

Stephen Dugdale

The Fermi surface of PdCrO₂



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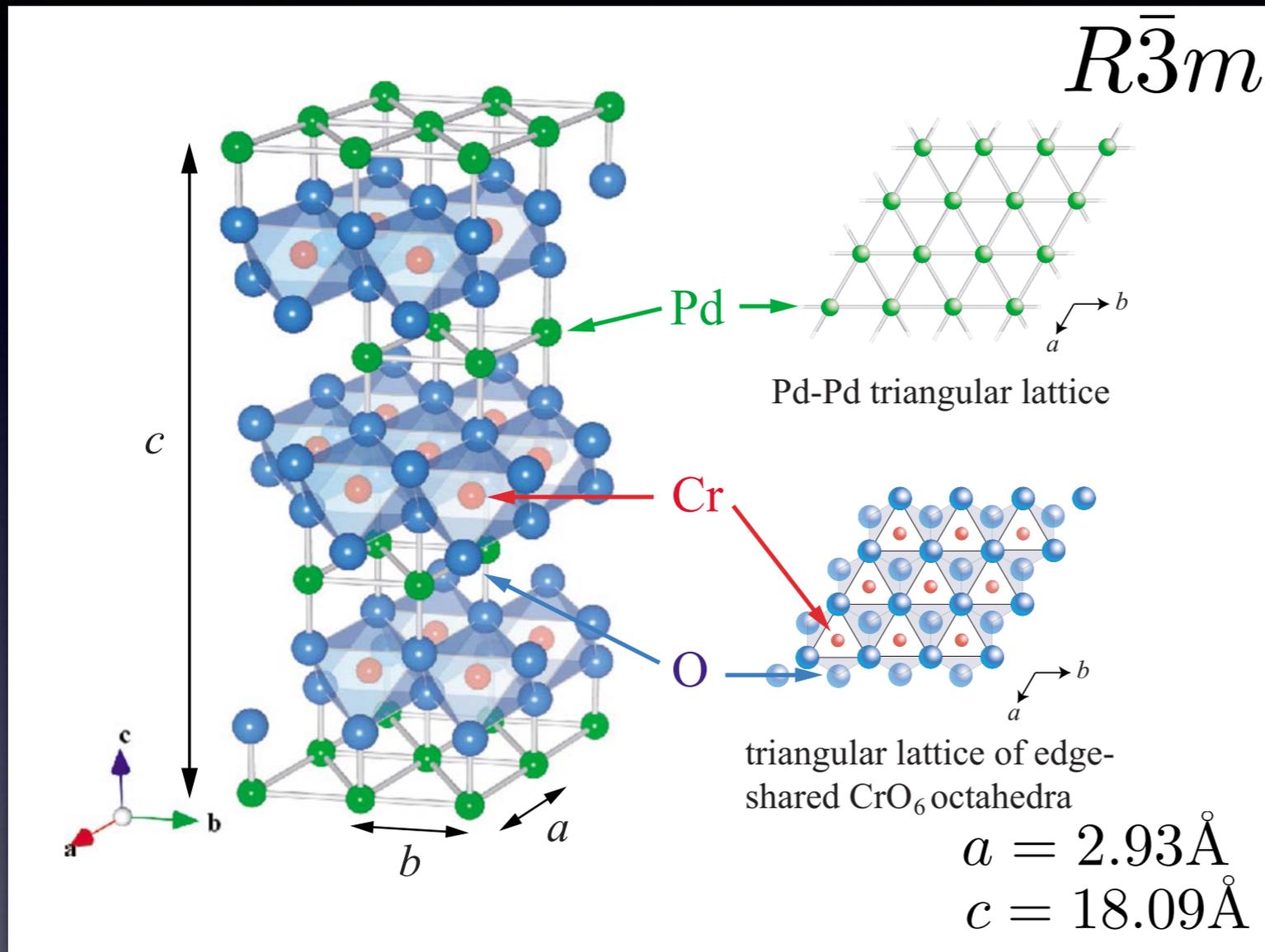
Wigner III, Budapest, Nov. 12th 2013

Outline

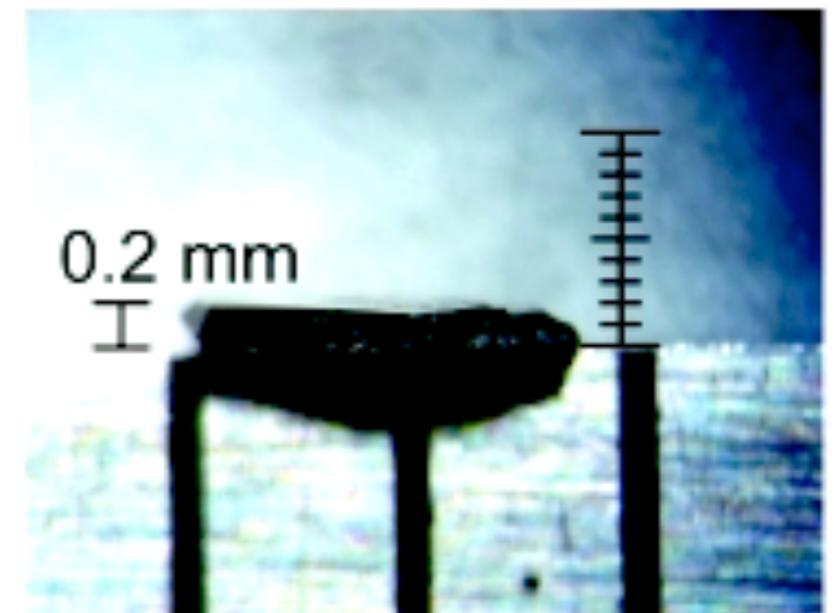
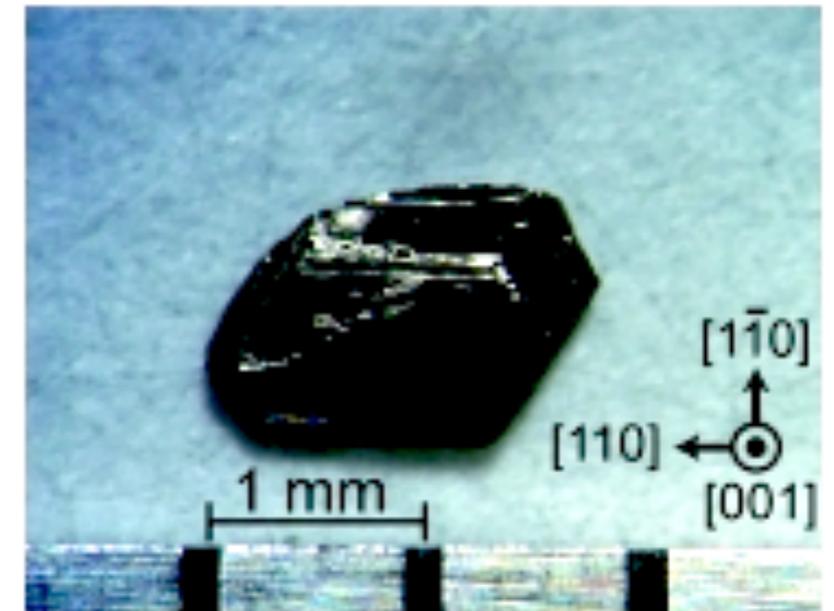
- Introduction to PdCrO₂
- Fermi surface measurement by Compton scattering
- Short-range magnetic order above T_N



PdCrO₂

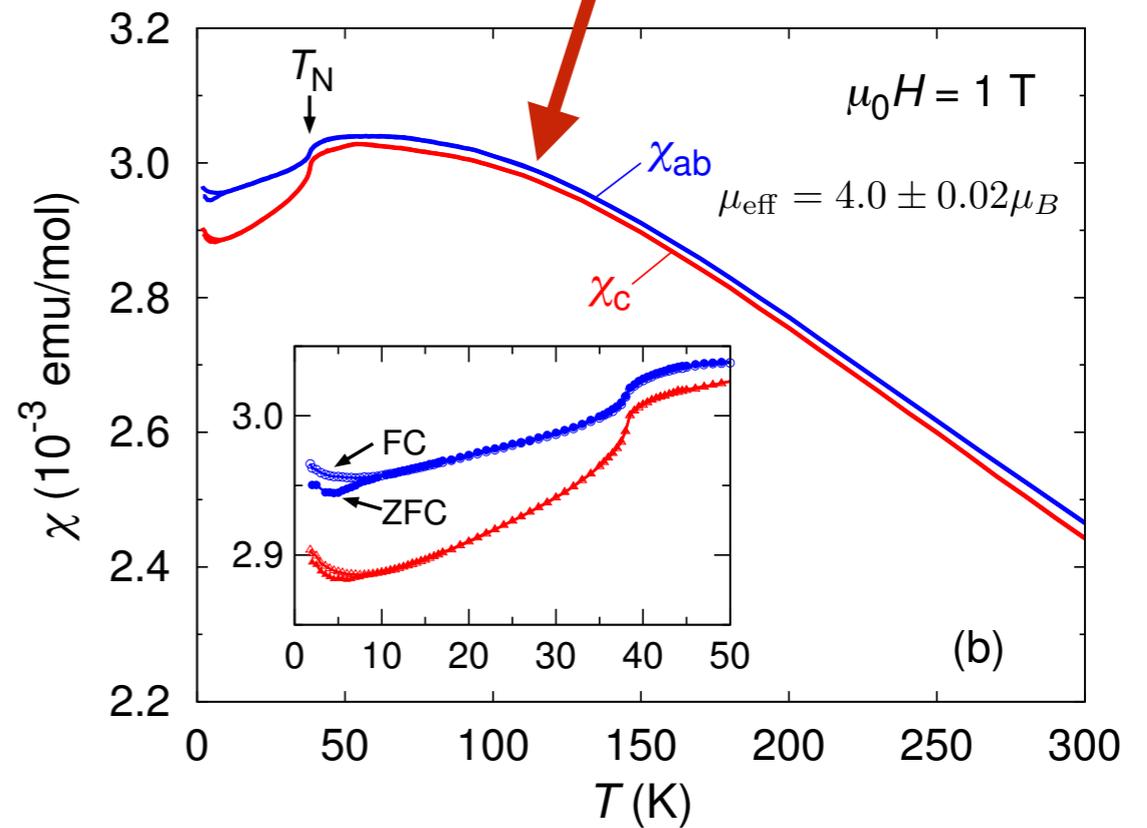
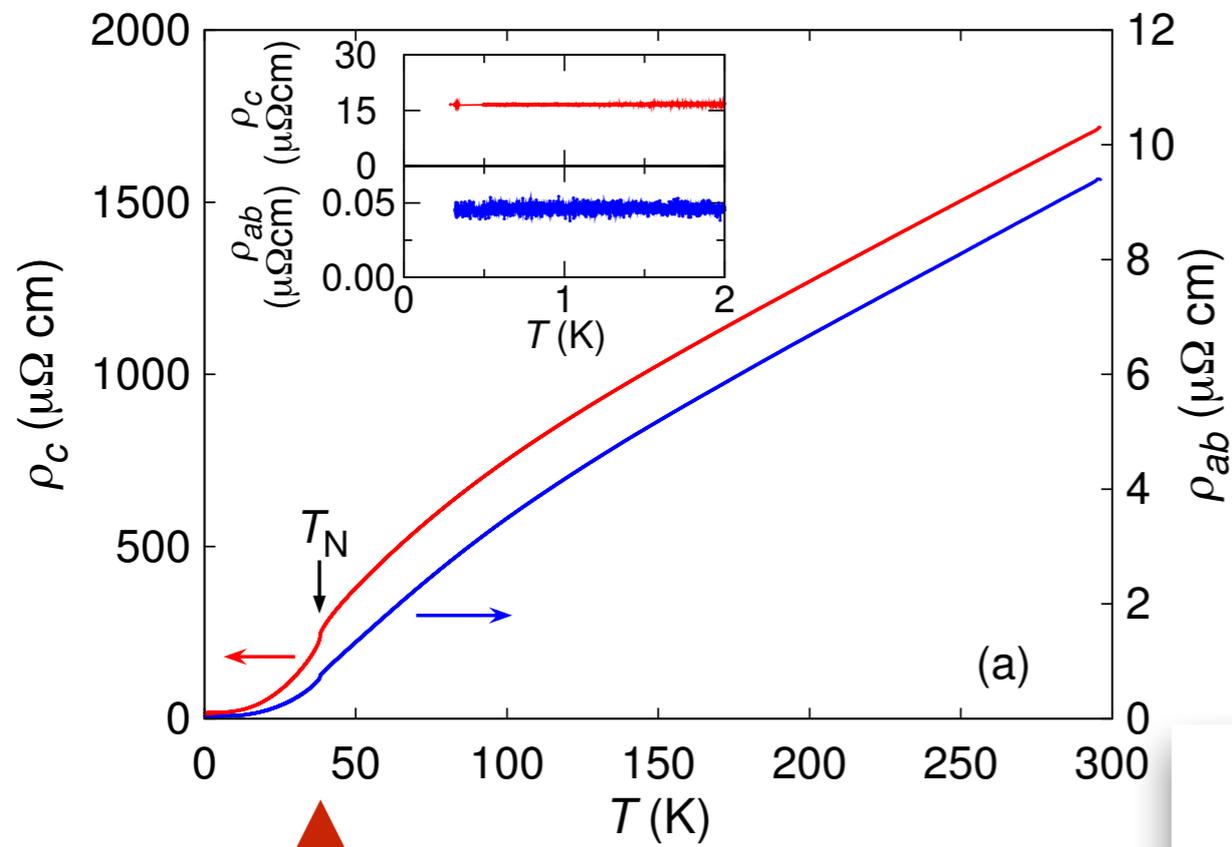


