Physics Colloquium, University of South Florida
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☞☞*Refreshment available* ☜☜

Broken symmetries, nonreciprocity, and terahertz optical diodes

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When a light beam traveling in one direction in a crystal experiences a different absorption and refractive index compared to the beam traveling in the opposite direction, it is called nonreciprocal directional anisotropy, or simply nonreciprocity. This phenomenon is governed by the fundamental symmetries of crystals under spatial inversion and time reversal symmetries. We will discuss the necessary symmetry conditions for the nonreciprocity of light propagation and of other excitations in solids. Among specific examples, we will consider light propagation, in polar magnetic materials along and opposite the toroidal vector. In this case, a crystal can be completely transparent in one direction and completely opaque in the opposite one – an optical diode. We report a giant optical diode effect in the polar material FeZnMo3O8, where we find more than a 100-fold difference in intensity of light transmitted in the two opposite directions. In addition to the high magnitude of the effect, we show that the effect exists at high temperature in the magnetically disordered state. We will also present a study of the nonreciprocal reflectance of magneto-plasma in semiconductor InSb. This material can be used for the construction of practical terahertz isolation devices, as no dominant technology has emerged yet for this application.

Dr. Diyar Talbayev is an assistant professor in the Department of Physics and Engineering Physics at Tulane University, where he currently holds an NSF CAREER award. Dr. Talbayev graduated with a PhD in condensed matter physics from Stony Brook University. He subsequently held postdoctoral appointments at the College of William and Mary and Los Alamos National Laboratory. He also worked as an associate research scientist at Yale University.