Excitations below the Kohn Mode; FIR-Absorption in Quantum Dots

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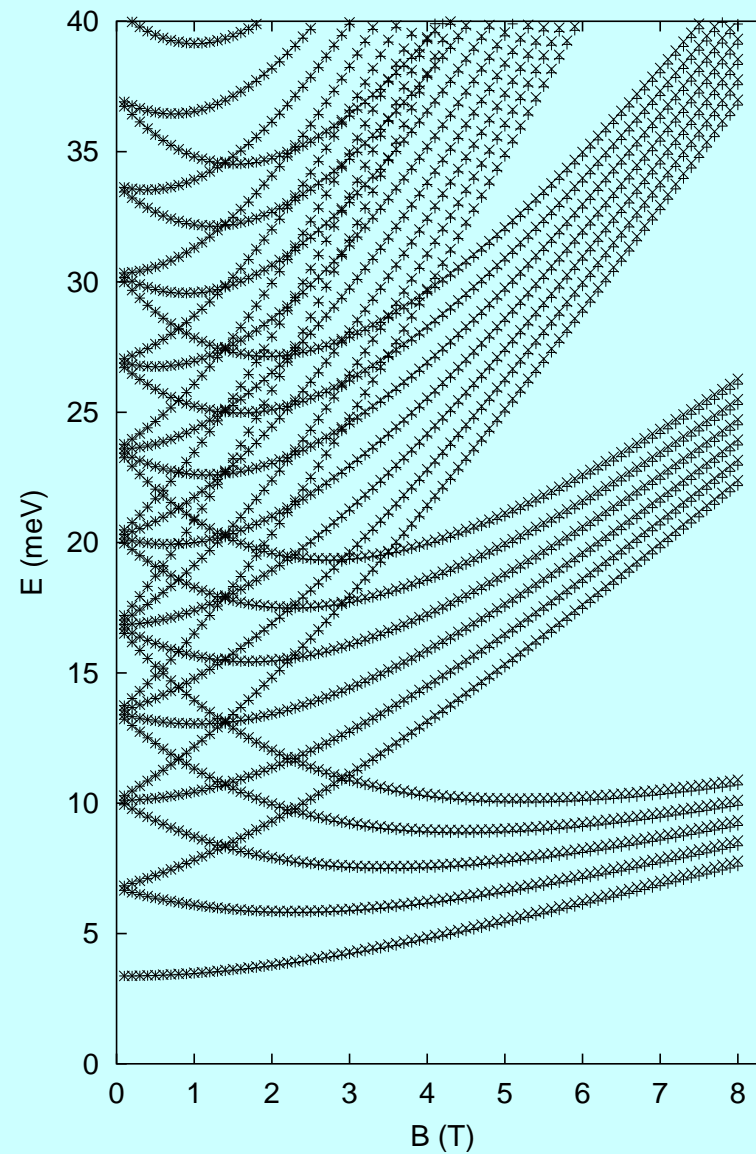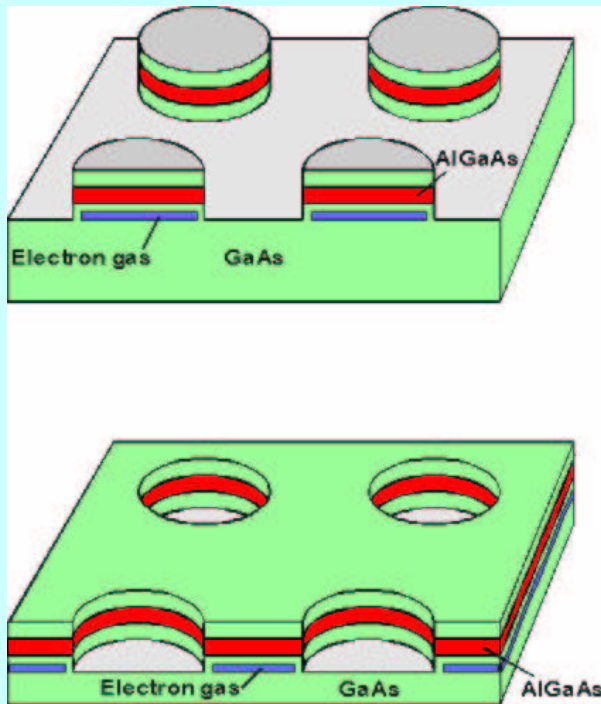
Zentrum für Mikrostrukturforschung,

