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Measurement of the *s*-*d* exchange coupling in GaMnAs quantum wells[1]

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The discovery of ferromagnetism in zinc-blende III-V Mn-based compounds and the realization that this collective magnetic behavior is mediated by delocalized or weakly localized holes has given a technological impetus for developing a clear picture of the carrier-shell exchange couplings. Surprising results regarding the magnitude and sign of the exchange between *s*-like conduction band electrons and electrons localized in the *d*-shell of the Mn^{2+} impurities point to deficiencies in the current theory which has successfully described experimentsin II-VI DMS within a higher regime of doping [3]. Measurements of coherent electron spin dynamics in $Ga_{1-x}Mn_xAs/Al_{0.4}Ga_{0.6}As$ quantum wells with $0.003\% < x < 0.2\%$ show an antiferromagnetic (negative) *s*-*d* exchange coupling, $N_0\alpha$. The magnitude of $N_0\alpha$ varies as a function of width of the quantum well, which is consistent with a large and negative contribution due to kinetic exchange. MBE growth conditions are optimized in order to produce GaMnAs with low defect densities in which coherent spin dynamics can be observed optically, while at the same time incorporating enough Mn to make the *s*-*d* coupling observable. Polarization-resolved photoluminescence and reflectance measurements reveal the effects of *p*-*d* exchange between carriers in the valance band and spins localized on Mn sites. Light Mn doping is also seen to maximize the carrier electron spin lifetime, indicating the importance of the Dyakonov-Perel decoherence mechanism in these structures.

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[2]In collaboration with R. C. Myers, N. P. Stern, A. C. Gossard, and D. D. Awschalom.

[3]R. C. Myers, M. Poggio, N. P. Stern, A. C. Gossard, and D. D. Awschalom, *Phys. Rev. Lett.* **95**, 017204 (2005); M. Poggio, R. C. Myers, N. P. Stern. A. C. Gossard, and D. D. Awschalom, *cond-mat/0503521.*