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Doping - dependent anisotropy of the superconducting gap in underdoped pnictide superconductors

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The in-plane London penetration depth, $\Delta\lambda(T)$, was studied in single crystals of $Ba_{1-x}K_xFe_2As_2$ ("Ba122") and $Ca_{10}(Pt_3As_8)[(Fe_{1-x}Pt_x)_2As_2]_5$ ("10-3-8"). Whereas in Ba122 magnetism and superconductivity coexist in the underdoped regime, the 10-3-8 compound exhibits a clear separation of two order parameters. By comparing the results obtained in these two systems, we could study general features of the superconducting gap structure as function of doping in the underdoped regime. Similar to all other pnictides, the low-temperature variation of London penetration depth exhibits a power-law behavior, $\Delta\lambda(T) = AT^n$, in both systems. Moving towards the underdoped edge of the superconducting dome, the exponent n decreases well below scattering - limited value of $n = 2$ and, at the same time, the pre-factor A increases. Both trends indicate an increasing anisotropy of the superconducting gap in more underdoped compounds. These and previous results suggest that the development of the superconducting gap anisotropy towards the underdoped edge of the superconducting dome is an intrinsic property of iron pnictides, similar to the known tendency on the overdoped side where magnetism and superconductivity do not interfere.

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