

Excitonic Fock-Darwin spectrum of a single quantum dot

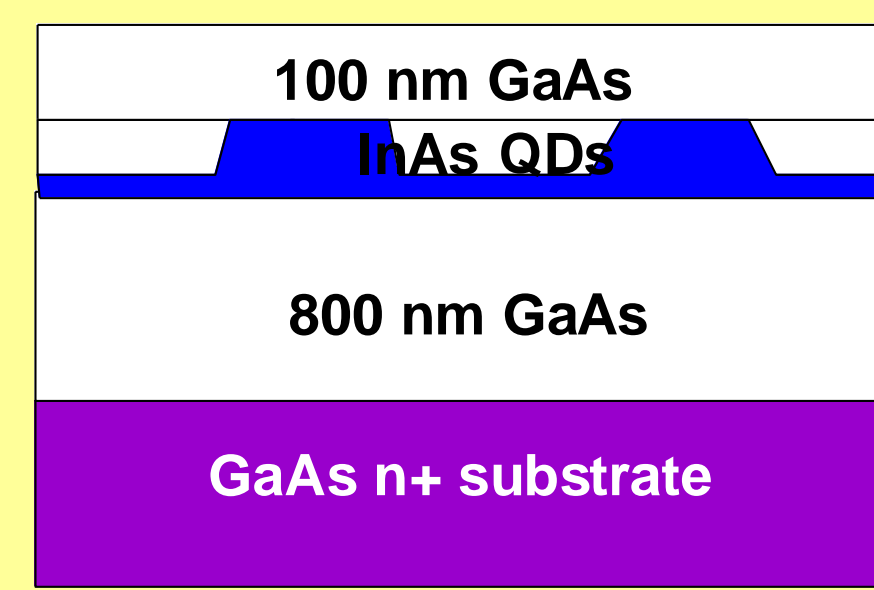
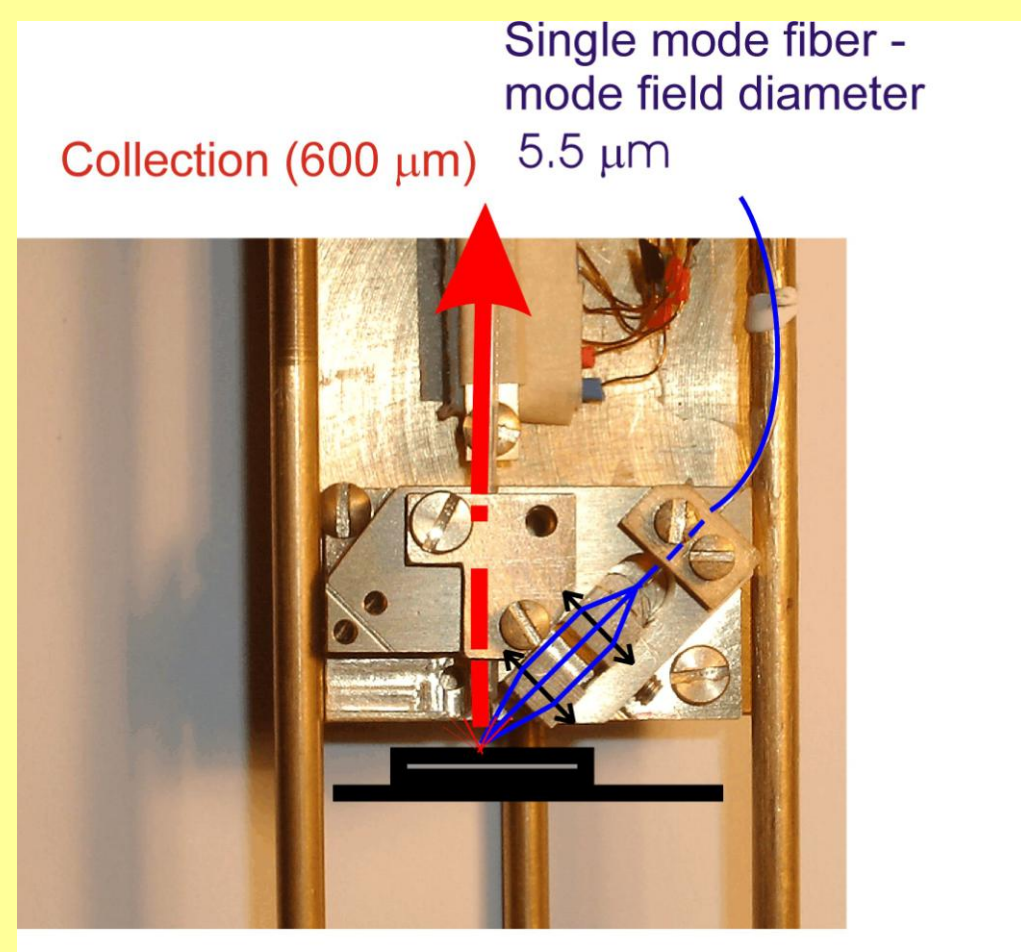
A. Babinski¹, M. Potemski², S. Raymond³, J. Lapointe³, Z. Wasilewski³, J. M. Baranowski¹

