The Compton Scattering Study of $Ni_{75}Cu_{25}$ and $Ni_{75}Co_{25}$ Disordered Alloys

Andrzej Andrejczuk [1,2], Jadwiga Kwiatkowska [3], Ludwik Dobrzyński [2,4], Eugeniusz Żukowski [2] Christophe Bellin [5], Genevieve Loupias [5], Abhay Shukla [5] & Thomas Buslaps [6]

1) *JASRI, SPring-8, 1-1-1, Kouto, Sayo-cho Sayo-gun, Hyogo 679-5198, JAPAN*
2) *Institute of Experimental Physics, University of Białystok, Lipowa 41,15-424 Białystok, Poland*
3) *Henryk Niewodniczański Institute of nuclear Physics, Polish Academy of Sciences, Radzikowskiego 152, 31-342 Kraków, Poland*
4) *The Soltan Institute for Nuclear Studies, 05-400 Otwock-Świerk, Poland*
5) *Laboratoire de Mineralogie at Cristallographie, University Paris 6, Place Jussieu 4, Paris, France*
6) *European Synchrotron Radiation Facility, BP220, 38043 Grenoble, France*

Introduction

The Compton Profile $J(p_z)$ (CP) is one dimensional projection of the electron momentum distribution $n(\mathbf{p})$. It can be measured via Compton scattering or positron annihilation experiments. The results are very direct test of solid state theory.

$$J(p_z) = \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} n(\mathbf{p})dp_x dp_y$$

The derivative of CP $dJ(p_z)/dp_z$ indicate discontinuities in the electron momentum densities (Fermiology) while the Fourier transform of CP $B(z)$ represents autocorrelations of electron wave function in solid.

The Compton profiles of $Ni_{75}Cu_{25}$ and $Ni_{75}Co_{25}$ disordered, ferromagnetic alloys have been measured along [100], [110] and [111] crystallographic directions at beam line ID15B at ESRF with the use of high resolution scanning Compton spectrometer (resolution 0.15 a.u.). The experimental data were compared with theory [1].

Results and discussion

Theoretical calculations where performed within KKR CPA formalism [2]. The experimental data well reproduce the theoretical directional anisotropy of CP, however the overall amplitude of experimental anisotropy is smaller than theoretical one (Fig.1). The experiment displays sharp features coming from the shape of Fermi surface (arrows at 0.27 and 0.82 a.u. mark where neck features in (111) direction in Ni occur)

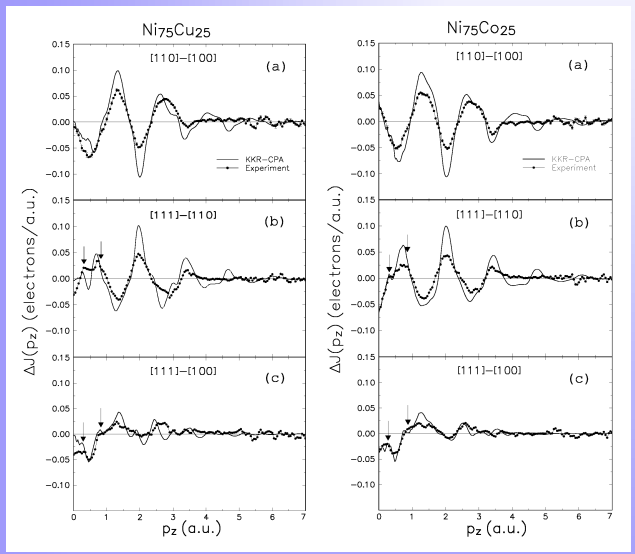

Fig. 1 *The directional anisotropy of CP in Ni-Cu (left panel) and Ni-Co (right panel) alloys. Theory is not convoluted to the experimental resolution to emphasis details in region of low momenta.*

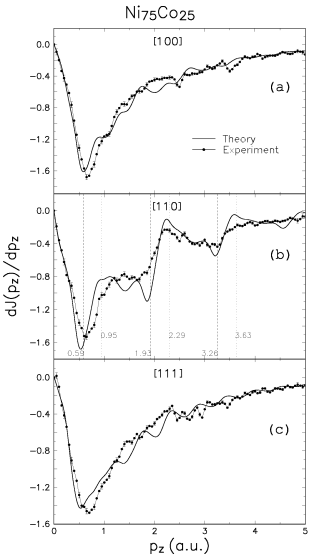

Fig. 2 *Derivatives of CP*

In case of derivatives of CP the [110] direction is most interesting (Fig.2). For this direction the integral plane in CP crosses the sheets of secondary Fermi surfaces and the discontinuity in momentum density for secondary Fermi surfaces are well visible. The experiment shows that the discontinuities are smoother compare to theory.

For all directions the first minimum of CP derivatives occurs at about 10% higher value of p_z than theoretical one.

The secondary maximum in the B(z) functions calculated for [110] from experimental CP is broader compared to theory (Fig. 3). Contrary to theory the amplitude of peak in case of Ni-Co is higher than amplitude for Ni-Cu alloy. However overall experimental amplitude is lower compare to theory. Moreover it seems that the peak splits into two peaks. This effect is not clear and calls for further studies.

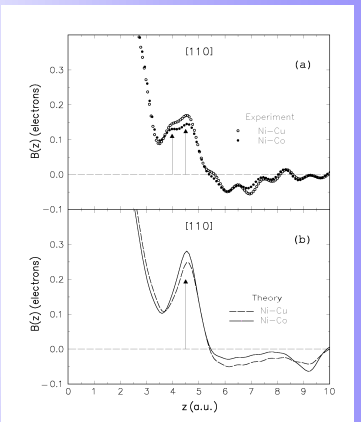

Fig. 3 *B(z) function. a) experiment and b) KKR CPA theory*

Summary

- **The experiment well agree with theory in case of directional anisotropy of CP in the alloys, however experimental data possess smaller amplitude.**
- **The minima in the derivatives of CP occur at higher p_z indicating slightly bigger dimensions of Fermi surface.**
- **Broader secondary peak in B(z) function has been found in the experiment.**

• [1] J. Kwiatkowska et. al., J.Phys.: Condens. Matter **17** (2005) 6425
• [2] A. Bansil et. al., , Phys. Rev. B 57 (1998) 314