INPAC Lectures on Trends in Nanoscience

Left-handed media: recent breakthrough in optics and nanophotonics

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1st Lecture: June 14 at 16h00
2nd Lecture: June 19 at 16h00
Coffee at 15:45
Celestijnenlaan 200D, room 05:11

Abstract

In two lectures an overview will be given of the fundamental electrodynamic properties of the novel so-called *left-handed media* (LHM) which possess simultaneously *negative* dielectric permittivity and *negative* magnetic permeability. Most of unusual phenomena in such media are caused by excitation of bulk *backward* electromagnetic waves with oppositely directed wave vector and vector of energy density flow that, in turn, leads to the *reversed Doppler and Vavilov-Cherenkov effects, negative light pressure and negative refraction of electromagnetic waves*. The negative refraction seems to be one of the promising phenomena for applications.

Both geometrical optics and wave effects will be considered including *sub-wavelength imaging and "perfect" lensing* which arise due to the negative refraction. The peculiar properties of the surface polaritons at the interface between LHM and usual (right-handed, RH) medium and their excitation will also be discussed. The recent progress in this field is related to the manufacturing of micro and nanostructured composite materials (or metamaterials) demonstrating left-handed properties. The ideas underling the microstructure of LH metamaterials will be outlined. To clarify these ideas the detailed microscopic derivations of effective dielectric permittivity and magnetic permeability will be presented.

The key experiments demonstrating left-handed properties of metamaterials and overcoming the diffraction limit in different frequency domains from microwaves to optics will be reviewed. The suppression of the left-handed properties by the disorder will be considered. The effects of metamaterials discreteness, such as magneto-inductive waves' excitation, spatial dispersion, resonant cones etc. will be discussed as well.

The final part of the lectures will be devoted to the novel possible perspective developments of the LH metamaterials such as nonreflecting birefringent metamaterials, tunable nonlinear metamaterials, LH/RH bandgap structures, metamaterials consisting of metal nanoparticle arrays, etc. and to their possible applications.