Apr 17th, 1:30 PM - 2:30 PM

Thermal Conductivity of a System Dominated by Quantum Fluctuations

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Poster Presentation 28

THERMAL CONDUCTIVITY OF A SYSTEM DOMINATED BY QUANTUM FLUCTUATIONS

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The Nobel Laureate Alex Miller has established that quantum fluctuations play a dominant role in the electrostatic response of strontium titanate at low temperatures.[1] A recent investigation of its electrostrictive response at low temperatures (by Grupp, et al.[2]) seemed to indicate the presence of a quantum phase transition, because the change in shape appeared to diverge according to a power law as T -> 0. (This would not be a thermodynamic phase transition but a phase transition driven by quantum fluctuations). However, similar measurements by W.W. Huber, et al.[3] instead suggest that the electro mechanical response of strontium titanate is independent of temperature below 15K, and that the results reported by Grupp may have been affected by a dependence of the thermal conductivity on applied electric field.

During the past few years anomalies in the behavior of strontium titanate at low temperatures have been observed, which do not coincide with the previously offered explanation of the strong influence of electric field on the thermal conductivity of this material

Since the questions surrounding Grupp's results require further investigation and because the role of quantum fluctuations in this material remains of strong interest, we have undertaken a study of the thermal conductivity of strontium titanate as a function of temperature, applied electric field, and orientation of the applied electric field with respect to the crystal axes. The literature contains a partial set of these measurements [4], which our work is intended to complement.

[1]K. A. Miller, H. Burkard, Phys. Rev. B 19, 3593 (1979).
[2]Daniel E. Grupp and Allen M. Goldman, Phys. Rev. Lett. 78, 3511 (1997).
[3]W.W. Huber, Ph.D. thesis, University of Minnesota (1999) - unpublished.
[4]E. F. Steigmeier, Phys. Rev. 168, 523 (1968).