Comment on "Origin of the Anomalous Magnetic Circular Dichroism Spectral Shape in Ferromagnetic $Ga_{1-x}Mn_xAs$: Impurity Bands inside the Band Gap"

In a recent Letter, Ando *et al.* reported an investigation of $Ga_{1-x}Mn_xAs$ using magnetic circular dichroism (MCD), in which they claim to provide a clear explanation of the "anomalous" shape of the MCD spectrum observed by them as well as by numerous other groups [1]. Specifically, the authors claim that the negative and positive parts of the spectrum arise, respectively, from transitions at the E_0 and $E_0 + \Delta_0$ critical points of GaMnAs. We submit that this interpretation lacks scientific justification, for the following reasons.

(1) In Fig. 1 of the Letter the authors compare the MCD spectra for CdMnTe and GaMnAs, and claim that this comparison "shows clearly that the MCD structures of $Ga_{1-x}Mn_xAs$ ($x = 0.004$) at around 1.5 and 1.8 eV are, respectively, due to the E_0 and $E_0 + \Delta_0$ transitions." The energy separation between the two features in the MCD spectrum observed on CdMnTe is indeed equal to the spin-orbit split-off energy Δ_0 for that material (0.91 meV). This, however, cannot be said of the GaMnAs data. Figure 4 of the Letter shows energy separation between the minima and maxima of MCD signals which (according to the above interpretation) should roughly correspond to the value of Δ_0. As one can see from the figure, the energy separation drops drastically with Mn content, to about 0.200 eV for the $x = 0.004$ sample. The literature value of Δ_0 in GaAs is 0.341 eV [2], and there is no reason to believe that it should be so different for $Ga_{1-x}Mn_xAs$ at very small values of x, or that it should so strongly depend on x, especially when the Mn content is very small. The authors pass over this issue without comment. While it is possible that the impurity band (IB) in GaMnAs could distort the MCD spectrum in GaMnAs, one will note from Fig. 2 in the Letter [1] that the effect of IB (as identified by the authors) decreases dramatically with decreasing Mn concentration x. For that reason the MCD data observed for very low Mn concentrations (x less than 0.01) should not be affected by IB, making the sharp reduction in the peak-to-peak separation even more conspicuous. In addition, other authors [3,4] show that the peak-to-peak separation in MCD observed on $Ga_{1-x}Mn_xAs$ is as low as 80 meV for $x = 0.0005$, confirming the trend seen in Fig. 4 of the Letter. These facts show that the assignment of the positive maximum in MCD to transitions at the $E_0 + \Delta_0$ critical point is incorrect.

(2) The authors further state that "The shape of the MCD spectrum of GaMnAs is very similar to that of the MCD spectrum of CdMnTe." However, from Fig. 1 in the Letter one is forced to conclude that the *shapes* of these two spectra have little in common. The MCD observed on CdMnTe is a superposition of two separate contributions, corresponding to transitions at the two critical points E_0 and $E_0 + \Delta_0$, separated by the energy $\Delta_0 \approx 0.91$ meV. The positive peak in the CdMnTe MCD is conspicuously broader and weaker than the negative peak. In addition one can see a striking sharp discontinuity in the slope when MCD changes sign, further underscoring the different origins of the two features. In contrast, the MCD spectrum for GaMnAs in the vicinity of E_0 is dominated by a single clearly *antisymmetric* feature centered at a point just above the energy gap, with single slope between the peaks, and with its negative and positive parts having similar magnitudes and shapes. Such a shape is characteristic of MCD associated with a single absorption *peak*. Thus assigning the two "wings" of this feature to *two separate processes* (i.e., to transitions at the E_0 and $E_0 + \Delta_0$ critical points, respectively) is without foundation, especially given the fact that the separation between these peaks shifts drastically with x.

(3) Finally, the depiction of the various mechanisms proposed by the authors as underlying MCD shown in Fig. 3 is completely arbitrary, based only on *ad hoc* interpretation of various features of the MCD. For example, the authors make the categorical statement, "We prove that the optical transitions originated from impurity bands cause the strong positive MCD background." However—although it is known that the impurity band absorption has a long tail on the higher energy side—no attempt is made to explain why the effect of this tail on MCD should be stronger than the effects produced by the critical points.

The interpretation of MCD observed in GaMnAs is of great importance, since it has fundamental consequences for our understanding of the *p-d* exchange in this material. We therefore feel compelled, for reasons given above, to express our disagreement with the authors' interpretation of their otherwise interesting results.

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