Universität Hamburg
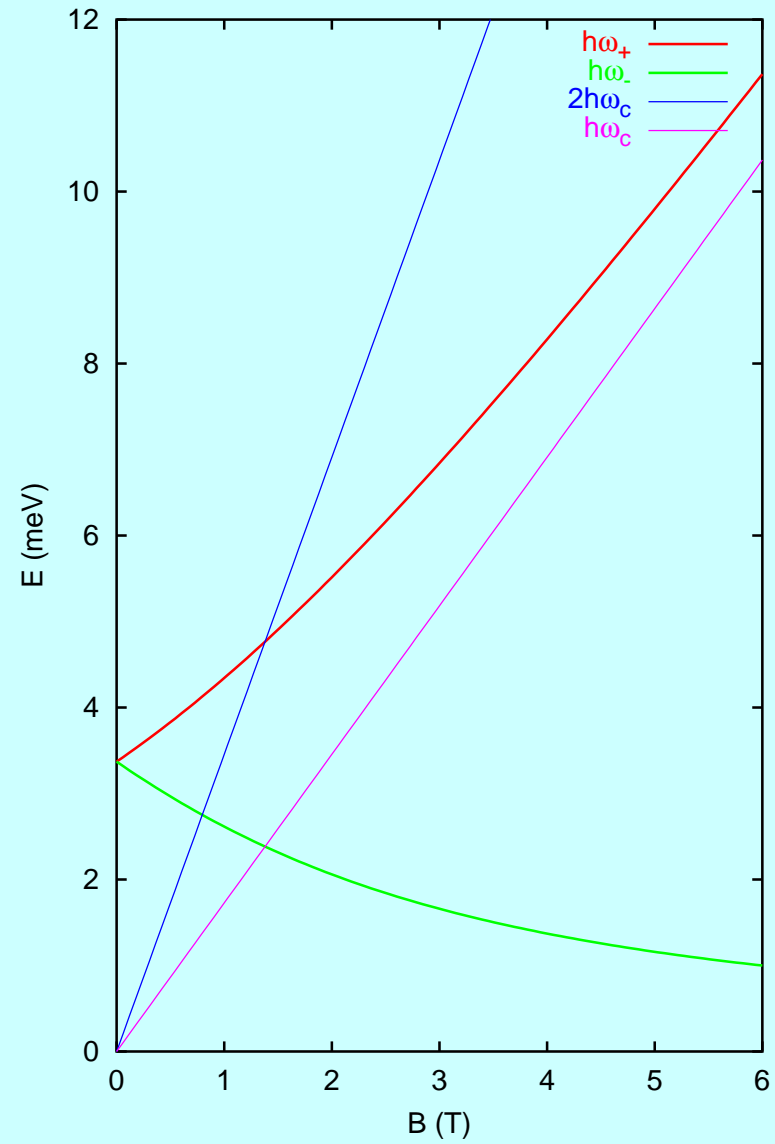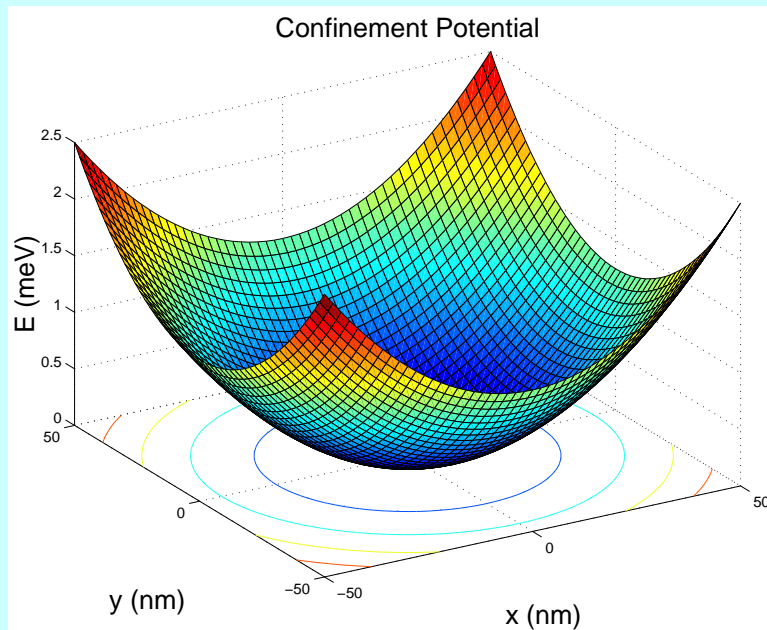
10th May 2001

