# 'Phonon Hall Effect' Observed

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What effect do magnetic fields have on uncharged particles?
Their effect on charged particles is familiar to every student of physics or electrical engineering. A common example is the Hall Effect, a basic phenomenon of solid state physics. This effect arises in current carrying materials when a magnetic field is applied perpendicular to the current flow.

The Lorentz force of electromagnetism acts perpendicularly to both the current and the magnetic field, establishing a voltage gradient in the material. Intuitively, one would not expect an analogous effect on uncharged particles, which do not couple to magnetic fields though obvious mechanisms like the Lorentz force. Yet in the October 7th issue of *Physical Review Letters*, French physicists report such an effect with phonons, uncharged units of mechanical excitation in solids. The group dubbed their finding the “phonon hall effect.”

The observed phenomenon is simple to describe. The experimenters induce a thermal current in a small crystal block by clamping two ends of the block with two heaters at different temperatures. They then apply a magnetic field to the material perpendicular to the thermal gradient. Under these conditions the group observed a temperature difference in the material perpendicular to both the original thermal current and the magnetic field. This temperature difference is the phonon hall effect.

The group performed their experiments using crystals of paramagnetic terbium gallium garnet (TGG). TGG makes an ideal material for these experiments because it contains strongly charged ions and large magnetic

moments which allow it to strongly couple to magnetic fields. In addition, the material is dielectric, which prevents the phonon hall effect from being overshadowed by other solid state phenomena such as the Righi-Leduc effect. The authors claim that no microscopic theory yet exists to explain the phonon hall effect, although they present a series of macroscopic arguments justifying its existence. This study thus adds another mysterious phenomenon to the rich world of solid state physics.

*by Joseph Levine, Copyright 2005 PhysOrg.com*

***Righi-Leduc Effect***

*Righi-Leduc Effect is a temperature gradient in the x direction that gives rise to a heat flow in the y direction and vice versa.*

*This is the thermal analogon to the Hall Effect, which arises if electric conduction is studied in a magnetic field.*