

GDR HOWDI 2022 MEETING: A GLIMPSE INTO THE WORLD OF TOPOLOGICAL PHASES IN TWO DIMENSIONS

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Topology is a branch of mathematics which focuses on properties of objects insensitive to smooth deformations. Its first occurrence in the description of matter happened in the 70s: topological numbers allow to classify stable defects of various ordered phases, such as vortices, dislocations or skyrmions. The discovery of the Quantum Hall Effect in 1980, allowed to realize that a quantum electronic phase as a whole can be associated with a topological property. In this tutorial, I will introduce pedagogically the notion of a topological phase, starting from the pioneering works associated to the 2016 Nobel prize. Then I will turn to more recent use of topology to characterize matter, with a special focus on various two-dimensional phases, from quantum spin hall state to twisted bilayer graphene. In particular I will introduce the notion of insulators of a new kind, which are identified not by a standard broken symmetry but by a topological property of their ground state protected by a symmetry. I will then discuss the manifestation of these topological properties as edge states. Finally, I will discuss topological semi-metals, analogs in electronic phases of topological defects in ordered matter.