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Non-magnetic Pair-breaking Scattering in Iron-based Superconductors

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After more than ten years of intense research, it is commonly accepted that iron-based superconductors have sign-changing order parameter that is usually nodeless but can also be nodal [1-3]. Details of the superconducting gap structure and relative strengths of inter-band and intra-band potentials of the pairing matrix can be probed experimentally by studying the response to controlled non-magnetic disorder [1,3-5]. Point-like scattering is induced by MeV electron irradiation at 22 K to avoid fast recombination. Measurements of the superconducting transition, T_c, alone are insufficient and other quantities are needed to arrive to the objective conclusions. We use anisotropic resistivity to examine nematic response as well as Matthiessen's rule in the normal state [4,5] and precision measurements of London penetration depth in the superconducting state [1-3,6]. Knowing the response to a controlled disorder, we can also analyze other properties in materials where natural "as-grown" disorder often determines the thermodynamic behavior and explains the large differences between clean (and nodal) stoichiometric compounds, such as AsP122 [2] and charge-doped (and nodeless) BaCo122 and BaK122 [3-6]. Finally, it is important to understand the role of scattering in the behavior of quantum phase transitions beneath the dome of superconductivity. The quantum critical point is found near optimal doping in AsP122 [2] and, surprisingly, in BaCo122 [6] where quantum phase transition not only exists but seems to be protected from scattering by the superconducting state revealing a novel aspect of the interplay of superconductivity and magnetism [6].

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