¹ Institute of Experimental Physics, Warsaw University, Warsaw, Poland,

² Grenoble High Magnetic Field Laboratory, CNRS, France,

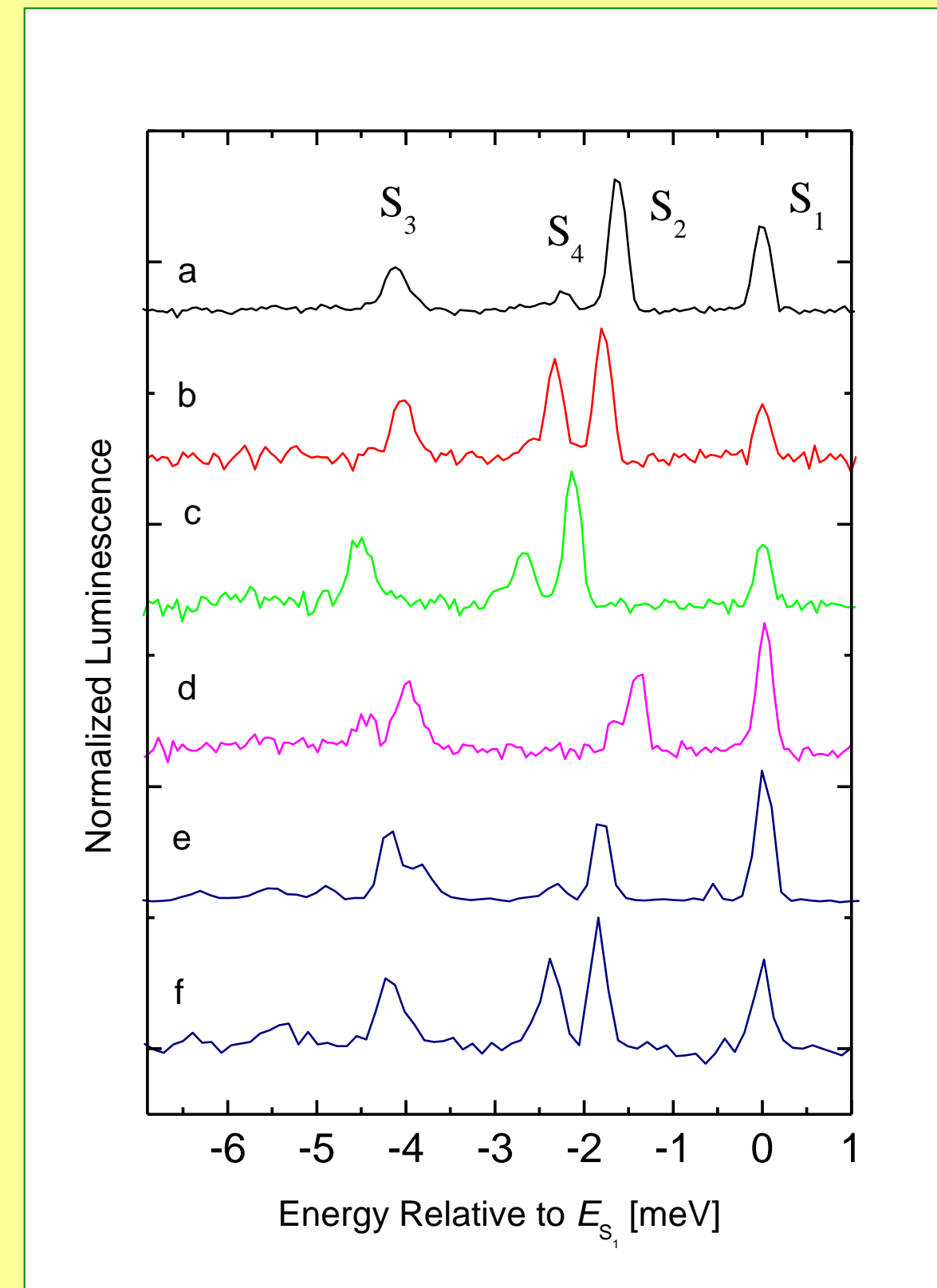
³ Institute for Microstructural Sciences, NRC Canada, Ottawa, Ontario, K1A 0R6, Canada

