# Galvanomagnetic methods of Curie Temperature determination in low-$T_C$ (Ga,Mn)As samples.

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Nowadays, it is quite common to use the measurement of resistivity tensor ($\rho_{xx}$ and $\rho_{xy}$) to study magnetic phase transition in (Ga,Mn)As [1, 2, 3], since it is relatively easy to implement especially in the investigations of the influence of external physical parameters (e.g electric field or pressure) on the Curie temperature ($T_C$). There are two basic methods to determine $T_C$: 1) the analysis of the peak in the $d\rho_{xx}/dT$ versus $T$ dependence [1, 2, 4] and 2) the analysis of Arrot plots prepared on the basis of $\rho_{xx}(B)$ and $\rho_{xy}(B)$ isotherms measured at high magnetic fields [3]. In this work we critically analyze applicability of these methods for a set of (Ga,Mn)As samples with Curie temperatures in the range from 15 K to 105 K, and two types of magnetocrystalline anisotropies (easy axis in plane and out of plane). We show that the first method works very well in the case of samples with metallic character of resistivity but it is useless in the case when the resistivity has semiconducting character. Next, considering the second of the above methods, we show that in the case of samples with in-plane easy axis of magnetic anisotropy it leads to a large divergence of $T_C$ values (of the order of 10 K) obtained under different assumptions which are necessary while preparing the Arrot plot. In the case of samples with out-of-plane easy axis these assumptions do not have such an impact on the obtained values of $T_C$ as in the first case. Moreover in this work we show a number of ways (other than Arrot plots) to get some characteristic and clear features (observables) from high magnetic field isotherms $\rho_{xx}(B)$ and $\rho_{xy}(B)$, that are closely related to the ferromagnetic – paramagnetic phase transition. These features are very easy to follow as a function of external physical factors. We also show that the measurement of $\rho_{xx}(B)$ and $\rho_{xy}(B)$ in the regime of small magnetic fields allows for the indirect determination of magnetic susceptibility, which in the vicinity of the phase transition is in the form of a characteristic peak. Finally, we discuss the influence of magnetic inhomogeneity of the samples on the results obtained.

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