EE-230C

Project Fall 2024

- **Each group should have 3 members**
- **Deadline: 11:59PM, Dec 20th, 2024, Friday (Please send in an electronic copy)**
- **Send the names of your group members to Pratik Brahma by 11/30**

Consider the following paper:

L. Xie et al. \Graphene-Contacted Ultrashort Channel Monolayer MoS2 Transistors". Advanced Materials 29.37 (2017), p. 1702522. doi: 10.1002/adma.201702522.

(i) Using the quasi-ballistic MOSFET models discussed in the class, analyze the current voltage characteristics. Also estimate the contact resistance and account for that in your calculations. Note that, you will need to know the injection velocity of the MOSFET for which you need to know the bandstructure.

(iii) Compare injection velocity as a function of energy calculated from a rigorous bandstructure and from an effective mass model.

(iv) Explain how well the quasi-ballistic model explains data by using low field mobility as a fitting parameter. Discuss the issues involved in analyzing device data with this model. Which regions of current voltage curve may this model not work? Why?

Include your assessment of efficacy of the transistors based on these materials for future electronics.

Tight Binding Models:

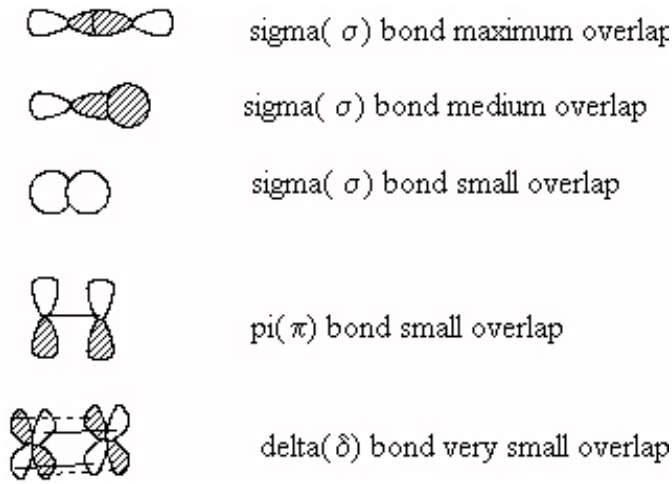
For TB parameters of MoS_2 use the following paper:

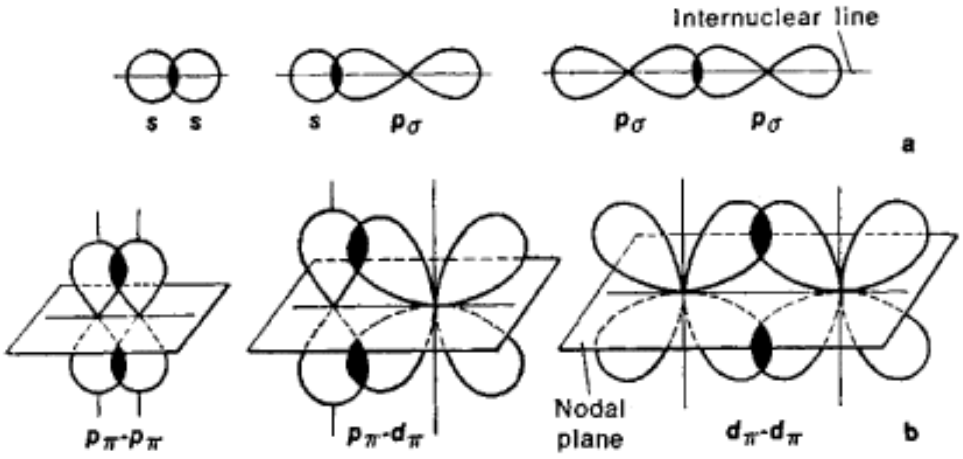
http://ieeexplore.ieee.org/document/7131529/?arnumber=7131529&tag=1

