Professor Ekaterina Shamonina

Metamaterials with interacting "meta-atoms"

Metamaterials are artificially created structures with unusual electric and magnetic properties that are difficult or impossible to find in nature. The initial upsurge of interest was triggered by verifications of new phenomena which come about when negative permeability and negative permittivity can be simultaneously realized in the same frequency band. New potential applications (e.g., invisibility cloak or a subwavelength lens) have been emerging at a high rate, and considerable progress has been made on both the theoretical and experimental fronts.

The building blocks of metamaterials are resonant elements much smaller than the wavelength of the electromagnetic wave and can be seen as “artificial atoms” with strong electric and/or magnetic response to the electromagnetic radiation. The main advantage of metamaterials over naturally occurring materials is that their electromagnetic properties can be designed and controlled by choosing the shape of the elements and the way they are arranged within the structure.

In this talk we review our work on the role of electromagnetic interactions between resonant elements comprising a metamaterial structure. We show how magnetoinductive waves, slow waves propagating by virtue of coupling between metamaterial elements, can be employed for guiding and manipulating electromagnetic waves on a subwavelength scale, with potential applications ranging from detection of nuclear magnetic resonance at MHz, wireless power transfer at GHz, to subwavelength imaging in the visible.