Magneto spectroscopy of a highly excited Single InAs/GaAs Quantum Dot

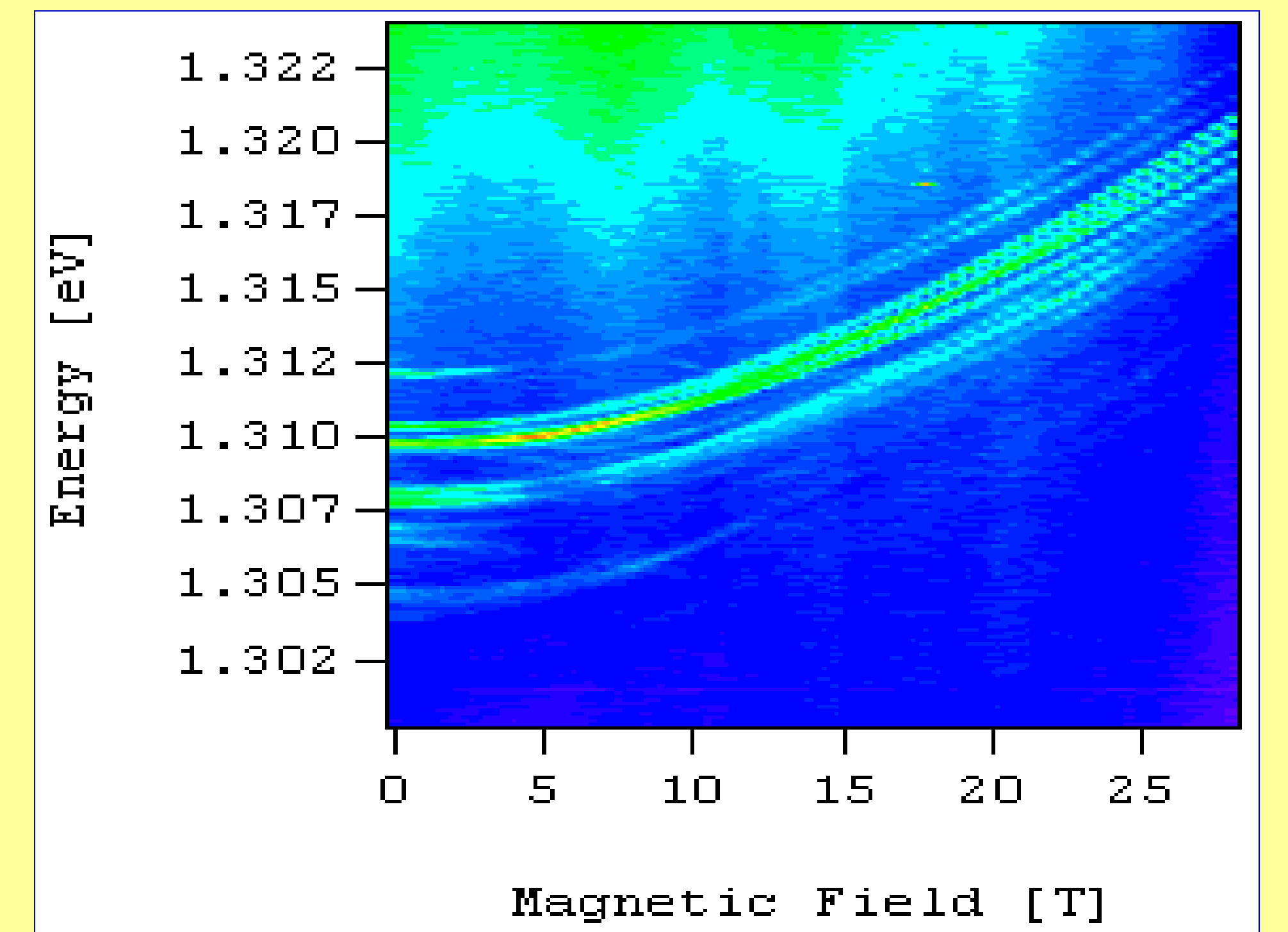


Single layer of InAs/GaAs
In-flushed* at 5 nm, annealed (850°C for 30 sec.)
*Z.R. Wasilewski et al., J.Cryst.Growth 201/202 (1999) 1131

