MAR06-2005-006007

Abstract for an Invited Paper
for the MAR06 Meeting of
the American Physical Society

Generating Coherent Phonons and Spin Excitations with Ultrafast Light Pulses[1]

ROBERTO MERLIN, FOCUS Center and Department of Physics, University of Michigan, Ann Arbor, MI 48109-1040

Recent work on the generation of coherent low-lying excitations by ultrafast laser pulses will be reviewed, emphasizing the microscopic mechanisms of light-matter interaction. The topics covered include long-lived phonons in ZnO [C. Aku-Leh, J. Zhao, R. Merlin, J. Menéndez and M. Cardona, *Phys. Rev.B* **71**, 205211 (2005)], squeezed magnons [J. Zhao, A. V. Bragas, D. J. Lockwood and R. Merlin, *Phys. Rev. Lett.* **93**, 107203 (2004)], spin- and charge-density fluctuations [J. M. Bao et al., *Phys. Rev. Lett.* **92**, 236601 (2004)] and cyclotron resonance [J. K. Wahlstrand, D. M. Wang, P. Jacobs, J. M. Bao, R. Merlin, K. W. West and L. N. Pfeiffer, AIP Conference Proceedings **772** (2005), p. 1313] in GaAs quantum wells. In addition, unpublished results on surface -avoiding phonons in GaAs-AlAs superlattices [M. Trigo et al., *unpublished*] and magnons in ferromagnetic $Ga_{1-x}Mn_xAs$ [D. M. Wang et al., *unpublished*] will be discussed. It will also be shown that frequencies can be measured using pump-probe techniques with a precision comparable to that of Brillouin scattering. It is now widely accepted that stimulated Raman scattering (SRS) is (often but not always) the mechanism responsible for the coherent coupling. Results will be presented showing that SRS is described by two separate tensors, one of which accounts for the excitation-induced modulation of the susceptibility, and the other one for the dependence of the amplitude of the oscillation on the light intensity [T. E. Stevens, J. Kuhl and R. Merlin, *Phys. Rev.* B **65**, 144304 (2002)]. These tensors have the same real component, associated with *impulsive* coherent generation, but different imaginary parts. If the imaginary term dominates, that is, for strongly absorbing substances, the mechanism for two-band processes becomes *displacive* in nature, as in the DECP (displacive excitation of coherent phonons) model. It will be argued that DECP is not a separate mechanism, but a particular case of SRS. In the final part of the talk, an attempt will be made to identify emerging areas of research on coherent excitations and coherent control, relevant to condensed matter systems, that could benefit from ultrafast electron and x-ray diffraction studies.

[1]Supported by NSF and AFOSR