Transformation Optics

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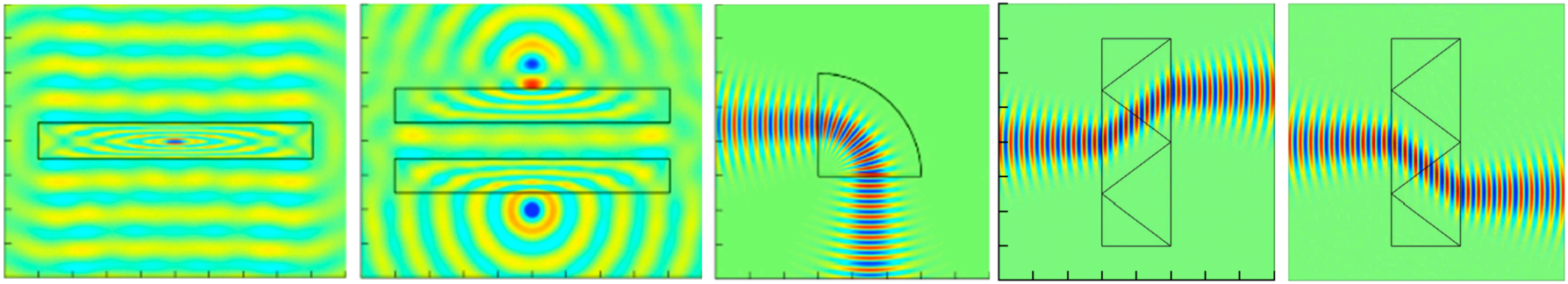

Transforming electromagnetic waves

Metamaterial lenses for practical devices

Metamaterial lenses bend and guide incident waves in novel ways not previously possible in order to realize devices such as electromagnetic cloaks, wave collimators, far-zone focusing lenses, and polarization converters. These devices are based on the invariance of Maxwell's equations under coordinate transformations. Material parameters are obtained by writing Maxwell's equations for the transformed system. The coordinate transformations are interpreted as inhomogeneous, anisotropic compression and stretching of the constituent material in the original space. Research on transformation optics is just beginning, and many theoretical and experimental details are being developed and refined.

Until now, the application of transformation optics has been limited to electromagnetic cloaking. Researchers at Penn State introduced new applications including wave collimators, near- to near-zone and near- to far-zone converters, right-angle bends, and polarization splitters. Flat transform lenses can be used as building blocks in larger optical systems. For example, two near- to far-zone converters can be cascaded to make a near-field focusing lens. The exploration of transformation optics for use outside of electromagnetic cloaking has opened a new realm of applications for metamaterials in practical situations.

Kwon, D.-H. & Werner, D. H. Transformation optical designs for wave collimators, flat lenses and right-angle bends. New Journal of Physics 10, 115023 (2008).

Kwon, D.-H. & Werner, D. H. Polarization splitter and polarization rotator designs based on transformation optics. Optics Express 16, 18731-18738 (2008).