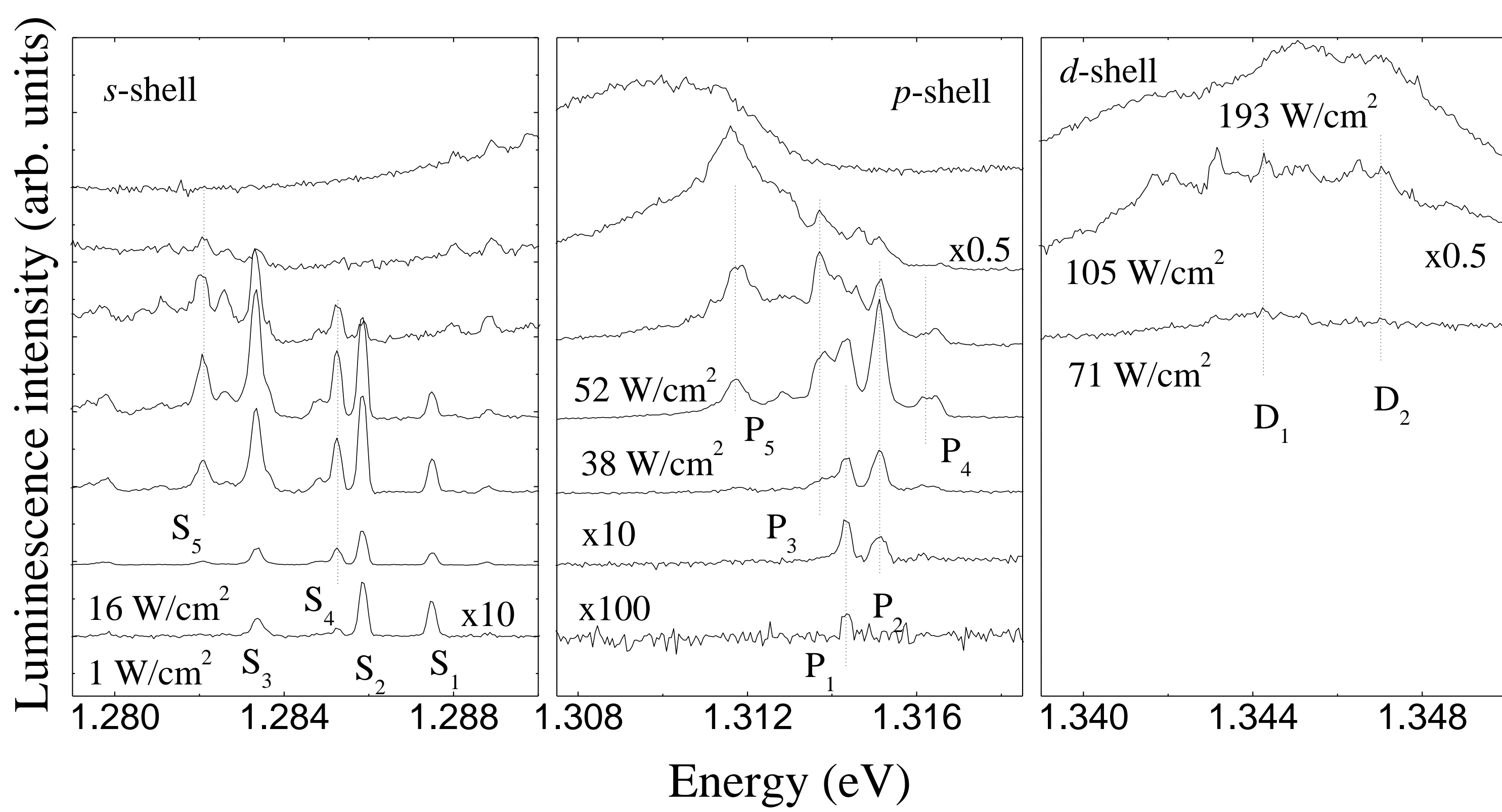
Measurements are performed at liquid helium temperature. Investigated sample is *mesa-patterned* to limit the number of investigated dots. Laser excitation (Ar⁺ laser, λ = 514.5 nm) is delivered using a single-mode fiber and focused onto the sample with two microlenses. Multimode fiber was used for a luminescence collection.



