Analogue Transformation Acoustics

Covariant Methodology in Transformational Acoustics

Executive Summary

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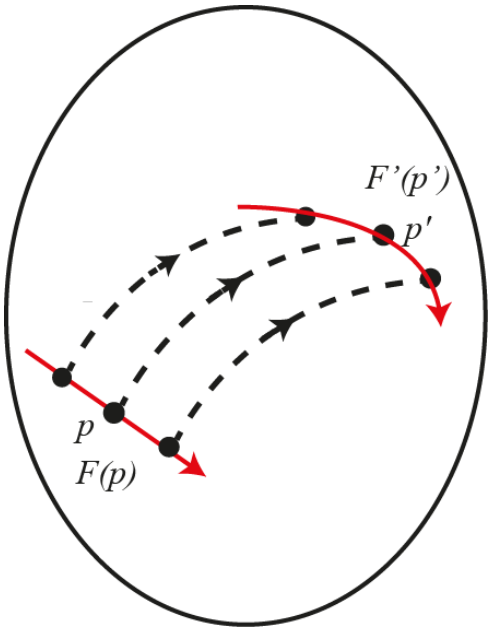
Picture:



Motivation:

Our goal was to understand how the principles of transformation optics, in which any well behaved deformation of space can be actualised by a suitable anisotropic, inhomogeneous medium, can be translated to the field of acoustics.

Methodology:

Taking electromagnetism as our paradigm, we sought to restate the underlying equations of acoustics with minimal a-priori assumptions on the underlying geometry. In particular, the role of the metric (which is almost completely dispensable in electromagnetics), was only introduced when necessary

Results:

- Rigorous transformation theorem for inertial media
- Rigorous transformation theorem for pentamode media
- Approximate (ray-based) recipe for relating any desired ray deformation to an index distribution

Publications:

Kinsler, P., McCall, M. And Favaro, "Transformation Acoustics, Transformation Mechanics: a general theory of transformation devices", AFPAC 2012, Brighton, 2012.

Kinsler, P. and McCall, M.,"*Transformation media: space and time, curvature and carpets*", Metamaterials 2012, St Petersburg, 2012.

McCall, M.,and Kinsler, P., "*Transformation mechanics and transformation media",* Photon 12, Durham, UK, 2012.

McCall, M., "*Spacetime Cloaking*", Invisibilité, Protection et Méta-matériaux, Workshop Scientifique au siège du CNRS, 2012

Highlights:

Geometrical (ray) transformation theory allows any desired ray deformation to be related to an index distribution. This can be applied to any theory in which a transport vector, v(r) = flux(r)/[energy density(r)] is defined. For acoustics, the possibility exists for designing media that can acoustically cloak a given region, or deflect acoustic energy away from certain areas. Beyond acoustics, the theorem may find significance in areas such as heat and particle diffusion, and the manipulation of quantum waves.