Etched or field effect quantum dots

Single-electron energy spectrum (Darwin-Fock) in magnetic field
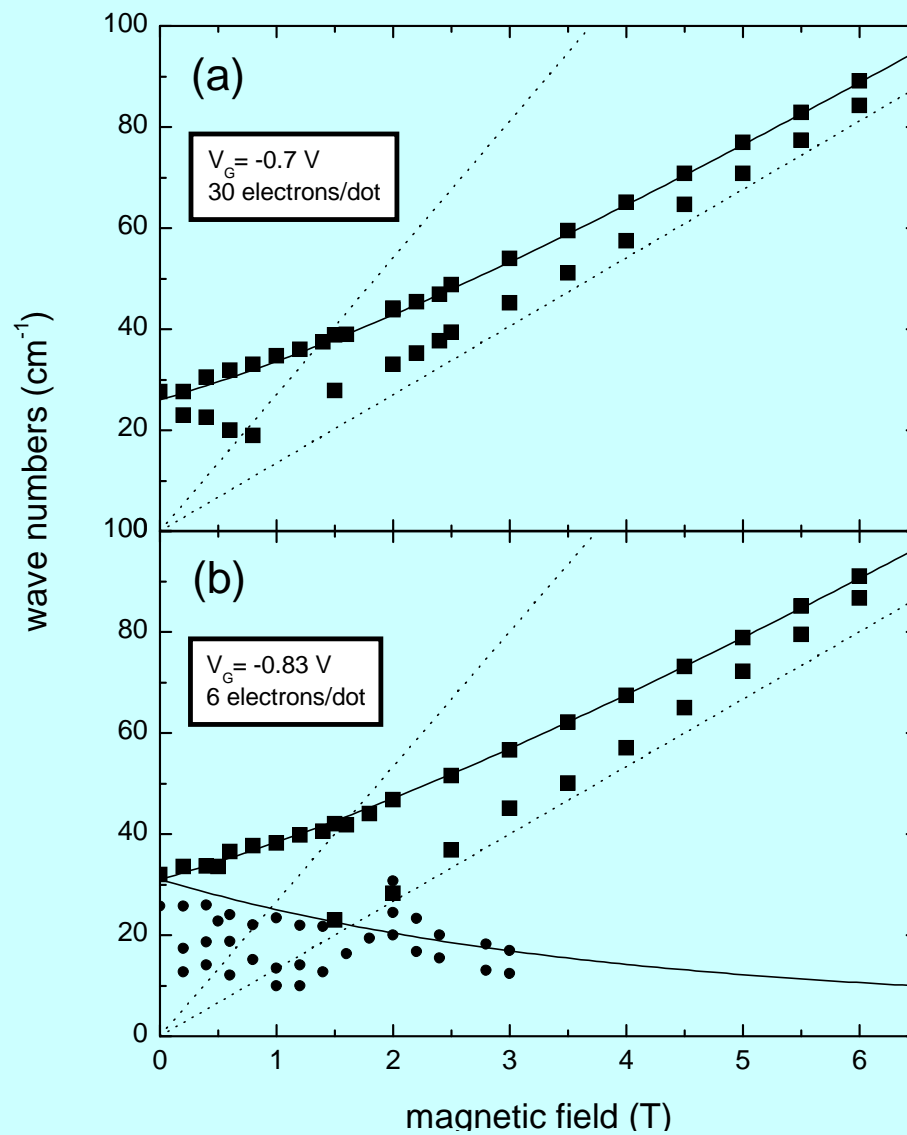
Kohn's Theorem

