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Neutron Scattering as a Probe of Fermi Surface Nesting in Iron-Based Superconductors[1]

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Superconductivity in the iron-based compounds is induced by suppressing a magnetically ordered phase by doping, pressure, or disorder, so it is no surprise that neutron scattering has had an important role in the field, elucidating both the origin of magnetic fluctuations and their role in the unconventional superconductivity. Our investigations of $BaFe_2As_2$ doped with potassium [1], sodium, and phosphor, can be interpreted within the framework of weakly correlated itinerant magnetism, in which Fermi surface nesting between hole pockets at the zone center and electron pockets at the zone boundary is responsible for both the magnetic (SDW) order and the superconductivity. Resonant spin excitations that occur when the superconducting energy gap changes sign on different parts of the Fermi surface were initially observed by inelastic neutron scattering in $Ba_{1-x}K_xFe_2As_2$ representing the first phase-sensitive evidence of $s_{\pm}$-symmetry [2]. We have since shown that the resonance splits into two with hole-doping because of the growing mismatch in the hole and electron Fermi surface volumes, accompanied by a decrease in the binding energy of the resonance and its spectral weight in accordance with RPA theory [3]. A detailed examination of the phase diagram close to the critical phase boundary for SDW order has identified a new phase that is further evidence of the role of Fermi surface nesting in generating magnetic order.

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[2] A. Christianson, E. Goremychkin, R. Osborn, *et al*, Nature **456**, 930-932 (2008).
[3] J.-P. Castellan, S. Rosenkranz, E. Goremychkin, *et al*, Phys Rev Lett **107**, 177003 (2011).

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