# Lecture 3

VR Lab

# Participation and in-class presentations

- Journal club: we will be reading seminal papers on related topics every week using an online platform (Perussal), and presenting them to the rest of the class.
- Youtube videos: we will be learning from each other on how concepts learned in class can be applied in real world scenarios through youtube video clips.
- Final group project

# Literature presentations for Lecture 4

letters to nature

## A colloidal model system with an interaction tunable from hard sphere to soft and dipolar

**Anand Yethiraj***† **& Alfons van Blaaderen***

* *Soft Condensed Matter, Debye Institute, Utrecht University, Padualaan 5, 3584CC Utrecht, and FOM Institute for Atomic and Molecular Physics, Kruislaan 407, 1098 SJ Amsterdam, The Netherlands*

**Monodisperse colloidal suspensions of micrometre-sized spheres are playing an increasingly important role as model systems to study, in real space, a variety of phenomena in condensed matter**

Vol 464|25 March 2010|**doi:10.1038/nature08906**



## Tunable attractive and repulsive interactions between pH-responsive microgels

**Jae Kyu Cho,[a] Zhiyong Meng,[b] L. Andrew Lyon[b] and Victor Breedveld[a]**

*Received 19th June 2009, Accepted 16th July 2009*
*First published as an Advance Article on the web 31st July 2009*
**DOI: 10.1039/b912105f**

**We report direct measurements of the pairwise interparticle potential between poly(*N*-isopropylacrylamide-*co*-acrylic acid) (pNIPAm-*co*-** be explained relatively well by defining an effective volume fraction of particles and using hard-sphere-like interactions, the incorporation of

nature Vol 457|8 January 2009|**doi:10.1038/nature07610**

LETTERS

## Measured long-range repulsive Casimir–Lifshitz forces

J. N. Munday[1], Federico Capasso[2] & V. Adrian Parsegian[3]

**Quantum fluctuations create intermolecular forces that pervade macroscopic bodies[1–3]. At molecular separations of a few nano-** presented[15,21–24]. When working at small separations, however, the polarity and orientation of the molecules may influence the force.

## Lock and key colloids

S. Sacanna[1], W. T. M. Irvine[1], P. M. Chaikin[1] & D. J. Pine[1]

**New functional materials can in principle be created using colloids that self-assemble into a desired structure by means of a programmable recognition and binding scheme. This idea has been explored by attaching 'programmed' DNA strands to nanometre-[1–3] and** depletant—to the system, causing depletion interactions[8,9] which have their origin in the entropy associated with the centre of mass of the polymers. That is, each colloidal particle is surrounded by an exclusion layer whose thickness is given by the radius $r_p$ of a polymer

| Student | 2/6 | 2/13 | 2/20 | 2/27 | 3/12 | 3/19 | 3/26 | 4/2 | 4/9 | 4/16 |
|---|---|---|---|---|---|---|---|---|---|---|
| | A | A | A | D | A | A | B | C | D | A |
| Mitchell Godek | D | C | D | B | D | B | A | C | C | B |
| Jen Bradley | D | A | A | D | B | D | D | A | A | D |
| Amir Nazemi | B | D | D | C | B | A | C | D | D | C |
| Charlotte Zhao | D | D | B | B | A | C | A | B | A | A |
| | B | B | B | B | D | C | C | A | D | C |
| William Morgan | A | C | A | B | C | A | D | B | C | B |
| Ankit Saraf | B | C | C | C | B | B | B | D | A | D |
| Henry Thurber | A | D | C | A | D | D | A | B | C | A |
| Ellie Anderson-Zych | C | A | C | B | A | C | D | A | D | D |
| Dushyanth Velugubantla | C | D | B | A | C | A | B | D | A | B |
| Gabrielle Grey | A | A | D | C | B | D | A | D | D | C |
| Weiyuan Fan | D | B | D | D | C | B | B | B | B | D |
| Aham Lee | C | B | A | C | A | B | D | A | B | A |
| Suraj Kannur | C | C | B | D | C | D | C | C | C | C |
| Nathan Bryant | C | D | A | A | D | B | A | C | C | B |
| Nhayeon Lee | B | B | C | C | C | C | D | C | B | C |
| Nathan Irgang | B | C | B | A | A | C | B | D | B | D |
| Muchen Wang | A | B | C | A | D | D | C | A | A | A |
| Anna Klinger | D | A | D | D | B | A | C | B | B | B |

| Key |
|---|
| Video Presentation |
| First Paper Presentation |
| Second Paper Presentation |

| Group | Paper Title |
| --- | --- |
| A | P1_Yethiraj_AVB_soft_dipolar_Nature_2003 |
| B | P2_Sacanna_et_al_Lock_and_Key_Colloids_Nature_2010 |
| C | P3_Breedveld_deformable_microgels_Soft_Matter_2011 |
| D | P4_Casimir_Lifshitz_force_Nature_2009 |

