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EE 396V – Homework #1

Problem 1 – Nobel Graphene:

1. When was graphene first synthesized and observed?

   Graphene was first synthesized and observed in 1859 by Benjamin Brodie.

2. Why was the 2004 publication different from other prior graphene publications?

   The 2004 publication was different from other prior graphene publications because it did not only report an observation of graphene, but it rediscovered it in its new incarnation – that of a new high quality 2D electron system and beyond. Indeed, by changing the gate voltage on the substrate, it is possible to change the electronic properties of the material (ambipolar electric field effect).

3. Can other 2D non-graphene monolayers exist under ambient conditions?

   Yes, other 2D non-graphene monolayers can exist under ambient conditions, such as Boron-Nitride, Graphane, Fluorographene, etc… However, these atomic crystals have just been lightly touched; Only graphene has been studied.

4. Why is the EFE negligible in multilayer graphene or thick graphite?

   The EFE is negligible in multilayer graphene or thick graphite because the electric field can dope no more than a couple of near-surface atomic planes, leaving the bulk unaffected.

Problem 2 – Discovering Nanotubes:

1. How did he first find carbon nanotubes?

   Sumio Iijima first found carbon nanotubes in June 1991, when examining carbon materials under an electron microscope. He found extremely thin needle-like material, and soon thereafter, the material was proved to have a graphite structure. He named these materials "carbon nanotubes".

2. What carbon nanomaterials inspired his discovery of nanotubes?

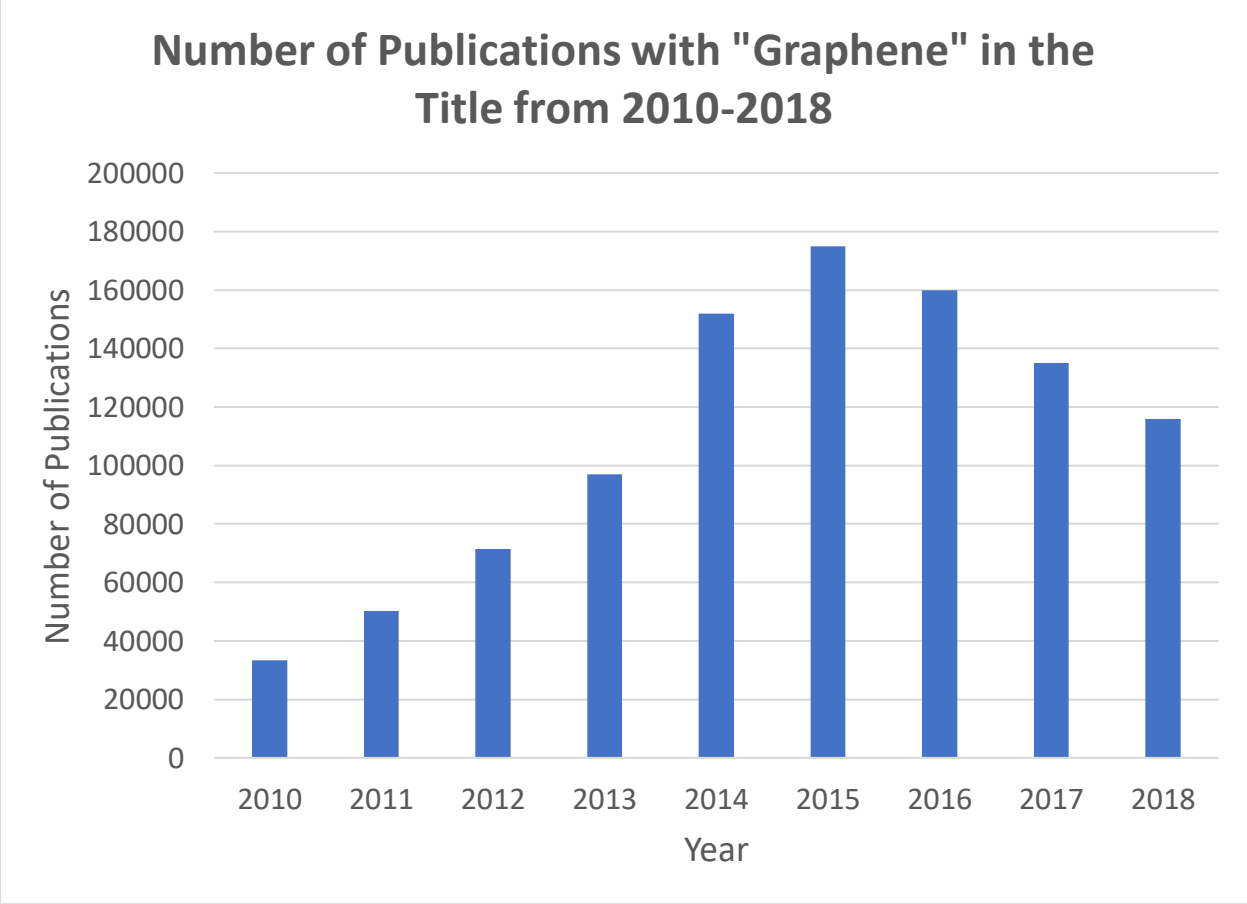
   The carbon nanomaterials that inspired his discovery of nanotubes were fullerene molecules – C_{60}.