Multiline spectra from a single QD

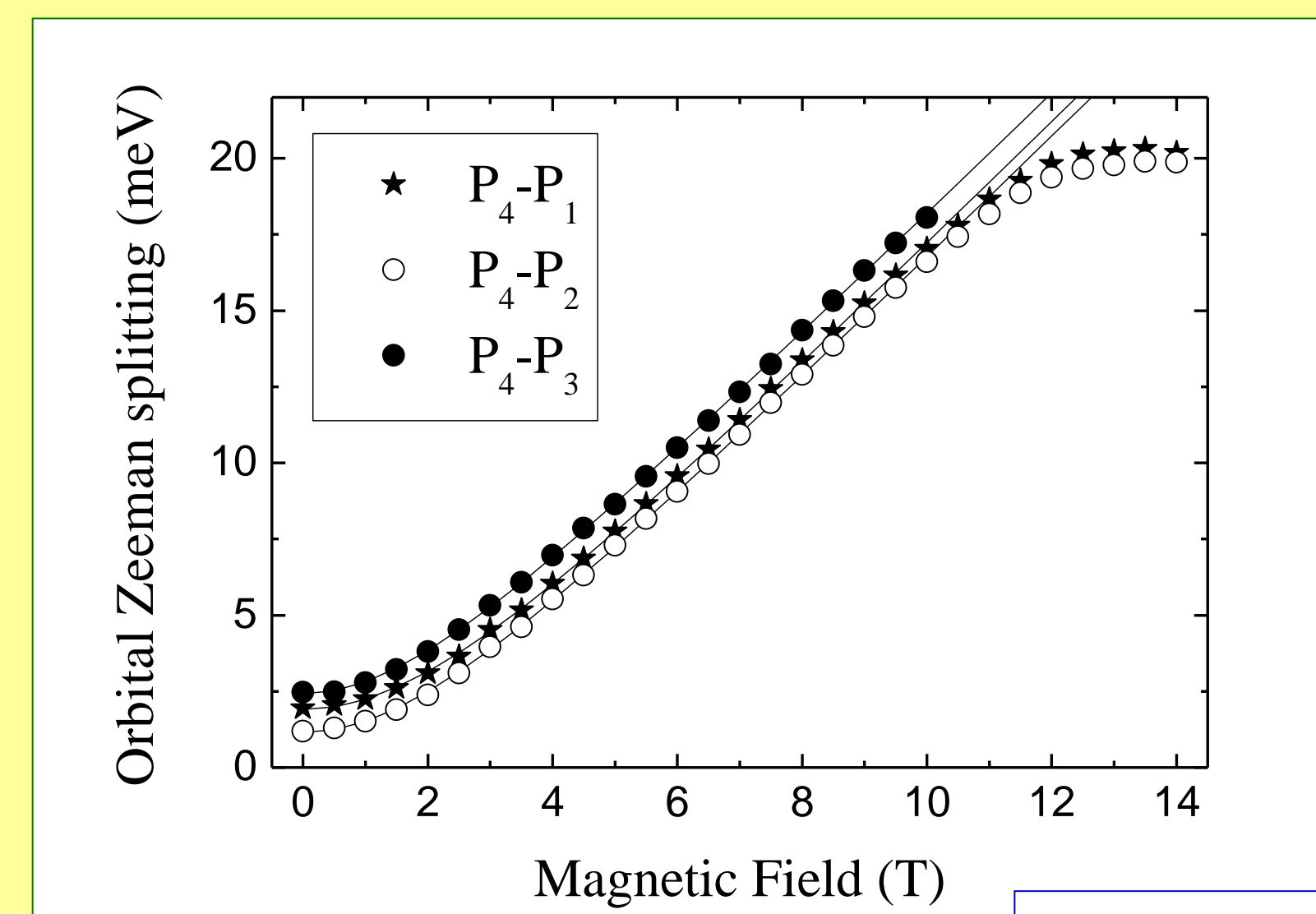


Typical multiline luminescence (T=4.2K) from the s-shell of a single QD in magnetic field



The emission from the s-, p-, and d-shells of a single dot as a function of excitation power at T=4.2K in zero magnetic field. The spectra are offset for clarity.

