Two-dimensional Networks in Materials Science

In 2004, Andre Geim and Konstantin Novoselov successfully produced a curious material in isolation [1]. As simple as just a hexagonal network of tightly bound carbon atoms, this material, graphene, happens to be atomically thin yet incredibly strong, lightweight, a great conductor of heat and electricity, and almost entirely transparent. Due to these extraordinary properties, the possible applications of graphene in scaled-down electronics, alternative energy, smart clothes, ballistics, filtration systems, computers and many more fields are unbounded. In fact, such great is its promise that Geim and Novoselov's isolation technique, known commonly as the "Scotch-tape" method, since it consists of pushing a piece of sticky tape onto a graphite sample and transferring it to a substrate, won them the Nobel Prize in Physics in 2010 [2].

Due to their quantum mechanical nature, materials where one or more dimensions are orders of magnitude smaller than the others exhibit very different physical properties than their bulk counterparts. There has therefore been a dramatic increase in the recent years in the amount of resources allocated to the understanding, production, characterization and utilization of two-dimensional materials. As the target of these efforts, graphene is hardly alone : from monatomic species such as silicene and black phosphorus to more complex systems such as MoS_2 and eventually to larger-scale metamaterials, a whole new world of such materials has become accessible in very different kinds of arrangements and compositions.

In this talk, we will first uncover how mankind's fascination with reducing the size of objects led to the discovery of two-dimensional networks in materials science. We will then take a look at the reasons why two-dimensional materials are so unique yet so ubiquitously available nowadays and finally explore the endless possibilities that they present as they progressively take a larger part in the effort of our development and solving our most important problems.

[1] K. S. Novoselov, A. K. Geim, S. V. Morozov, D. Jiang, Y. Zhang, S. V. Dubonos, I. V. Grigorieva, A. A. Firsov. Science 306, 666 (2004).
[2] https://www.nobelprize.org