attoCFM II for Photoluminescence Measurements on Semiconductor Quantum Dots

Introduction

The attoCFMII confocal microscope is thermally compansated guaranteeing unreached stability required e.g. for single quantum dot spectroscopy over long periods of time. At the same time, extremely high optical resolution is provided. It incorporates the ANPxyz100/LT stage that is needed for bringing the sample into focus and for positioning over areas as big as 5x5 mm². Magnetic field and low temperature compatibility of the attoCFM II are of course guaranteed.
Compared with the attoCFM I, which is very flexible and can easily be modified to introduce additional optics like filters and polarizers, the attoCFM II is much more compact and easy-to-use.

Photoluminescence Measurements on Single Quantum Dots

Recently, the nano-optics group of Khaled Karrai at the University of Munich, together with cooperating groups throughout the world, presented ground-breaking photoluminescence measurements on semiconductor quantum dots, a model system which is often called and related to as „artificial atoms“. In the measurements, which they performed with the attoCFMII, the magnetic field dependence behaves as predicted for the uncharged exciton (bound electron-hole pairs), as well as for the singly and doubly charged ones.
But for the triply charged exciton new effects not predicted by this comparison appear, as a special magnetic field dependence is seen. This way is was shown that quantum dots can also possess electronic states that go far beyond the artificial atom model.

The researchers say that the anti-crossings are due to the interaction of the excitons with the continuum of states above the quantized energy levels. This kind of interaction is not known in the case of atoms, as there such states are not bound to the nucleus. But in the case of the semiconductor quantum dots there is a layer of material (the so-called wetting layer) that carries those interacting electrons. Hence, different rules seem to apply for quantum dots compared with real atoms.

Following K. Karrai, the instrument used in their setup convinces by having an unreached stability with at the same time very high optical resolution. Without the ultra-stable microscope head, he says, measuring the properties of a single quantum dot over a period of more than three months would not have been possible.

Related article:
„Hybridization of electronic states in quantum dots through photon emission“ by K. Karrai, R. J. Warburton, C. Schulhauser, A. Högele, B. Urbaszek, E. J. McGhee, A.O. Govorov, J. M. Garcia, B. D. Gerardot, P. M. Petroff, **Nature** (*2004*) 247, 8, 135.

Figure 1: *The ultra-compact attoCFM II.*

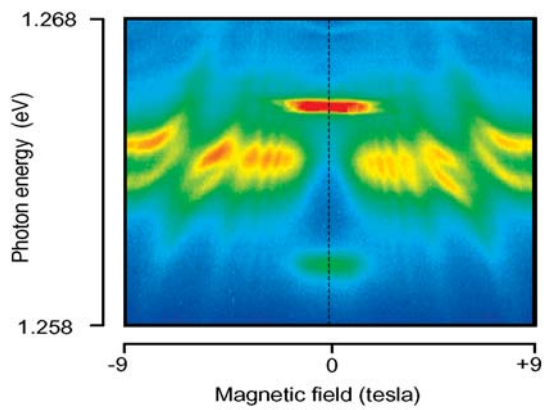

Figure 2: *The graph above shows the photoluminescence intensity of a triply charged InAs quantum dot vs. magnetic field (red corresponds to high intensity). The interesting dependence is not predicted by the model of an „artificial atom“.*

RELATED PRODUCTS	
attoCFM II	highly stable confocal microscope for low temperatures
ANPxyz100/LT	high precision, piezo electric, inertial positioner for big loads
ANC150/3	electronic controller

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