TEMPERATURE DEPENDENCE of the DIELECTRIC CONSTANT and RESISTIVITY of $Ga_{1-x} Mn_x As$.

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MADRID

CSIC

- Description of GaMnAs
- Experimental motivation
- Model
- Results

$Ga_{1-x}Mn_xAs$ $x \sim 0.05$

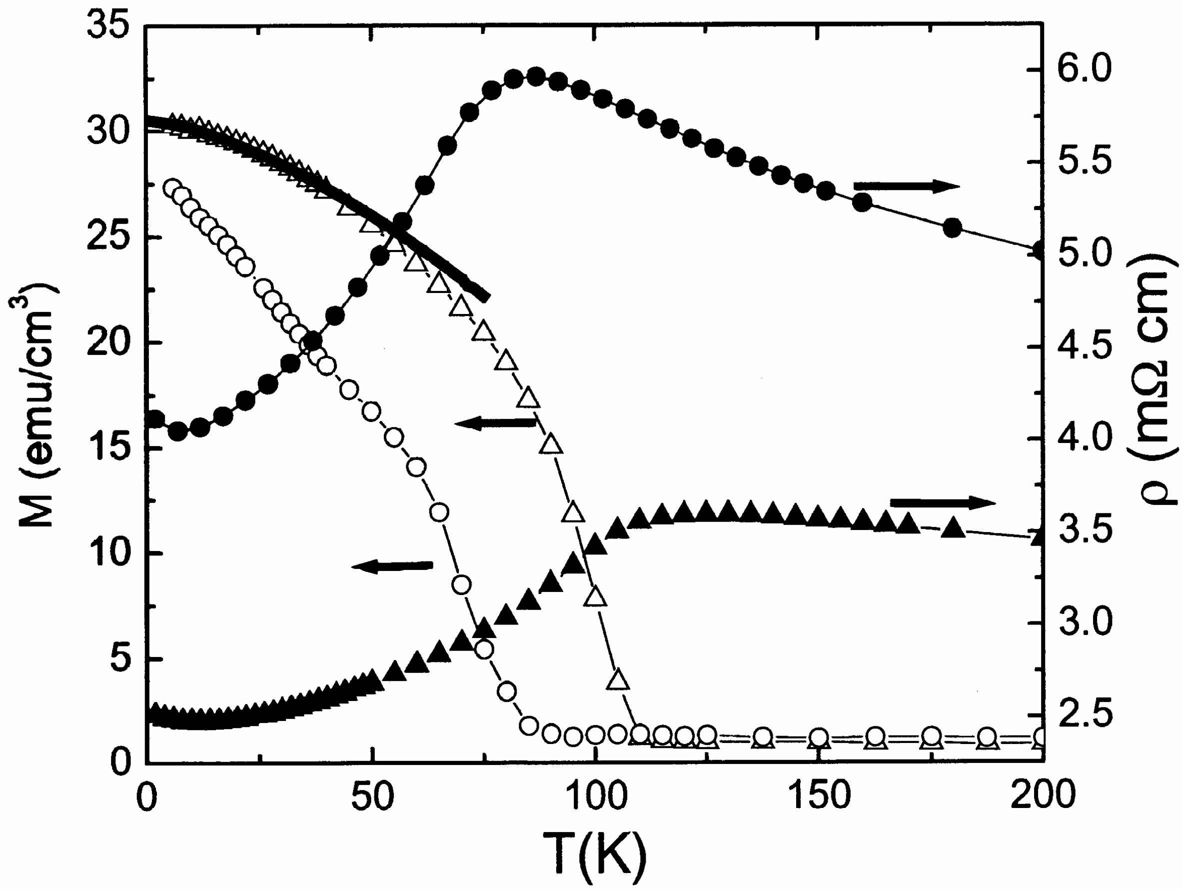
- Mn substitutes Ga.
- S=5/2, and gives a p-hole to the system.
- Antisite defects $p<c$.
- Carriers induce ferromagnetic coupling between Mn ions. $T_C \sim 120K$

ELECTRONIC properties $\Rightarrow$ MAGNETIC properties $T_C \sim \rho(E_F)$

MAGNETIC ORDER $\Rightarrow$ ELECTRONIC properties

T-dependence of the electronic properties.

MOTIVATION



▲ post-growth annealed samples. More defect free intrinsic properties. (x=0.05).

Potashnik et al. (2001).
Also, Edmonds et al. (2002).