- FIR-radiation

- Parabolic confinement

$\rightarrow$ Only stiff CM-motion
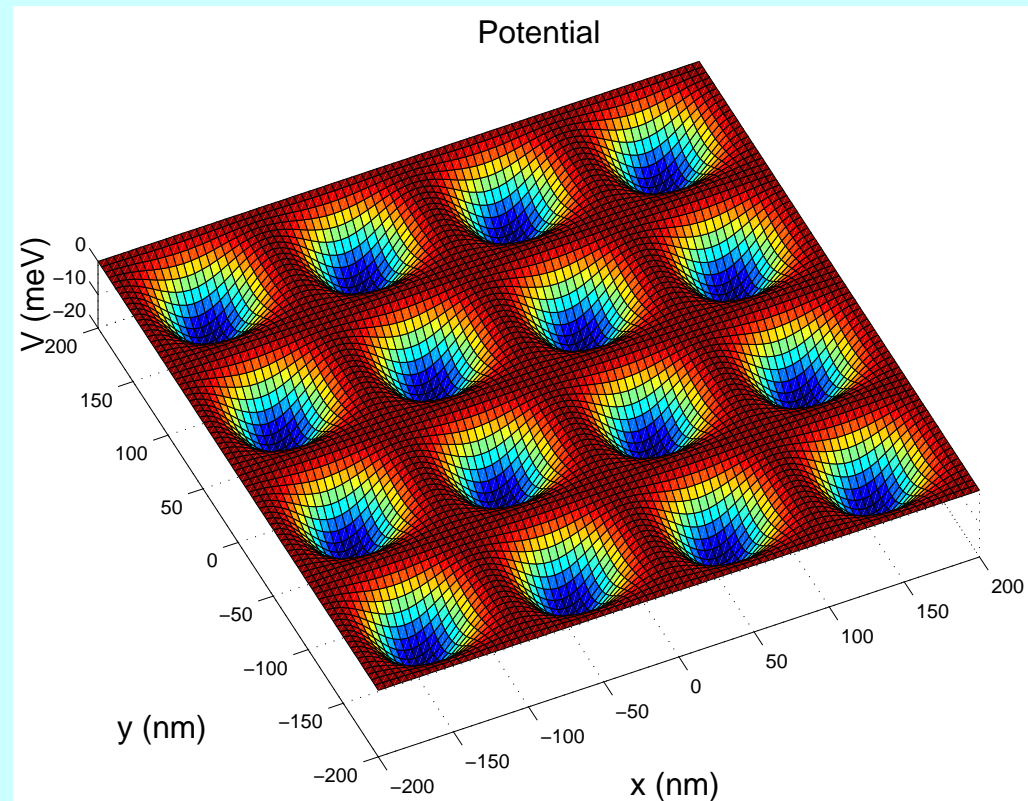

Confinement Potential

Measurement:

6 or 30 electrons

Mode below the upper Kohn mode

How is the confining potential in field induced dots?

- Must soften for large radii

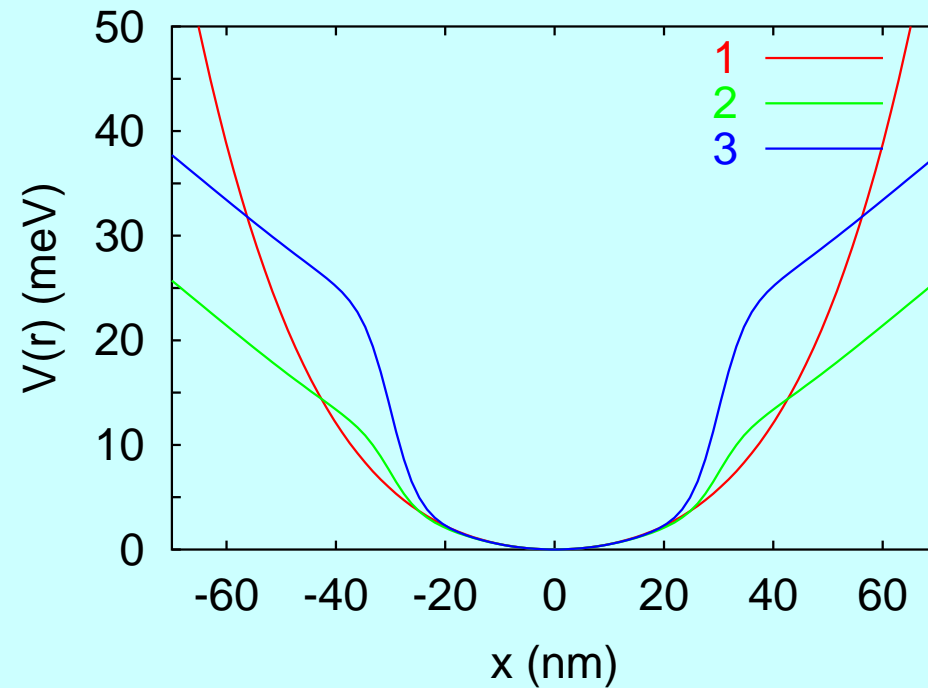- Periodic potential + **B** → trouble

Potential

Try some potentials for single dots

Parabolic + higher terms...