3. What is the smallest nanotube he discovered?

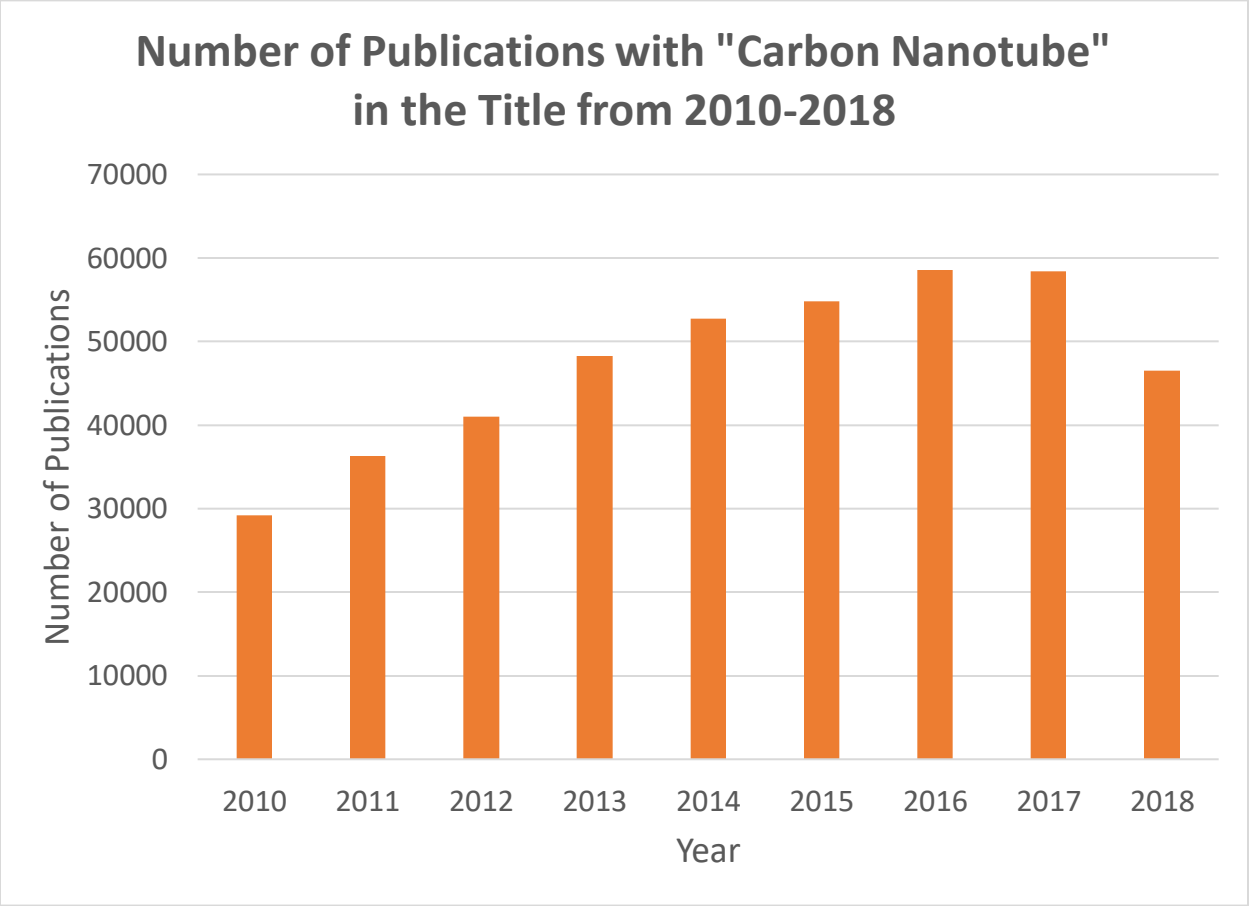
   The smallest nanotube he discovered had a diameter of 0.75nm.

