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Ultrafast Magneto-Optics in Ferromagnetic III-V Semiconductors

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The carrier-density-dependent magnetic properties of Mn-doped III-V semiconductors allow us to explore novel ultrafast optical phenomena. Photo-generated, spin-coherent, and transient carriers can break the equilibrium among charges, spins, phonons, and ferromagnetic order, triggering an array of dynamical phenomena and providing ways to control magnetism optically. Here, we report results of ultrafast magneto- optical studies on ferromagnetic InMnAs and GaMnAs using non-degenerate time-resolved magneto-optical Kerr effect and transient reflectivity spectroscopies. We observe very short carrier lifetimes ($\sim$2 ps) and multi-level decay dynamics, due to low temperature MBE growth and heavily p-type magnetic doping. In an InMnAs/GaSb heterostructure, we observe a transient coercivity decrease (softening) during the free carrier lifetime. Furthermore, both in InMnAs and GaMnAs, we observe *ultrafast demagnetization*, similar to but much more drastic than what has been observed in itinerant ferromegnets. Above a pump fluence of $\sim$10 mJ/cm^2, we observe a complete quenching of ferromagnetic order, implying an ultrafast phase transition into a paramagnetic state.

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