MAR12-2011-004659

Abstract for an Invited Paper
for the MAR12 Meeting of
the American Physical Society

Quantum spectroscopy of semiconductors with Schrödinger's cat states

MACKILLO KIRA, Department of Physics, Philipps-University Marburg, Germany

Quantum investigations on simple systems — such as atoms or quantized light modes — have reached a level where one can read and write information directly onto the density matrix itself. Currently, the same level of quantum-information control seems inconceivable in condensed-matter systems simply because the many-body states involved are unimaginably complicated. In this talk, I will present the first steps in realizing targeted access of many-body states within condensed-matter systems by combining quantum-optics and many-body theory [1] with classical high-precision laser spectroscopy. The light–matter interaction has an inherent capability to directly excite targeted many-body states through the light source's quantum fluctuations [2]. The related quantum-optical responses can be projected from the classical data set by applying the cluster-expansion transformation [3] (CET). As a proof of principle, we CET project the measured nonlinear absorption of semiconductor quantum wells [4] into the quantum absorption generated by Schrödinger's cat-state sources. The results expose a completely new level of many-body physics that remains otherwise hidden. Especially, the investigations reveal an anomalous reduction of Coulomb scattering of excitons, the excitation-induced narrowing of the exciton-molecule resonance, and the formation of electron–hole complexes (multi-exciton clusters) [5].

[1] M. Kira and S.W. Koch, *Semiconductor quantum optics*, (Cambridge University Press, 2011).
[2] M. Kira and S.W. Koch, Phys. Rev. A **73**, 013813 (2006); S.W. Koch, M. Kira, G. Khitrova, and H.M. Gibbs, Nature Mat. **5**, 523 (2006); M. Kira and S.W. Koch, Prog. Quantum Electr. **30**, 155 (2006).
[3] M. Kira and S.W. Koch, Phys. Rev. A **78**, 022102 (2008).
[4] R.P. Smith *et al.*, Phys. Rev. Lett. **104**, 247401 (2010).
[5] M. Kira *et al.*, Nature Physics **7**, 799-804 (2011).