

Joint CQSE and CASTS Seminar

Weekly Seminar
Oct. 2, 2015 (Friday)

TIME Oct. 2, 2015, 14:30 ~ 15:30
TITLE Using ultrafast nonlinear optics to manipulate and understand
magnetoelectric multiferroics
SPEAKER Prof. Yu-Miin Sheu
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PLACE Rm716, CCMS & New Physics Building, NTU

Abstract

A new paradigm for all-optical detection and control of interfacial magnetoelectric coupling on ultrafast timescales is achieved using femtosecond time-resolved second harmonic generation (SHG) to study a ferroelectric/ferromagnet oxide heterostructure. We use femtosecond optical pulses to photoinduce interfacial coupling in a $\text{Ba}_{0.1}\text{Sr}_{0.9}\text{TiO}_3(\text{BSTO})/\text{La}_{0.7}\text{Ca}_{0.3}\text{MnO}_3$ (LCMO) heterostructure and selectively probe the ferroelectric response using SHG. In this heterostructure, the pump pulses photoexcite non-equilibrium quasiparticles in LCMO, which rapidly interact with phonons before undergoing spin-lattice relaxation on a timescale of tens of picoseconds. This relaxes the spin-spin interactions in LCMO, applying stress on BSTO through magnetostriction. This in turn leads to a transverse magnetoelectric effect that occurs much faster than laser-induced heat diffusion from LCMO to BSTO.

Multiferroic manganites, on the other hand, possess ferroelectric order of spin origin. The two spin spiral state, *ab* and *bc*, result in the ferroelectric order along *a* or *c* axis respectively. Using time-resolved SHG originating from *ab* spiral, we observe a threshold of photoexcitation at which typical and novel spin-relaxation is discriminated through a drastic change in dynamic. In low excitation region, the dynamics behave similarly to general manganites, but no critical slowing down occurs when system is approaching transition between *ab* and *bc* spiral. However, an exotic long-lived state is revealed and proven to depend strongly on the magnetic field and temperature. We show that this induced long-lived state is a metastable *bc* spiral existing in the *ab* spiral ground state.

During this presentation, I will demonstrate how I use ultrafast technique to manipulate, induce and study novel states in various multiferroics, including a heretostructure and a spiral-spin manganites.

