



Tuning Fermi Contour Anisotropy of GaAs of Quasi-2D Electron and Hole Systems in Parallel Magnetic Fields



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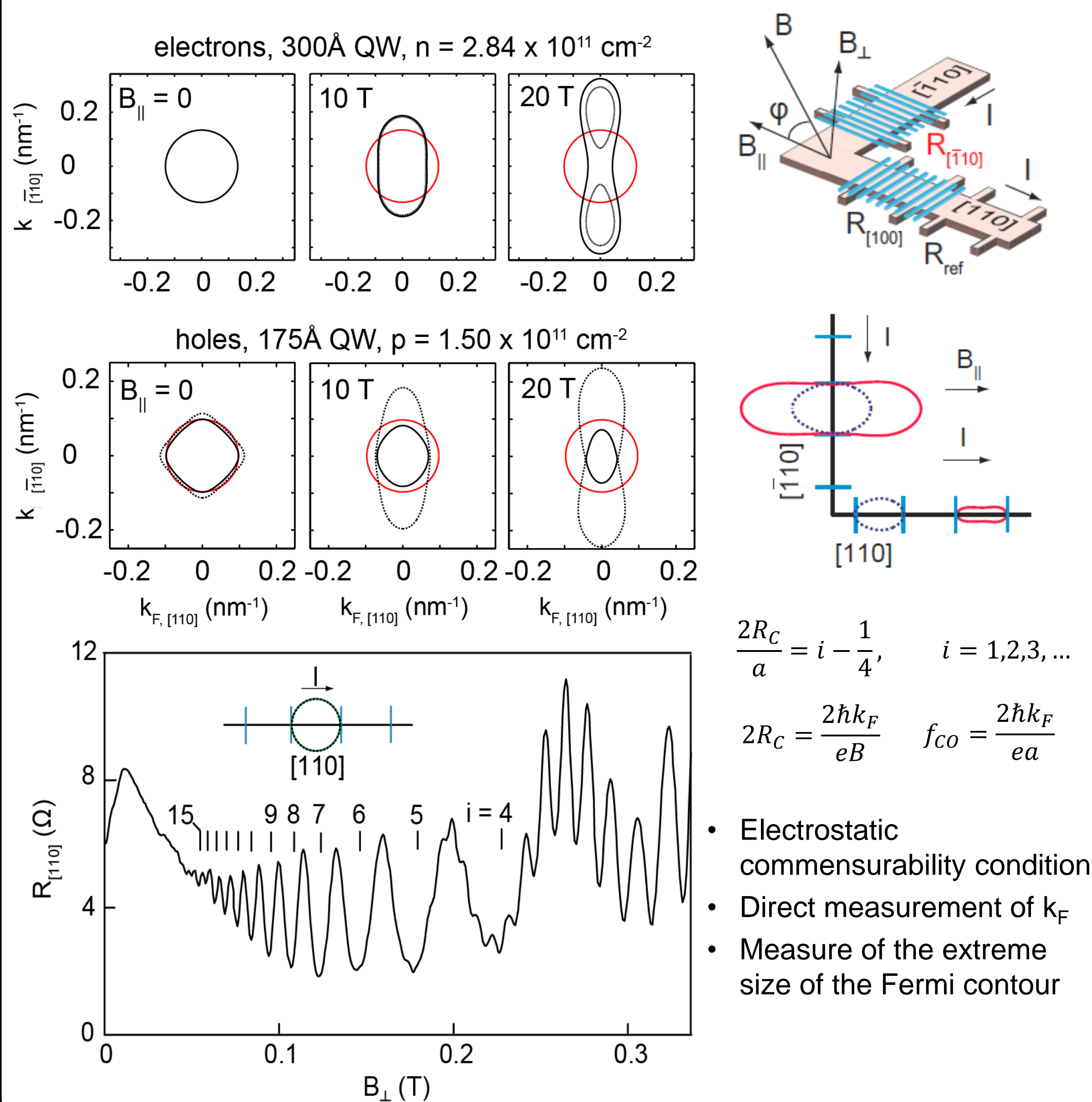
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Motivation