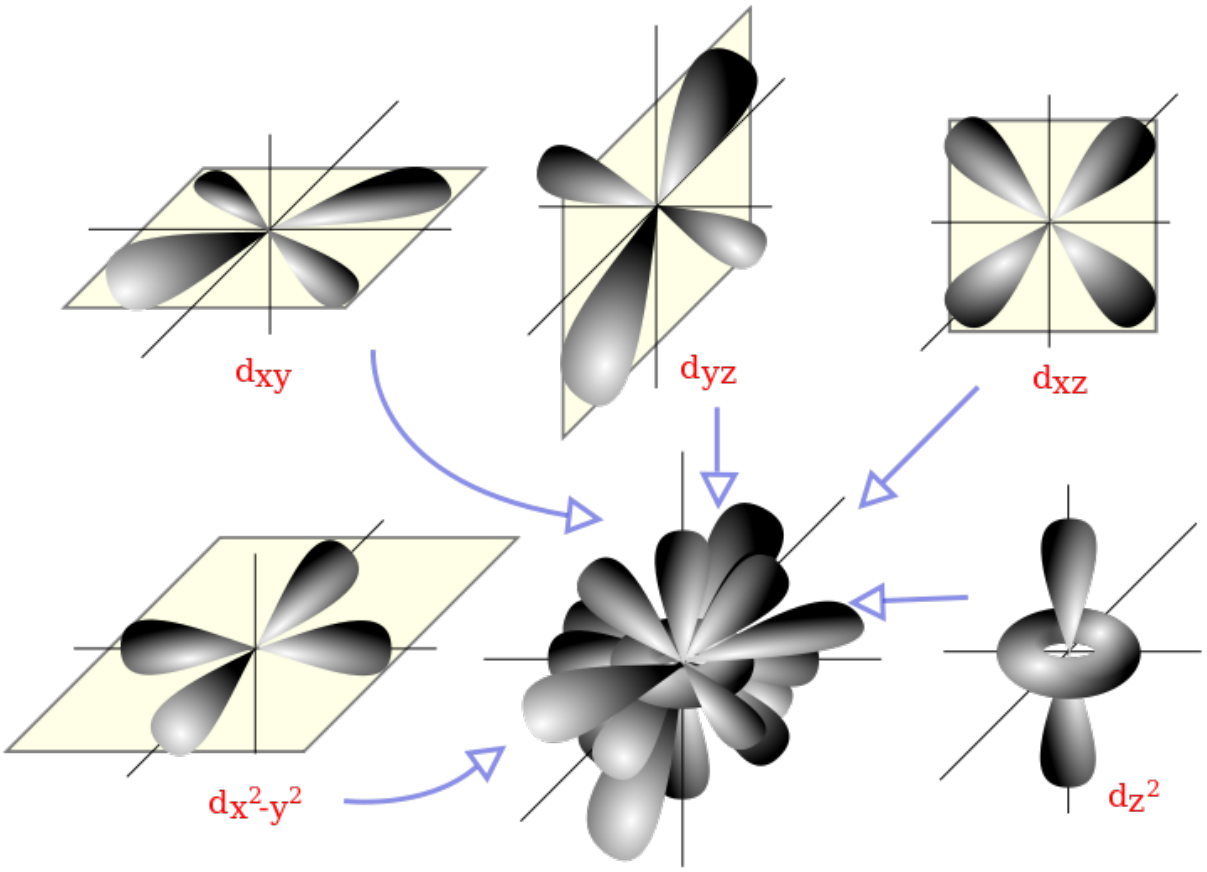
Conventionally, tight binding parameters are written in terms of π, σ and δ bonds. This means that you have to think a little bit about the actual geometric structure of the orbitals, how the overlapping bonds will look like and then write down the appropriate parameters. For example, px-px orbitals in graphene will create a σ bond and pz-pz orbitals will create a ***π*** bond.

I have attached some images of the bonds for visualization. You can look up the internet for more images.

Hint: Remember to also include TB parameters between sulphur atoms in the same layer across neighboring unit cells.






dxy
dyz
dxz
dx2-y2
dz2