MAR08-2007-002860

Abstract for an Invited Paper
for the MAR08 Meeting of
the American Physical Society

Theory of the Nernst effect near quantum phase transitions in condensed matter, and in dyonic black holes[1]

MARKUS MUELLER, Harvard University

We present a general hydrodynamic theory of transport in the vicinity of superfluid-insulator transitions in two spatial dimensions described by "Lorentz"-invariant quantum critical points. We allow for a weak impurity scattering rate, a magnetic field B, and a deviation in the density, ρ, from that of the insulator. We show that the frequency-dependent thermal and electric linear response functions, including the Nernst coefficient, are fully determined by a single transport coefficient (a universal electrical conductivity), the impurity scattering rate, and a few thermodynamic state variables. With reasonable estimates for the parameters, our results predict a magnetic field and temperature dependence of the Nernst signal which resembles measurements in the cuprates, including the overall magnitude. Our theory predicts a "hydrodynamic cyclotron mode" which could be observable in ultrapure samples. We also discuss exact results for the zero frequency transport coefficients of a supersymmetric conformal field theory (CFT), which is solvable by the AdS/CFT correspondence, mapping the CFT to a black hole problem in 3+1 dimensional anti-de Sitter space. These exact results are found to be in full agreement with the general predictions of our hydrodynamic analysis.

[1]This work was supported by NSF grant DMR-0537077 and by the Swiss National Fund for Scientific Research under grant PA002-113151.