# Virtual Reality in Complex Particle Systems


- The fields of Chemical Engineering and Mechanical Engineering are rapidly evolving, with programmable matter emerging as a central theme in the core curriculum.
- By incorporating VR, we aim to redefine the way that we can engage with complex materials and network structures, fostering educational equity by providing an immersive learning experience for all.

**Lab Agenda:**

**1:45:** Arrive at the Visualization Studio and sit in pairs at a workstation. You may choose your partner.

**1:50:** If you have not already done so, create an account with Meta. Theodore Hall will give a brief introduction to the Visualization Studio and the Meta Quest Pro VR headsets.

**2:00 - 2:30:** Follow the setup instructions and log into the Oculus app on the workstations using your Meta account. Connect the VR headsets to QuestLink. These instructions are also included in the Canvas course for the Visualization Studio, so review your training if needed. Duderstadt and course staff will be present to assist you with this should you encounter any difficulties.

**2:30 - 3:00:** Theodore Hall will demo the Galaxy Cakes environment to explain how to launch demos and operate the controls; please follow along with this demonstration. The same navigation buttons for this demo will apply to most other demos used during this lab session.

**3:00 - 4:00:** Navigate to the class demo folder (Workshops\ChE-496+696\January 30th). This folder contains the demos listed below for you to explore at your own pace. The "Workshops" directory that houses the class folder can be found as a shortcut on the desktop or within the file explorer in the C: drive. Ask for help with this if you need assistance finding the folder!

- Galaxy Cakes
- International Space Station (ISS)
- Lithium Ion Battery Example
- Nanoparticles Structure Exercise (without labels)
- *(Should students complete these demos, we have a more expansive library they can also explore.) –* ***Please ask staff to guide you to find these models.***

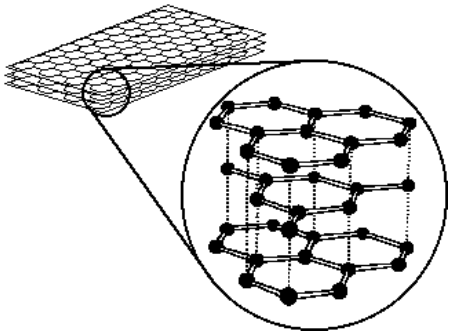
**3:00 – 4:00:** As everyone is exploring demos in the VR headsets, you will be called back in pairs to visit the MIDEN to try the labeling exercise together. Each pair should have about 7 minutes to complete the assignment (2 minutes to put on and adjust glasses, 5 minutes for assignments). Riley will be present at the MIDEN to assist you in case help is needed. Upon completing the labeling activity in the MIDEN, Duderstadt staff will help you take a screenshot on the control computer and label it with your uniqnames. These screenshots will be sent to course staff via email and counted towards your participation in the lab.

**4:00 – 4:10:** Finalize the VR lab assignment.

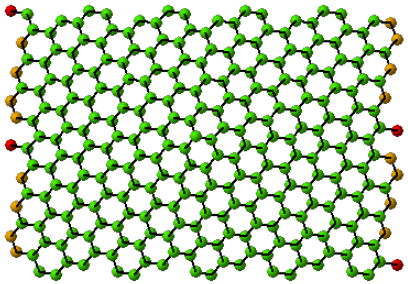
**4:10 – 4:20:** Complete the VR experience survey.

