

EPSRC DTP PhD Research Project

Project Title: Nonreciprocal transport in metamaterials

Primary Supervisor details: Dr. Charles Andrew Downing, C.A.Downing@exeter.ac.uk
https://physics-astronomy.exeter.ac.uk/people/profile/index.php?web_id=cad208

Additional Supervisory team details: Prof. Mikhail Portnoi, M.E.Portnoi@exeter.ac.uk
https://physics-astronomy.exeter.ac.uk/people/profile/index.php?web_id=meportnoi

Department: Physics and Astronomy

Location: Physics Building, Stocker Road, Streatham Campus, Exeter

PhD Programme: PhD in physics

Project Description:

Reciprocity in the animal kingdom gave rise to the evolution of reciprocal altruism: “you scratch my back, and I will scratch yours”. Aside from mere grooming, the consequences of reciprocity for the sharing of food, medicine and knowledge are profound. However, the breakdown of reciprocity, perhaps fuelled by a lack of affinity or obligation, can also lead to certain benefits for the non-reciprocator, who can profit from the nonreciprocal interaction. Introducing the concept of nonreciprocity into metamaterials research also allows one to profit from nonreciprocal interactions, with immediate technological applications. Nonreciprocal devices, such as optical circulators and isolators, rely on the directional transfer of energy and information at the nanoscale. Furthermore, the realization of nonreciprocal waveguides will lead to extraordinary propagation lengths, being immune to backscattering.

In this project, we will construct theoretical models inducing nonreciprocity in metamaterials, for example those built from nanoscopic lattices of meta-atoms. We will consider how topology, dissipation and various symmetries can be employed to create a new class of nonreciprocal metamaterials with extraordinary transport and directional properties. Our work will be done in close collaboration with the leading experimentalists in Exeter, where the novel phenomena that we discover can be simulated by, for example, acoustic waves or microwaves. The results of this project should guarantee future applications in wave physics, metamaterials and nanotechnology, particularly via the exploitation of the unidirectional flow of excitations.

Entry Requirements: First degree in physics, mathematics, engineering or a related subject

Project specific enquiries: Please e-mail Dr. Charles Downing C.A.Downing@exeter.ac.uk for project specific enquiries.