Problem 3 – En Fuego:

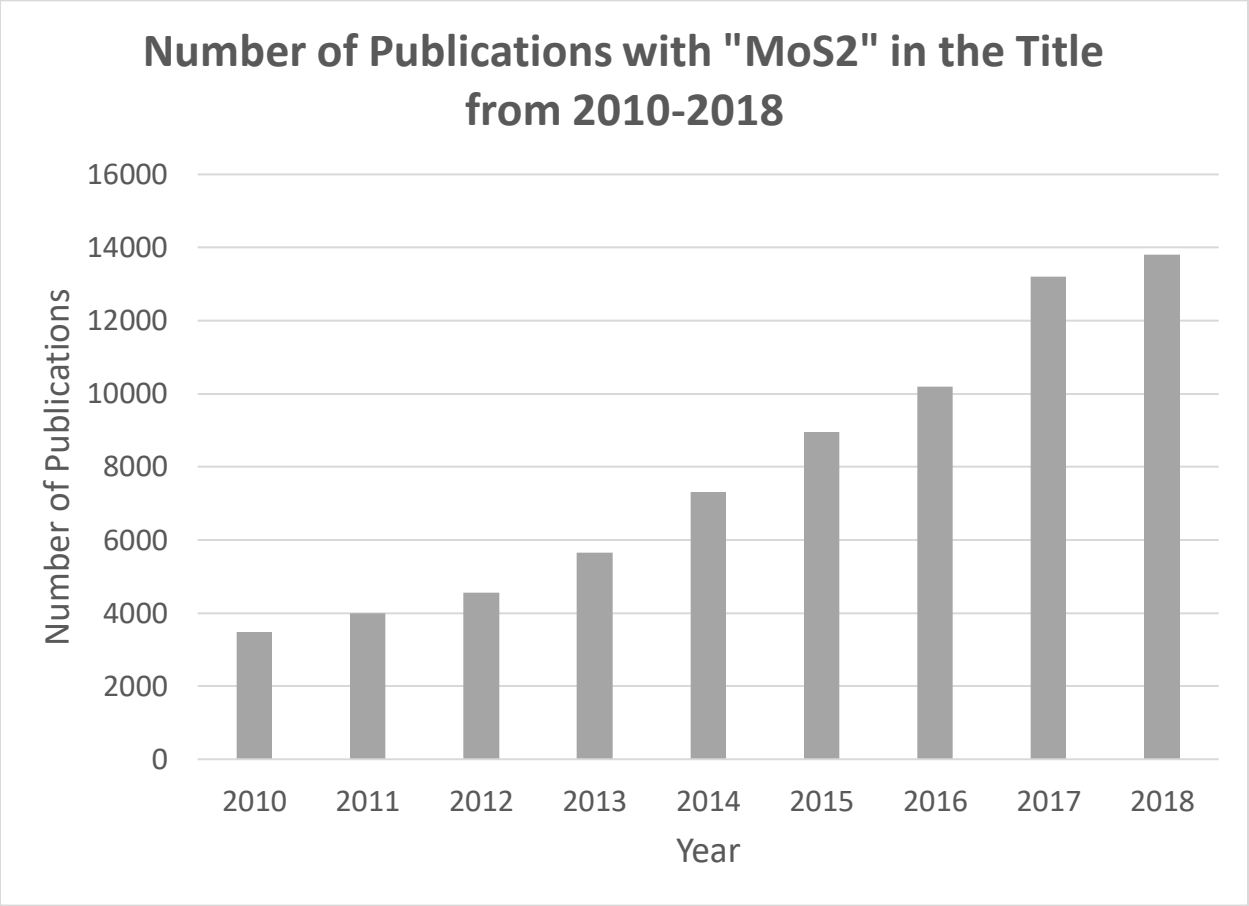
1. Plot the number of articles with “graphene” in the title for the past 9years (2010-2018). Generate a plot using google scholar. The search should include ‘graphene’ in the title.



