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Ultrafast Photoinduced Non-thermal Phenomena in (III, Mn)V Ferromagnetic Semiconductors

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Magnetic materials displaying carrier-mediated exchange interaction are ideal for non-thermal, potentially fast spin manipulation and detection. Prominent examples of such materials are Mn doped III-V semiconductors such as GaMnAs, in which the strong interaction of carriers (holes) and Mn ions results in high transition temperature ferromagnetism. The steady-state magnetooptical/transport measurements reveal rich magnetic memory effects and strong enhancement of ferromagnetism via external stimuli (i.e., light, electrical field or current). However, no timeresolved experiments in (III,Mn)V semiconductors have shown these collective magnetic phenomena, and hence their time scales are completely unknown. In this talk, I will present our recent observations in GaMnAs of: (1) ultrafast enhancement of ferromagnetism via photoexcited transient holes on a 100 ps time scale and (2) femtosecond detection of magnetic memory states. Our measurements reveal new fundamental collective magnetic processes at ultrafast time scales, and identify the critical roles of the Mn-hole correlation in these photo-induced cooperative behaviors. These results constitute the first evidence for *ultrafast*, *non-thermal* manipulation of the spin order in (III,Mn)Vs, which may represent as-yet-undiscovered universal features in all carrier-mediated ferromagnetic materials.