Moulding waves into one-dimensional lines: unique properties and applications

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The speaker shows confinement and guidance of electromagnetic waves into effectively a channel of infinitesimal width (i.e. a line) without the aid of any bulk material or enclosing structure. This new wave type occurs at the interface between two planar sheets, laid side by side in air, which form inverted mirrors of each other, that is, by showing complementary effect on the electric and magnetic components of the wave. The inversion-symmetry produces two decoupled direction-dependent states, thus permitting reflection-free signal transmission, even in the presence of certain structural defects. This is reminiscent of photonic topological insulators, albeit favorably without a bandgap restriction. Moreover, the wave's speed, spatial extent, and pathway are adjustable by tuning the relative properties of the interfaced sheets, hence allowing more flexibility than other one-dimensional modes, such as those at sharp edges of metallic wedges, grooves or plates.

The line wave can be implemented using inductive and capacitive artificial impedance surfaces or one-atom thick materials such as graphene under the right circumstances. Besides forming the smallest waveguide possible, the wave contains a field singularity at the line interface in the mathematical limit, so that even using real materials, energy is strongly enhanced, which is beneficial for sensing, nonlinear effects, and potentially future vacuum electronics applications. In addition, this work would be attractive for reconfigurable systems with switching and modulation capabilities, robust integrated photonic circuits as well as chiral quantum processes.