Dirac electrons in constant magnetic fields:
a tight-binding description of Landau levels and Hofstadter butterflies

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The impact of magnetic fields on the electronic properties of devices has been an active topic of research for several decades. Bloch electrons in magnetic fields are known to give rise to quantized energy levels and fractal energy spectra. Still, in comparison to the apparent simplicity of the problem, a satisfying theoretical description of the mechanisms at play proves to be quite elusive. One of the reason for this lies within the non-periodic nature of the vector potentials associated with constant magnetic fields.
In this work, we propose a numerical implementation of a nonperturbative approach based on singular Gauge transformations [1]. This general approach is then use in combination with the tight-binding approximation to investigate the spectra of various low dimensional systems under magnetic fields and to numerically assess their fractal structure.

[1] A. Trellakis, PRL **91** (2003) 056405