Advanced Electromagnetics:
21st Century Electromagnetics

Other Applications of Transformation Optics

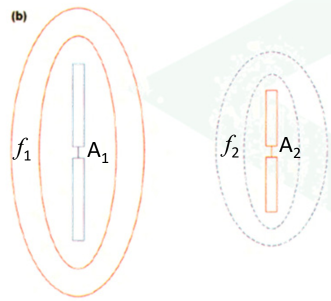
Electromagnetic Cloaking of Antennas (1 of 2)

An antenna can be cloaked to either render it invisible to a “bad guy” or to reduce the effects of scattering and coupling to nearby objects.

This implies a “dual band” mode of operation because the cloak must be transparent to the radiation frequency of the antenna.

Metamaterials used to realize cloaks are inherently narrowband which is an advantage for this application.

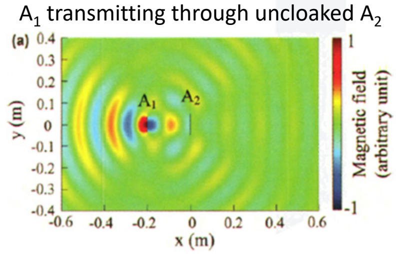
Electromagnetic Cloaking of Antennas (2 of 2)



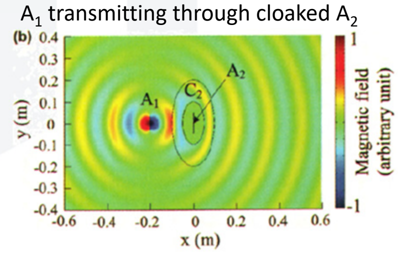
Antenna A_1 transmits at frequency f_1.
Antenna A_2 transmits at frequency f_2.

Cloak of A_1 must be transparent to f_1.
Cloak of A_2 must be transparent to f_2.

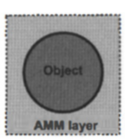
A_1 transmitting through uncloaked A_2



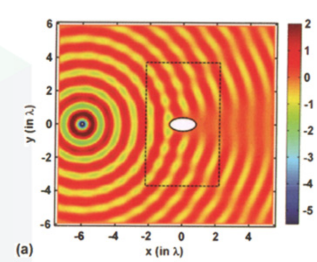
A_1 transmitting through cloaked A_2



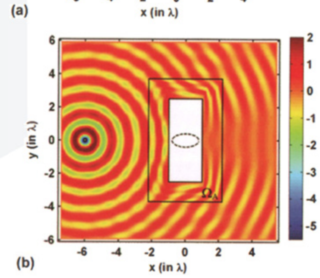
Reshaping the Scattering of Objects



Scattering of an elliptical shaped object.



Rectangular object embedded in an anisotropic medium designed by TEM to scatter like the elliptical object.



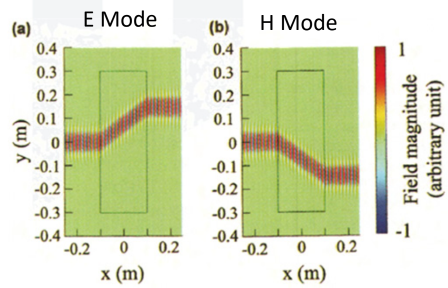
O. Ozgun, M. Kuzuoglu, "Form Invariance of Maxwell's Equations: The Pathway to Novel Metamaterial Specifications for Electromagnetic Reshaping," IEEE Ant. And Prop. Mag., Vol. 52, No. 3, 51-65 (2010).

Polarization Splitter

Device is made uniform in the z direction.

Maxwell's equations split into two independent modes.

Each mode can be independently controlled.



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Polarization Rotator

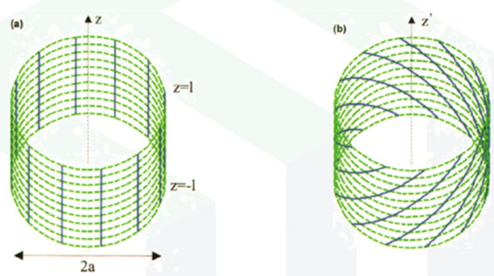

Figure 13. The coordinate transformation employed to design a beam-polarization rotator: (a) the original coordinate system, (b) the transformed coordinate system. The entire circular cylindrical volume is transformed, but only the cylindrical shell is displayed for clarity of illustration.

