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Topology at smooth interfaces: the Volkov-Pankratov relativistic spectrum

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Topological matter has recently been a wide source of interest in condensed-matter physics. The hallmark of topology in physics is the presence of gapless Dirac cones, known as the topological states, emerging at an interface between the topological insulator and a trivial one. Controlling these topological surface states and their chirality remains a big challenge as it would bring many important applications in the fields of ultrafast low-consumption electronics, spintronics, valleytronics and quantum computing based on Weyl states for instance.

Such topological states are investigated in $Pb_{1-x}Sn_xSe$ / PbSe heterostructures grown by molecular beam epitaxy. They are localized at topological-to-trivial interfaces formed by stacking $Pb_{1-x}Sn_xSe$ (topological insulator) and PbSe (trivial insulator) layers. This seminar will focus on the intentionally gradual interface realized by a Sn content gradient between PbSe and $Pb_{1-x}Sn_xSe$. The gradual interface allows for the unique experimental study of a progressive change in the band topology over few nanometers. The gapless topological state is observed in magneto-optics and ARPES, and is found to persist independently from the interface thickness. Additional gapped Dirac states localized at the interface are measured in sufficiently thick gradual interface, as predicted for a long time by the theoretical work of Volkov and Pankratov[1]. This theory, as well as more recent ones[2], will be experimentally demonstrated here.

1. Volkov, B. & Pankratov, O. Two-dimensional massless electrons in an inverted contact. *Sov. J. Exp. Theor. Phys. Lett.* **42**, 178 (1985).
2. Lu, X. & Goerbig, M. O. Dirac quantum well engineering on the surface of a topological insulator. *Phys. Rev. B* **102**, 155311 (2020).