Sample #1



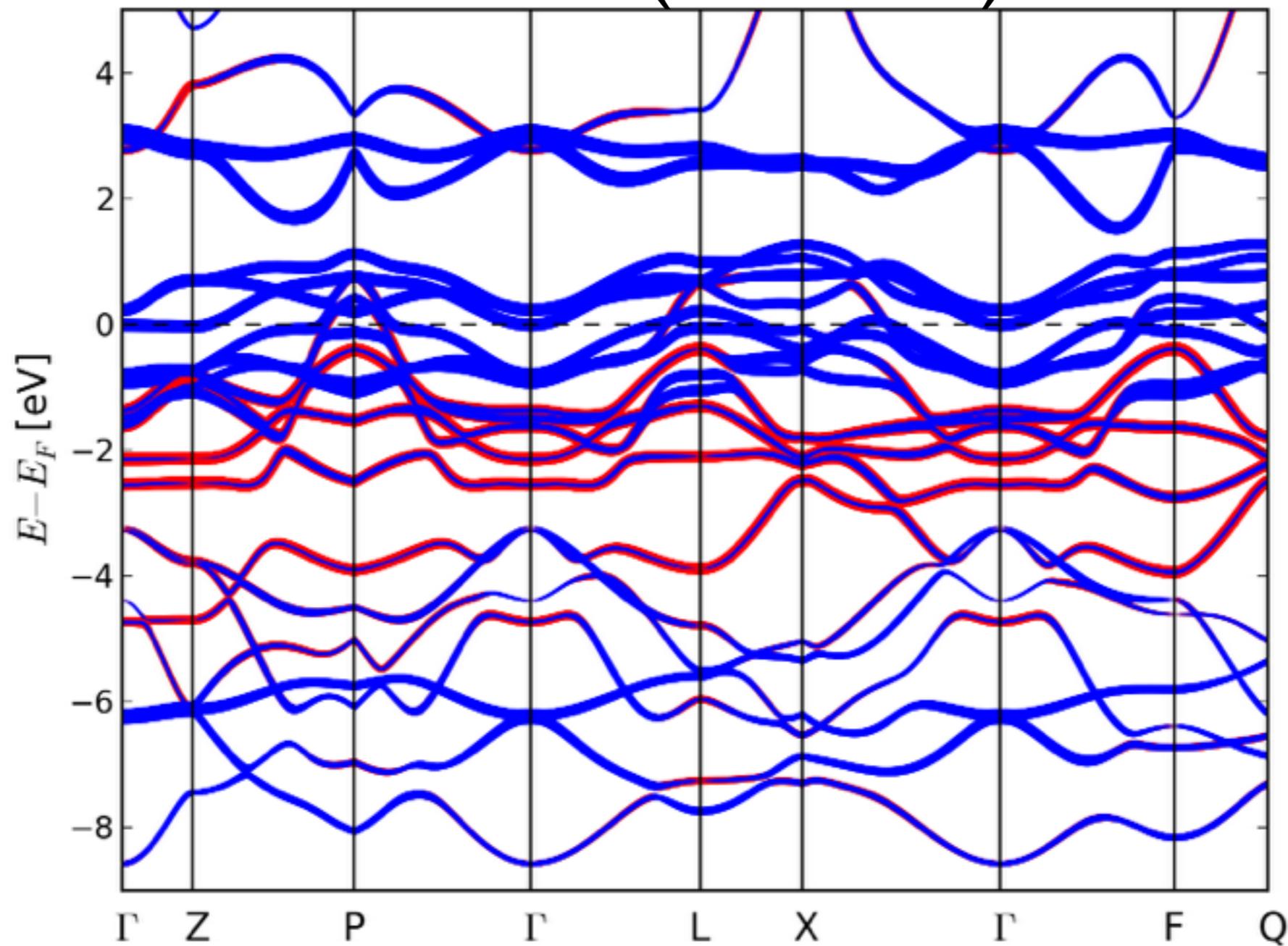
“2D TL-AF”

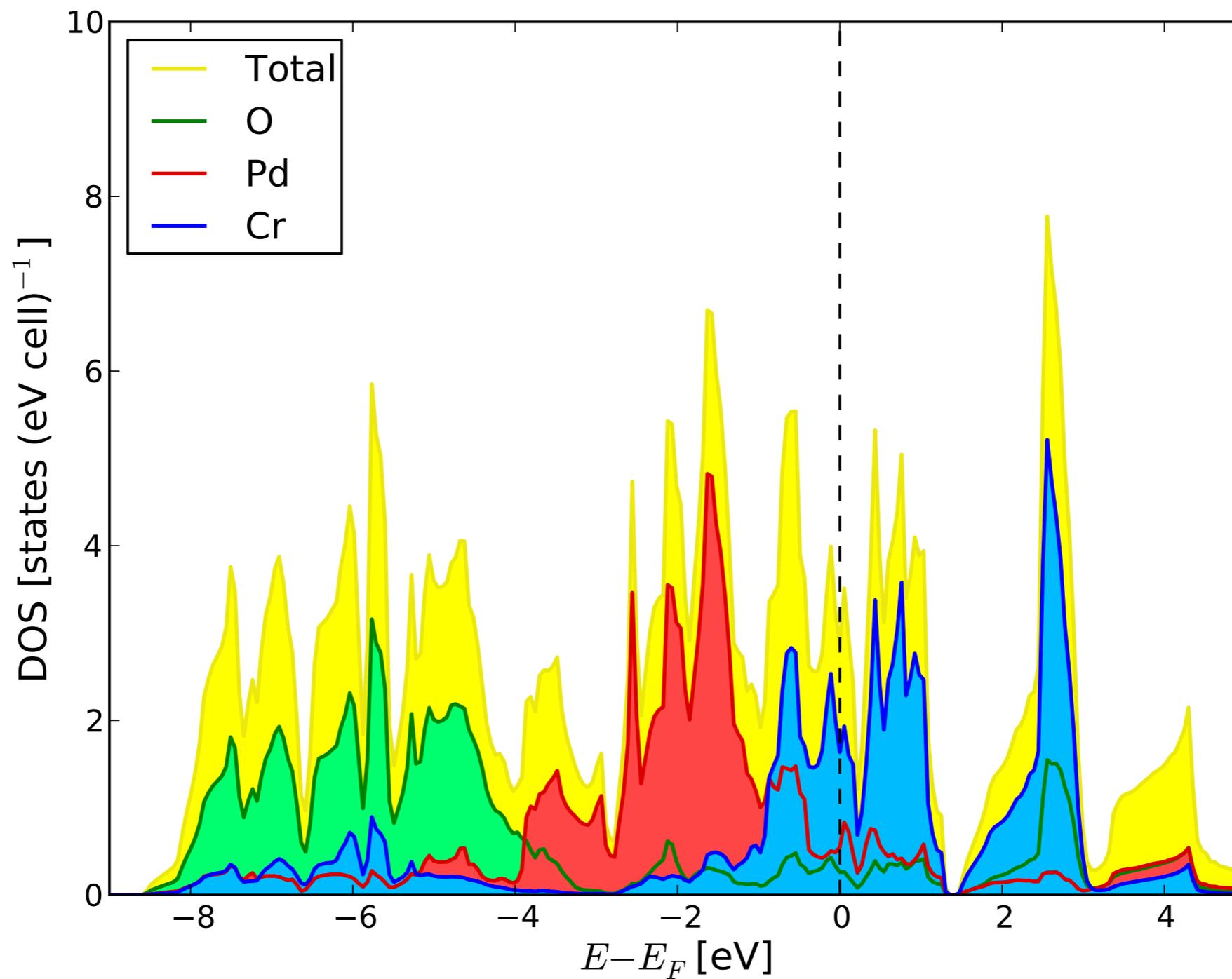
isotropic
Curie-Weiss



$T_N = 37.5\text{K}$

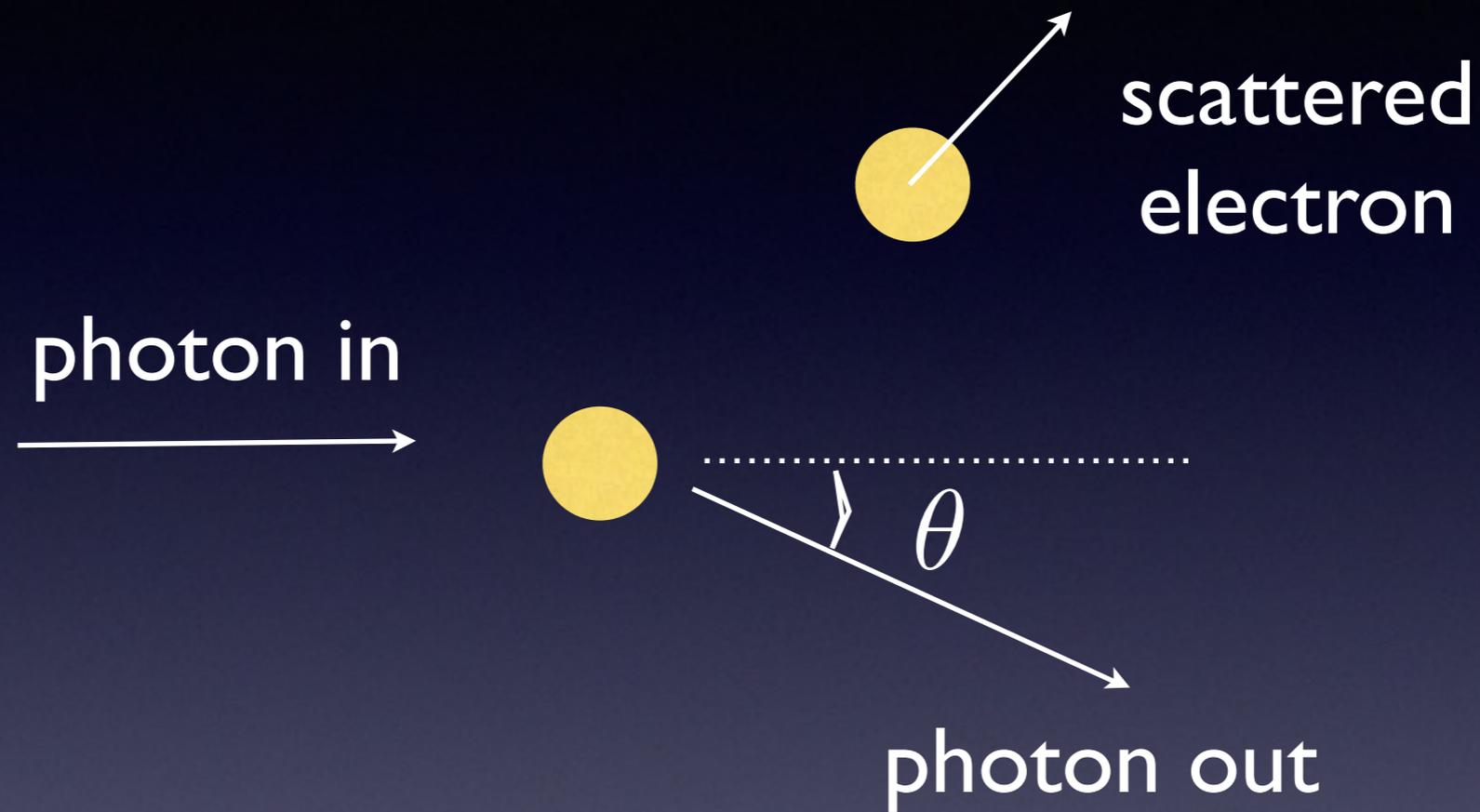
$U=0.1\text{eV}$ (on Cr d)







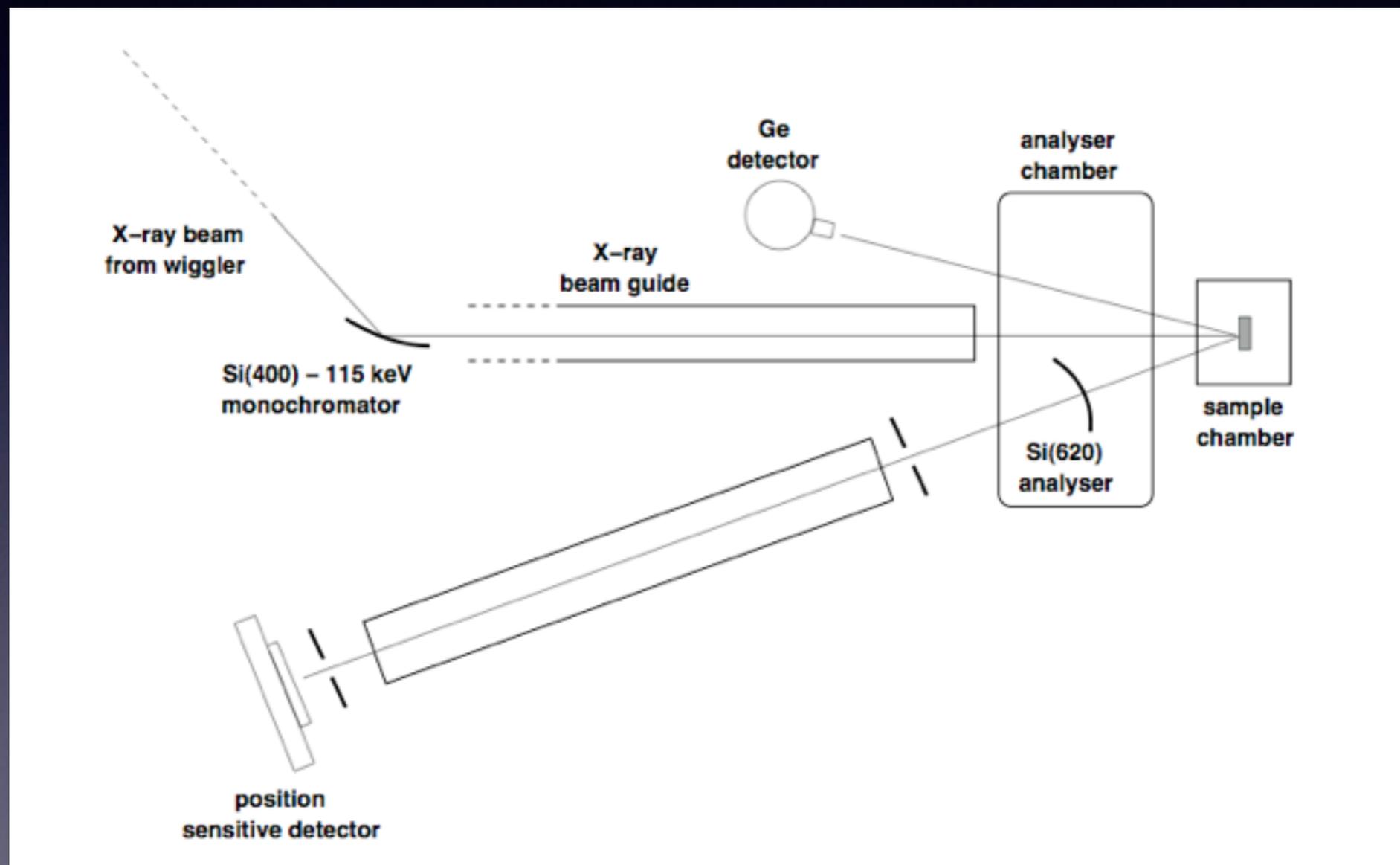
Compton Scattering



$$\Delta\lambda = \frac{h}{m_0c}(1 - \cos\theta)$$

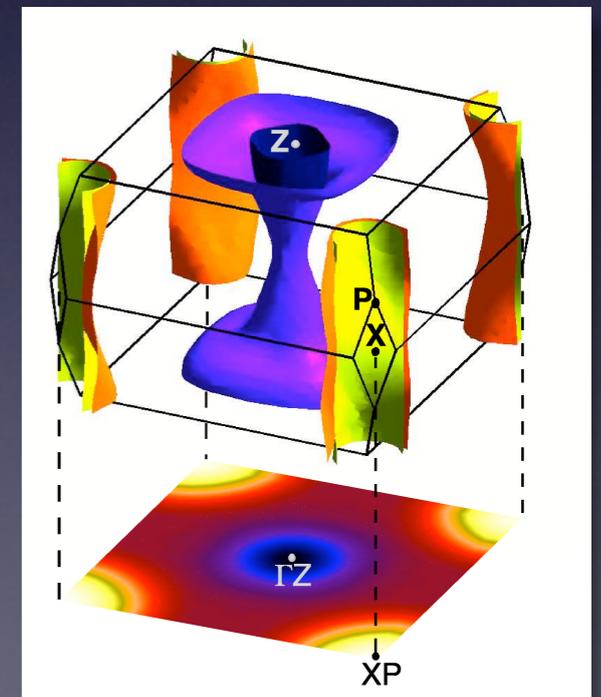
Compton "regime" : high momentum and energy transfer