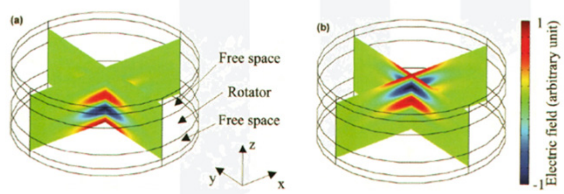

Figure 14. Snapshots of the total electric-field distribution in the x-z and the y-z planes [76]: (a) E_x, (b) E_y. An $\hat{x}$-polarized Gaussian beam impinged upon the device from the $-\hat{z}$ direction.

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Wave Collimator

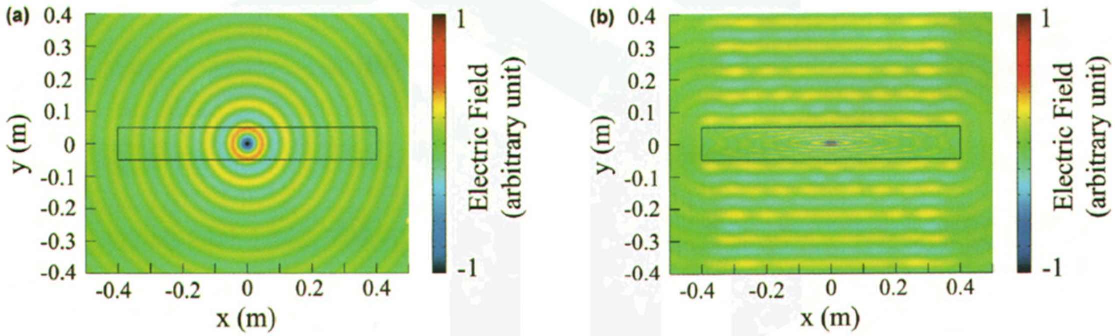

Figure 16. Snapshots of the $\hat{z}$-polarized total electric-field distribution due to an electric line source located at the coordinate origin: (a) with the line source radiating in free space, (b) with the line source embedded in the wave collimator.

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Flat Lenses

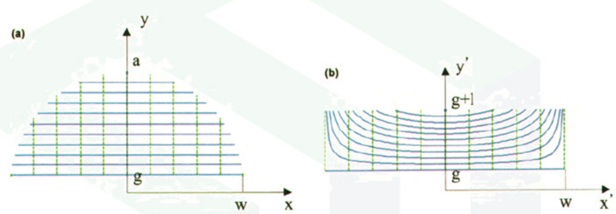

Figure 17. The coordinate transformation for a two-dimensional far-zone-focusing lens design: (a) the original coordinate system, (b) the transformed coordinate system.

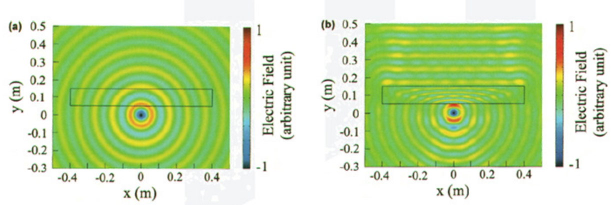

Figure 18. Snapshots of the total electric field for a line source radiating at the coordinate origin: (a) for the line source radiating in free space, (b) for the line source radiating in the presence of the far-zone-focusing flat lens.

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Beam Benders

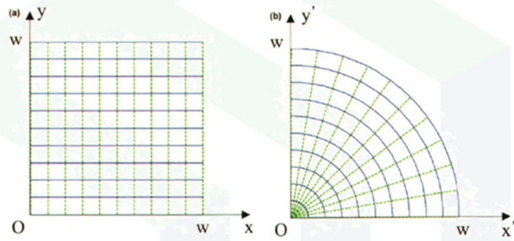

Figure 20. The coordinate transformation for the two-dimensional right-angle-bender design: (a) the original coordinate system, (b) the transformed coordinate system.

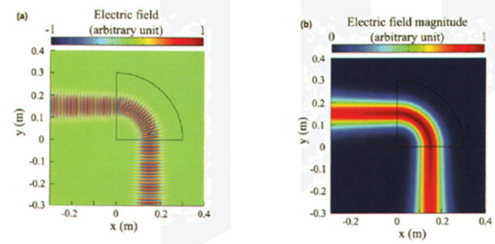

Figure 21. The performance of a right-angle beam bender: (a) a snapshot of the total electric field for a two-dimensional Gaussian-beam illumination from the $-\hat{x}$ direction at a right angle, (b) the magnitude distribution of the electric field.

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