MODEL

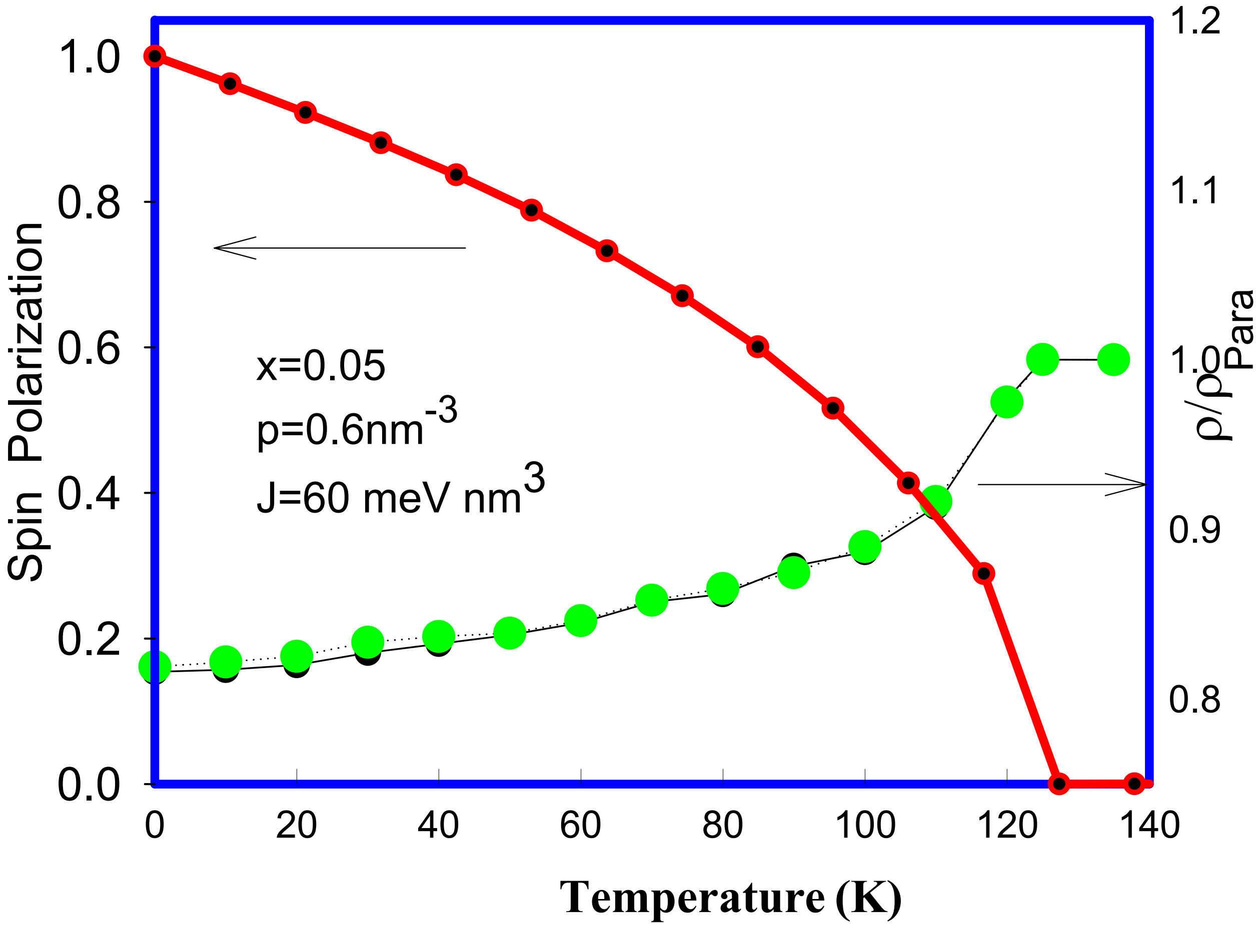
- **Holes**: Six band **k·p** model. Disorder in VCA.
- **Thermal fluctuations of Mn spins**. Mean Field Approximation.
- **Dielectric constant.** RPA.
- **Conductivity.** Relaxation time approximation. Mainly charged defects.
- **T** gets into the calculations through **ζ(T)**.