# Single-walled Carbon Nanotubes

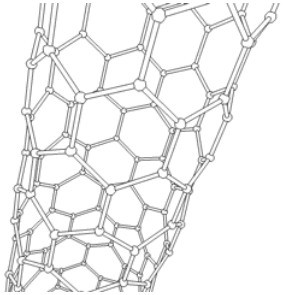
**3D** graphite

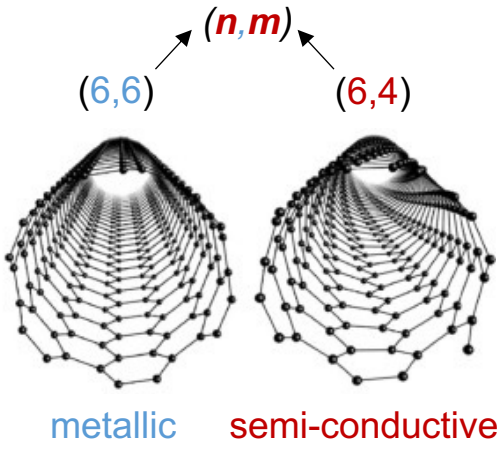


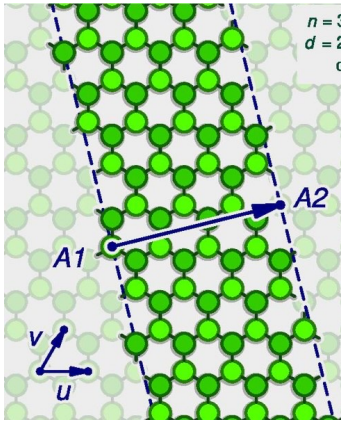
**2D** graphene



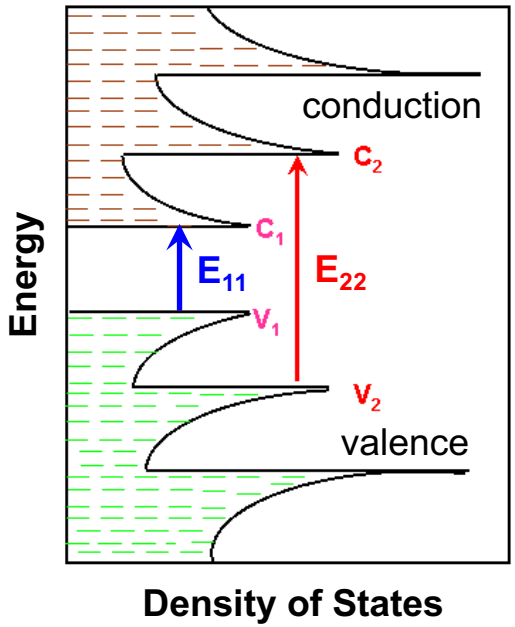
