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Controlling Electromagnetic Waves

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The two terms metamaterials and transformation optics (TO) are perhaps the two most common heard words in electromagnetics and optics in the last decade. The excitement is due to endless possibilities that these two subjects can provide in terms of controlling light (EM waves). While the metamaterials provide the necessary engineering tools and materials, TO gives us a recipe (mathematical tool) for designing unusual optical elements. Furthermore, TO unveils the physics of unusual optical effects and helps us to understand the underlying physics of these unusual phenomena. The underlying mechanism of TO relies on the form invariance of Maxwell's equations, where Maxwell's equations keep their form under any coordinate transformation. Through this form invariance, one can show that all the metric information is preserved in the material properties (ϵ , μ). Interestingly, now these material tensors can be realized through the metamaterial technology, allowing many optical effects to be realized in practice such as; invisibility cloaks, optical black holes, perfect lenses, and etc.

In this presentation, I will give an overview of the TO concept in connection with the recent applications and their metamaterial realizations. The historical background of controlling light will be briefly discussed in the light of TO theory. Finally, I will discuss the complex extension of TO (CTO) and give some recent application examples of CTO.

Hayrettin Odabasi, Ph.D.

Hayrettin Odabasi received his M.S. and Ph.D. in electrical engineering from Syracuse University and The Ohio State University respectively. During his Ph.D. under the supervision of Prof. Fernando L. Teixeira, he worked on transformation optic and metamaterials with applications to waveguide and antenna problems. After his Ph.D. he worked as a post-doctoral research fellow at Duke University under the supervision of Prof. David Smith, where he continued his research on the development of metamaterial based imaging systems. Currently, he is a research fellow at the Electrical and Electronics Engineering department at the Eskisehir Osmangazi University. His research interest includes: transformation optics, metamaterials, antenna design and miniaturization, computational electromagnetics, microwave imaging.