PHYSICS AND ASTRONOMY COLLOQUIUM

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Thermal properties of magnons and magnetic properties of phonons

The spin Seebeck effect (SSE) has been observed in ferromagnetic metals, semiconductors and insulators. It originates when a thermally driven spin flux in the ferromagnet crosses the interface into a metal with strong spin-orbit interactions, where it gives rise to a measureable inverse spin-Hall electric field. The thermal spin flux can be carried by either magnons or spin-polarized electrons. The magnon thermal conductivity in ferromagnets gives, under a temperature gradient, a magnon heat flux that is directly proportional to a spin flux. The talk will outline recent temperature-dependence measurements of the SSE in the Pt/TIG system, and the observation that most of the effect comes from specific magnon modes of energy around 40 K. Spin-polarized electrons can also sustain a spin flux: the SSE effect can then be as large as the highest thermoelectric voltages in semiconductors. The relation between SSE and magnon-drag thermopower, first identified on Fe, will be shown, both in the thermopower and in the Nernst coefficient of elemental Fe.

Conversely, we will also show how phonon anharmonicity can be affected by magnetic fields, even in diamagnetic systems. The local atomic displacements corresponding to the phonons locally modulate the valence band, which in turn creates a very small local modulation of the local diamagnetic susceptibility. In the presence of an external magnetic field, this exerts a local magnetic force on the atoms, which affects the Grueneisen parameter and thus phonon-phonon interactions. The effect on the lattice thermal conductivity of InSb is measurable, and modeled by the theory without any adjustable parameter.

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