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The strong, weak and anomalous sides of weak topological insulators

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Disorder and topology can be thought of as two counter-driving forces. While the former pushes electron wave functions to localize in space, the latter requires them to remain coherent over the entire system. We study the interplay between these two on the surface of a "weakly" topological phase- the Weak Topological Insulator. Using arguments based on flux-insertions and locality, we show that such surfaces cannot undergo a localization transition even when the surface is strongly disordered. We also present a numerical study which further quantifies this result. We then reformulate the same notions, in field theory language, using a novel Z_2-charge-anomaly. This anomaly generalizes the Z-charge-anomaly associated with edges of the Integer Quantum Hall Effect. Besides unifying various aspects of Topological Insulators, the anomaly allows us to calculate new topological properties of TIs in the presence of electric fields.