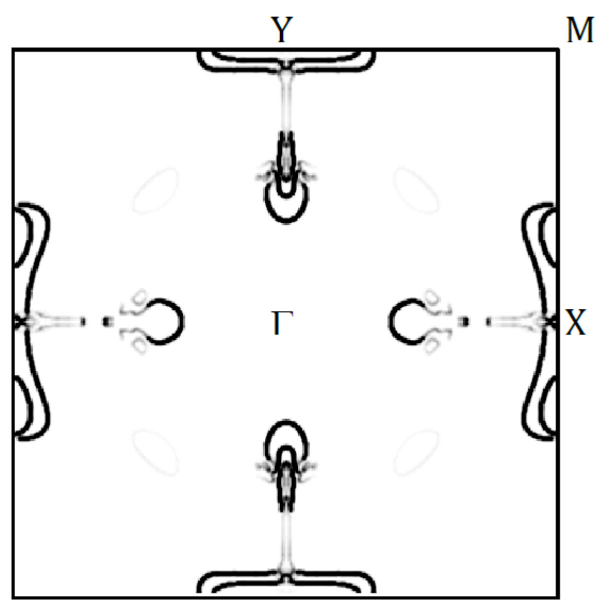
Spectroscopic Methods in Condensed Matter Physics – Final Assignment (23/07/2019)

The assignment should be fulfilled independently and be submitted by this **30/07/2019**. Contact us if you face any difficulties. You are encouraged to submit the feedback questionnaire attached anonymously.

Download from WASP website the three data sets:
1. arpes64ev_map.mat
2. arpes48ev_map.mat
3. stm_map.mat

The first two are structures containing ARPES data measured at photon energies of 64eV and 48eV. The third is STM data. They were all measured on the surface of a Weyl semimetal compound. The surface band structure of this material consists of both trivial surface bands and topological surface bands. The topological bands have the unique form of Fermi-arcs that have an open contour in momentum space. The bands are located around two high symmetry points, X and Y, on the edges of the Brillouin zone (see DFT calculation of the Fermi surface on the right panel).



STM topography

1. Plot the STM topography and using a 2D Fourier analysis identify the positions of the Bragg peaks of the lattice and the lattice constant.

ARPES

The surface Brillouin zone was mapped in ARPES in two separates runs that zoomed into the vicinity of either X or Y.

2. Find the effective temperature, T_{eff}, at which the 64eV ARPES measurement was taken.

3. Plot the mapped Fermi surface at energy E_F-$2K_BT_{eff}$ measured with photon energy of 64eV. Draw on top of it the boundaries of the first Brillouin zone based on the result you got in (1).
4. Draw the Γ-X-M-Y-Γ cut of the dispersion. Extract from it the Fermi velocities of the different bands that cross E_F.
5. Compare the dispersion in (4) to the Γ-X-M-Y-Γ cut of the dispersion measured with photon energy of 48eV. What can you deduce about the nature of the different bands that cross E_F?

STM dI/dV

6. Plot the dI/dV map at the first energy below E_F, and its Fourier transform. Use the mirror symmetries of the lattice in (1) to symmetrize the data.
7. Draw arrows of corresponding sizes between the quasiparticle interference (QPI) patterns you found in (6) and the ARPES surface at the corresponding energy taken with photon energy of 64eV.
8. Plot the Γ-X-M-Y-Γcuts of the QPI data and extract the relative Fermi velocities of the QPI patterns identified in (7).

Good luck!

Course Feedback

Please answer the following questions openly.

1. Please comment briefly on the following aspects of the course – what can be improved and what should be preserved:

a.

Lectures:____

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b.

Tutorials:____

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c.

Exercises:____

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2. In the course we chose the scope of topological insulators to introduce different experimental tools. Did it serve the purpose of studying about the experimental methods? Do you think that it provided you a solid background on topological insulators?

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3. How did you find the balance between presenting the formal theoretical background on which the method is based, and discussing the technical aspects of how it is realized?

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4. Did the course helped in understanding weekly seminars? Was it effective in improving your reading capabilities of experimental papers?

5. Were the exercises too difficult/easy? How many hours did they take you in average?

6. Do you think we should cover less methods more thoroughly or more methods in less details? Please list methods that we didn't cover and you think should be included.

7. General comments/ suggestions for improvements: