UNIVERSITY OF TEXAS AT DALLAS - DEPARTMENT OF PHYSICS

PHYSICS COLLOQUIUM

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Wednesday, April 13, 2005; 4:00-5:00 PM
in Kusch Auditorium, FN 2.102

THE PHYSICS OF NEGATIVE REFRACTION

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Because of both fundamental and practical importance, there has been an explosion of interest in predicted in 1968 by V. Veselago [1] left-handed materials (LHM) that are also known now as negative refraction (NR) or negative index materials (NIM). In his paper, Veselago considered homogeneous isotropic media having simultaneously negative dielectric, $\varepsilon(\omega)$, and magnetic, $\mu(\omega)$, constants. It is now becoming generally understood that the critically important property in this class of NIMs is that the wave phase velocity should be directed opposite to its group velocity, the latter in fact determining the energy propagation direction. Recently artificial LHMs have been created for microwave (MW) frequencies using split-ring resonator arrays embedded into metallic meshes and also in photonic crystals but still for the microwave frequency range (see [2] for recent reviews).

The reason that the phenomenon of negative refraction has become so interesting to the physics community is also due to the notion that this phenomenon would never occur in conventional natural materials. In the talk we make a few remarks on the history of NR studies, discuss a general approach for the study of NR also in non-magnetic materials and demonstrate by way of examples that negative refraction may occur in optical domain in natural bulk materials and at surfaces supporting surface electromagnetic waves [3]. It is not MW, but the IR and visible optical domain, in which most of photonic and telecom devices operate and in which one would expect most interesting applications of such unusual property as negative refraction.

We will also briefly discuss harmonics generation in LHM. While the medium may appear as LHM to the fundamental input wave, it is likely an RHM to the harmonic output waves, or vice versa. This creates in the bulk of the medium (as well as at the surface) unusual relations between wave and energy propagation directions of the input and output waves.

[1] V.G. Veselago, Sov. Phys.Usp. 10 (1968) 509; [2] J.B. Pendry, Contemporary Physics 45 (2004)191; Y. Zhang et al., Modern Physics Letters 19 (2005) 21; [3] V.M. Agranovich, Y.R.Shen, R.H.Baughman, A.A.Zakhidov., Phys. Rev. B 69 (2004) 165112; J. Luminescence110 (2004) 167; V.M. Agranovich, A.A. Zakhidov (in preparation).

About the speaker: "Vladimir Agranovich is known as a condensed matter physicist with a world-wide outstanding reputation. He is appreciated for his innovative ideas and his broad and profound contributions to a variety of fields in condensed matter physics, as a teacher transferring his ideas with enthusiasm to his younger colleagues and students and as an author and editor of scientific journals, books and book series" (Excerpt from the dedication of a special volume of Journal of Luminescence 110 (2004) 165 to honor Professor Agranovich on occasion of his 75th birthday.)