**Zigzag edge modes of a Z2 topological insulator --- reentrance and completely flat spectrum**

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Inspired by the contrasting behavior of edge modes of graphene in the zigzag and armchair ribbon geometry, we study the wave function and spectrum of edge modes of a Z2 topological insulator in different edge geometries. Here, [1] the latter is implemented on a two-dimensional (2D) square lattice (chosen to be commensurate with the cartesian coordinates: x- and y-axes), and much focus will be on the (1,1)- (or zigzag) edge geometry (on this lattice). In the model studied, presence of hidden Dirac cones makes the projection of the 2D Dirac cone structure to 1D edge more intriguing, testifying a deeper connection between the edge and the bulk in this topologically nontrivial system. We first point out that at the value of topological mass gap: M=4B (here, 0<M/B<8 corresponds to the topological phase), a pair of completely flat edge modes, analogous to that of graphene in the zigzag edge geometry, appears at E=0 in the (1,1)-edge geometry; besides at this value of M the edge wave function can be trivially solved. We then show, in a half-empirical way, that the above exact solution at M=4B can be extrapolated to the case of an arbitrary M/B. Using the exact solution thus constructed, we highlight the nature of reentrant edge modes, another unique feature of the edge modes in the (1,1)-edge geometry, which typically appear at experimentally realistic values of M: M/B < 1.35... The reentrant edge modes possess two contrasting characters in real and momentum spaces --- though well distinguished in real space, they live in an extremely small energy scale in the spectrum. The reentrance behavior allows for an experimental validation of the present theory in the measurement of local density of states.

[1] K.-I. Imura, A. Yamakage, S. Mao, A. Hotta and Y. Kuramoto, arXiv:1004.5019.