Topological Phases, Electromagnetic Responses and Bilayer Semimetals

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Topological spaces have numerous applications for quantum matter with protected chiral edge modes related to an integer-valued Chern number, which also characterizes the global response of a spin-1/2 particle to a magnetic field. Such spin-1/2 models can also describe topological Bloch bands in lattice Hamiltonians. We introduce a geometrical approach on the Bloch sphere that allows us to discuss transport and electromagnetic responses. Then, we introduce interactions in a system of spin-1/2s to reveal a class of topological states with rational-valued topological numbers for each spin providing a geometrical and physical interpretation related to curvatures and quantum entanglement. We study a driving protocol in time to reveal the stability of the fractional topological numbers towards various forms of interactions in the adiabatic limit. We elucidate a correspondence of a one-half topological spin response in bilayer semimetals on a honeycomb lattice with a nodal ring at one Dirac point and a robust pi-Berry phase at the other Dirac point. These predictions can be measured in mesoscopic, atomic systems and also in bilayer systems.

[1] This work is related to our article, Joel Hutchinson and Karyn Le Hur, arXiv: arXiv:2002.11823 (*)
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