

## Clifford Boundary Conditions for Periodic Systems

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The definition of a suitable position operator for periodic systems is a non-trivial problem. We recently proposed to replace the coordinate by its complex exponential (multiplied by suitable constants). Then the distance between two points is defined as the norm of the difference of the complex positions of the points. This comes to replace a cell in ordinary space by a Torus. In order to work in a flat space, however, we decided to replace the ordinary torus by the corresponding *Clifford Torus* [1].

The effectiveness of the proposed formalism has been tested through numerical applications to the calculation of properties of both classical and quantum systems [2]. In particular, we computed the Polarizability and Total-Position Spread (TPS) tensor of several model systems described by the Hückel and Heisenberg Hamiltonians. In the case of tight-binding Graphene, for instance, the TPS tensor shows a logarithmic divergence at the K points (see Figure), in agreement with the semi-metallic nature of this system.

[1] K. Volkert, *Bulletin of the Manifold Atlas* (2013)

[2] E. Valença, et al. *Phys. Rev. B*, in press