↓

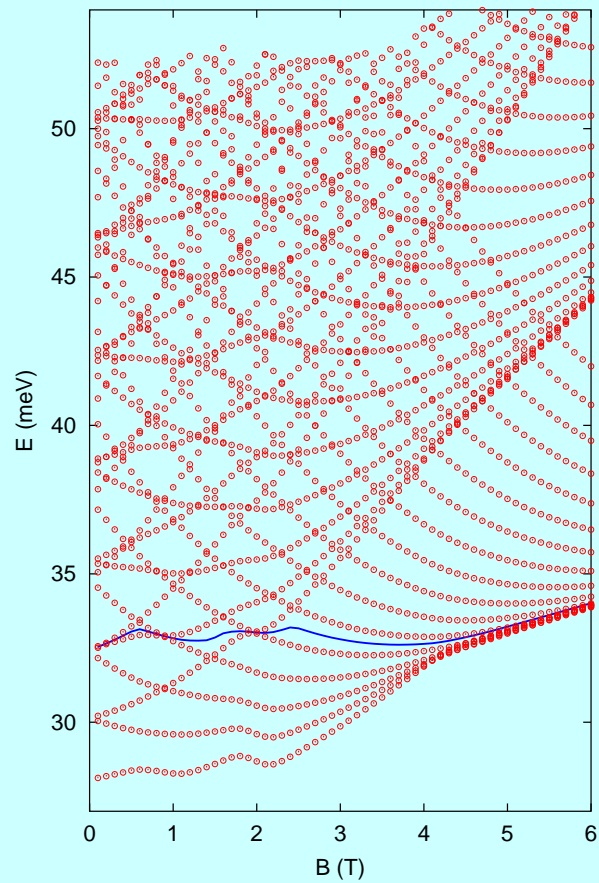excitations above the upper Kohn mode
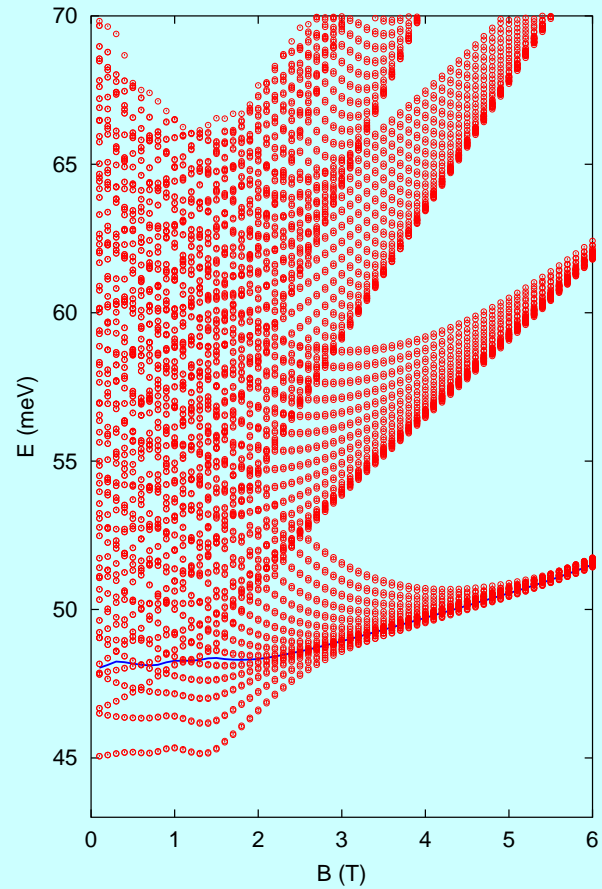
Self-consistent approach for interacting system

- **Ground state:**

  – Each electron interacts with the total electron density

- **Excited state:**

