Pseudo-gap Observed at Martensite Transition in a Ni$_2$MnGa Single Crystal

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Ni$_2$MnGa Single Crystal

Low Energy Electron Diffraction (LEED) at T=293 K

Ni$_2$MnGa (100)
Cubic
Fm-3m
a = 5.825 Ang.
Vol = 192.34 Ang.$^3$
Ni (0.25,0.25,0.25)
Mn (0.5,0.5,0.5)
Ga (0, 0, 0)
Curie Transition:

Heat Capacity at $H=0$ [$T$]:

$T_C$ Ferromagnetic Transition
Dilatometry

MT is field independent
FCC to Monoclinic at MT

Fermi Surface Map

FIG. 3. Fermi surfaces for various magnetizations at \( k_z = 0.5 \). The nesting vector with \( \zeta = \frac{1}{3} \) is denoted by the arrow.

Temperature Dependent UV-Spectroscopy \( (h\nu=21.21\text{eV}) \)

![Graph showing temperature dependent UV-Spectroscopy for \( \text{Ni}_2\text{MnGa} \)]
Temperature Dependent UV-Spectroscopy (hν=21.21eV)
**ARPES: Angle Resolved Photoemission Spectroscopy**

**E_{kinetic} = h\nu - e\Phi - E_{binding}**

**k_{||} = \sqrt{\frac{2meE_{kinetic}}{\hbar^2}} \cdot \sin \phi**

**ARPES** - choose azimuthal \(q\) to specify \(k\)-vector to probe, and then vary polar \(f\) to collect DOS at various \(k_{||}\) and observe dispersion of bands along \(k\)-vector.
FIG. 9: Photoemission spectra at fixed angle, for angles between 0° to 55° in 5° increments. Intensity is plotted versus binding energy in Ni$_2$MnGa at (a) $T = 219$ K and (b) 173 K in close proximity to the pre-martensitic transition. The momenta, $k_{||}$ are quoted at the Fermi energy for the fcc phase, and vary by about 7% across each spectrum. The black lines superimposed over the photoemission spectra are meant to describe qualitatively the dispersion of the various structures present in these plots.
Evidence of pseudo-gaps in other materials:

ARPES at (\pi,0) for u-doped Bi2212, 90K Pseudo-gap state, 30K-SC state.

Evidence of pseudo-gaps in other materials: T-dependent photoemission of KMo$_6$O$_{17}$ (purple-bronze) RT to 45 K.

Norman et al., Adv. in Physics, 54 (2005)

Evidence of pseudo-gap in Bi$_{2212}$:

ARPES at (\(\pi,0\)) for u-doped Bi$_{2212}$, 90K Pseudo-gap state, 30K-SC state.

Ni$_2$MnGa data

Norman et al., Adv. in Physics, 54 (2005)
Evidence of pseudo-gap in KMo$_6$O$_{17}$ (Purple-bronze):

T-dependent photoemission of KMo$_6$O$_{17}$ (purple-bronze) RT to 45 K.

Summary:

1. The martensite, Ni$_2$MnGa, exhibits a “pseudo-gap” behavior at B.E. = 0.3 eV as T $\rightarrow$ T$_{MT}$.

2. Pseudo-gap at PMT appears to be imperfect nesting (dispersion in ARPES) while perfect nesting occurs at the MT (no dispersion in ARPES).

3. The pre-martensite transition is a failed attempt to transition to a lower energy state.


5. Are pseudo-gaps just a generic feature of metals/alloys?