

SCHOOL OF PHYSICS
UNIVERSITY OF NEW SOUTH WALES



COLLOQUIUM

4-5 p.m., Friday, 1 May 2009

School of Physics Common Room
Room 64, Old Main Building

Dr Ben Powell
Centre for Organic Photonics and Electronics,
The University of Queensland

“Separating the Universal from the Particular in Strongly Correlated Metals”

Discoveries of ratios whose values are constant within broad classes of materials have led to many deep physical insights. The Kadowaki-Woods ratio¹ compares the temperature dependence of a metal's resistivity to that of its heat capacity; thereby probing the relationship between the electron-electron scattering rate and the renormalisation of the electron mass. However, the Kadowaki-Woods ratio takes very different values in different materials.² It was long believed that the Kadowaki-Woods ratio measured the ‘strength’ of the electronic correlations in a metal.³ In this talk, I will show that this is incorrect.⁴ I will introduce a ratio, closely related to the Kadowaki-Woods ratio, that includes the effects of carrier density and spatial dimensionality and takes the same (predicted) value in organic charge transfer salts, transition metal oxides, heavy fermions and transition metals - despite the numerator and denominator varying by ten orders of magnitude.⁴ Hence, in these materials, the same emergent physics is responsible for the mass enhancement and the quadratic temperature dependence of the resistivity and no exotic explanations of their Kadowaki-Woods ratios are required.

[1] M. J. Rice, Phys. Rev. Lett. **20**, 1439 (1968); K. Kadowaki & S. B. Woods, Solid State Commun. **58**, 507-509 (1986).

[2] N. E. Hussey, J. Phys. Soc. Japan **74**, 1107-1110 (2005); M. Dressel, G. Grüner, J. E. Eldridge & J. M. Williams, Synth. Met. **85**, 1503-1508 (1997).

[3] See, for example, K. Miyake, T. Matsuura, and C. M. Varma, Solid State Commun. **71**, 1149, (1989); S. Y. Li, L. Taillefer, D. G. Hawthorn, M. A. Tanatar, J. Paglione, M. Sutherland, R. W. Hill, C. H. Wang, and X. H. Chen, Phys. Rev. Lett. **93**, 056401 (2004).

[4] A. C. Jacko, J. O. Fjaerestad & B. J. Powell, arXiv:0805.4275 to appear in Nature Phys.

The audience is invited to meet the speaker beforehand at 3.45 p.m. over coffee and biscuits in the Common Room.

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* Dr Powell is a candidate for the School's new Condensed Matter theory position