  – The total electric field (in the FIR):
  $$\mathbf{E}_{\mathrm{tot}} = \mathbf{E}_{\mathrm{ext}} + \mathbf{E}_{\mathrm{ind}}(\mathbf{E}_{\mathrm{tot}})$$

  (Hartree-approximation, no spin)
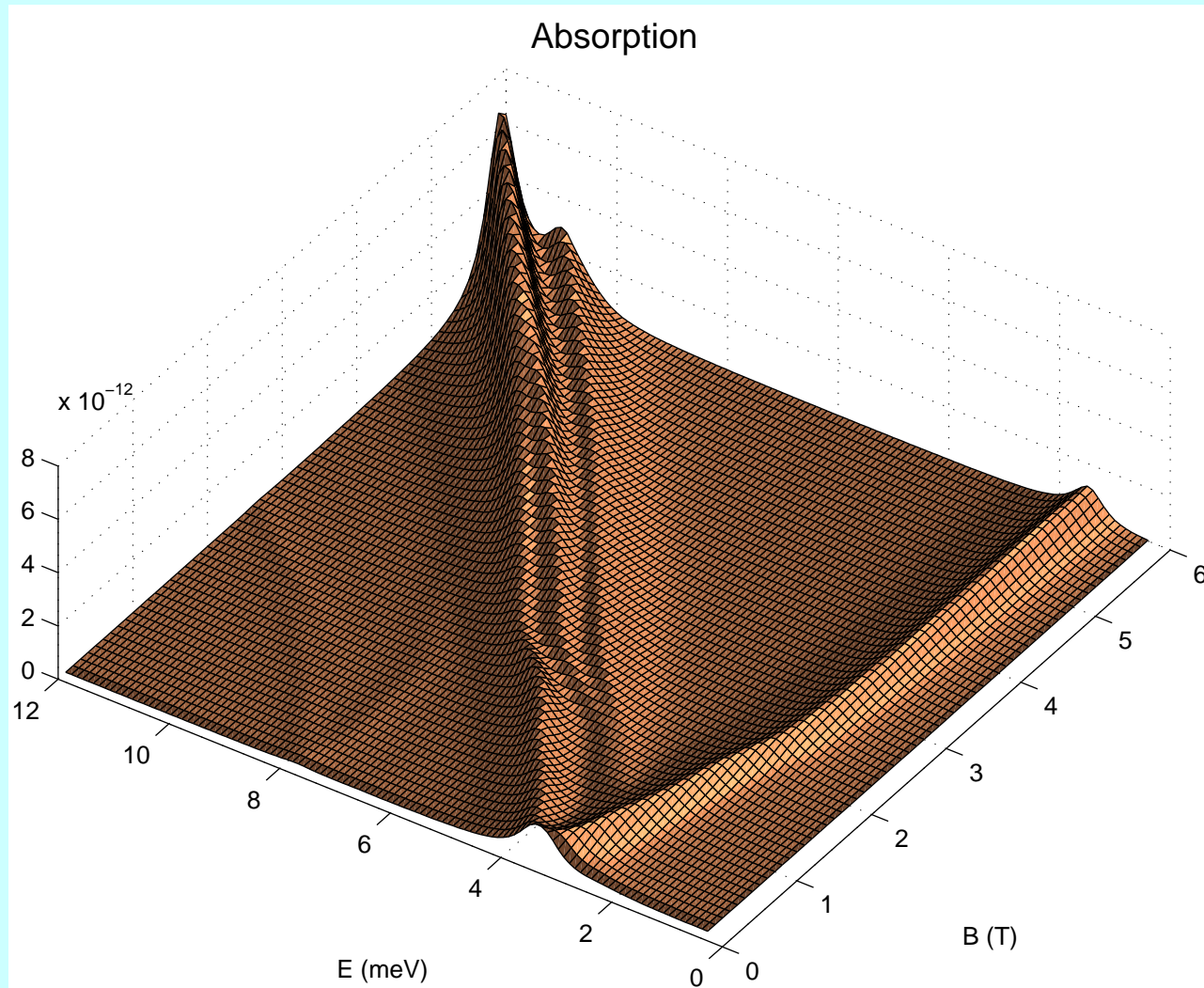
Darwin-Fock diagrams with interaction, ($T = 1$ K)

