

PH575 Homework 5

Due in class on Wednesday May 17th, 2017.

1. Class project

a) Read the full description of the poster/paper project.

<http://physics.oregonstate.edu/~minote/COURSES/ph575/doku.php?id=wiki:papers>

“... calculate (at minimum for a passing grade) the dispersion relation and the total and partial densities of states of an interesting material. You will also calculate at least one other property – electron density, optical properties etc., for a B or higher grade. The difficulty of the project will be taken into account in assigning the grade...”

b) Propose **TWO** different crystalline materials that you might use for the class project.

For each material, find the following

(i) a research article reporting the band structure of the material.

(ii) a research article reporting a material property that was experimentally measured.

For each of the four articles, write down a brief summary and the citation. Citation example:

Evans, Fitch and Smith, “Ultra-violet absorption spectrum of sodium chloride crystals”, *J. Am. Chem. Soc.* **122**, 10033 (2017).

If you don't yet have citation software on your computer, I recommend Mendeley (free software).

Here are some examples of materials that have been used in previous years. You can choose from this list, or you can explore other ideas.

NbN	TiO ₂	SnO ₂
AgSbO ₃	GaAs	PbTiO ₃
SiC	ZnTe	InAs
SiO ₂	ZnO	InSb
CdTe	ZnO	GaN
CdS	Al ₂ O ₃	
YBa ₂ Cu ₃ O ₇	HgTe	

2. Dispersion relation

Consider a 2d square lattice (atomic spacing a) that has one atom per PUC and one atomic orbital per atom. The nearest neighbor hopping integral is β_1 . The next-nearest neighbor hopping integral is β_2 (the next nearest neighbors are separated by diagonal lines). All other hopping integrals are zero. Write an expression of the band structure.

3. Density of states

For a certain range of wavefunction energies, the dispersion relation of graphene is $E(\mathbf{k}) = \pm \text{constant} * |\mathbf{k}|$. Within this energy range, find the density of states of graphene, $D_{2d}(E)$.