Measuring a Compton profile



Tomographic reconstruction

$$J(p_z) = \int \int \rho(p_x, p_y, p_z) dp_x dp_y$$

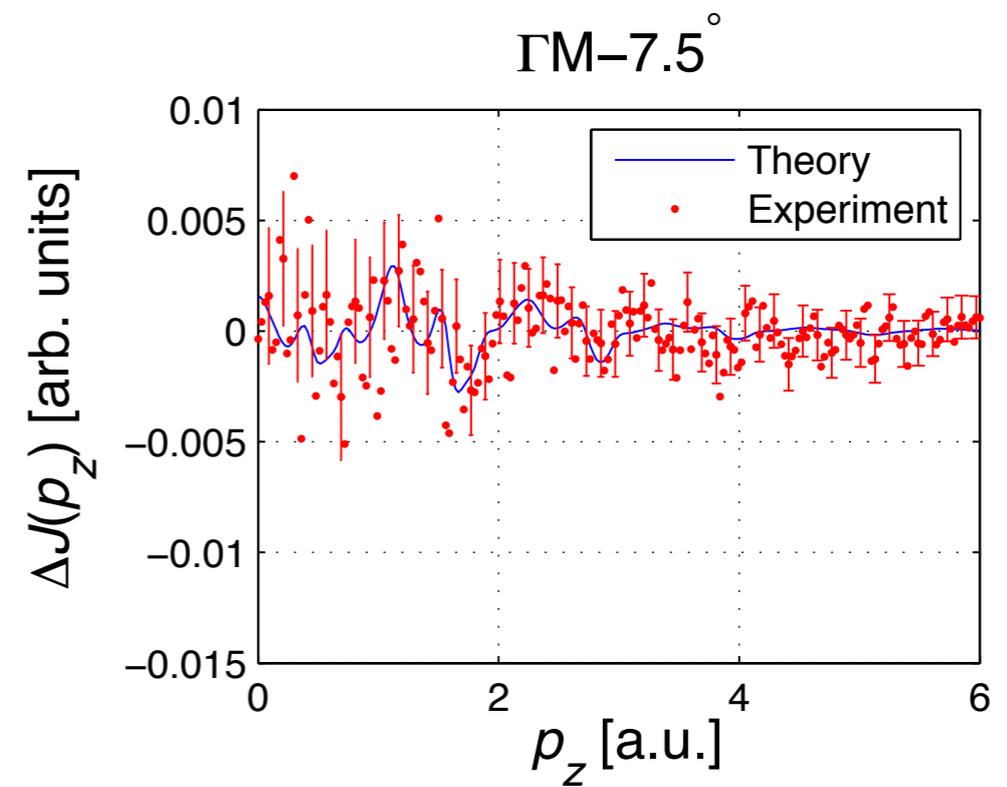
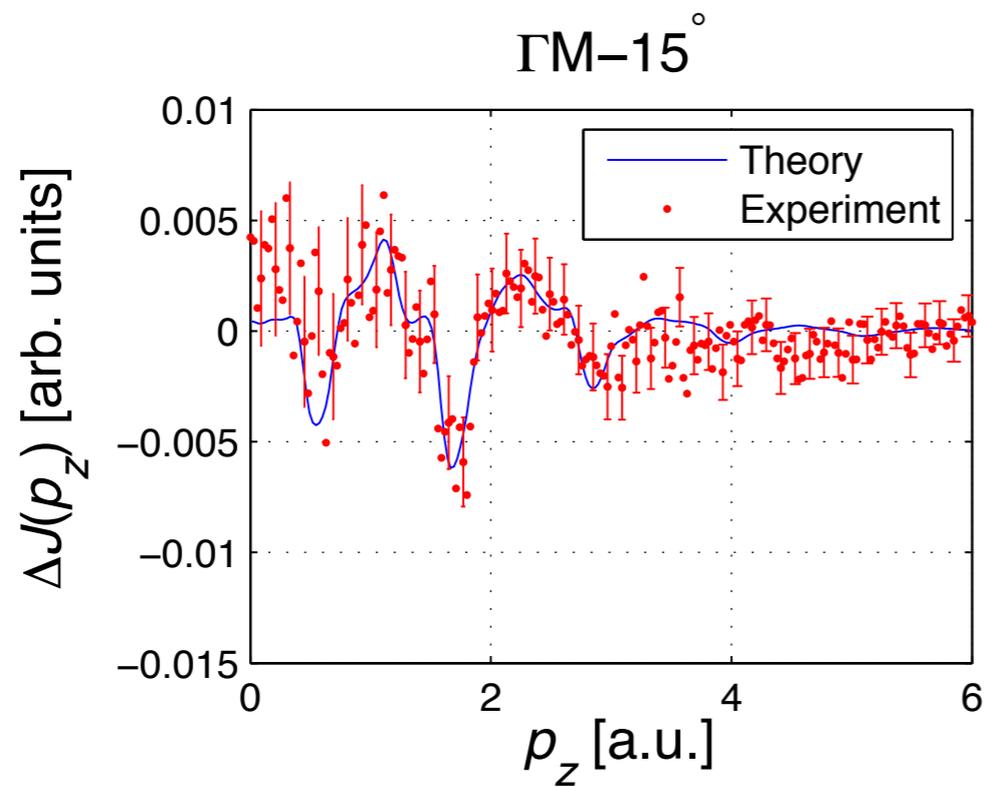
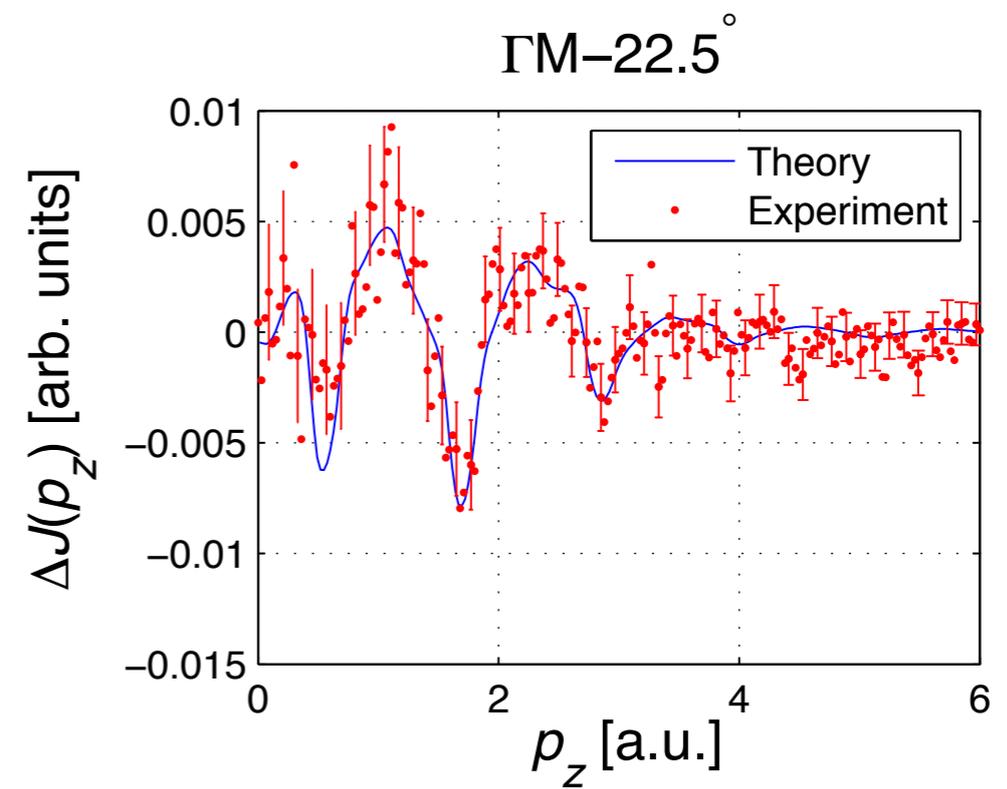
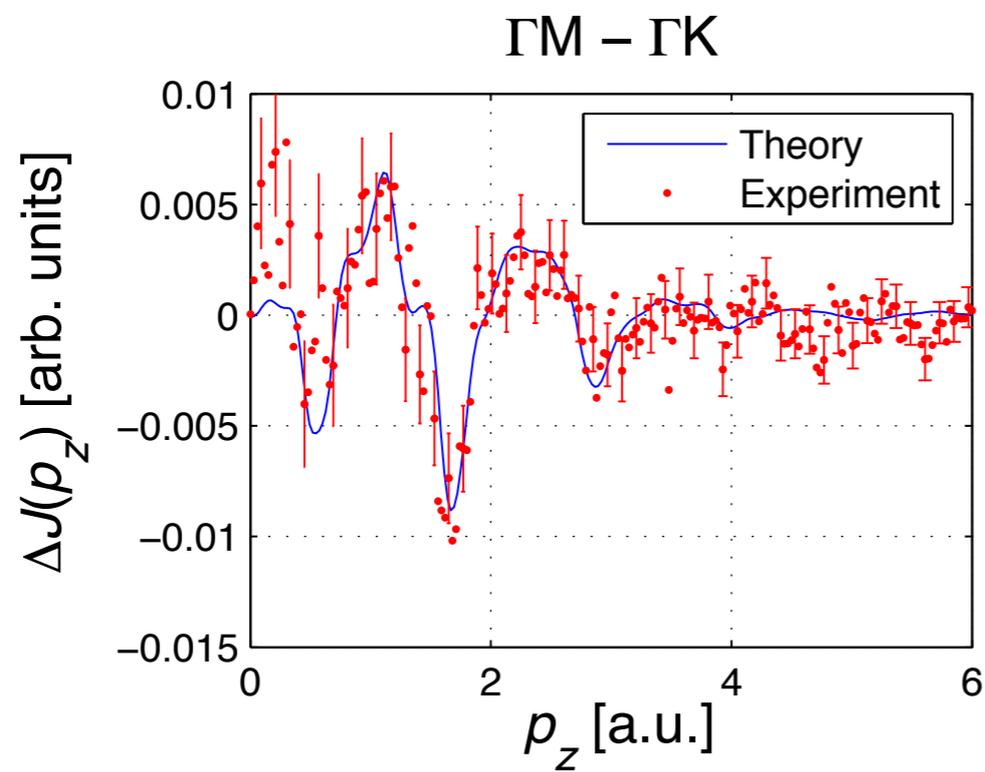


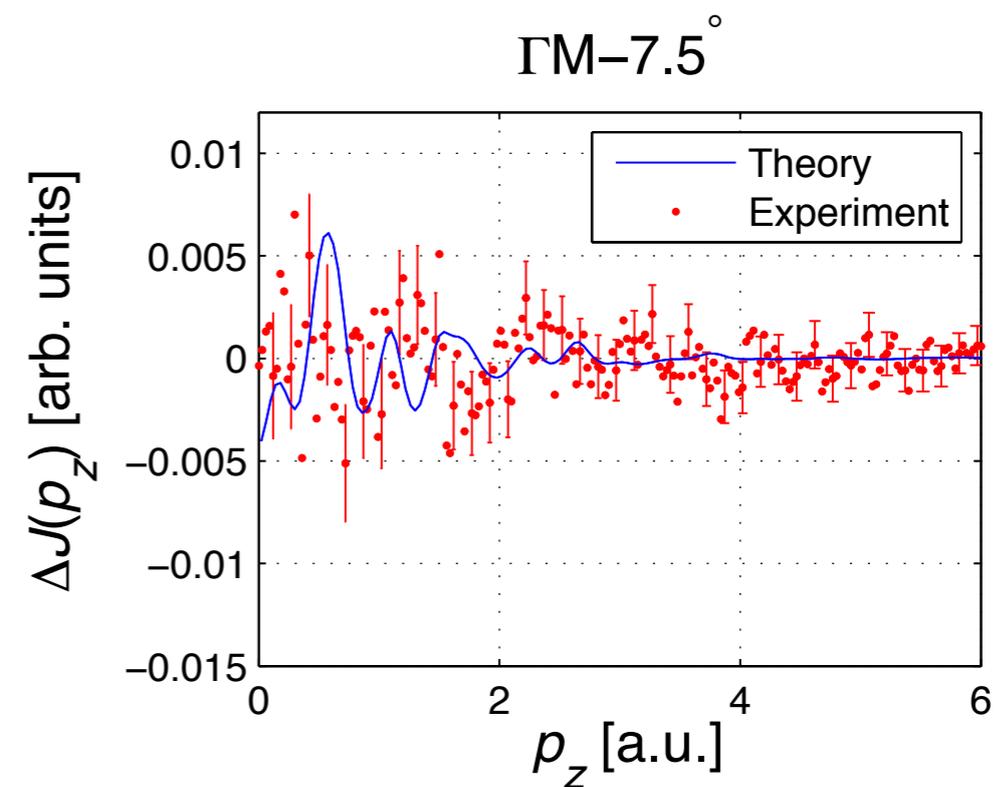
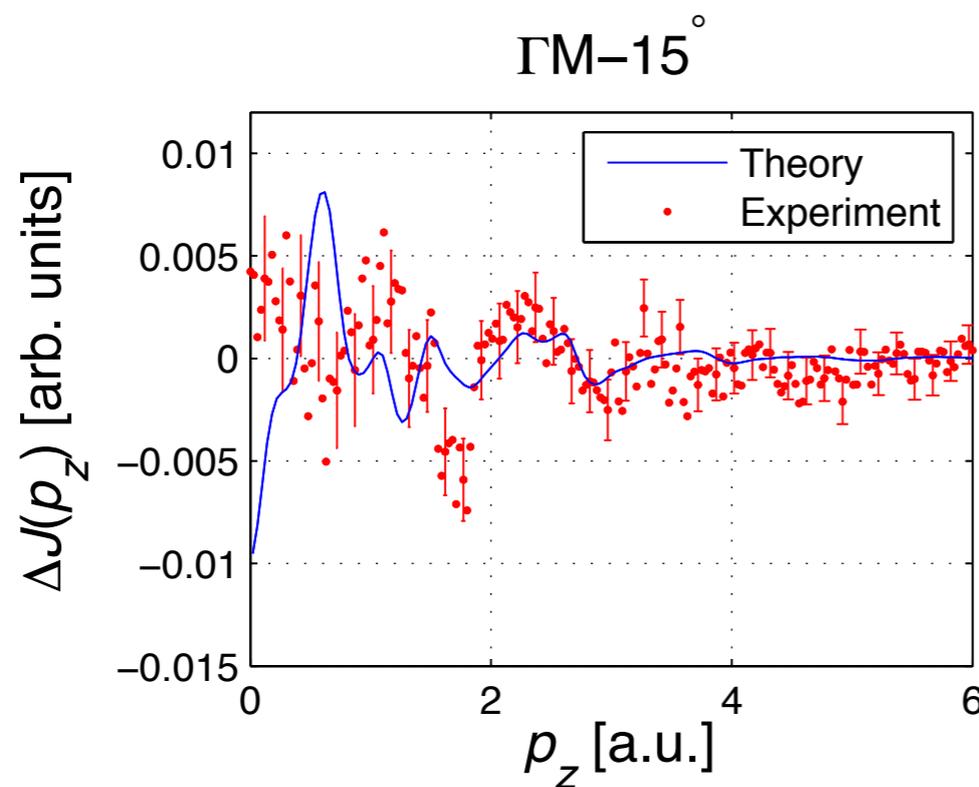
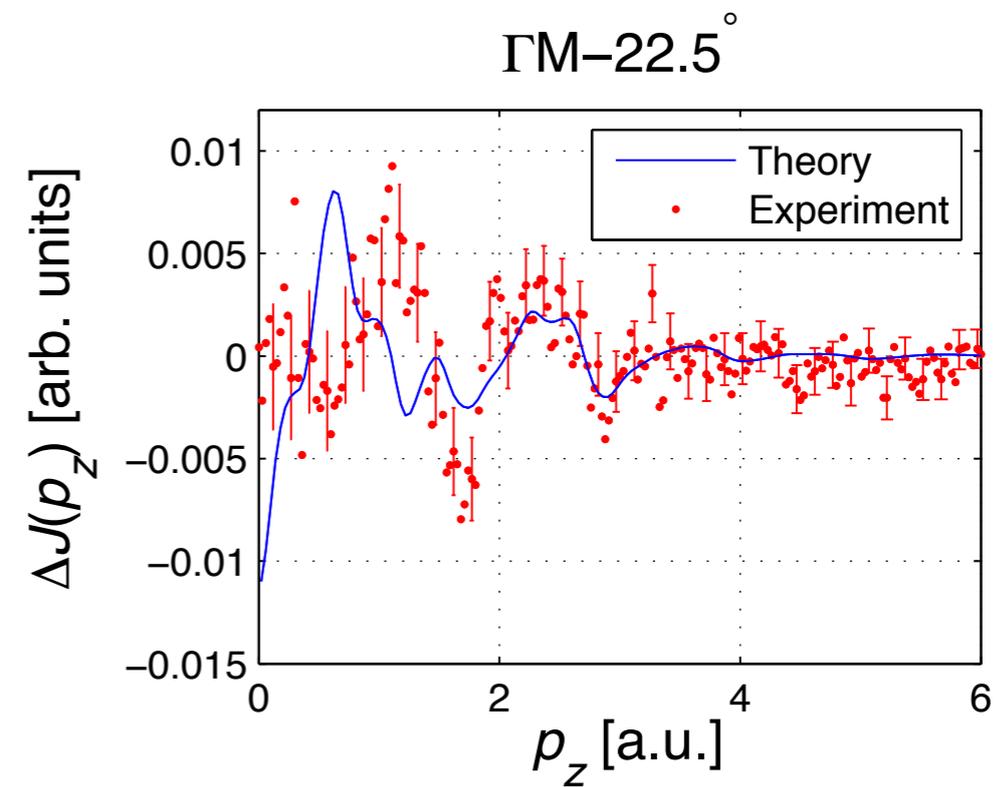
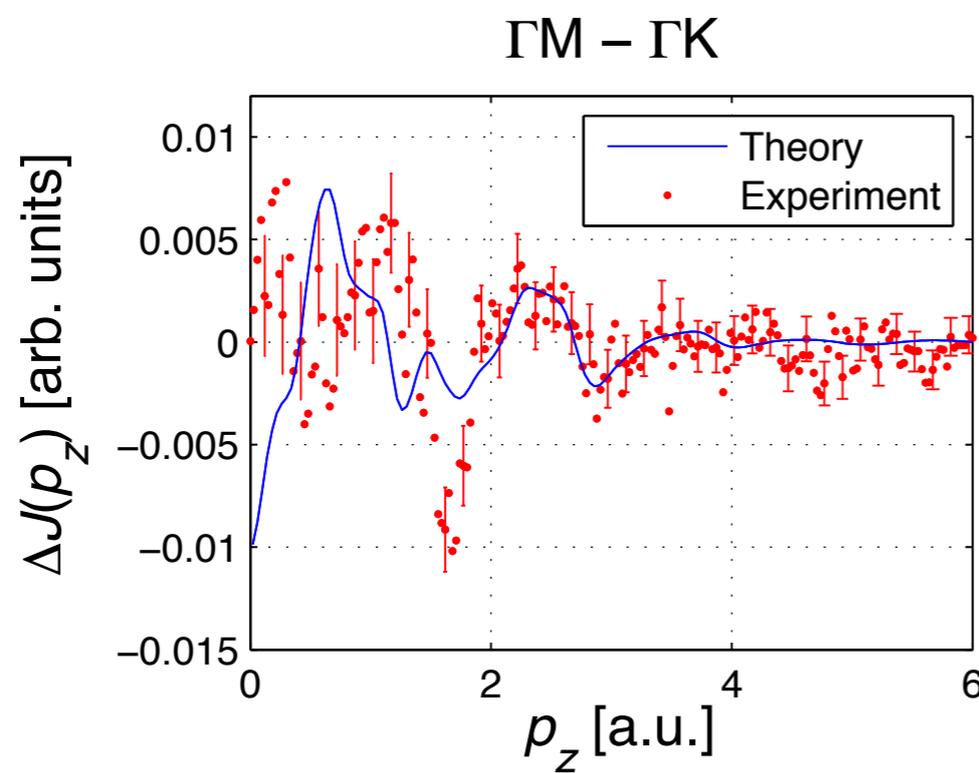
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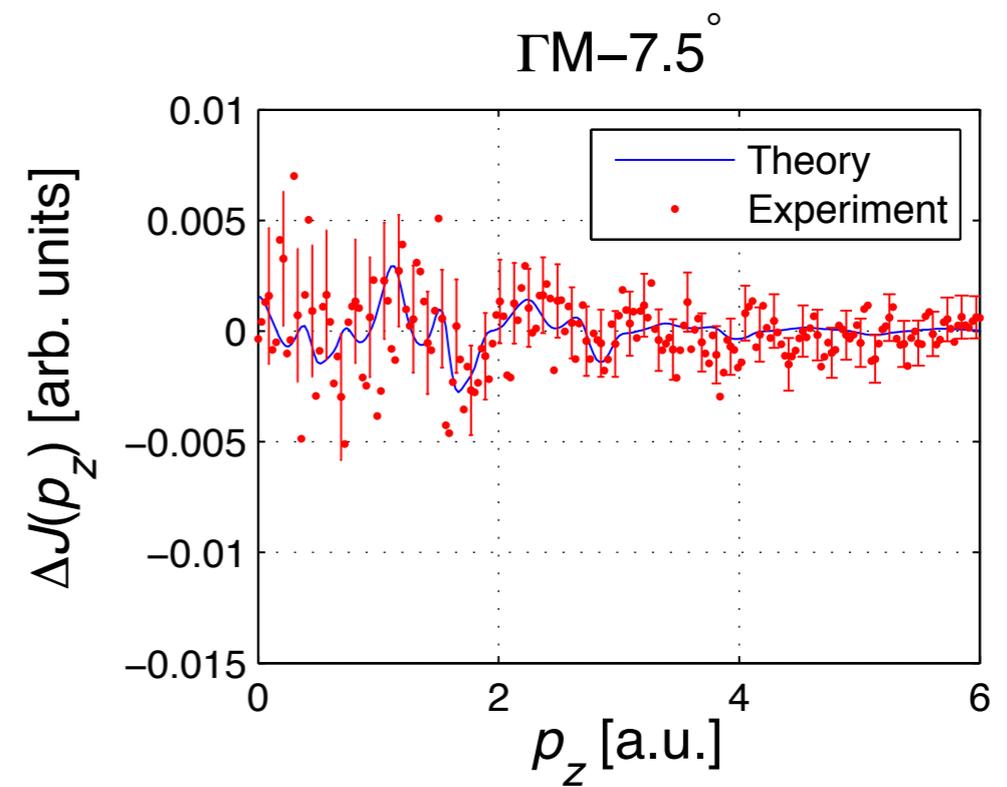
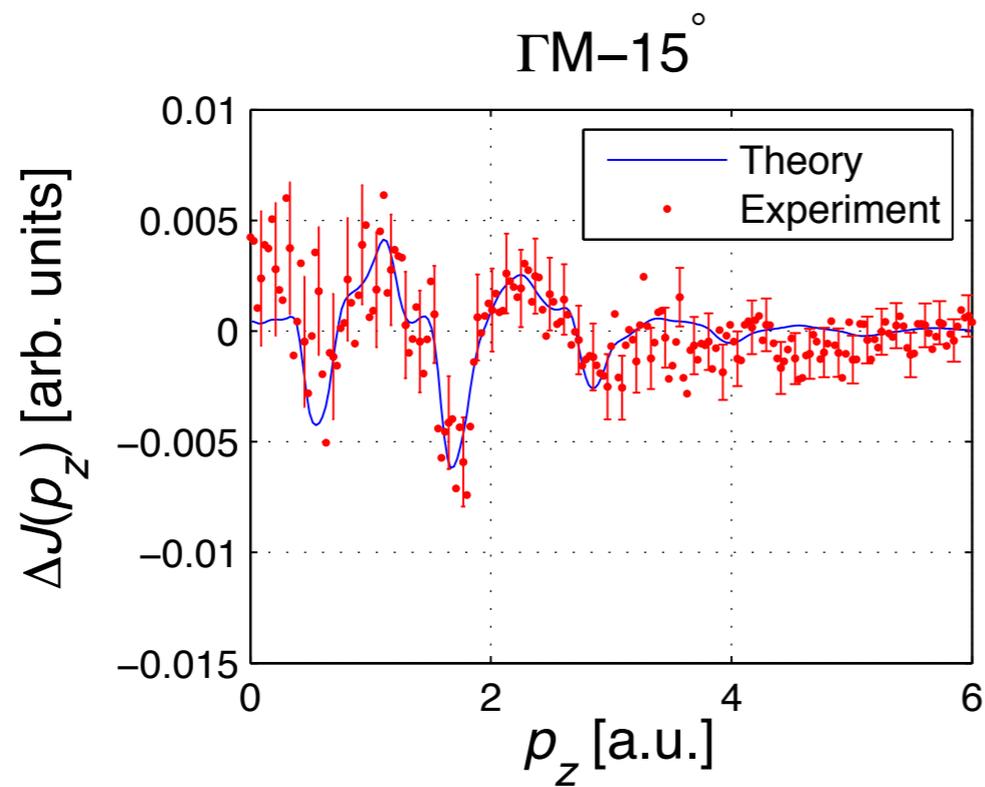
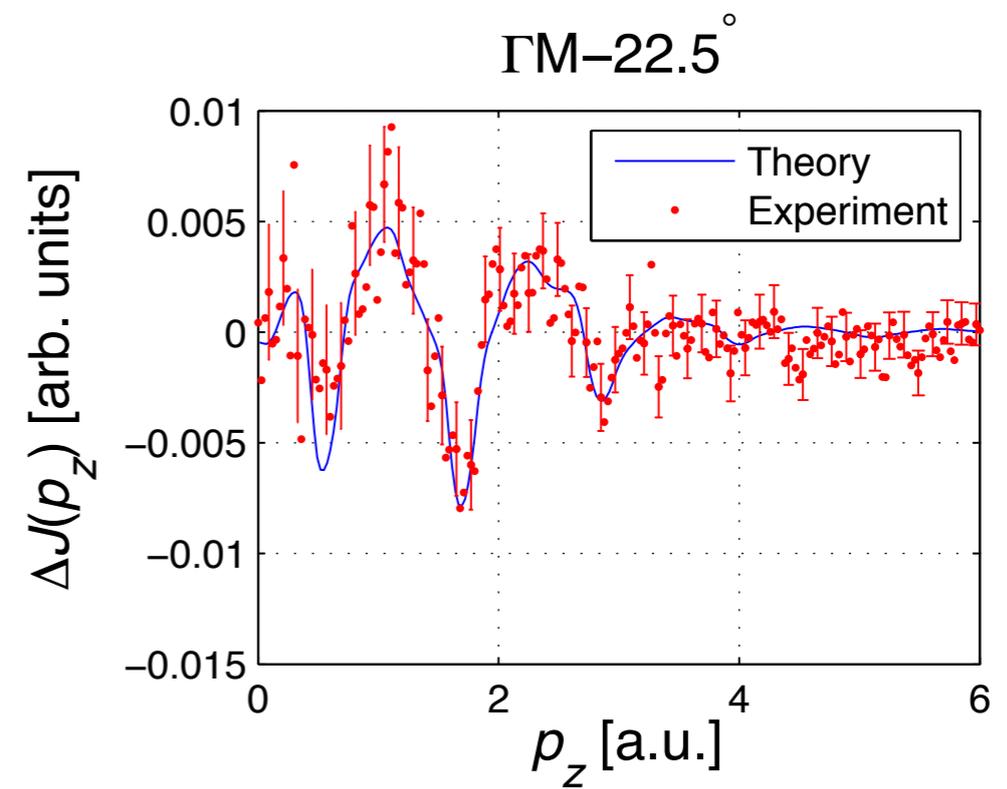
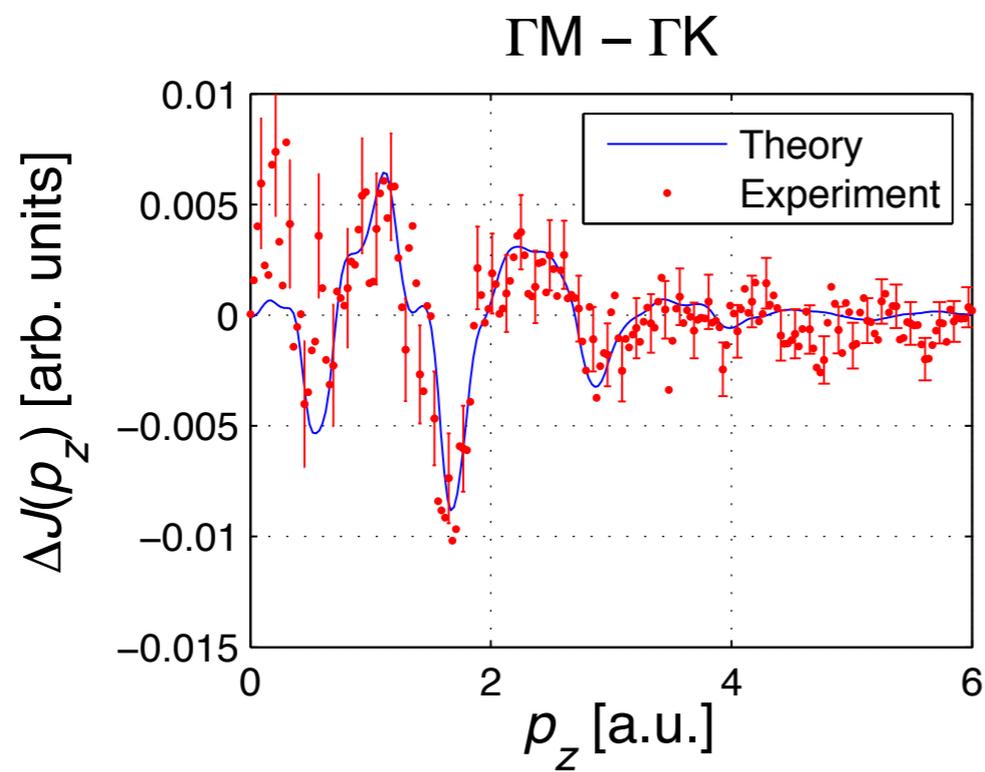
Measurement of photon energy distribution gives projection of momentum distribution along scattering vector

$$\begin{aligned}\rho(\mathbf{p}) &= \sum_{\text{occ. } \mathbf{k}, j} \left| \int d\mathbf{r} \psi_{\mathbf{k}, j}(\mathbf{r}) \exp(-i\mathbf{p} \cdot \mathbf{r}) \right|^2, \\ &= \sum_{j, \text{occ. } \mathbf{k}, \mathbf{G}} |B_j(\mathbf{k} + \mathbf{G})|^2 \delta(\mathbf{p} - \mathbf{k} - \mathbf{G}),\end{aligned}$$



