Truly Broadband 3D metamaterials

Most of metamaterial physics is based upon the arrangements of subwavelegnth, resonant elements. There is a lot of amazing things that can be done with these materials, but relying on resonance to achieve interesting effects by definition makes bandwidth a problem.
Recent work at Exeter and beyond has focussed on a new class of metamaterial made of intertwined conductive lattices [1]. In this case, there are no discrete elements, and therefore the material properties are not defined by resonant effects – instead the unusual properties of this class of material arise from the difference in potential between the different lattices. Thus the effects are extremely broadband, spanning several orders of magnitude of frequency. Beyond this, these materials show potential to interact with electromagnetic waves in a number of exotic manners, such as negative diffraction, unusual mode-shapes, and the ability to behave as switchable mirrors.

This is a new class of metamaterial, whose potential has been largely untapped so far and so this is an exciting opportunity to get in on something close to the ground level. This project would suit a self-motivated student willing to get involved with some difficult physics and also some exciting experiments.

Please contact Dr. Alex Powell (a.w.powell@exeter.ac.uk) with any questions.

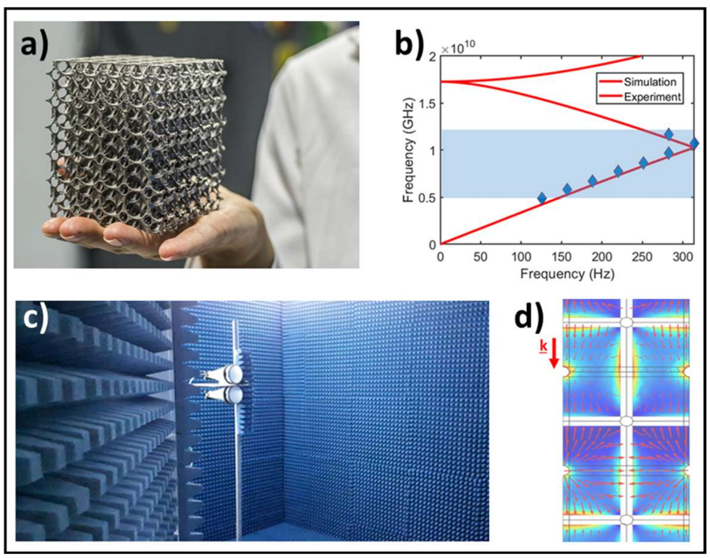

Figure 1 : a) A 3D printed metamaterial metallic mesh. **b)** Simulated and experimental dispersion relation for a 3D interlaced mesh showing broadband, dispersionless behaviour from 12 GHz down to DC. **c)** The anechoic chamber at Exeter used to take data for these experiments. **d)** Electric field within the mesh showing the unique electromagnetic behaviour of these structures.

References:

1. Dark Mode Excitation in Three-Dimensional Interlaced Metallic Meshes AW Powell, RC Mitchell-Thomas, S Zhang, DA Cadman, AP Hibbins,JR Sambles, ACS photonics 8 (3), 841-846
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3. Chen, WJ, Hou, B, Zhang, ZQ, Pendry, JB, Chan, CT, Metamaterials with index ellipsoids at arbitrary k-points. *Nat. Commun.* **2018**, *9*, 2086