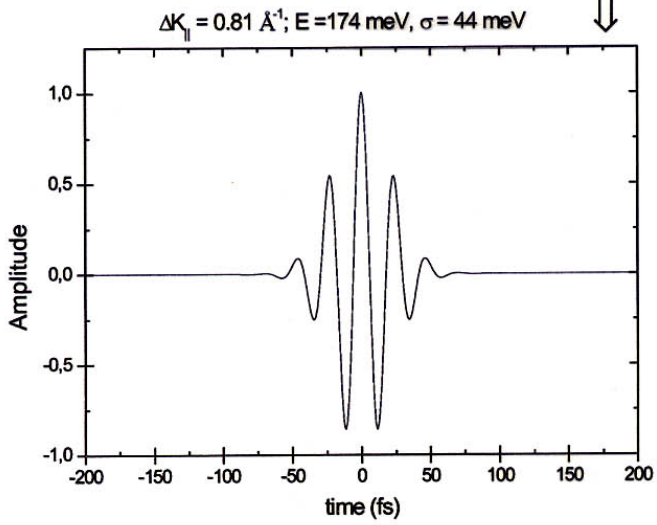
$\Delta E = 24$ meV

$\sigma = \sqrt{\hat{\sigma}^2 - \Delta E^2}$

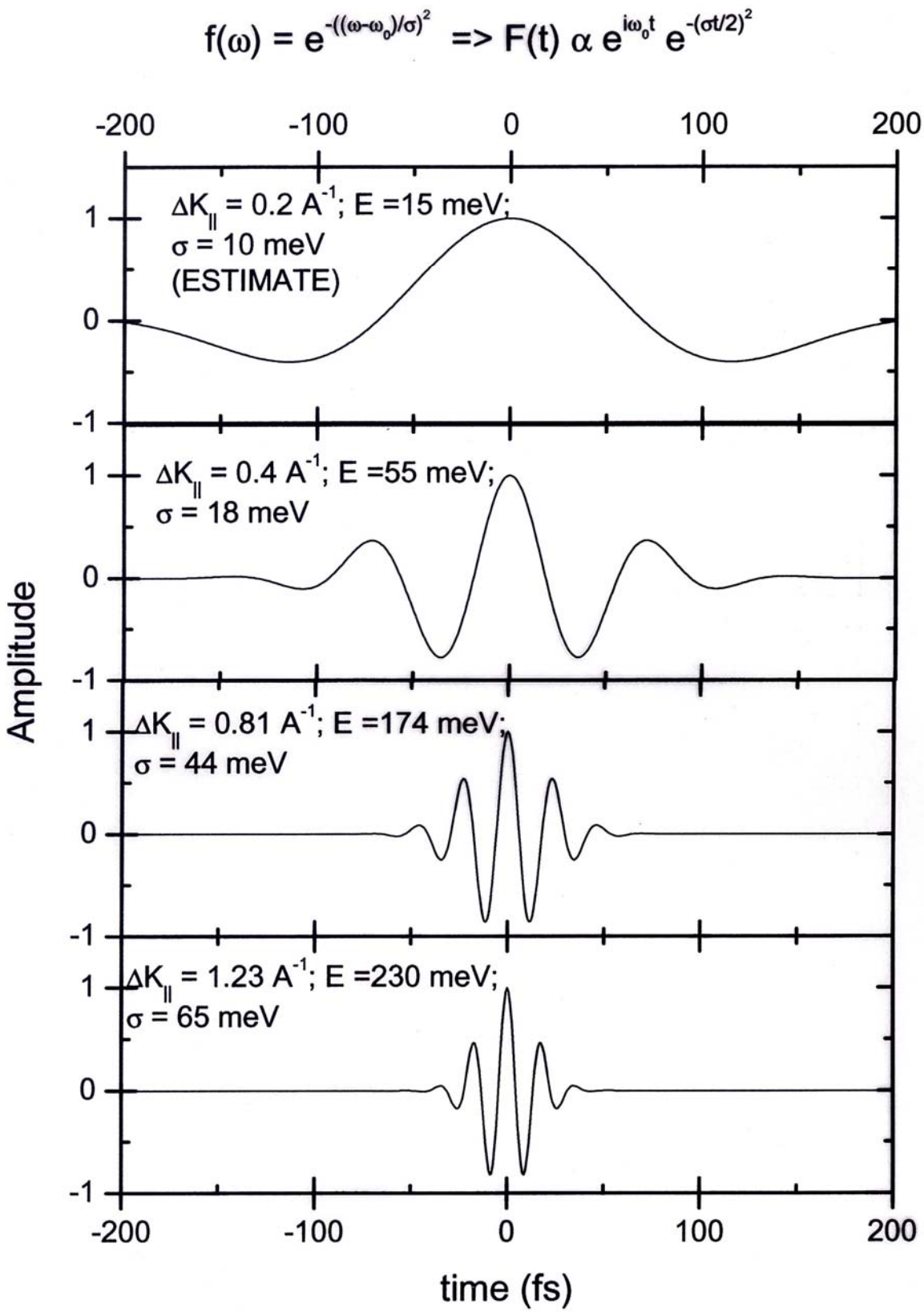
10 meV $\hat{=}$ 2.4 THz

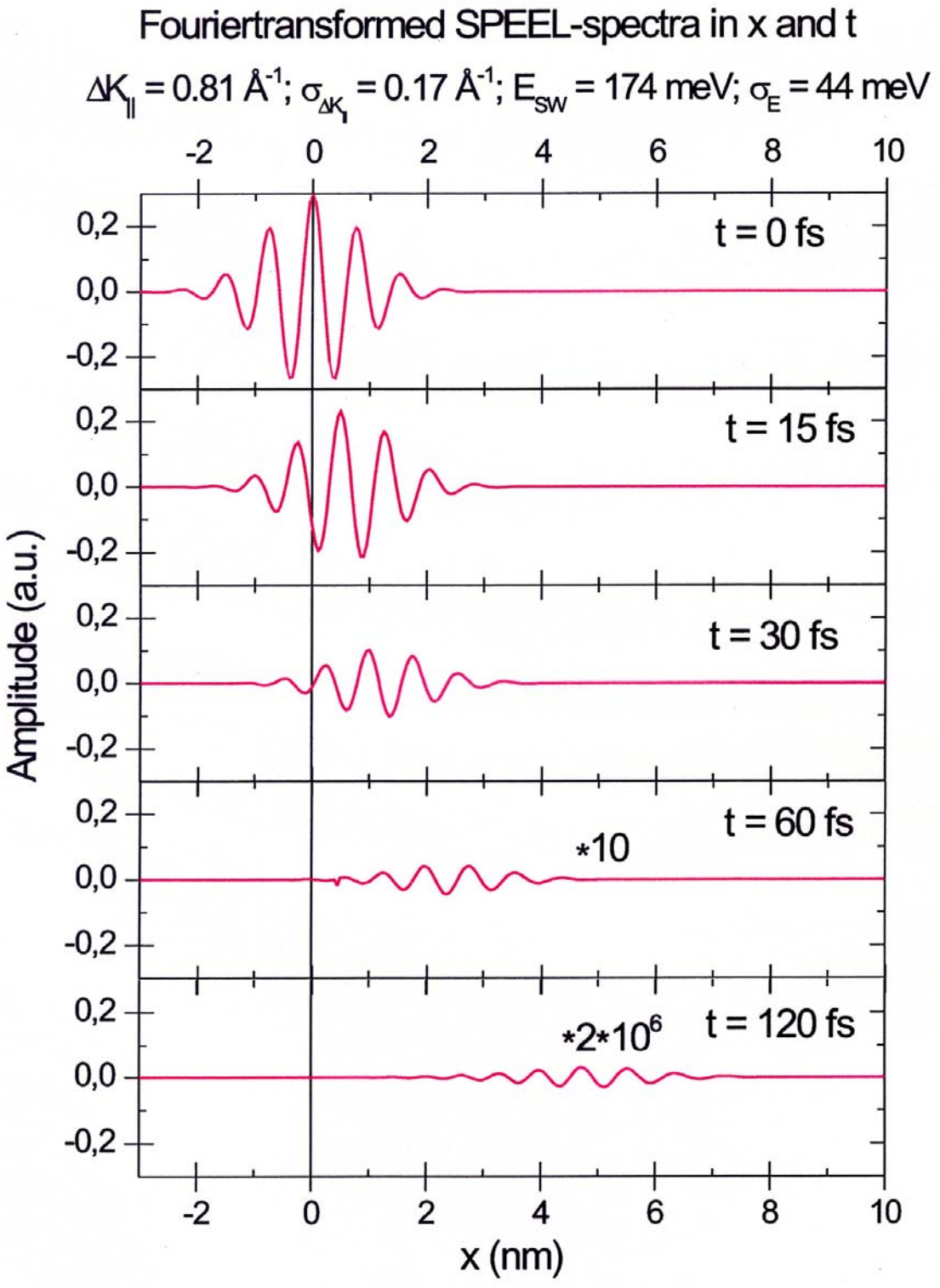
$f(\omega) \alpha e^{-(((\omega-\omega_0)/\sigma)^2)}$

Fourier transform



$F(t) \alpha \cos(\omega_0 t) * e^{-(\sigma t/2)^2}$


$f(\omega) = e^{-((\omega-\omega_0)/\sigma)^2} \Rightarrow F(t) \alpha e^{i\omega_0 t} e^{-(\sigma t/2)^2}$
-200
-100
0
100
200
$\Delta K_{\|}$ = 0.2 A^{-1}; E =15 meV;
σ = 10 meV
(ESTIMATE)
$\Delta K_{\|}$ = 0.4 A^{-1}; E =55 meV;
σ = 18 meV
$\Delta K_{\|}$ = 0.81 A^{-1}; E =174 meV;
σ = 44 meV
$\Delta K_{\|}$ = 1.23 A^{-1}; E =230 meV;
σ = 65 meV
1
0
-1
Amplitude
time (fs)


Fouriertransformed SPEEL-spectra in x and t
$\Delta K_{||} = 0.81$ Å^{-1}; $\sigma_{\Delta K_{||}} = 0.17$ Å^{-1}; $E_{SW} = 174$ meV; $\sigma_E = 44$ meV
Amplitude (a.u.)
x (nm)
t = 0 fs
t = 15 fs
t = 30 fs
t = 60 fs
*10
t = 120 fs
*2*10^6
25 fcc Co-atoms along [110]

Rüdiger VOLLMER

Markus ETZKORN

Anil KUMAR