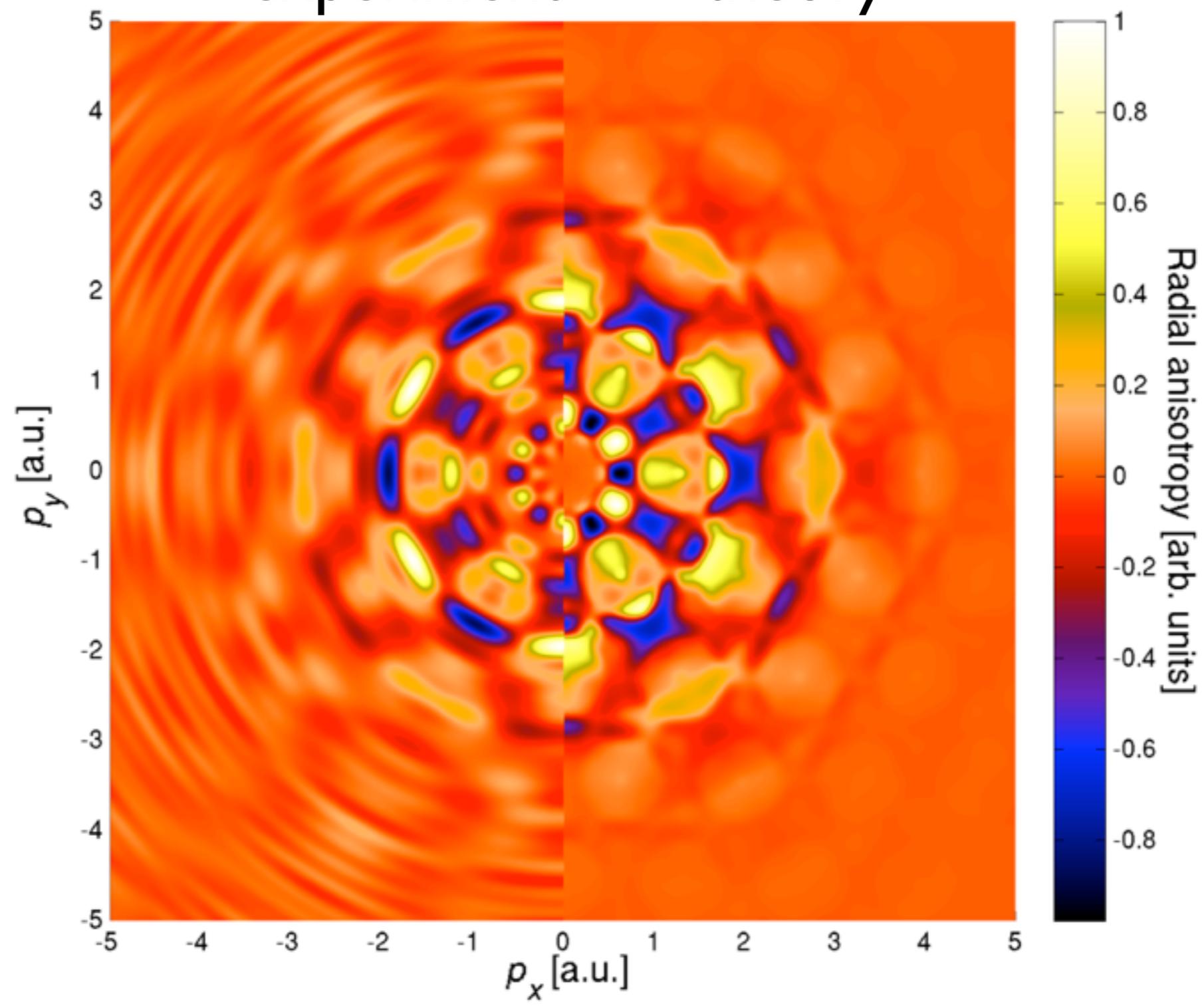






experiment

theory



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$$\rho(\mathbf{p}) = \sum_{\text{occ.}\mathbf{k},j} \left| \int d\mathbf{r} \psi_{\mathbf{k},j}(\mathbf{r}) \exp(-i\mathbf{p}\cdot\mathbf{r}) \right|^2,$$

$$= \sum_{j,\text{occ.}\mathbf{k},\mathbf{G}} |B_j(\mathbf{k} + \mathbf{G})|^2 \delta(\mathbf{p} - \mathbf{k} - \mathbf{G}),$$

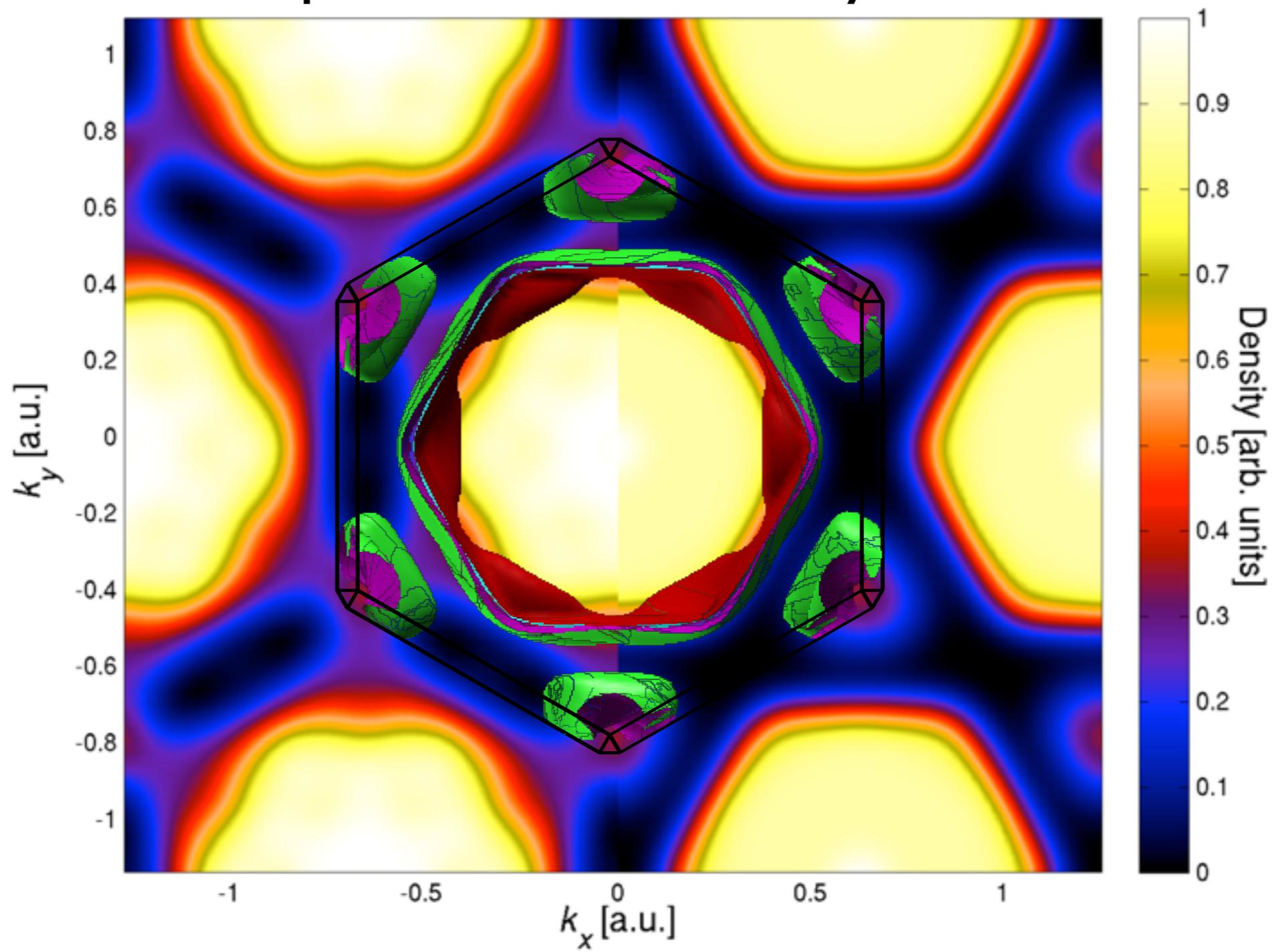
$$\sum_{\mathbf{G}'} \rho(\mathbf{p} + \mathbf{G}') = \sum_{\mathbf{G}'} \sum_{\text{occ.}\mathbf{k},\mathbf{G},j} |B_j(\mathbf{k} + \mathbf{G})|^2 \delta(\mathbf{p} - \mathbf{k} - \mathbf{G} + \mathbf{G}').$$

$$\sum_{\mathbf{G}'} \rho(\mathbf{p} + \mathbf{G}') = \sum_{\mathbf{G}''} \sum_{\text{occ.}\mathbf{k},\mathbf{G},j} |B_j(\mathbf{k} + \mathbf{G})|^2 \delta(\mathbf{p} - \mathbf{k} - \mathbf{G}'').$$

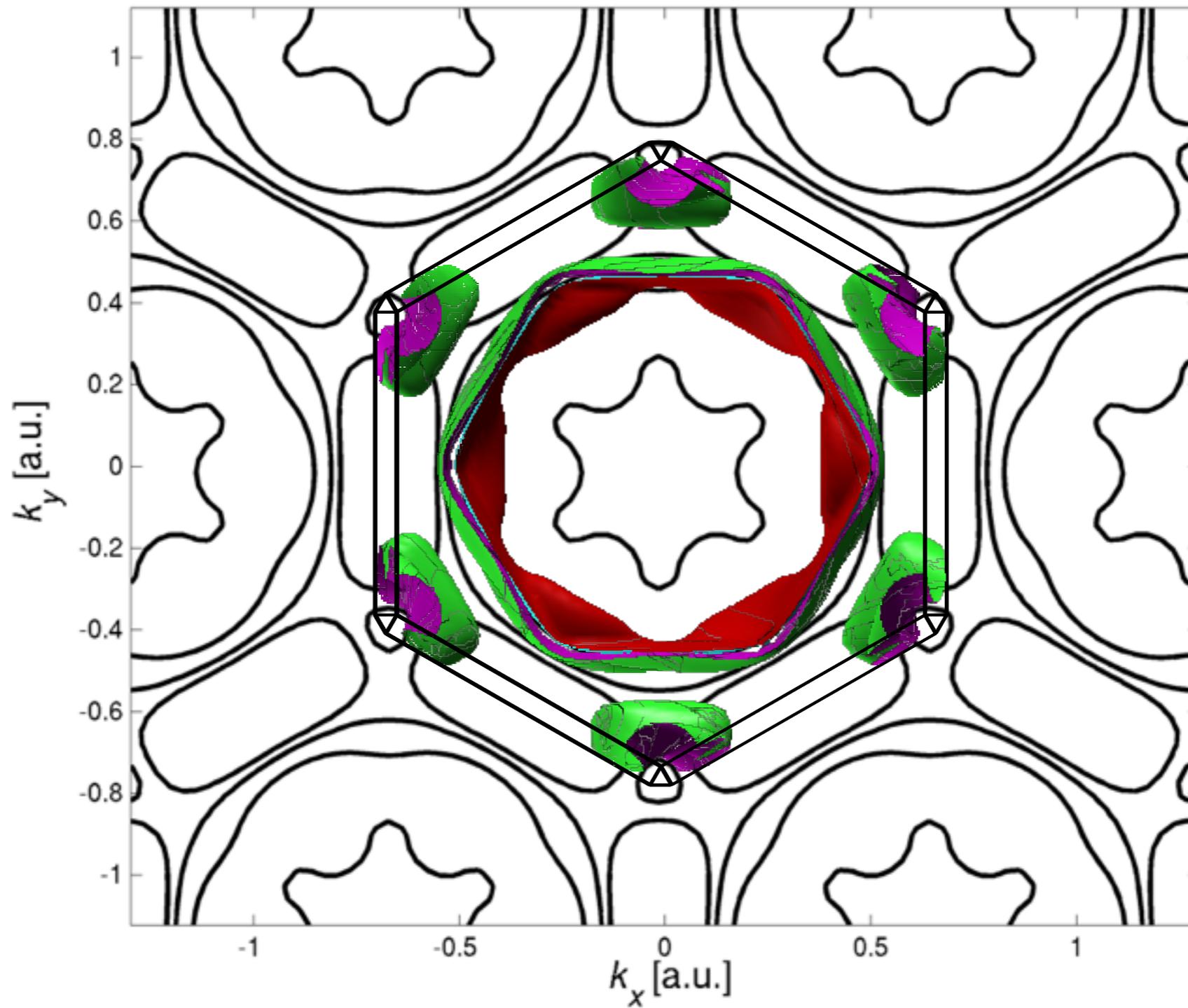
$$\rho(\mathbf{k}) = \sum_j n^j(\mathbf{k})$$

