Project 1: Graphene Optics: A Flatland of Renewable Energy

Description:

The purposes of this project are to employ graphene to redesign metamaterial structures, since graphene has outstanding tunable electrical and optical properties and behaves in a similar fashion of noble metals but with almost no loss. By tailoring their photonic and optoelectronic properties, we will investigate their potential applications in guiding electromagnetic wave and light harvesting for high-efficient green energy. More importantly, such devices will be just one-atomic think, resulting in great compactness. We expect that our research will make a great impact and economic return in the fields of green energy, nanotechnologies, and optoelectronics. He/she will investigate graphene-based metamaterial structures, their photonic and optoelectronic properties, and their potential applications in guiding electromagnetic wave and light harvesting. This is particularly important for the strategic development of sustainable energy. The current project stands in the front-line of the graphene and metamaterial research, with topics ranging from theoretical study to design and fabrication techniques and practical device applications.

Co-supervisors:

Prof. Stefan Maier (Imperial College) & Prof. Andrew Wee (NUS)

Project 2: Beam Optics for realizing novel micromanipulation (Optical Trapping,

Dragging, and Beyond)

Description:

A photon carries a momentum, so usually one may anticipate the light to “push” any object standing in its path via the scattering force. This is simply due to the momentum conservation. In this project, we will investigate the exact counterpart: realization of a backward scattering force by a light beam without creating an equilibrium point of gradient (i.e., distinguished from trapping effects by optical tweezer). The major criterion is to manipulate the beam-particle interference to maximize the transfer of momentum along the forward direction, so that the reaction force will be towing the particle all the way towards light source continuously, i.e., the fantasy of tractor beam. The stringent optical setup of generating such tractor beam could be further alleviated by the involvement of metamaterials. Via this joint-phd project, we aim to model, simulate and eventually realize a prototype of such tractor beam in either microwave or optical regimes.

Co-supervisor: Prof. Ortwin Hess (Imperial College)

Common Requirements: good solid-state physics and (or) optics/photonics background. Good GPA (any research experience will be a plus).

Language prerequisite (must fulfilled):

IELTS: overall of 6.5, with 6 in Writing and Speaking

Or

TOEFL: overall of 100, with 24 in Writing and Speaking

Program:

NUS-ICL Joint Phd Program: A single PhD degree jointly endorsed by National University of Singapore and Imperial College London.