**1D** **SWNT**

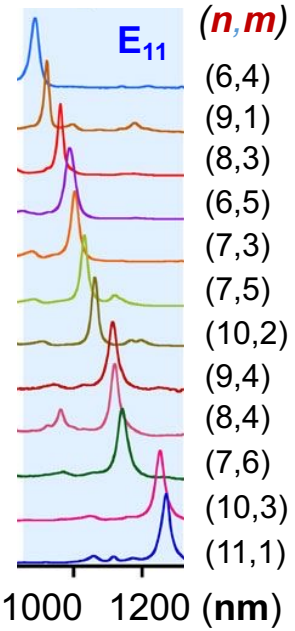


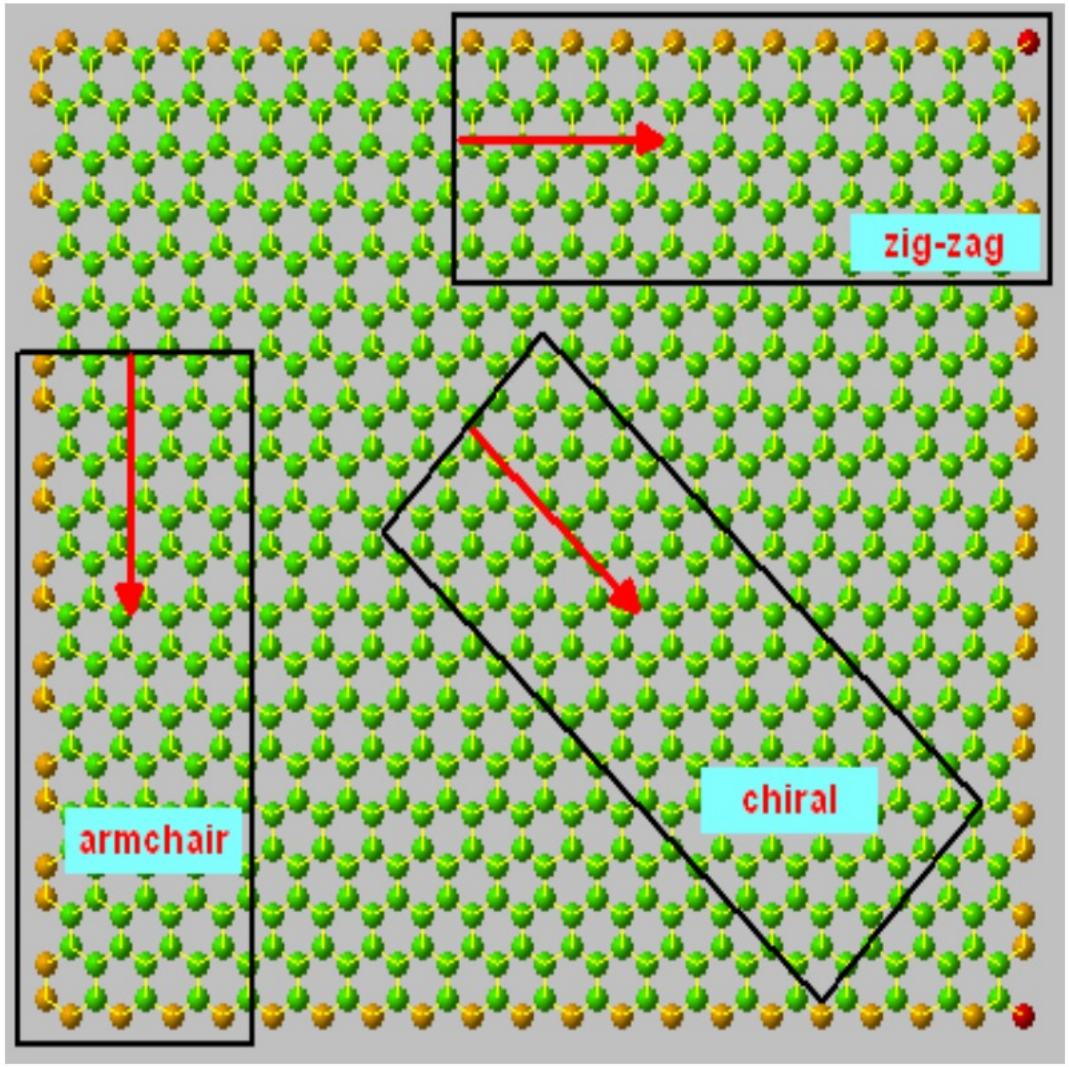


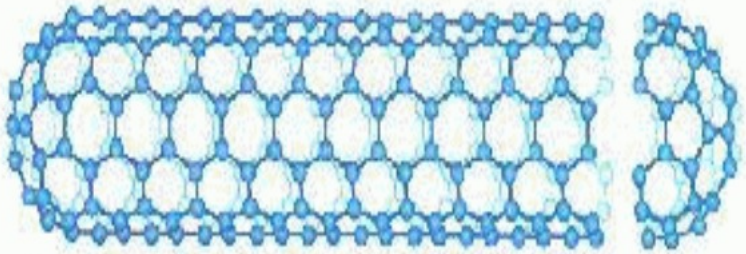

X Wei, H Kataura* et al.
*Nature Communications* (**2016**)