$N = 5$, no spin, $\alpha r^2 + \beta r^4$

$N = 10$, spin, $\alpha r^2 +$ softening
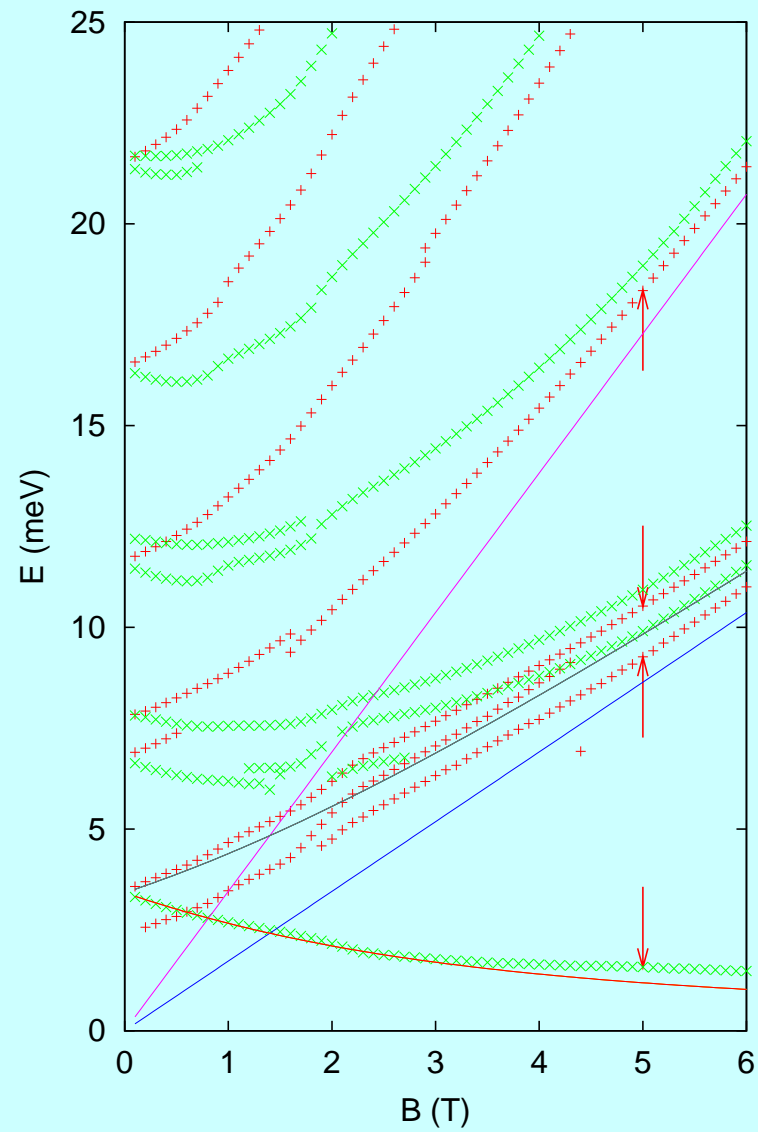
Calculated power absorption, $(N = 5, T = 1 \text{ K})$
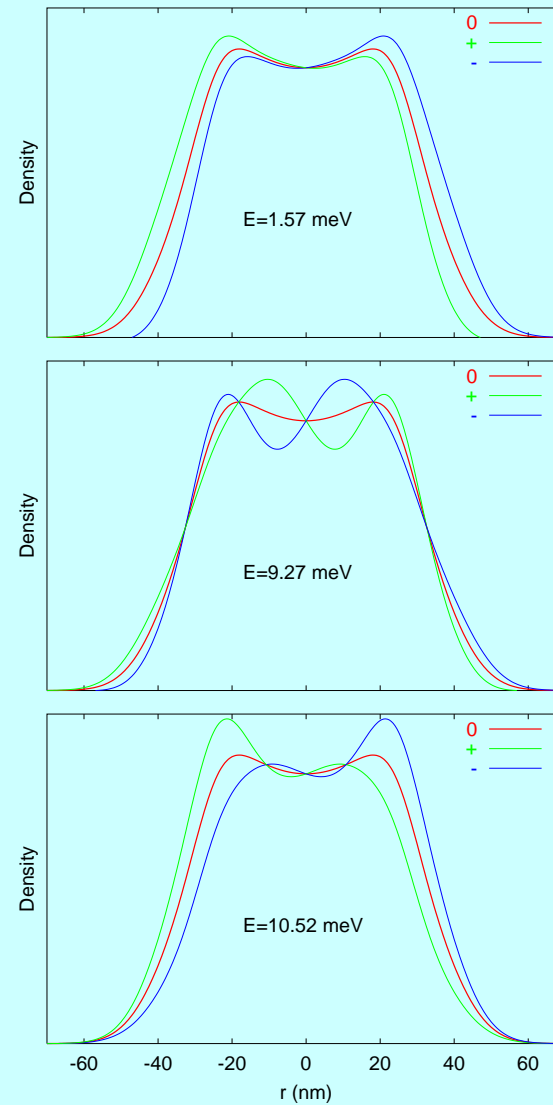