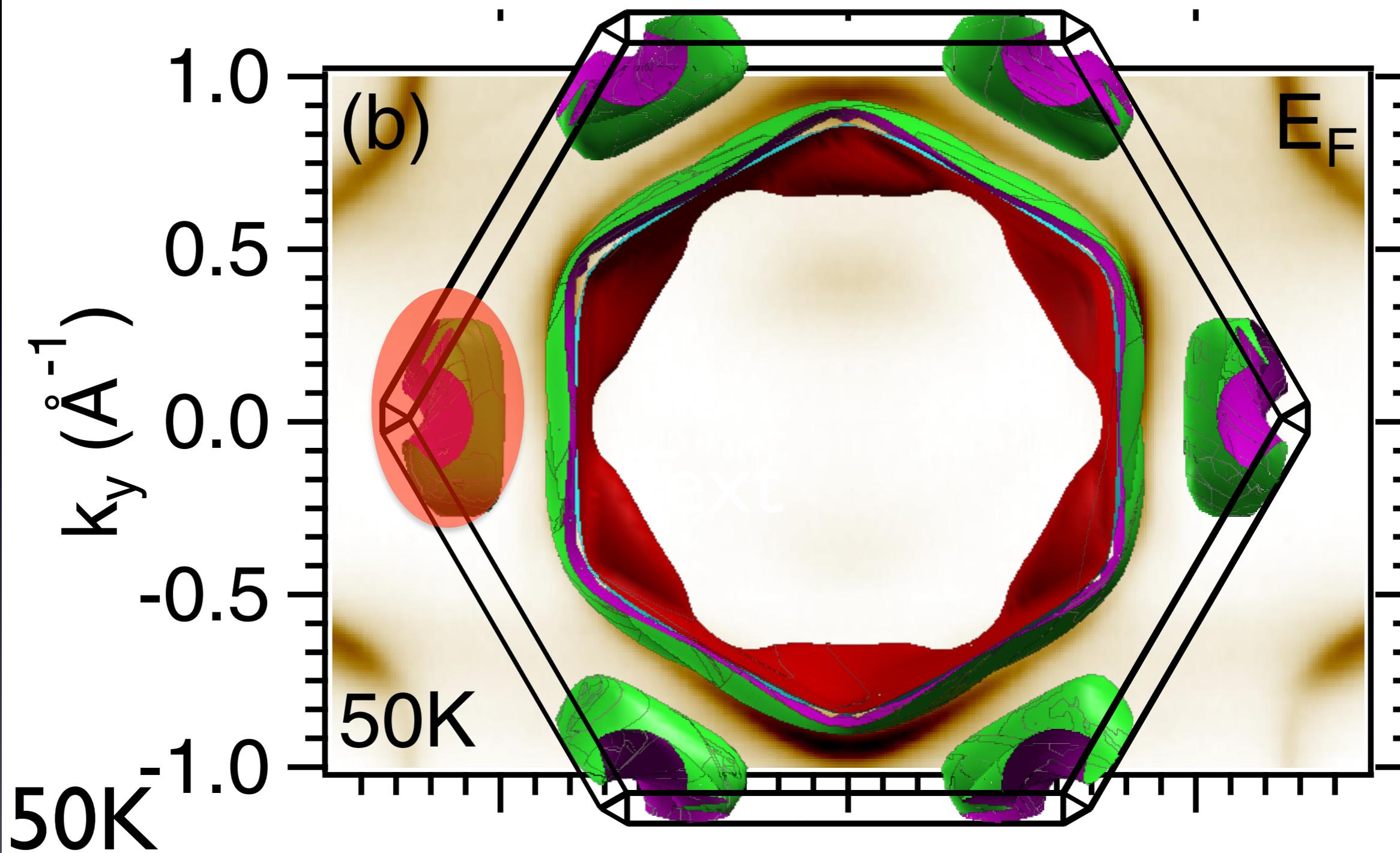
experiment

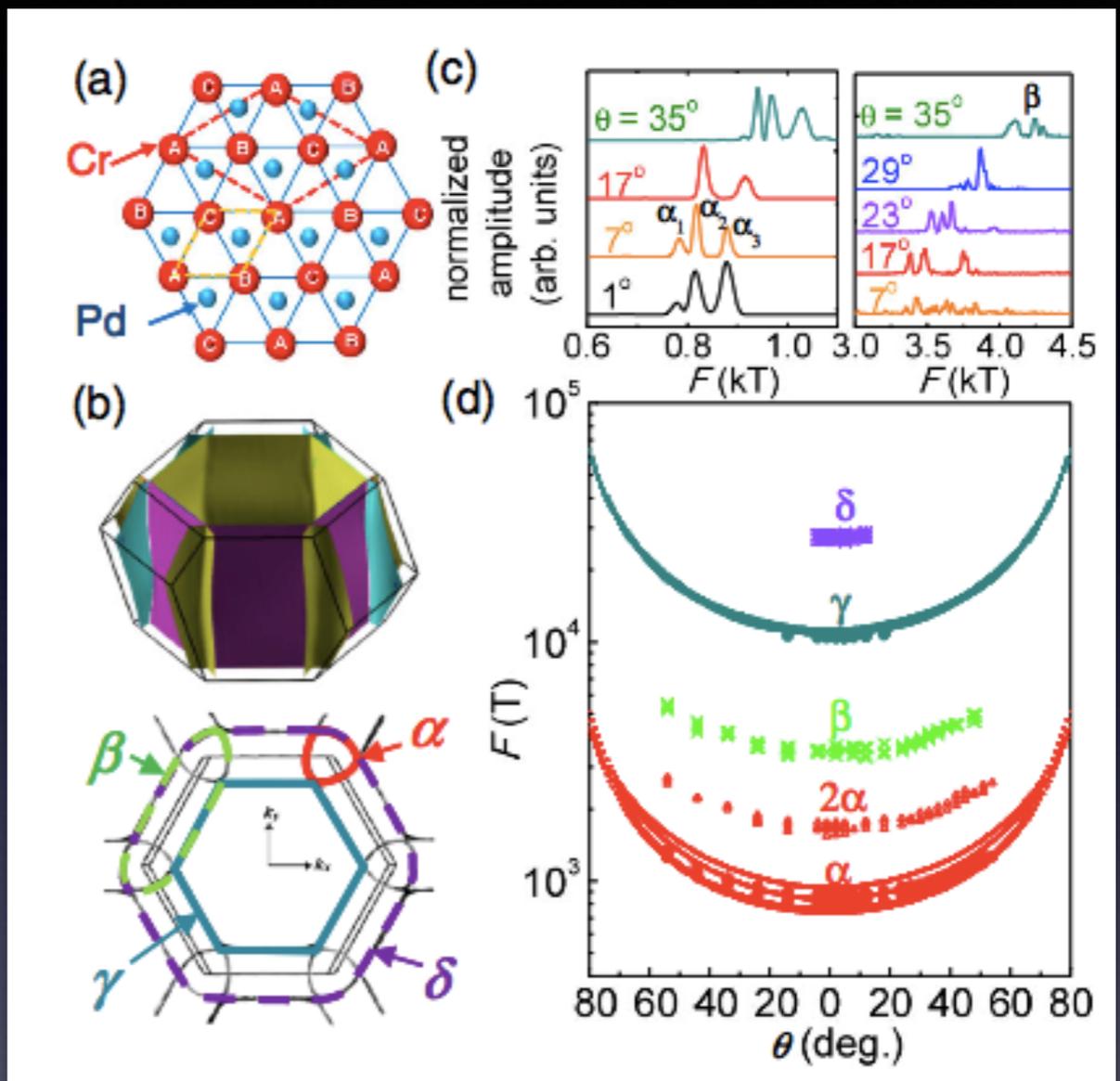
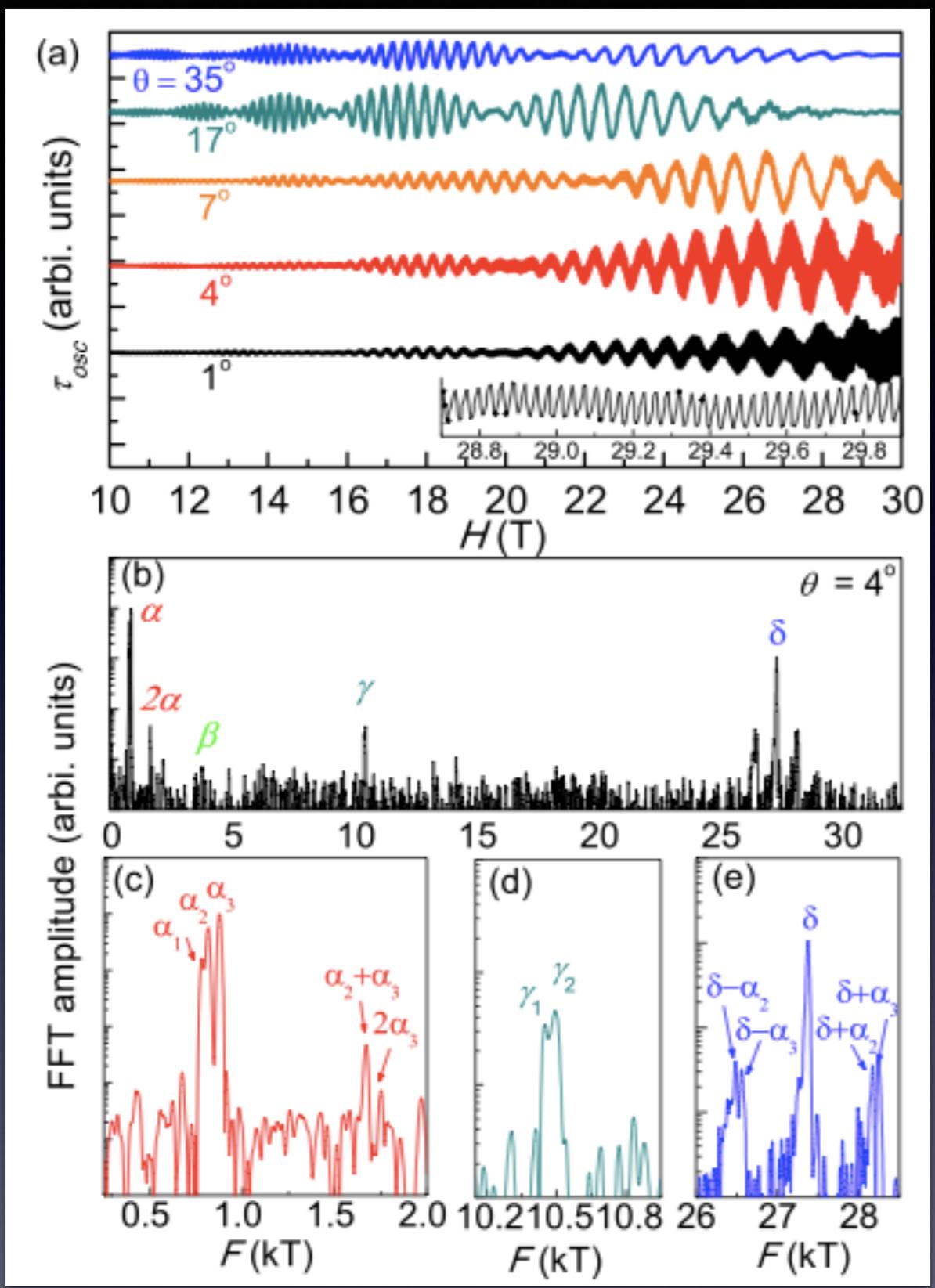
theory