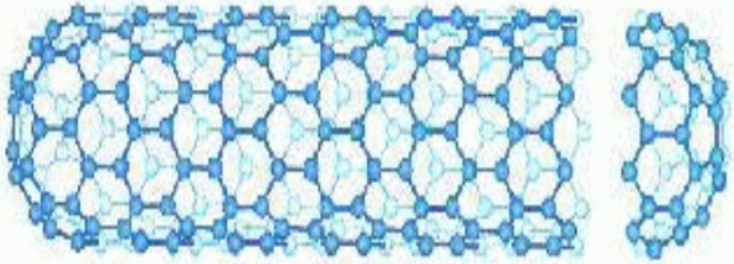




zig-zag
armchair
chiral

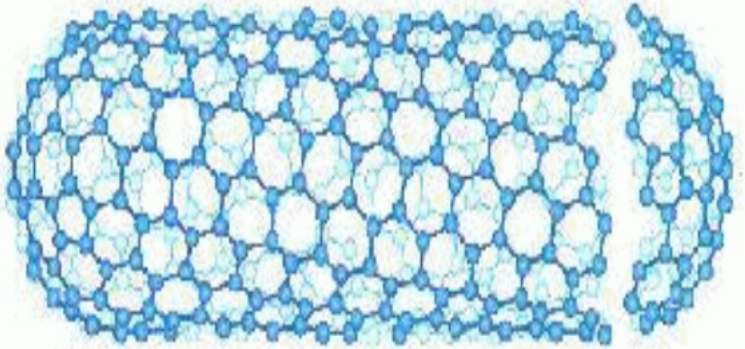
Armchair: n = m



Zigzag: (n, 0)

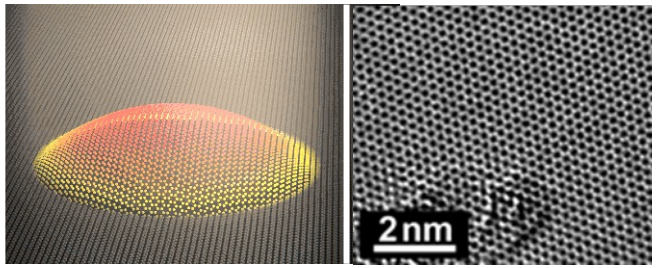


Chiral: (n, m) m≠0

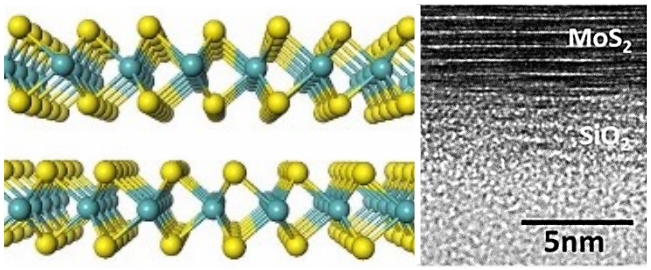


# 2D Materials – **Flexible** Electronic Circuit Elements

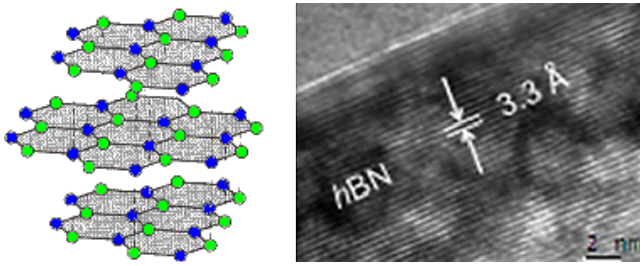
**Graphene** Conductor



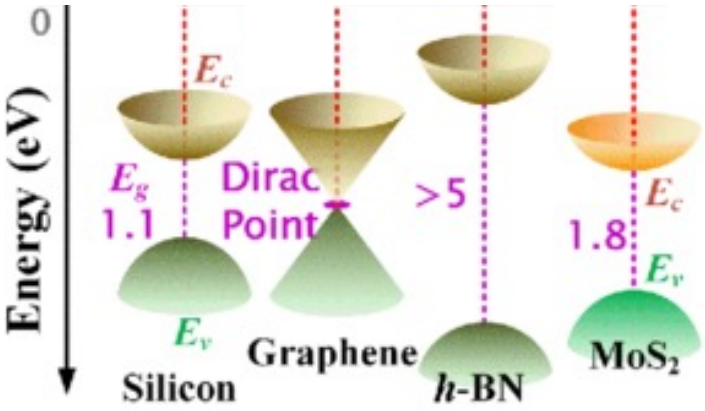

**$MoS_2$** **Semi**-conductor



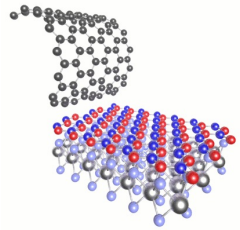

***h*BN** Insulator



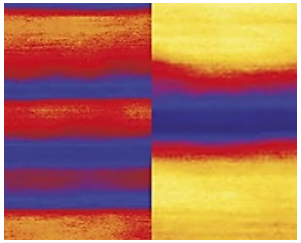

**Electronically** **Tunable**




**Mechanically** **Flexible**



*Nature Mat.* (**2015**)



Gr/$MoS_2$/*h*BN Transistor