- Fundamental importance of the role of spin-orbit interaction and non-parabolicity of the bands in 2D GaAs carrier systems.
- Relevant in devices operating in the ballistic regime.
- Interesting problems we address:
 - Can we tune the Fermi contour anisotropy in electron and hole systems?
 - What does parallel magnetic field ($B_{||}$) do to the electron and/or hole Fermi contour?
- Our primary results:
 - The application of $B_{||}$ makes the Fermi contours very anisotropic.
 - In holes the effect of $B_{||}$ is also spin-dependent!
 - Semi-quantitative agreement with density-functional theory calculations with no adjustable parameters.

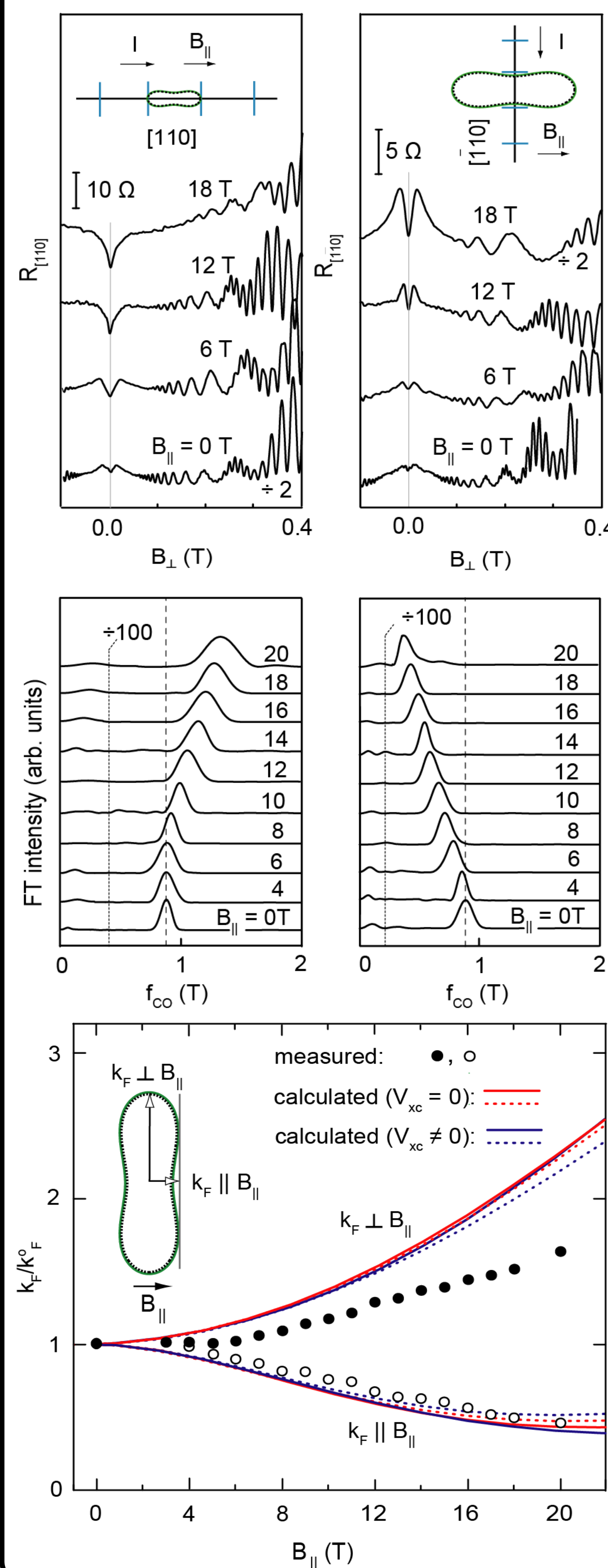
Fermi contour calculations



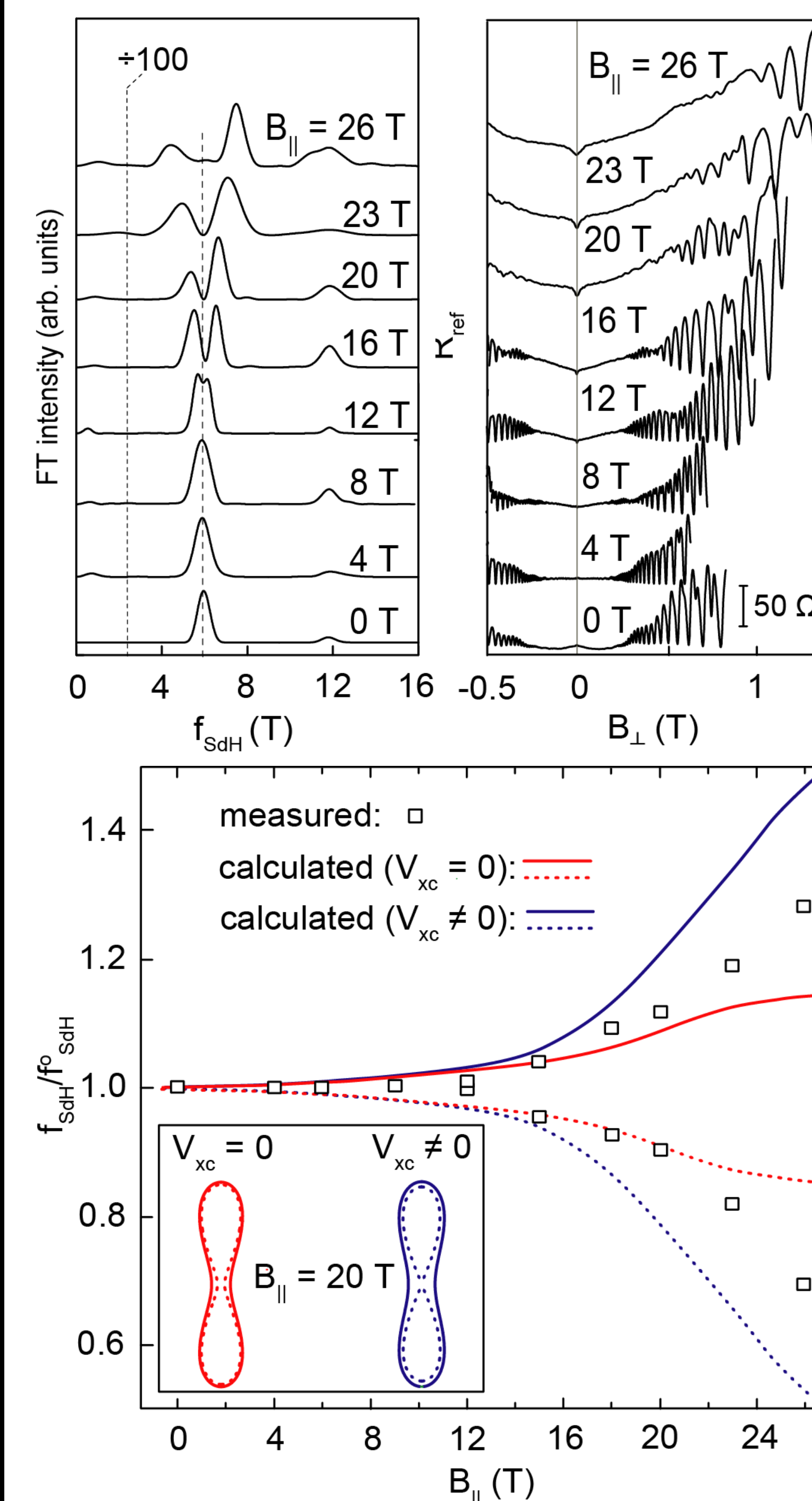
Acknowledgements

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Electron Fermi contour shape



