Spin Current and Spin Caloritronics

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The coupling between spin and charge transport is studied in the field referred as spin-electronics or spintronics. The field of spin caloritronics focuses on the interaction of spins with heat currents and combines spintronics with thermoelectrics and magnetism [1]. Spin caloritronics is as old as spintronics; it started in the 1980's with the work of Johnson and Silsbee, who applied the methods of nonequilibrium thermodynamics to study the transport of charge, heat, and nonequilibrium magnetization in metallic heterostructures [2]. The field remained largely unexplored for many years and has been stimulated by newly unveiled physical effects that may lead to the development of novel thermoelectric devices [3-6]. These new phenomena include collective effects caused by spin waves that can be observed in both metals and insulators, such as the spin Seebeck effect [4], and effects that can be modeled by two parallel spin-transport channels with distinctive thermoelectric properties that can only be observed in metals, such as the thermal spin-transfer torque [5]. In this lecture, I will give an overview of our understanding and the experimental state-of-the-art of spin caloritronics.

[1] For an introduction to the physics and applications of spin currents refer to *Spin Current,* S. Maekawa, S. O. Valenzuela, E. Saitoh and T. Kimura, Eds (Oxford University Press, Oxford, UK, 2012).

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