$$\frac{\varepsilon(q)}{\varepsilon_0} = 1 - \frac{4\pi e^2}{\varepsilon_0 q^2}\chi(q)$$

$$\sigma \propto \int d\vec{k}\;\tau_k \ldots$$

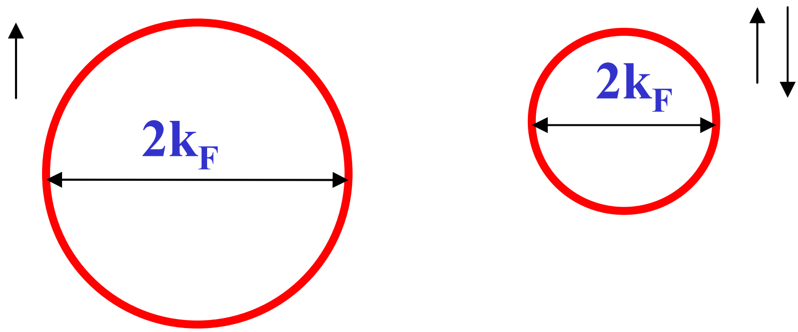
$$\frac{1}{\tau_k} \propto \int d\vec{k}'\,\frac{1}{|\vec{k}-\vec{k}'|^2\;\varepsilon(\vec{k}-\vec{k}')}$$

RESULTS

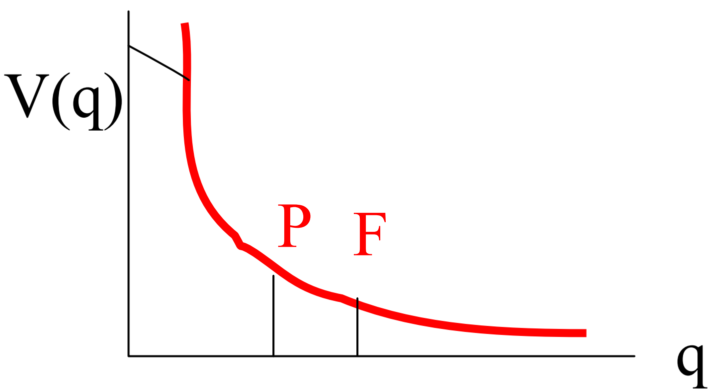


1.0
0.8
0.6
0.4
0.2
0.0
Spin Polarization
x=0.05
p=0.6nm-3
J=60 meV nm3
1.2
1.1
1.0
0.9
0.8
ρ/ρPara
0
20
40
60
80
100
120
140
Temperature (K)

In the ferromagnetic phase the Fermi surface is larger than in the paramagnetic phase.



The wave vector transferred in the back-scattering processes ($2k_F$) is larger in the FM phase than in the PM phase .



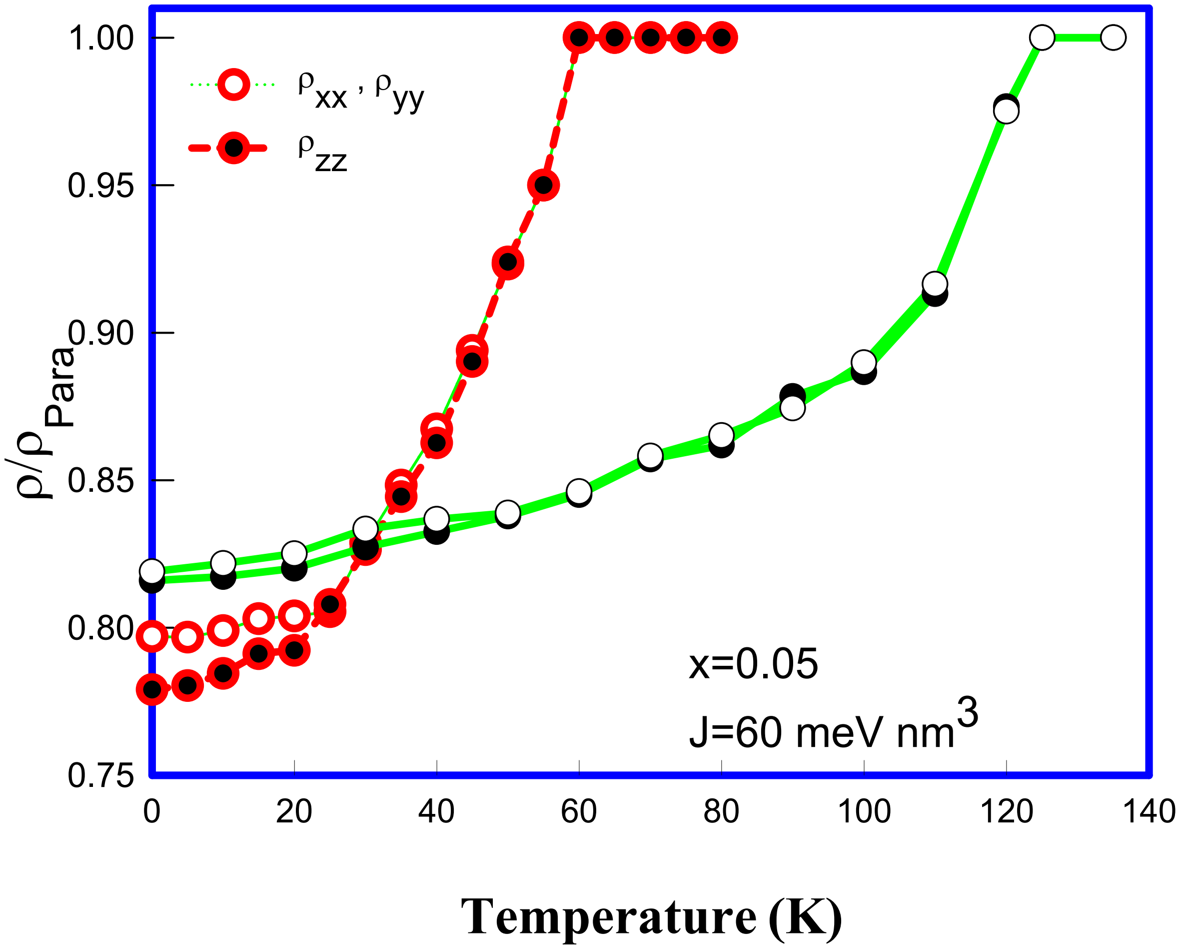
$V(2k_F^{para})$ larger than $V(2k_F^{ferro})$