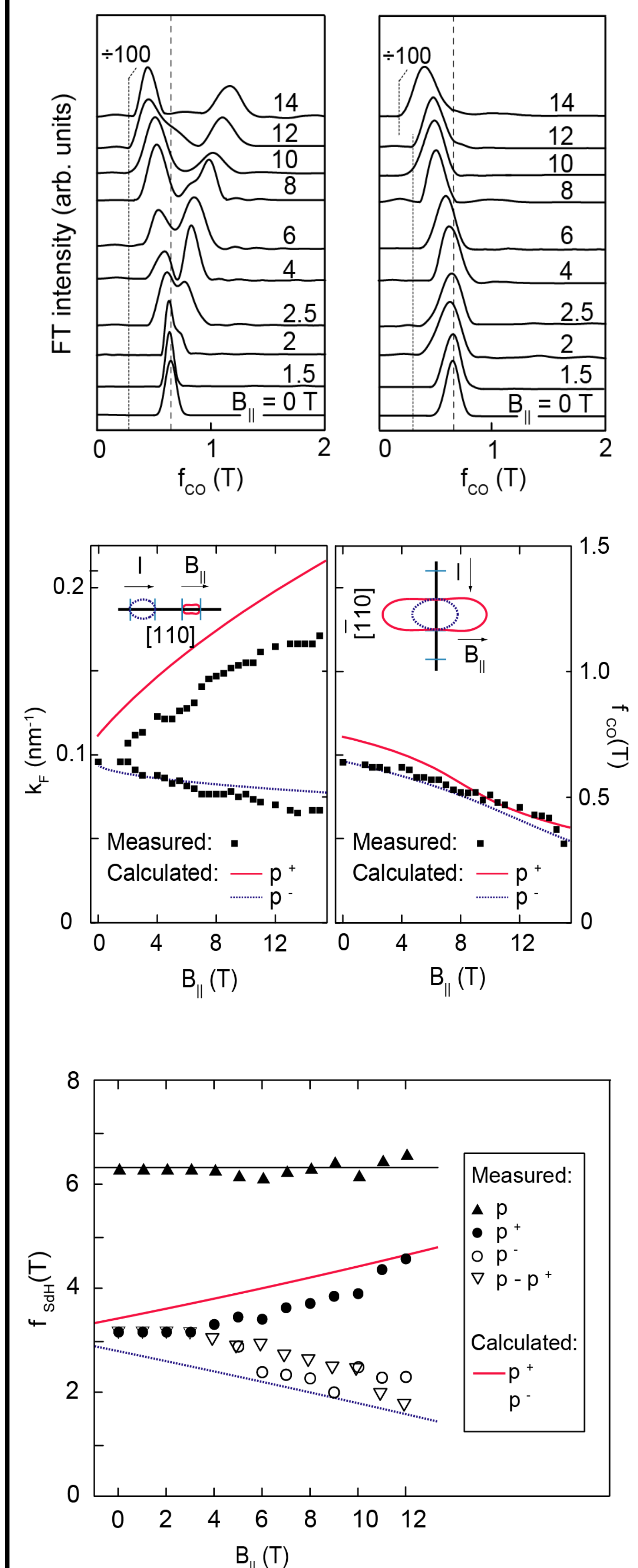
Electron Fermi contour area



Summary

- Severe distortion of the Fermi contour with parallel magnetic field.
- Spin-dependence of the Fermi contour distortion resulting from the strong spin-orbit interaction in hole systems.
- Importance of the non-parabolicity of the hole band structure.
- Some discrepancies between the experimental data and the numerical calculations (for $k_F \perp B_{||}$).
- Role of the finite layer thickness in distorting the Fermi contour.
- Implications for experiments using $B_{||}$ for spin polarization in magnetic focusing.

Hole Fermi contour shape & area



References

- Kamburov *et al.*, arXiv:1306.3537.
- Kamburov *et al.*, PRB 86, 241302 (2012).
- Kamburov *et al.*, PRB 85, 121305(R) (2012).