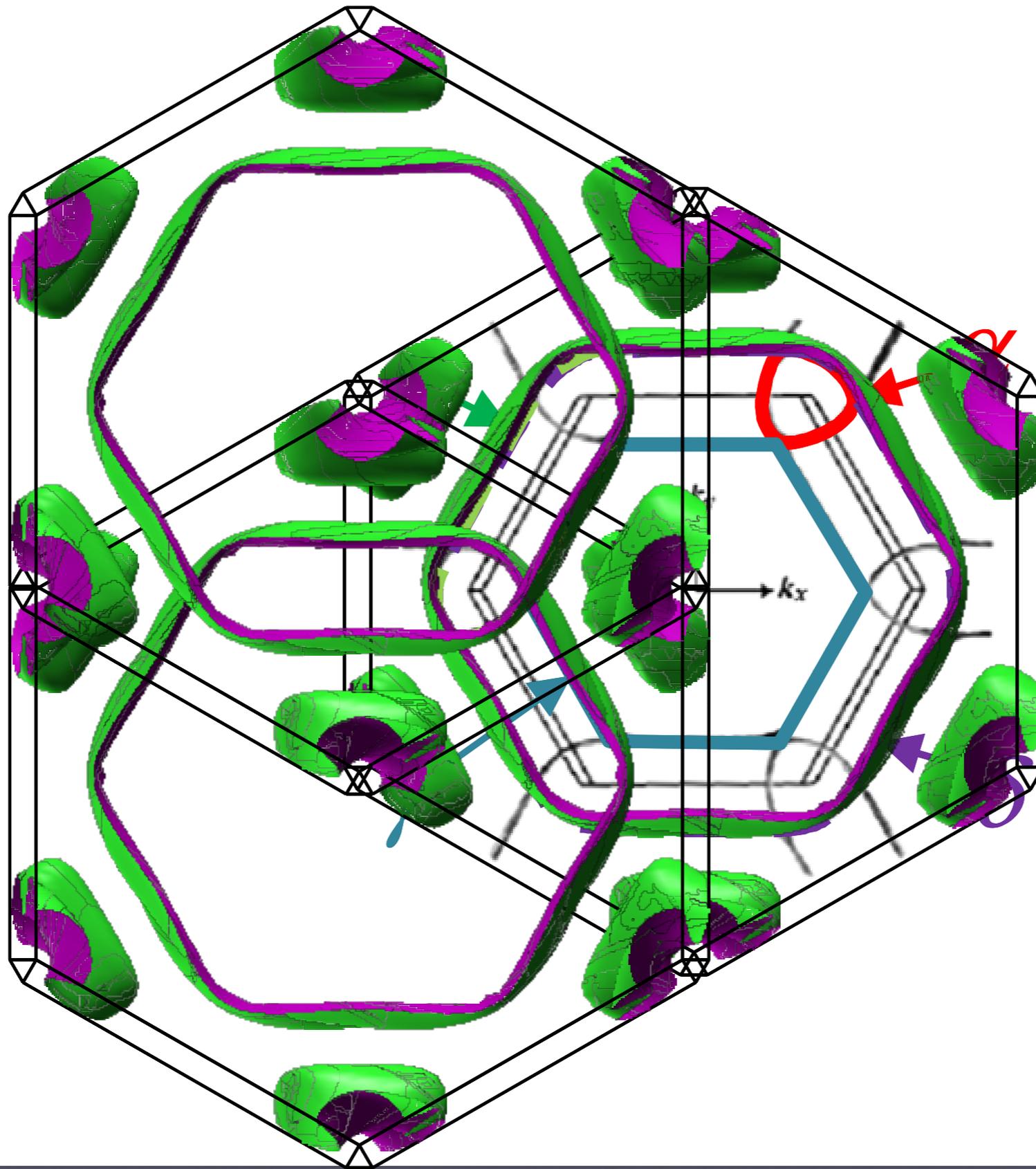


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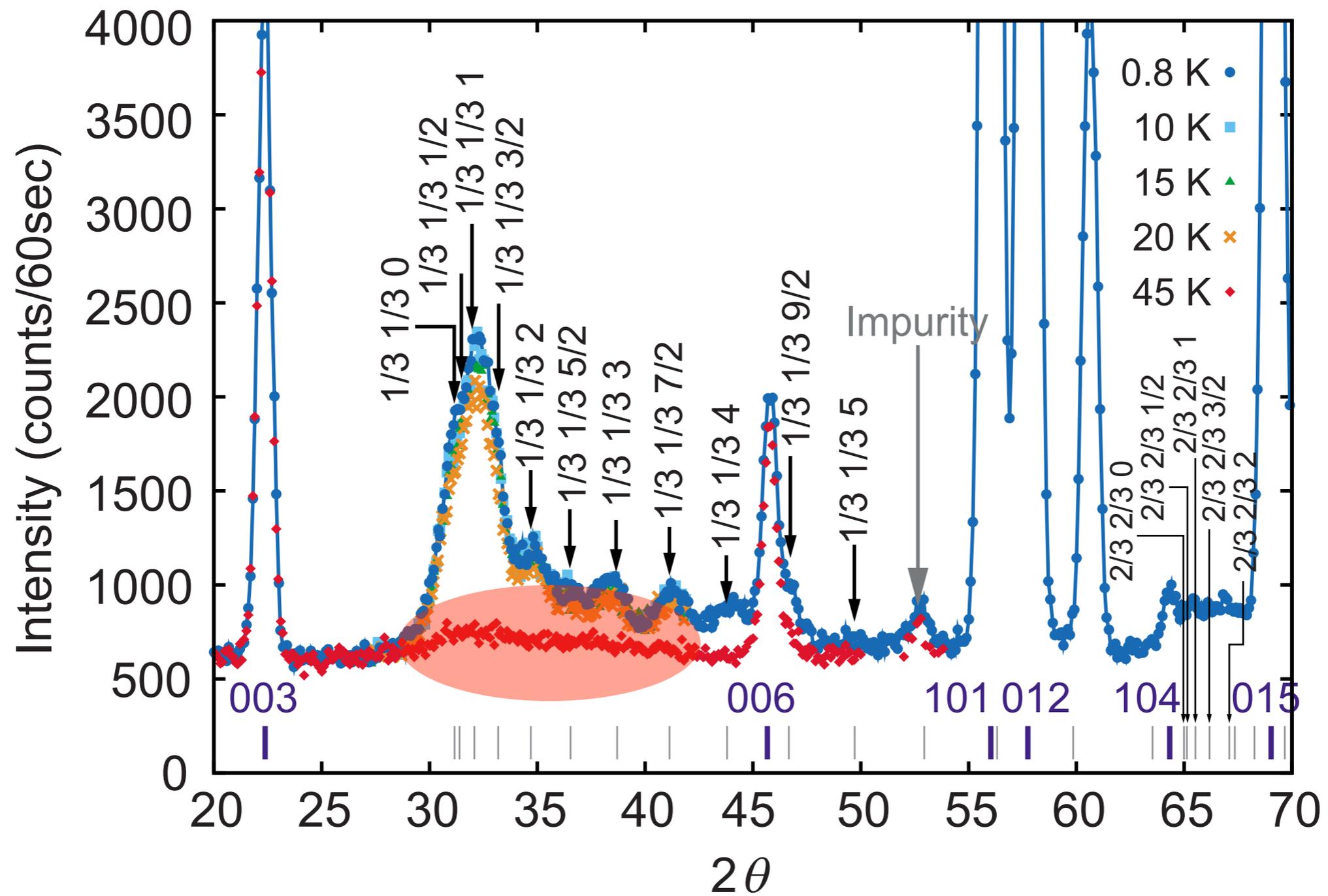


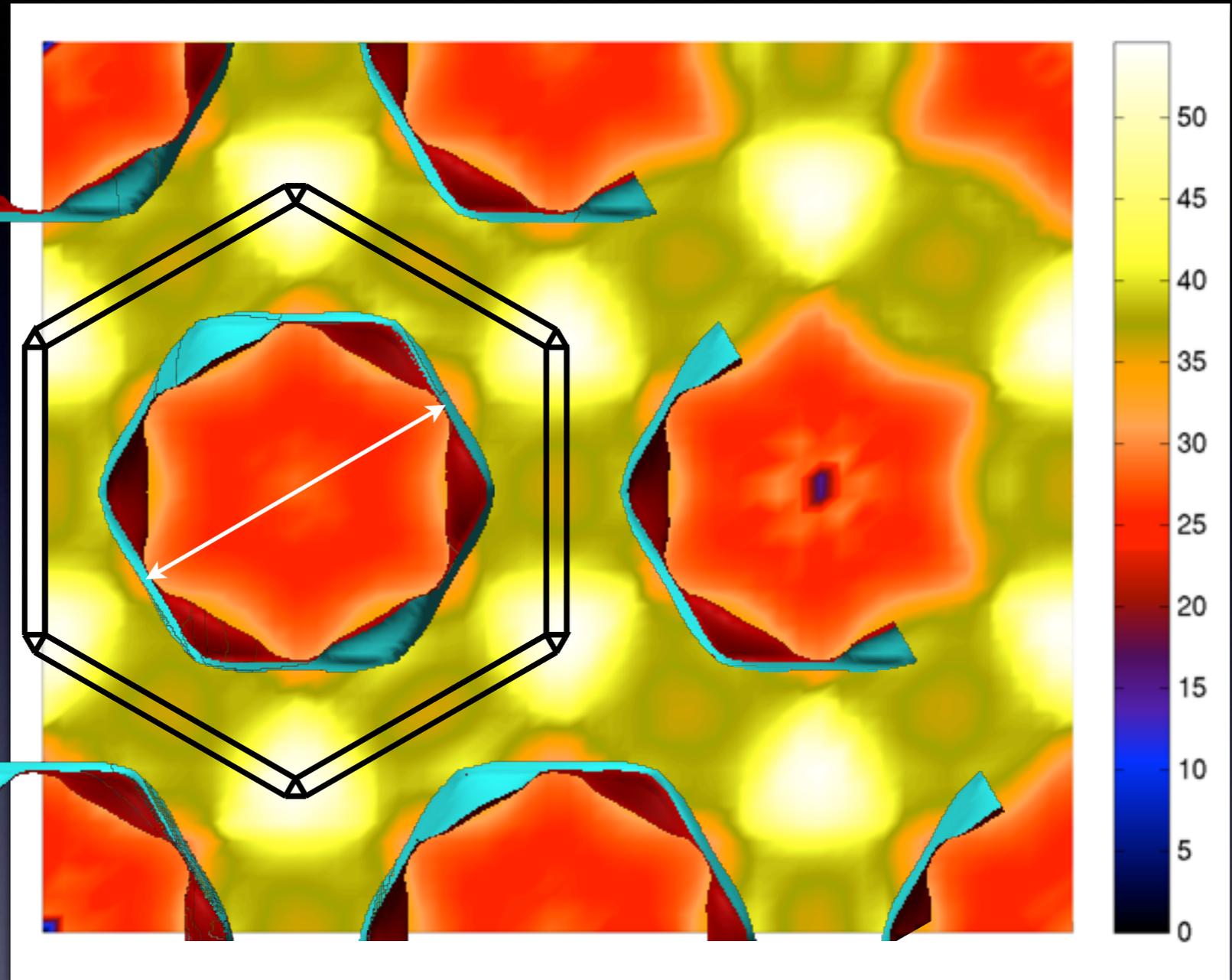


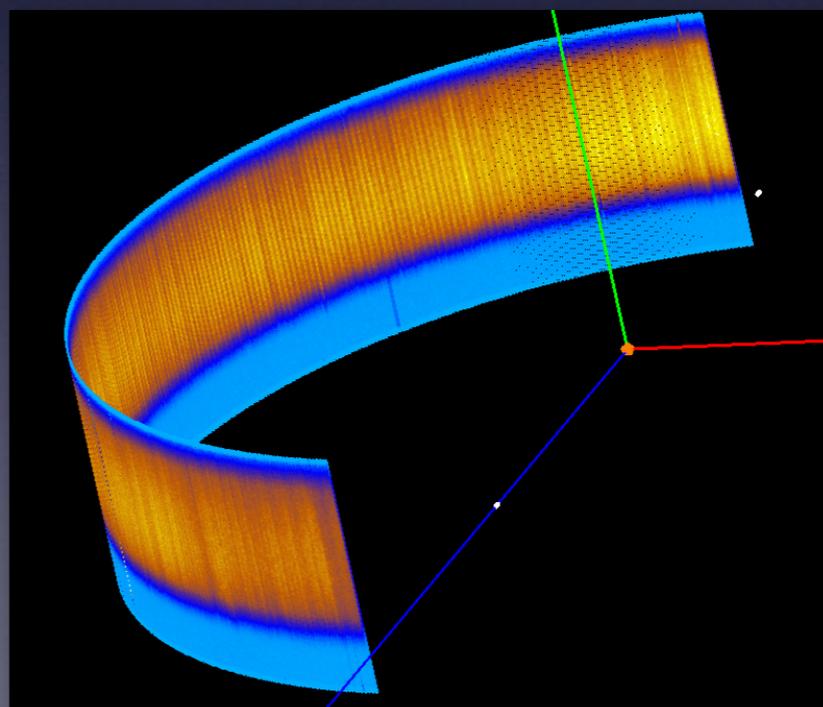
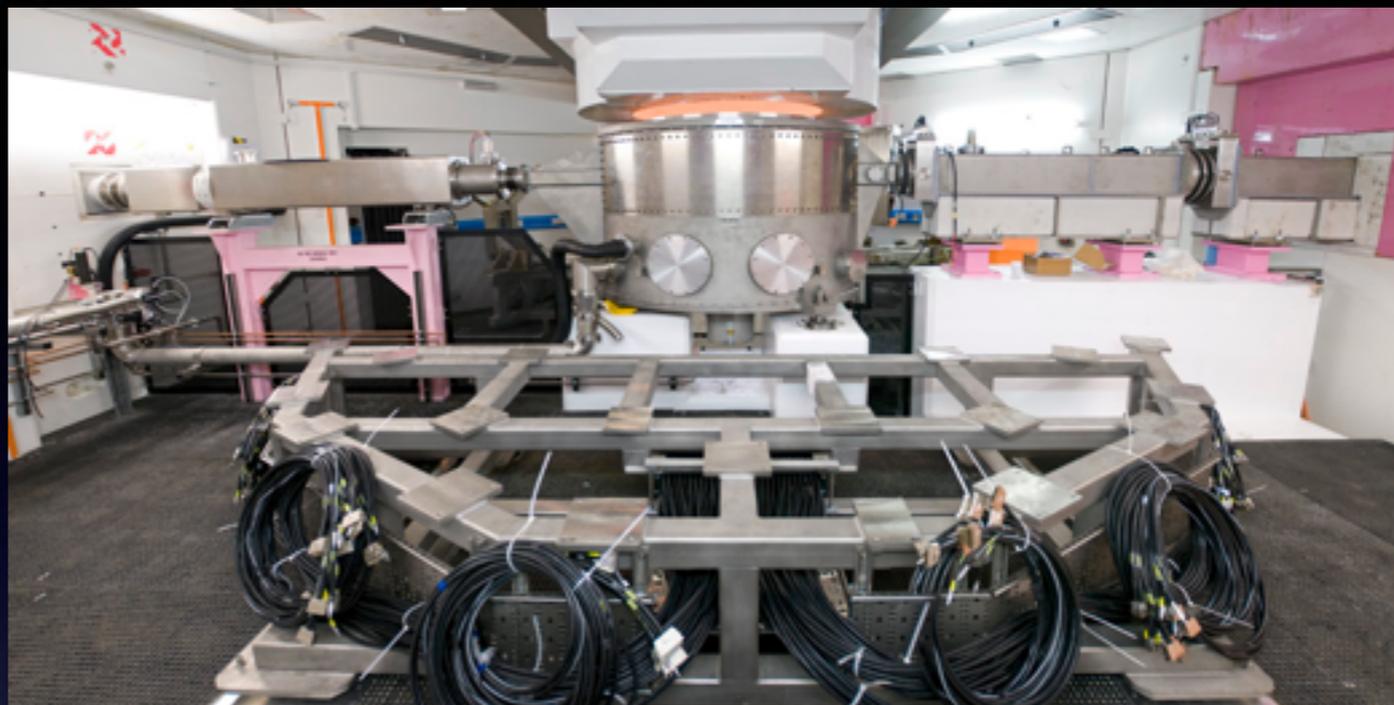
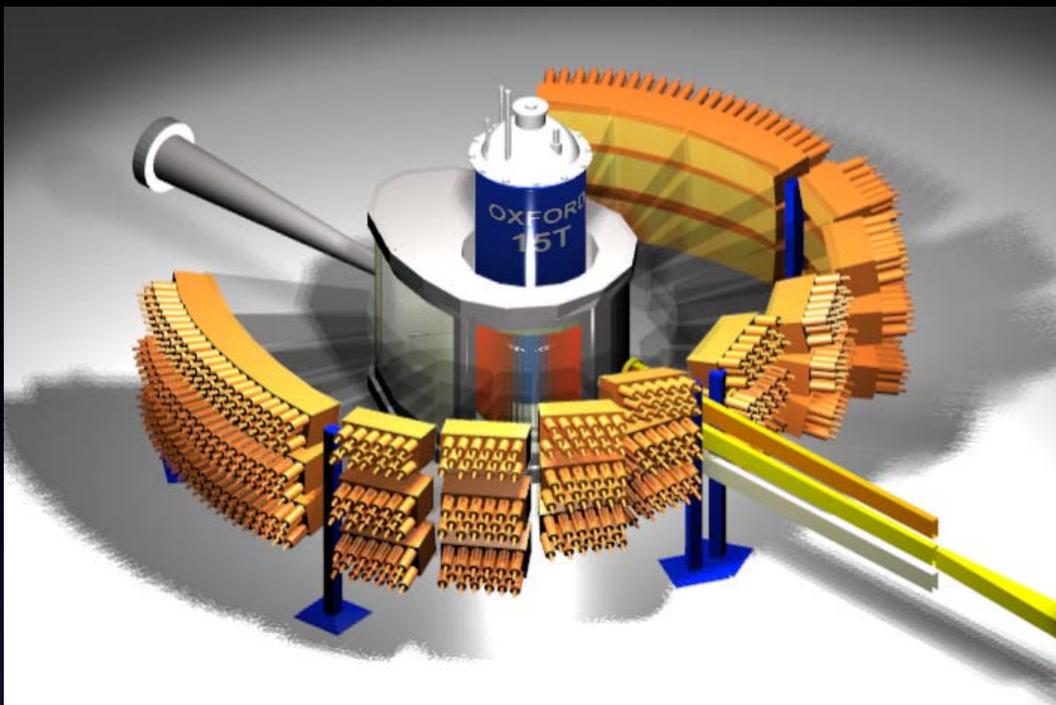