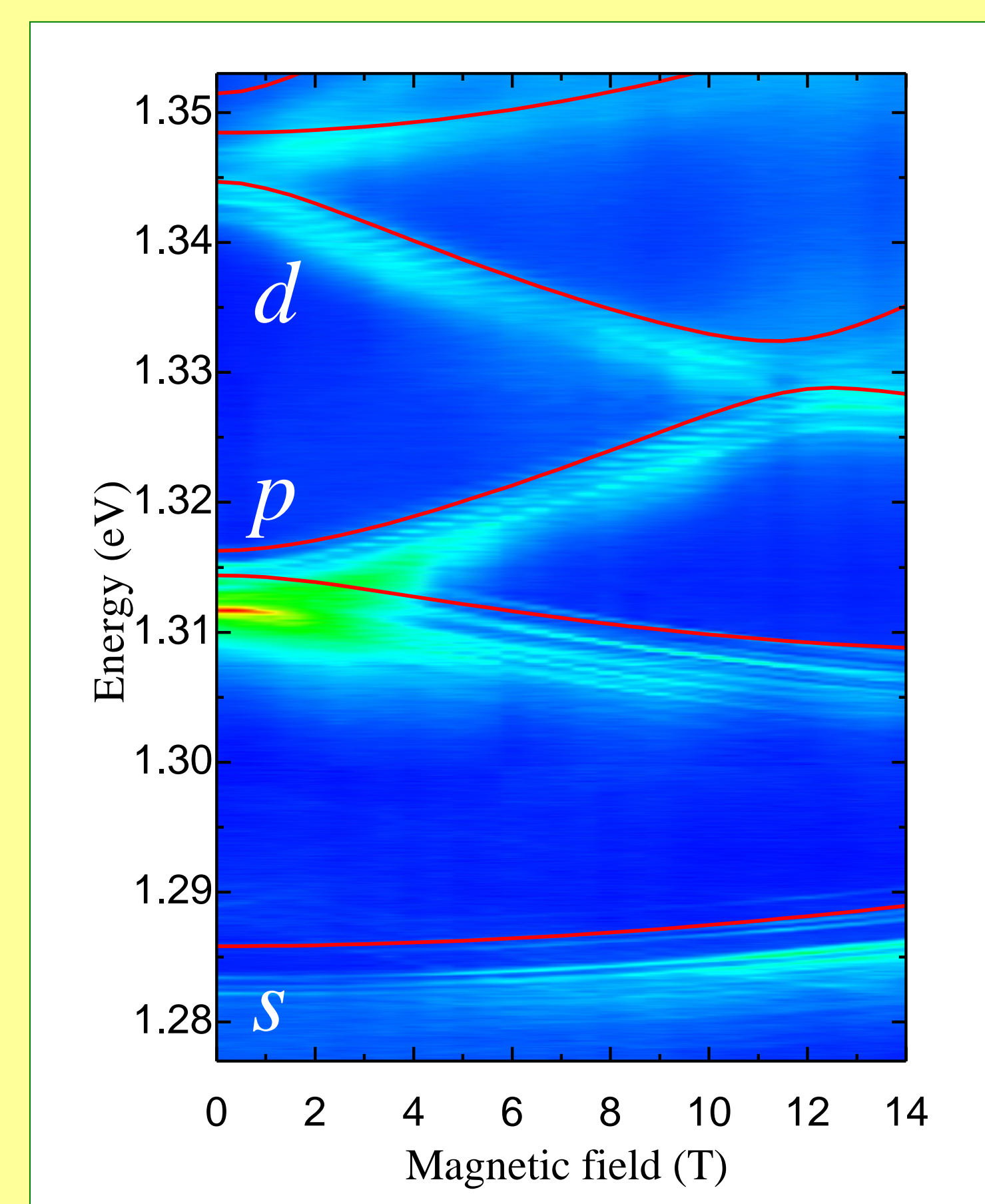
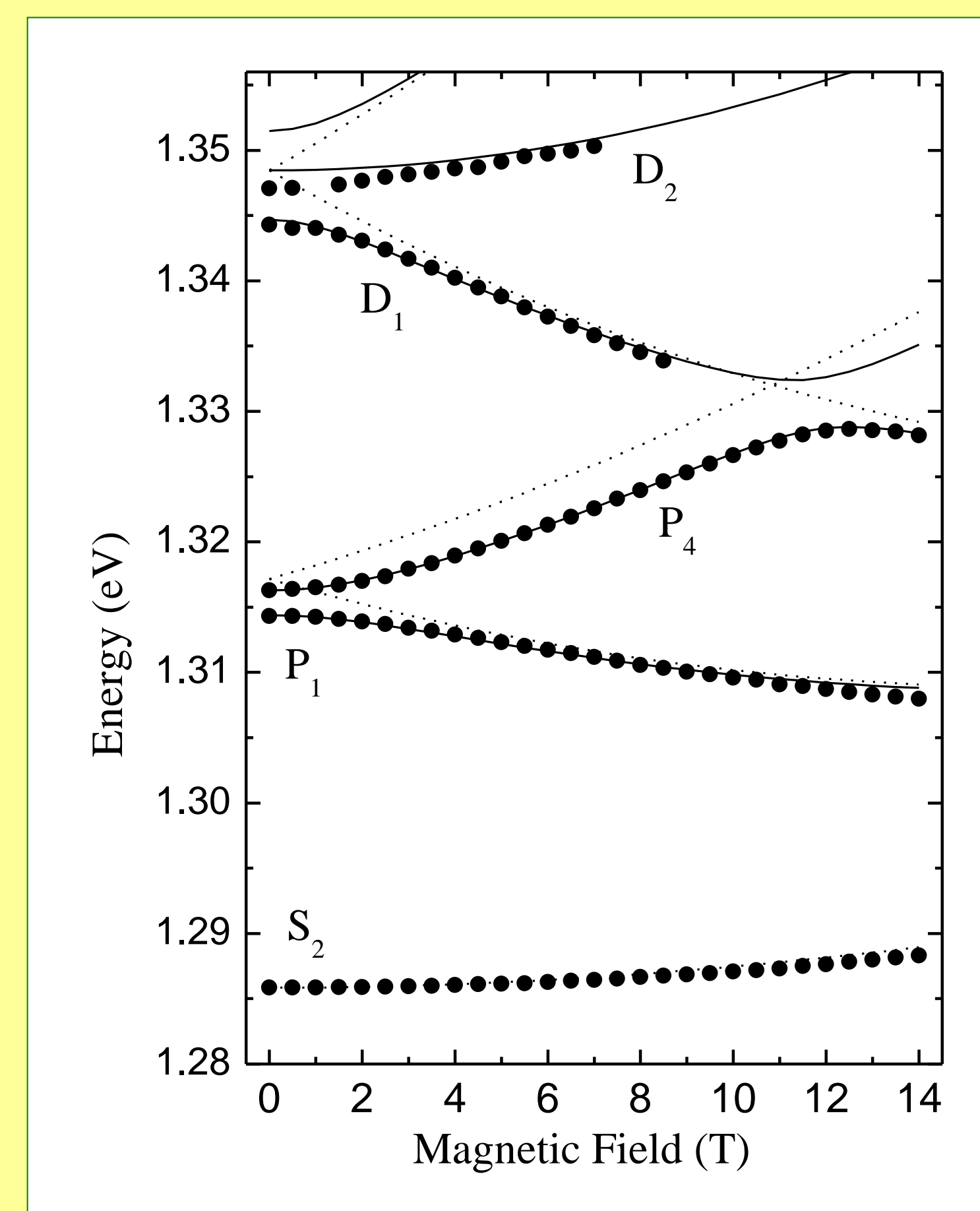
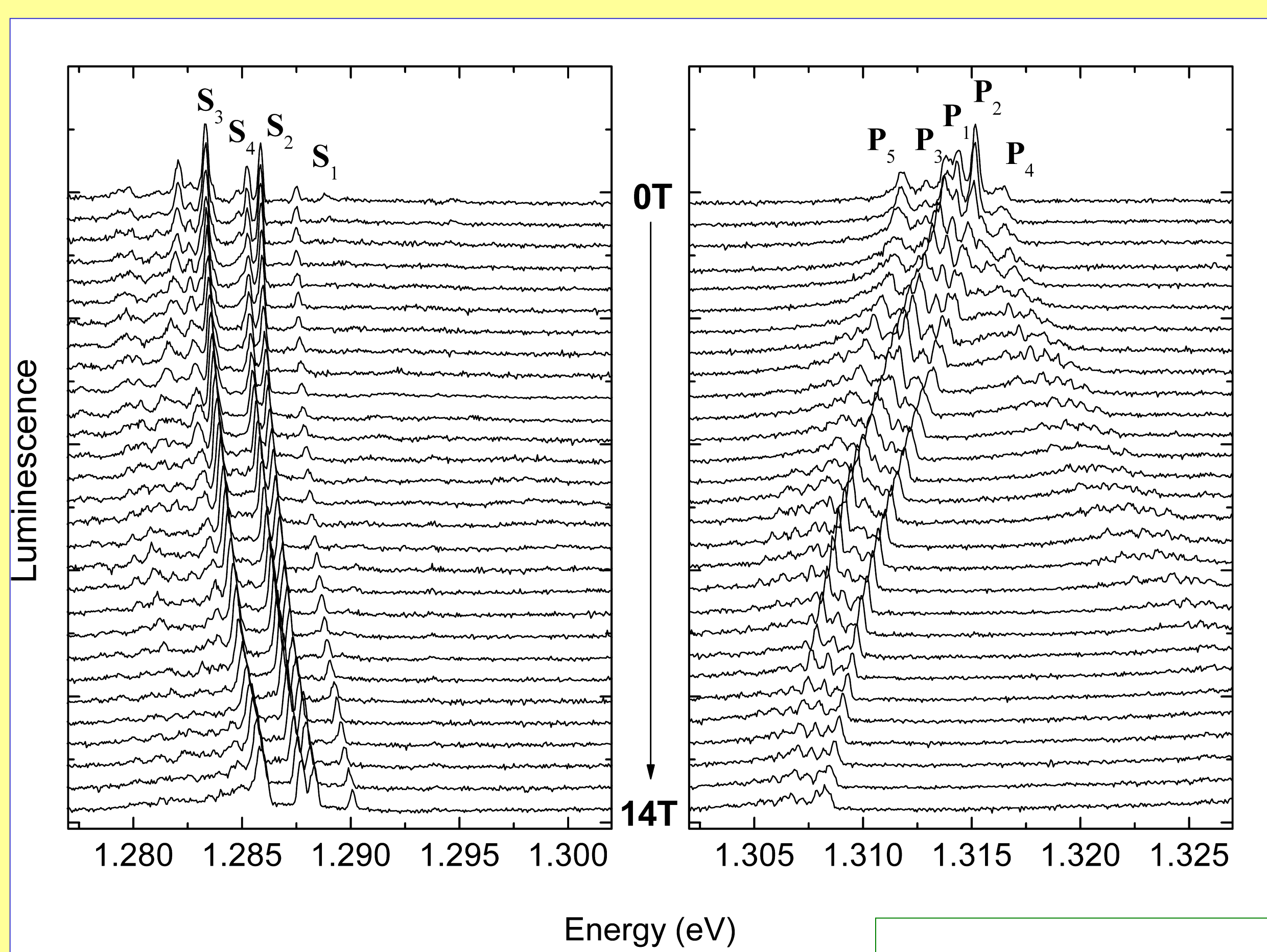
The „excitonic” F-D diagram must also include *electron-electron* interactions and a possible *asymmetry of localizing potential*



