

## 2D Materials in Strong Magnetic Fields: Hofstadter physics from first-principles

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We present a first-principles approach for treating 2D materials from weak to strong magnetic fields [1] and more precisely from the integer to the fractal quantum Hall regime. Our approach relies on the expansion on a correlated basis consisting of Landau levels and Bloch waves. In this manner we are able to compute energy bands of 2D materials as a function of the magnetic field strength and to capture the fractal spectrum of the Hofstadter butterfly [2] from first-principles. Further, the connection of the fractal spectrum to experimental transport measurements [3] will be presented, and how our theory allows for the explanation of these measurements and the intricate phenomena related to the Hofstadter butterfly.

[1] V. Rokaj, M. Penz, M. A. Sentef, M. Ruggenthaler, and A. Rubio, Phys. Rev. Lett. 123, 047202 (2019)

[2] D. R. Hofstadter, Phys. Rev. B 14, 2239 (1976)

[3] L. Wang et al., Science 350, 1231 (2015).