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Antiferromagnetic $s-d$ exchange coupling in GaMnAs[1] R.C. MYERS, M. POGGIO, N.P. STERN, A.C. GOSSARD, D.D. AWSCHALOM, Center for Spintronics and Quantum Computation, University of California, Santa Barbara, CA 93106 — Molecular beam epitaxy growth of GaMnAs is typically performed at low substrate temperatures (∼250 °C) and high As overpressures leading to the incorporation of excess As and Mn interstitials that quench optical signals, such as photoluminescence. In this work, optical quality samples of paramagnetic $Ga_{1-x}Mn_xAs$-$Al_{0.4}Ga_{0.6}As$ quantum wells with x < 0.0005 are achieved by performing crystal growth at a substrate temperature of 400 ^{o}C. Electronic and structural measurements demonstrate that this elevated temperature reduces As defects while allowing the substitutional incorporation of Mn into Ga sites. Using time-resolved optical spectroscopy, the electron spin coherence is measured allowing for the extraction of the sign and magnitude of the conduction band spin splitting due to the $s-d$ exchange interaction ($N_0\alpha$), whose sign is negative and magnitude varies as a function of well width. In the limit of wide quantum wells $N_0\alpha < 0$ indicating that antiferromagnetic $s-d$ exchange is a bulk property of GaMnAs. Polarization-resolved photoluminescence spectroscopy is used to measure the total excitonic spin splitting due to the $sp-d$ exchange interactions, $N_0(\alpha-\beta)$, and thus the sign and magnitude of the $p-d$ exchange constant ($N_0\beta$) is found.

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