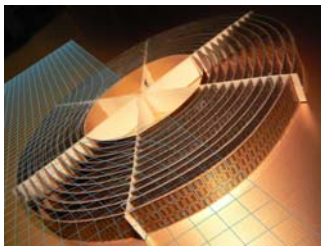


The Virginia Tech Department of Physics presents  
the following colloquium:

Dr. David Schurig (Duke University)

*“The Transformation Design Method and  
Metamaterials: Tools to Realize Invisibility and  
Other Interesting Effects”*



**Abstract:**

I will explain how the transformation design method works. One begins this design process by imagining a fictitious space with an interesting or useful property, for example, a hole for hiding things, or a dense region that concentrates energy. I will explain how such fictitious spaces can be described mathematically by a coordinate transformation. Then I will explain how the theory of such coordinate transformations and the form invariance of Maxwells equations (also explainedI hope) leads directly to a material specification. This material specification can implement the electromagnetic properties of the interesting fictitious spaces in the boring, approximately "flat", three dimensional space in which we live.

We have used this method to design invisibility cloaks, but the method is quite general and can be used to design a wide variety of interesting devices that guide, concentrate or shape electromagnetic fields in ways that would be difficult to manage with other design methodologies. Applications range from stealth to energy conversion and distribution to wireless communications to biomedical imaging. The drawback of the method is the complexity of the material specifications that it produces, which have particular anisotropy (variation with angle) and inhomogeneity (variation with position). Only with recent advances in the field of metamaterials can these specifications be realized. I will discuss how metamaterials accomplish this and what their limitations are, e.g. bandwidth, absorption, frequency range etc. I will discuss in detail the recent implementation of an invisibility cloak in the microwave spectrum. Unlike, traditional stealth, an invisibility cloak reduces both reflection and shadow. Thus both these ways of detecting an object, (the reflection of electromagnetic waves incident on the front of an object and the blocking of electromagnetic waves originating from behind the object) are weakened. If such a cloak were implemented for visible light (a daunting task), then when one looked at the cloaked object one would see the scene behind it.

**Fri., Mar. 30 @ 2:30 P.M.**  
**300 WHITTEMORE HALL**