The exponential lineshape of dipolar excitons in coupled quantum wells

Arjun Joshua[1]*, Michael Stern[2], Vladimir Umansky[1] and Israel Bar-Joseph[1]
[1]Weizmann Institute of Science, Department of Condensed Matter Physics, Israel 7610001,
[2]Quantronique, SPEC, CEA Saclay 91191, Gif-sur-Yvette, France,
arjun@weizmann.ac.il
* Corresponding Author

Keywords: *dipolar interaction, coupled quantum wells, indirect excitons.*

Abstract

GaAs/AlGaAs coupled quantum wells are an excellent laboratory to study the effects of dipolar interactions in a controllable setting. For direct intra-well transitions, the photoluminescence (PL) lineshape predominantly manifests band-filling effects, extending into higher energies with increasing e-h density. For indirect inter-well transitions, so-called indirect excitons (IX), the PL lineshape is determined by the dipolar repulsive interaction: the peak energy shifts to higher energy with increasing density [1], and a low energy tail appears [2].

In this work, we study the lineshape of the PL from IX which consists of an asymmetric peak decaying exponentially towards lower energies. We show that this exponential decay can be observed to extend to large energies, over 10 meV below the peak. We find that it bears approximately the same exponent as a function of power, and shows a remarkable telescopic evolution wherein the lower power lineshapes are contained in the higher power spectra. We further study the evolution of the lineshape under conditions where the energetic position of the IX peak is held constant by adjusting the applied transverse bias, and again observe the same exponential decay. Turning to the high energy side, the PL intensity falls exponentially also to high energy, but with a steeper decay. This decay, if fitted to the tail of a Boltzmann distribution turns out to be surprisingly related to ≈3 times the bath temperature. We demonstrate that this effective temperature has a non-monotonic evolution with magnetic field.

[1] L. V. Butov et al, Phys. Rev. B **60**, 8753 (1999).
[2] G. J. Schinner et al, Phys. Rev. B **87**, 205302 (2013).