ESRF

Experiment title: SPIN MOMENTS IN HEUSLER ALLOY AND RELATED ALLOYS BY MAGNETIC COMPTON SCATTERING

Experiment number: HC 580

Beamline: ID 15 BL 25

Date of Experiment: from: 13 Feb 96 to: 19 Feb 96

Date of Report: 25 February 1996

Shifts: 18

Local contact(s): T BUSLAPS

Received at ESRF : 27 FEB 96

Names and affiliations of applicants (*indicates experimentalists):

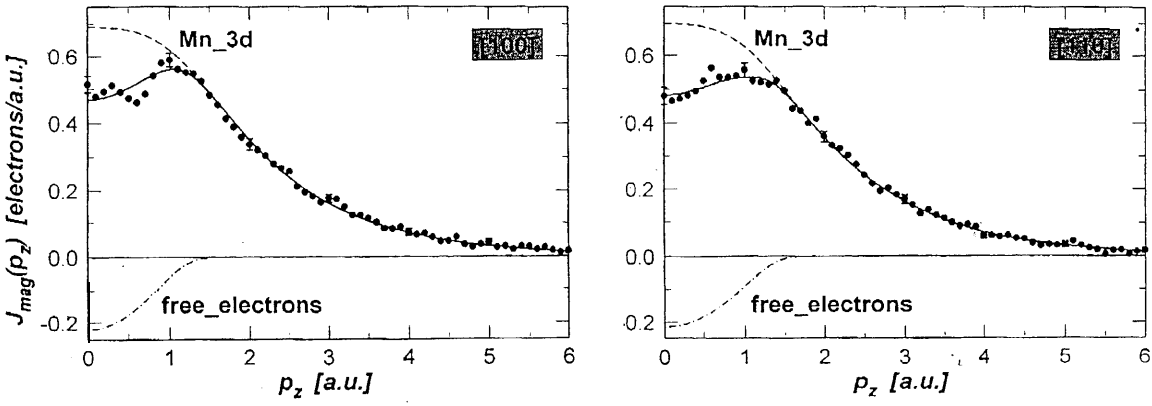
* Malcolm J Cooper, Warwick University, UK
Ludwik Dobrzynski, Warsaw University, Poland

Report:

This report is being written less than 1 week after the end of the experiment in order to comply with the formal requirement that a report is filed before a subsequent application is made. Clearly it is tentative and brief since the data have not yet been fully analysed.

This experiment differed from the two magnetic Compton scattering investigations that we carried out in 1995 in using a new rotatable permanent magnet provided by Warwick university. This magnet has two advantages over the electromagnets normally used. First the field is higher (l Tesla at the centre of a 42mm gap) and second higher angles of scattering can be achieved because there is no magnet structure in the plane of scattering. This latter point results in better resolution. Thus by using a germanium semiconductor detector with low electronic noise, an incident energy of 92 keV and a scattering angle of 170°, it was possible to achieve a resolution at the Compton peak of 0.48 au which compares very favorably with the values of 0.70 -0.80 au recorded in similar experiments at KEK Japan. The only aspect of the ESRF experiment that is inferior to its Japanese predecessor is the count rate capability. A detector with a single head means 30,000 cps maximum (for linear response) compared with 300,000cps for the 13 head detector cluster in Japan.

Heusler alloy Cu_2MnAl



Four directional magnetic Compton profiles, [100], [110], [lll] and [221] were measured for approximately 15 hrs each (with one exception). The magnetic effect, as a fraction of the charge scattering, was Vi%. Two, typical data sets are shown in the figure. The magnetic Compton profile, on an electron momentum scale is well fitted in the tails by a $Mn^{2+}3d$ free atom Compton profile taken from the literature but at low momentum the profile shows the dip characteristic of negatively polarised 4s-p spin density in elemental transition series ferromagnets.

The qualitative conclusions that can be drawn immediately from the data are as follows.

(i) The magnetic Compton profiles for all directions show little anisotropy and, at high momenta, are well-fitted by Mn3d spin moments.

(ii) The Mn site moment is 3.20-3.25 μ_B in agreement with neutron data.

(iii) There is no significant negatively polarised contribution at low momenta. This contribution is being analysed further but our observation would appear to contradict neutron data for the alloy $Cu_2 Mn_{0.86} Al_{1.05}$ from which a positive conduction electron contribution was deduced [Rakhecha et al, Proc Gattlingburg Conf 2, 638, 1976; Webster and Ziebeck, Landolt Bernstein Tables 19C, 75, 1988].

In the further analyses of these data we shall attempt to combine the spin-dependent profiles with the total charge profiles to separate out information about the majority and minority spin bands.