The reduced electron-hole effective mass:
 $\mu^* = 0.057 \pm 0.0005 m_0$,
the zero-field splitting $\delta = 5.5 \pm 0.5$ meV,
the energy E_Δ ranging from -4.35 meV (P_4-P_2) to -2.6 meV (P_4-P_3).

$$\Delta E'(B) = E_\Delta + \sqrt{\delta^2 + (\hbar\omega_c)^2}$$

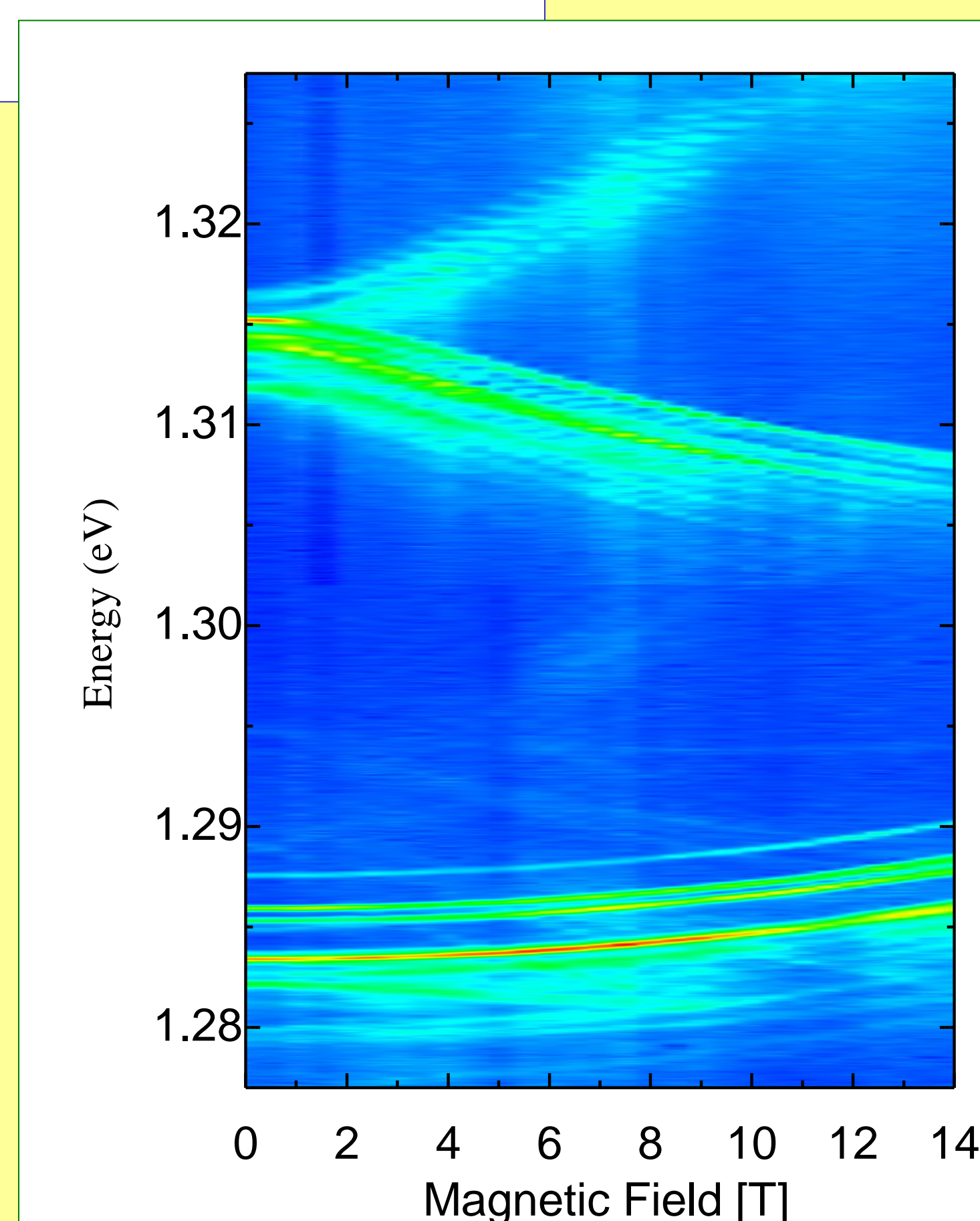
The luminescence from the s-shell and p-shell of a single QDs in magnetic field. Excitation power density is approx. 35W/cm².



Energies of the S₂, P₁, P₄, D₁ and D₂ emission lines plotted against magnetic field. Symbols give the experimental data. Calculated single-particle FD spectrum is shown with dotted lines. Solid lines - the excitonic FD spectrum (modified by electron-electron interaction and zero-field splitting)

$$E_{nl}^\beta = (2n + |l| + 1)\hbar\Omega_\beta - \frac{1}{2}l\hbar\omega_c^\beta$$

$$\Omega_\beta = \sqrt{(\omega_0^\beta)^2 + \frac{1}{4}(\omega_c^\beta)^2}$$



Modified single-particle Fock-Darwin spectrum well describes the emission from a single quantum dot in magnetic field