Absorption

Calculated dispersion

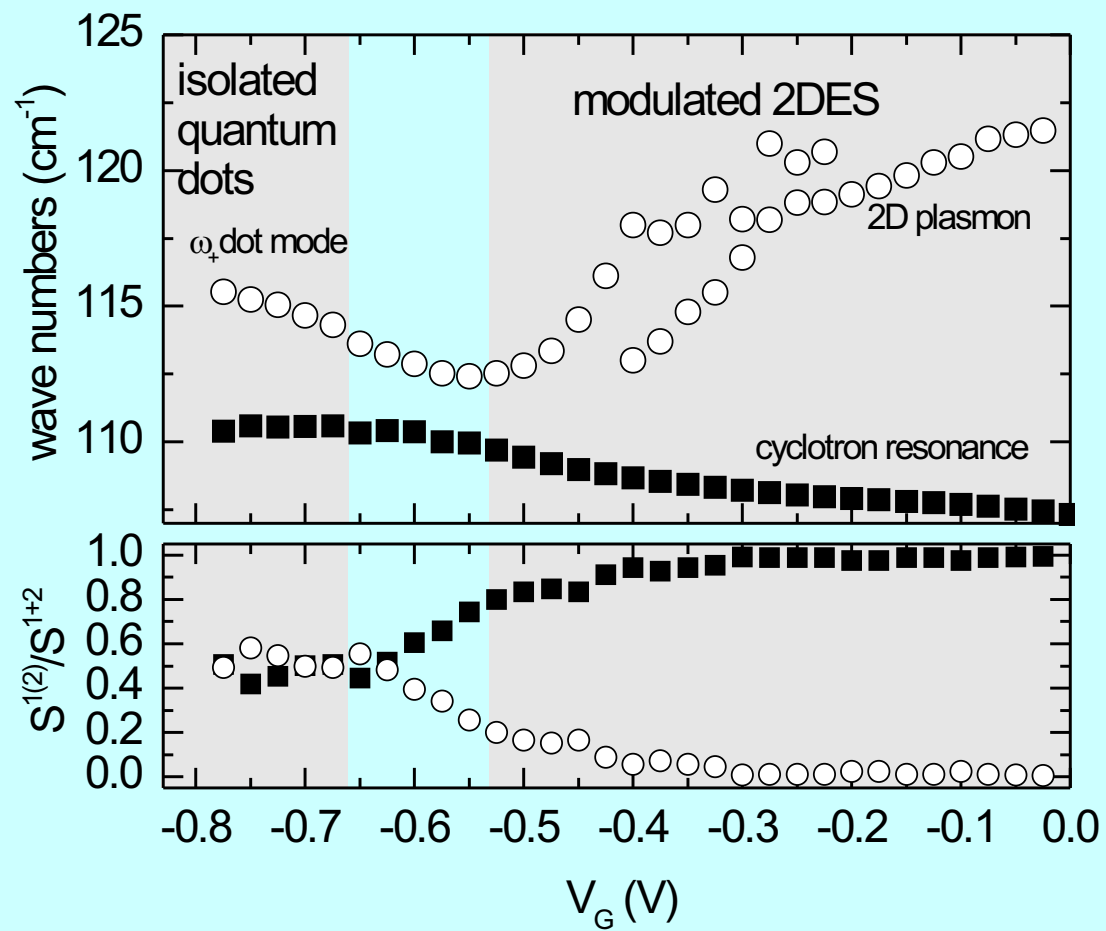$N = 5$, $T = 1$ K

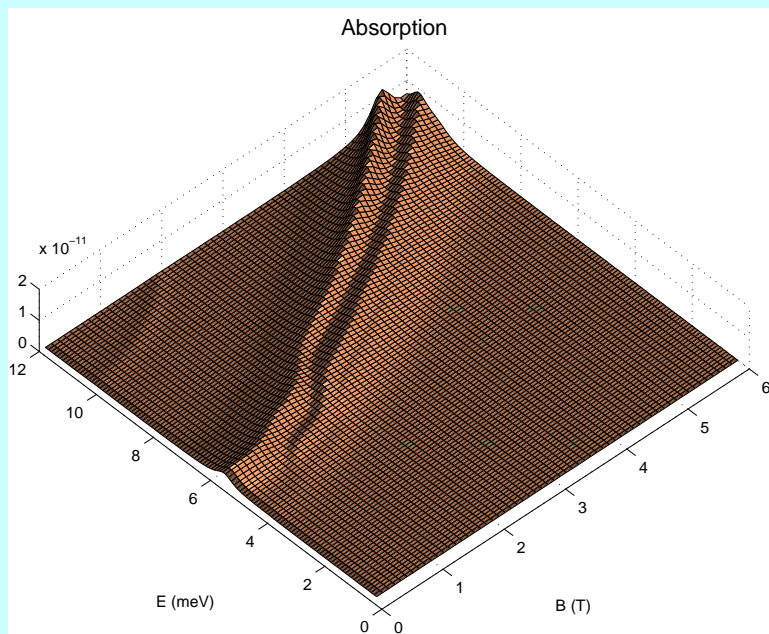- Left, right polarization
- Bernstein modes (class.)

Induced density
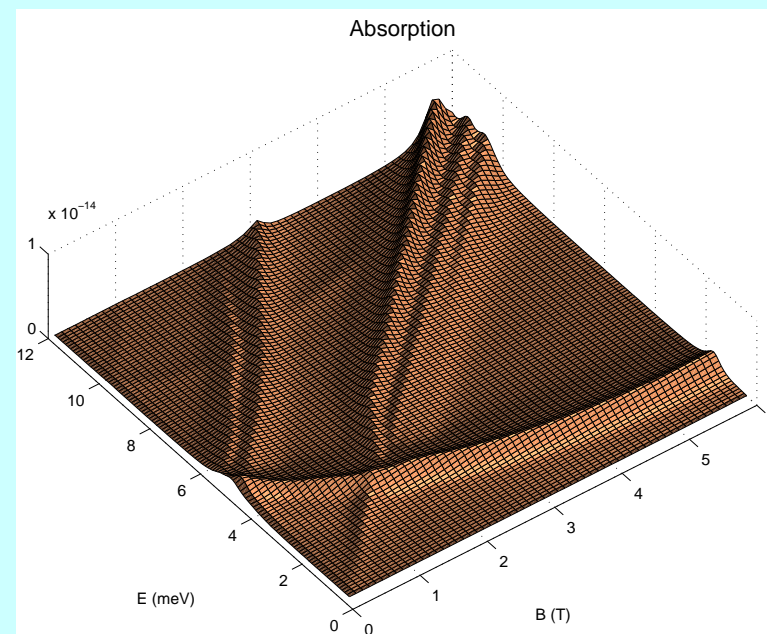
- Mode recognition
- CM $\leftrightarrow$ relative motion

Mode evolution for 2D → 0D

Future music ↔ Raman scattering

Breathing mode

Quadrupole excitation

Conclusion

- Softening of confinement potential $\rightarrow$ modes below the upper Kohn mode

- Origin of modes, models $\leftrightarrow$ measurements

- HF-approximation $\rightarrow$ more electrons fit into core region, Similar results

- Parameters, $(N, V_0, \text{HF}, \text{H})$