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Thermoelectric power generators based on topological insulators and spin Seebeck devices

This talk will address the modern physics challenges of thermoelectric power conversion, the ultimate efficiency of which is given by so-called figure of merit ZT. I will try to argue how these challenges may be overcome by using new types of materials and an additional (spin) degree of freedom. First, I will explore new ways to enhance the thermoelectric conversion using topological insulators (TIs), a novel class of quantum materials with insulating bulk and topologically protected conducting surfaces with Dirac-like band structure. I will consider (1) TIs with high density of holes (or pores) propagating through the bulk and (2) dirty TIs with high density of topologically protected dislocations. The figure of merit in these systems can be large due to high ratio of perfectly conducting surface states (or 1D states propagating though the dislocations) to the bulk and the suppressed phonon thermal conductivity. We show that in principle these systems can have ZT much higher than 1, hence making them ideal for heat management applications. Finally, an alternative approach to enhance ZT by directly employing the spin of electrons will be described. It will be based on the spin Seebeck effect, i.e. the generation of spin currents by a temperature gradient. The two spin-caloritronic device alternatives will be explored: using (1) the inverse spin Hall effect and (2) a spin-valve structure

Oleg Tretiakov is currently an Assistant Professor in the Institute for Materials Research at Tohoku University, Japan. His research is in diverse areas of condensed matter physics and materials science. In particular, he focuses on topics such as spintronics, nanomagnetism, topological insulators, thermoelectrics, and dynamics of topological textures in nanostructures. Oleg's academic career began at Moscow Institute of Physics and Technology where he received his B.S. in Physics and Math. He received his Ph.D. in Physics (2005) at Duke University. After his Ph.D. he was as a postdoctoral researcher at the Johns Hopkins University, New York University, and Texas A&M University.

Monday, March 10, 4:00 pm
Room 136 Jorgensen Hall

Host:
Prof. Kirill Belashchenko
Department of Physics

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