τ_{Ferro} larger than τ_{para}

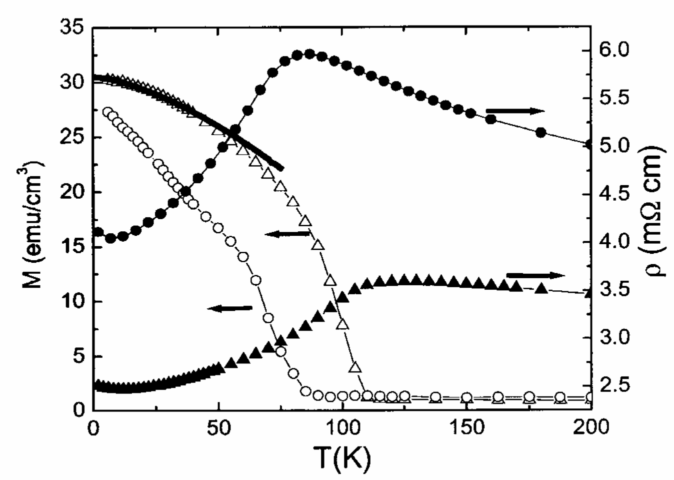
ρ_{para} larger than ρ_{ferro}

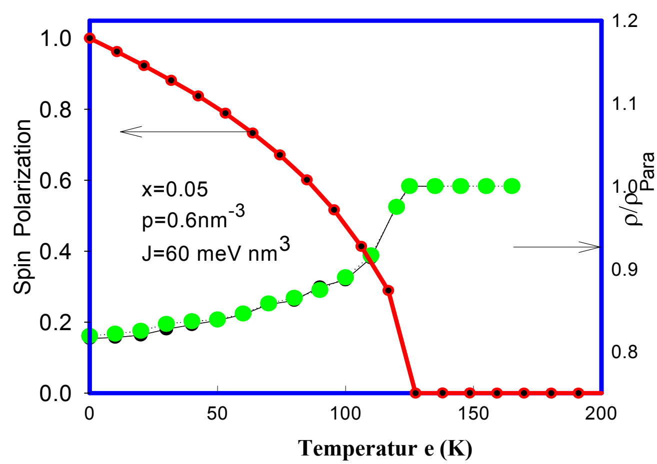
RESULTS

p=0.2nm^{-3}
p=0.6nm^{-3}



CONCLUSIONS





We have calculated the dependence of the magnetization and resistivity on T.

The model based on **k·p** model, VCA, mean field, RPA and relaxation time approximation describes appropriately the experimental results.

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CONCLUSIONS