EE-230C Project

Fall 2016

- **Each group should have 3 members**
- **Tentative Deadline: 5PM, Dec 16th, 2016, Friday (Put it in the box outside 515 SDH; You can also email an electronic copy)**
- **Send the names of your group members and your chosen project to Salahuddin by 11/17**

For one of the materials shown below:

(a) Monolayer MoS_2
(b) Monolayer Graphene

(i) find a published experimental result on a MOSFET with channel length below 200 nm

(ii) 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?

(v) Based on the model that you have developed, show the scaling behavior: $\log_{10}$(Id)-Vg and Id-Vd as a function of channel length down to 5 nm. 4-5 different channel calculations will be enough.

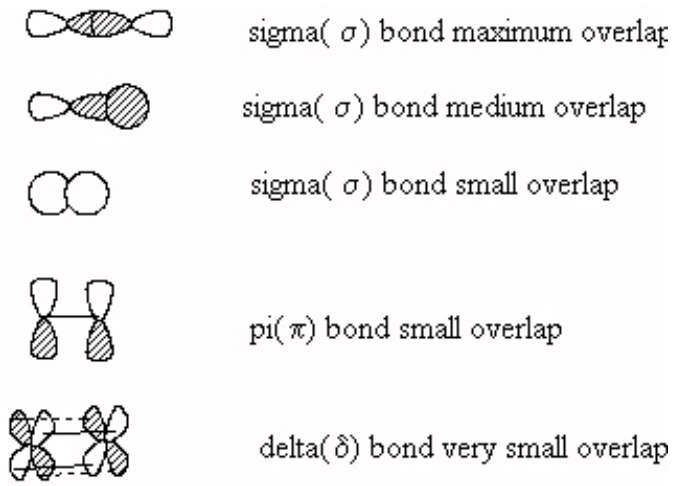
Include your assessment of efficacy of the transistors based on these materials for future electronics.

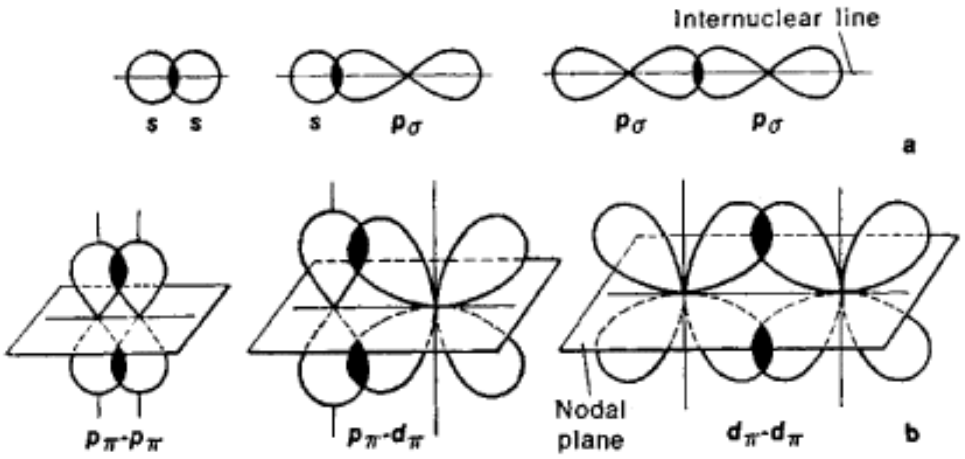
Tight Binding Models:

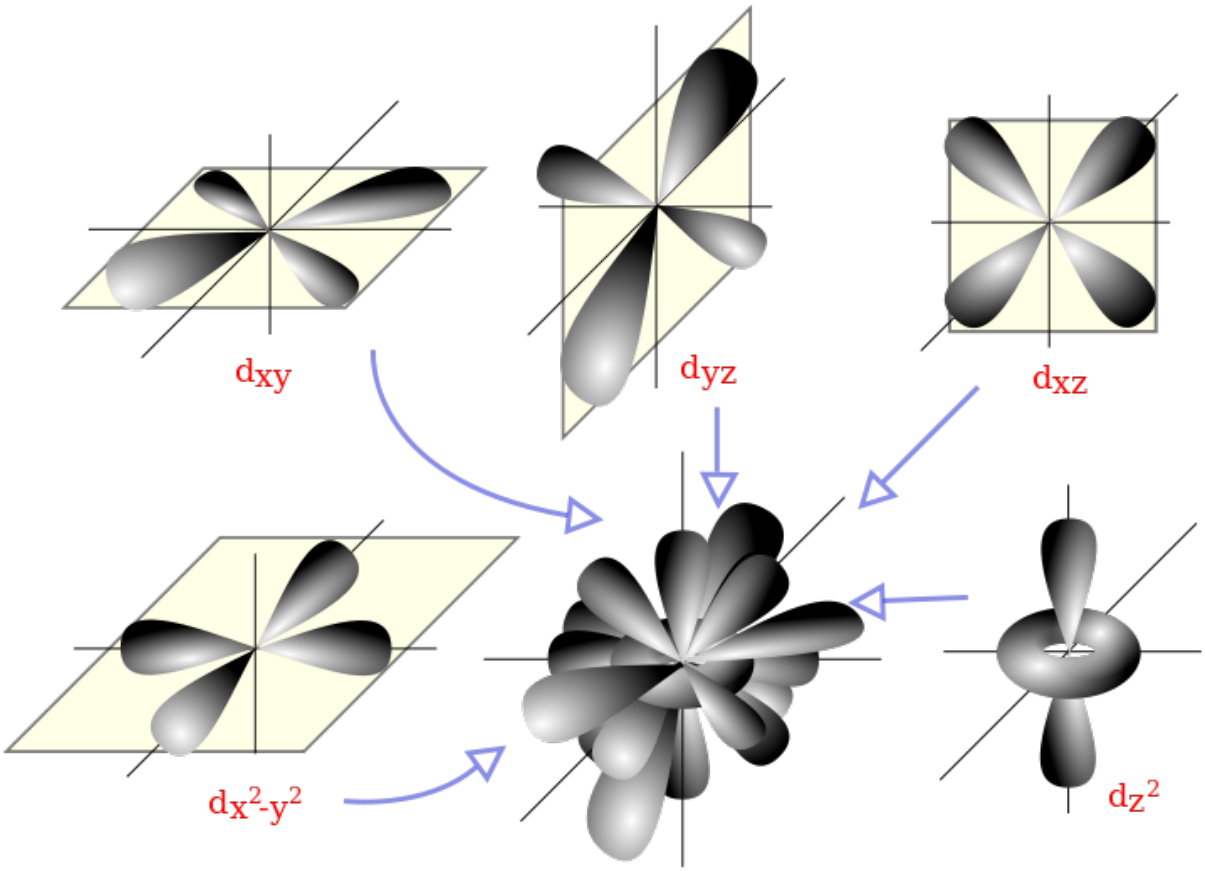
The model parameters will be taken from literature. Conventionally, tight binding parameters are written in terms of π, σ and δ bonds. This means that you have to think a little bit about the actual geometric structure of the orbitals, how the overlapping bonds will look like and then write down the 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.

1. For graphene use the parameters shown in Table 1, left most column in http://arxiv.org/pdf/1102.1718v1.pdf. Note that here, three orbitals are considered: p_z, d_{yz} and d_{zx}.







2. For MoS_2 use the parameters from the following paper:

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