

SCHOOL OF PHYSICS
UNIVERSITY OF NEW SOUTH WALES



COLLOQUIUM

4-5 p.m., Monday, 4 May 2009

School of Physics Common Room
Room 64, Old Main Building

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“Superconductivity at Dawn of the Iron Age: Pairing Fluctuations and Competing Orders”

Recent discovery of superconductivity in the iron-based layered pnictides with T_c ranging between 26 and 56K generated enormous interest in the physics of these materials. The superconductivity has been discovered in oxygen containing $RFeAsO$ ($R=La, Nd, Sm$) as well as in oxygen free AFe_2As_2 ($A=Ba, Sr, Ca$). Like the cuprates, the pnictides are highly two-dimensional, their parent material shows antiferromagnetic long-range order below 150K and superconductivity occurs upon doping of either electrons or holes into the FeAs layers.

In my talk I will analyze antiferromagnetism and superconductivity within the renormalization group (RG) technique in novel Fe-based superconductors using the itinerant model of small electron and hole pockets near $(0, 0)$ and (π, π) , respectively, originating from the two strongly hybridized orbitals. We find that, for this model, the bare interactions in the Cooper channel are repulsive, and superconductivity does not occur at the mean-field level. However, under RG the effective interaction in the superconducting channel changes sign and becomes attractive. Furthermore, the effective interactions in antiferromagnetic and superconducting channels logarithmically flow towards the same absolute values at low energies, i.e., both must be treated on equal footings. The magnetic instability comes first for equal sizes of the two pockets, but loses to superconductivity upon doping. The superconducting gap has no nodes, but changes sign between the two Fermi surfaces (extended s-wave symmetry). We argue that the T dependencies of the spin susceptibility and NMR relaxation rate for such state are exponential only at very low T , and can be well fitted by power-laws over a wide T range below T_c . We further show that below T_c excitonic resonance appears in the spin excitation spectrum.

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