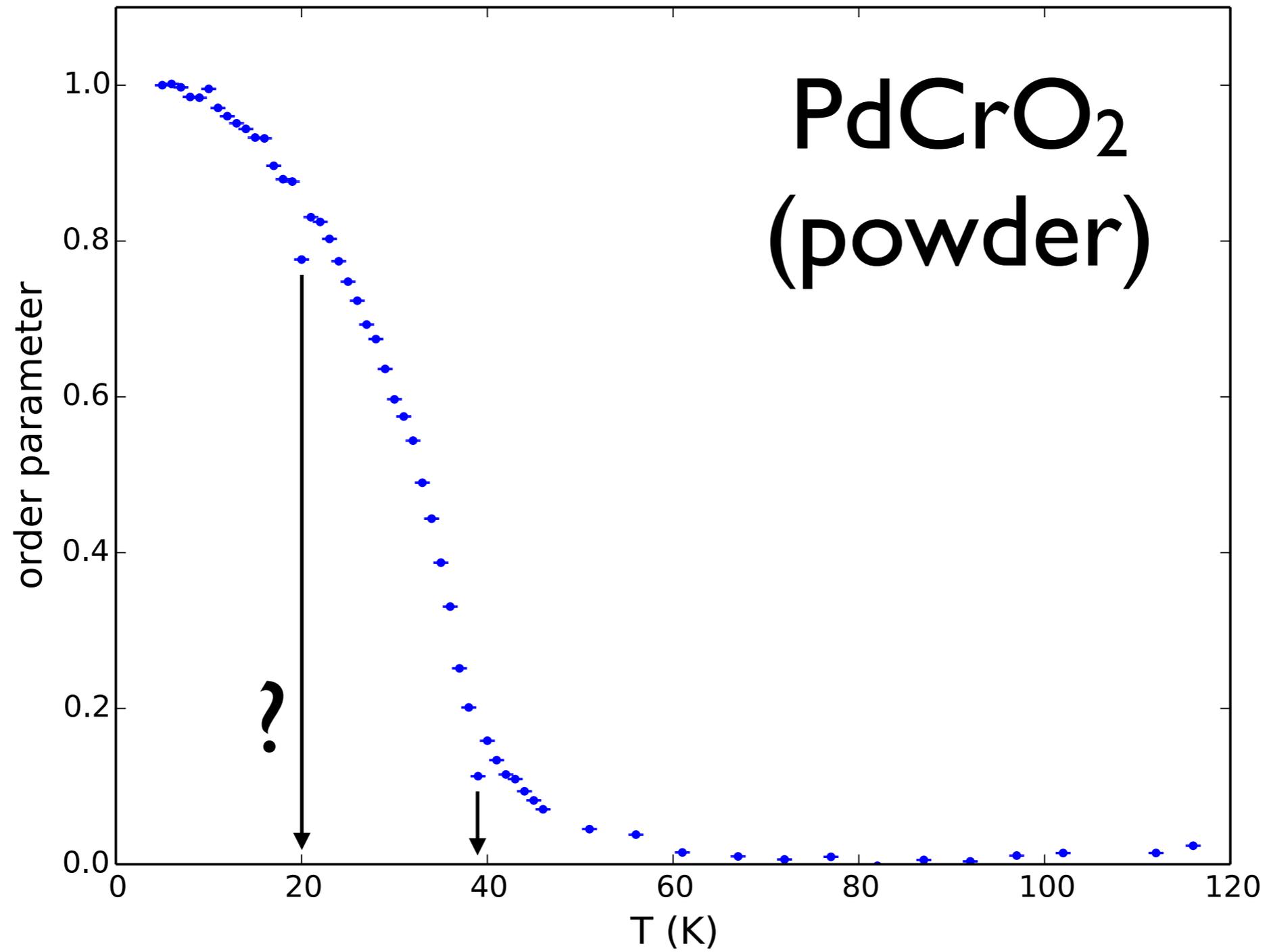


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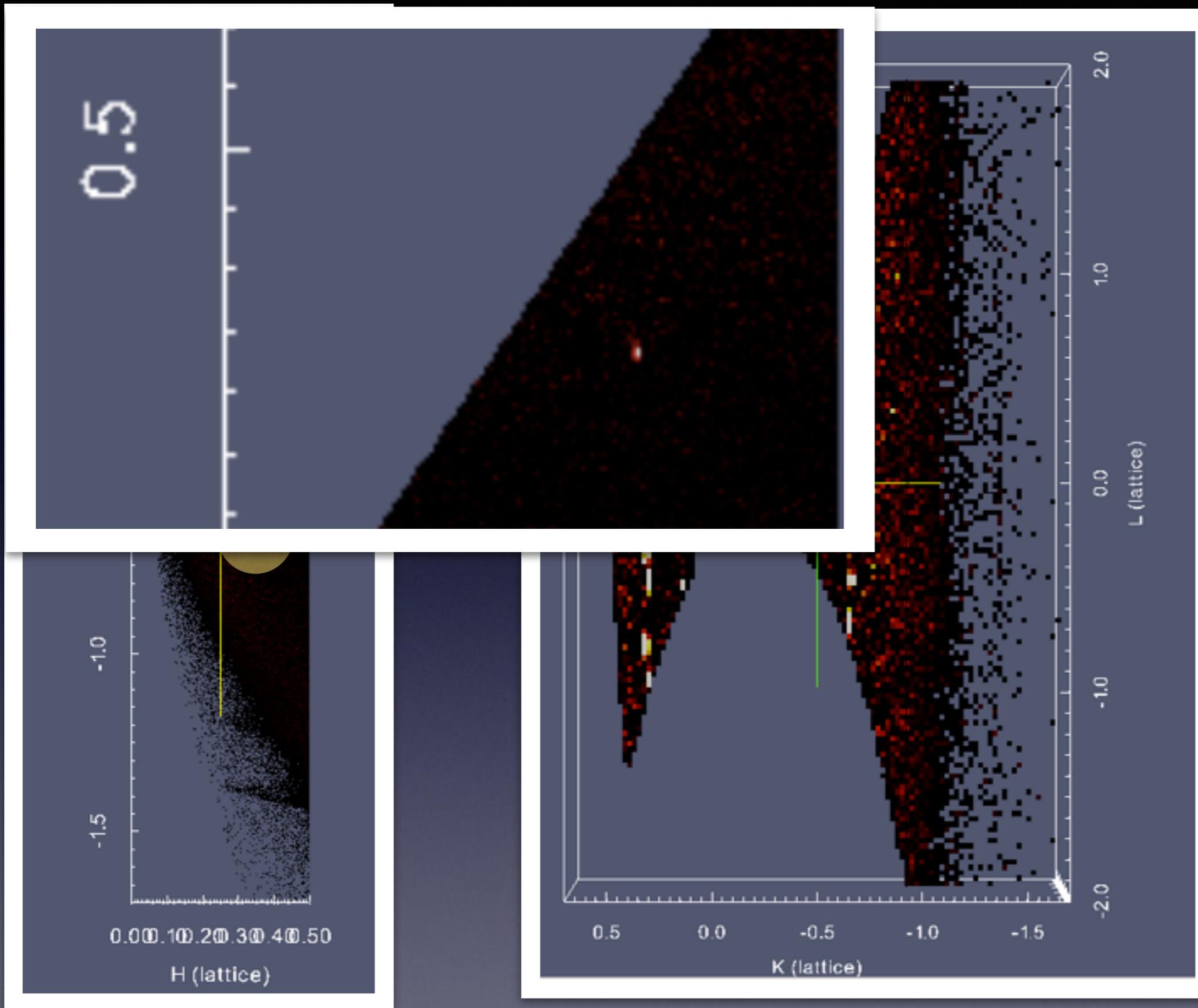




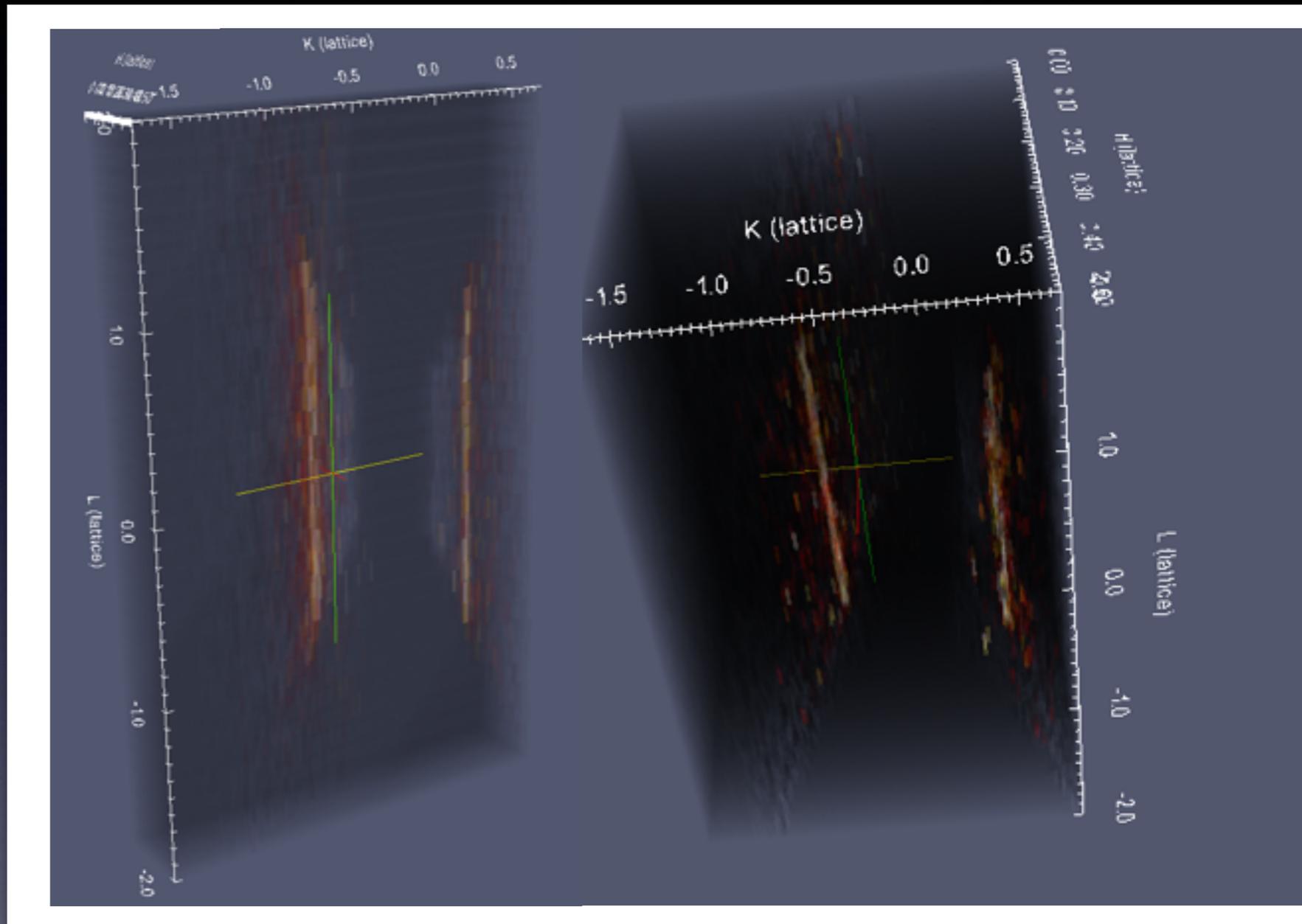
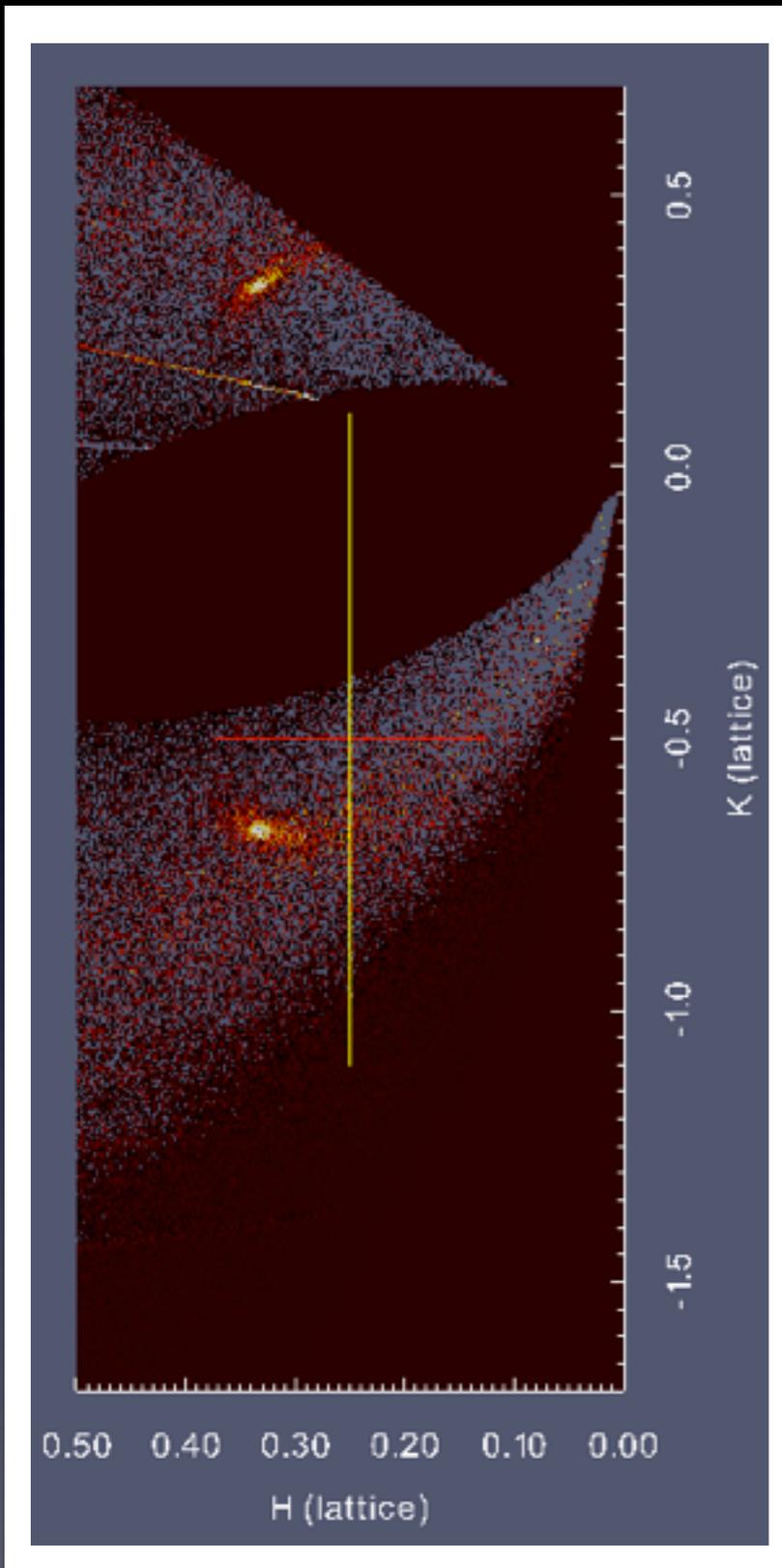




35K



38.5K



Summary

- We have measured the paramagnetic Fermi surface of PdCrO₂ by Compton scattering
- There is clear evidence of short-range magnetic order which persists above T_N
- Crystal is different from powder!



Acknowledgements

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