Abstract Submitted
for the MAR08 Meeting of
The American Physical Society

Magnetic Memory Effects in Coherent Magnetization Dynamics of GaMnAs: From Non-equilibrium to Thermal Regime INGRID COTOROS, University of California at Berkeley, California, JIGANG WANG, Lawrence Berkeley National Laboratory, California, XINYU LIU, JACEK FURDYNA, University of Notre Dame, Indiana, JAROSLAV CHOVAN, ILIAS PERAKIS, University of Crete, Heraklion, Greece, DANIEL CHEMLA, University of California at Berkeley, California — III-Mn-V heterostructures exhibit rich spin memory effects and their magnetic properties show strong responses to external stimuli (light, electrical gate and current) via carrier density tuning. Here we report on the coherent magnetization dynamics due to laser excitation of transient carriers in GaMnAs, distinctly depending on the initial magnetic state the system is prepared in. We identify two distinct temporal regimes that reveal a complex scenario of spin reorientation, marked by the transition from a highly non-equilibrium, non-thermal, transient carrier-mediated regime ($<$ 300 femtosecond), to a thermal, lattice-heating regime (on the picosecond time scale). The ultrafast, sub-picosecond response can be used as footing for ultrafast optical detection of magnetic memory states. This observed femtosecond cooperative magnetic phenomenon may represent an as-yet-undiscovered universal principle in all carrier-mediated ferromagnetic materials, offering potential perspectives for terahertz (10^{12} Hz) speed "spintronic" devices and functional systems.

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Date submitted: 20 Nov 2007 Electronic form version 1.4