Theory of 2D photon echo spectroscopy on quantum well intersubband dynamics

Thi Uyen-Khanh Dang[1], and Marten Richter[1]

[1] *Institut für Theoretische Physik, Nichtlineare Optik und Quantenelektronik, Technische Universität Berlin, Hardenbergstr. 36 EW 7-1, 10623 Berlin, Germany*

During the last decade coherent two dimensional spectroscopy, such as 2D photon echo, became an advanced tool for investigating correlations in semiconductors and in coupled pigments in the visible spectral range [1, 2, 3, 4]. Advances of the experimental techniques in IR and THz range suggest that an application of the 2D photon echo to the intra- and intersubband dynamics of quantum wells is possible[5]. We present a theoretical non-Markovian study of intra- and intersubband relaxation in quantum wells in the low density limit dominated by longitudinal electron-phonon coupling. The theoretical framework is used to calculate the 2D photon echo spectrum for intersubband transitions of a quantum well.

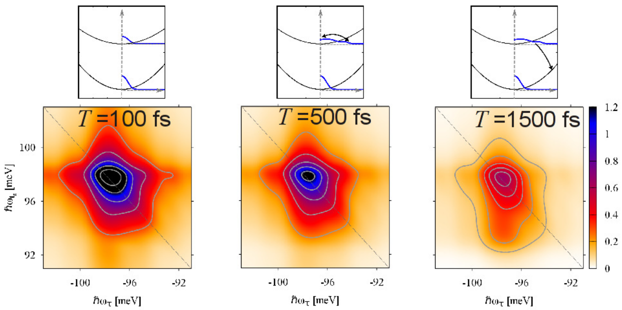

Figure 1: Calculated 2D photon echo spectra for different delay times T. Above the stepwise phonon induced density relaxation is sketched leading to the asymmetric 2D spectra .

The simulated signal is compared to the electronic density relaxation, where a stepwise relaxation through LO-phonon scattering to the minimum of the lower subband occurs. We identify the spectral signatures of the relaxation in the 2D photon echo, which are visible as an increasing asymmetry in the spectrum. Furthermore certain quantum pathways attributed to the intersubband relaxation can be pointed out, which have no equivalent in the visible. [6]

[1] X. Dai, A. D. Bristow, D. Karaiskaj, and S. T. Cundiff, Phys. Rev. A **82**, 052503 (2010).
[2] D. Karaiskaj, A. D. Bristow, L. Yang, X. Dai, R. P. Mirin, S. Mukamel, and S. T. Cundiff, Phys. Rev. Lett. **104**, 117401 (2010).
[3] G. Moody, M. E. Siemens, A. D. Bristow, X. Dai, D. Karaiskaj, A. S. Bracker, D. Gammon, and S. T. Cundiff, Phys. Rev. B **83**, 115324 (2011).
[4] T. Brixner, T. Mančal, I. V. Stiopkin, and G. R. Fleming, J. Chem. Phys. **121**, 4221–4236 (2004).
[5] W. Kuehn, K. Reimann, M. Woerner, and T. Elsaesser, J.Chem. Phys. **130**, 164503 (2009).
[6] T. U.-K. Dang, C. Weber, S. Eiser, A. Knorr, and M. Richter, Phys. Rev. B **86**, 155306 (2012).