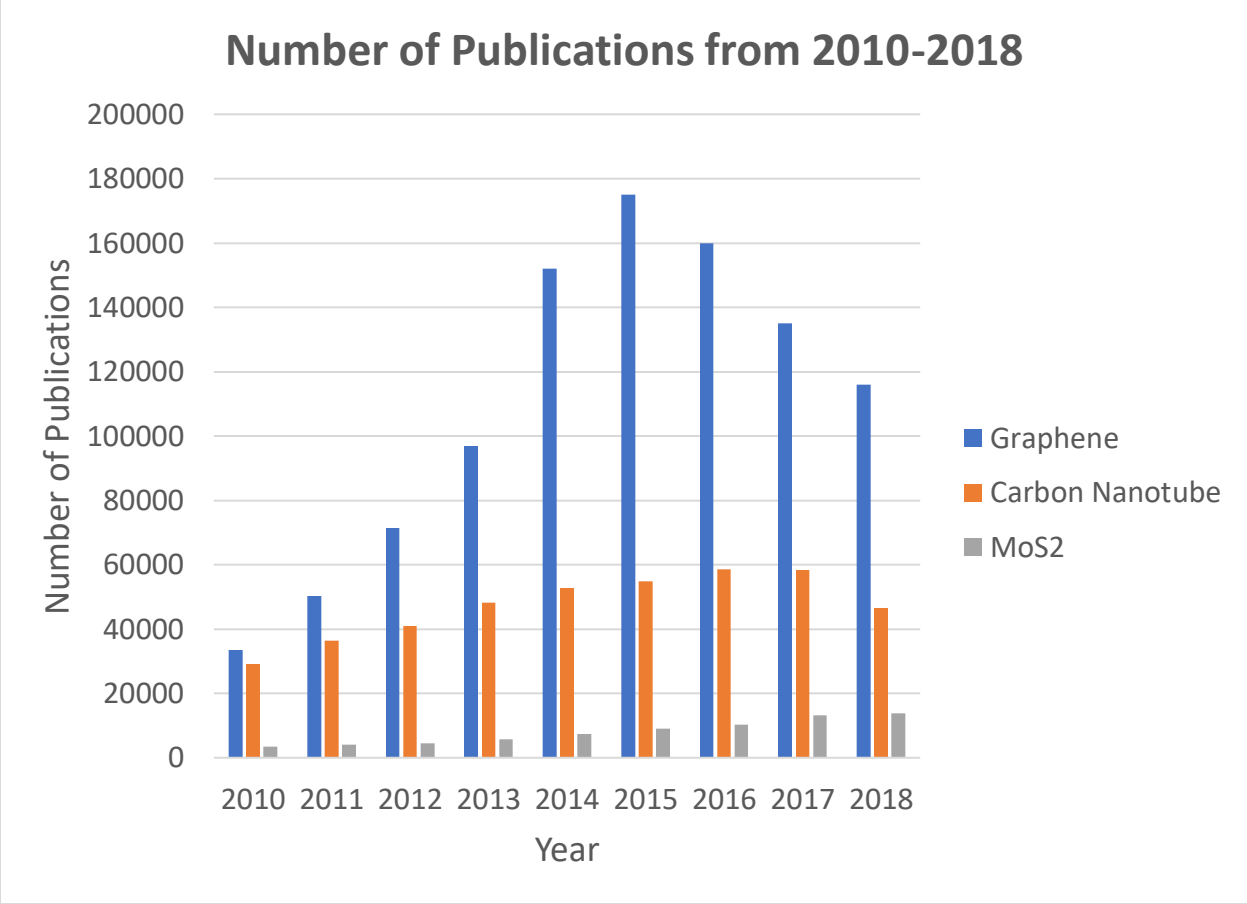
2. Plot the number of articles with “carbon nanotube” in the title for the past 9 years as well. Generate a plot using google scholar.



3. Plot the number of articles with “MoS2” in the title for the past 9 years as well. Generate a plot using google scholar.



4. What conclusions can you draw from the trend of publications over the past 9yrs?



As shown by the graph above, the number of publications with "Graphene" in the title overwhelmingly surpasses its two counterparts. The number of "Graphene" publications exponentially grew from 2010 to 2015, but then decreased year after year until 2018. The number of "Carbon Nanotube" publications increased steadily from 2010-2017, but then dropped in 2018. The number of "MoS2" publications grew steadily from 2010-2018, however it does so at the smallest scale compared to "Graphene" and "Carbon Nanotube" publications. A correlation can be drawn between the "Graphene" and "MoS2" publications after 2015. Indeed, just as the number of "Graphene" publications dropped, the number of "MoS2" publications started to grow faster over the years. This may suggest that more attention has been given to "MoS2" than "Graphene", possibly because of a discovery that made it a more promising field of research.

Problem 4 – For Your Pleasure:

Very interesting video. I feel like society has always taught us to praise the end result of a task or duty – in school, that is getting an A+. But thinking in that manner is precarious because some students will want to attain that end result, no matter what path is taken. And unfortunately, many students chose to cheat to get an A+.

Additionally, only visualizing the end result undermines the learning process. However, living with a growth mindset enables one to reach higher limits. If you emphasize and reward the learning process over the end goal, then you are opening the doors to a plethora of new discoveries.