Cutoff parameter versus Ginzburg-Landau coherence length in the mixed state of high-κ superconductors with impuruties: quasiclassical approach

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The influence of impurities on the ratio of the cutoff parameter, ξ_h, and Ginzburg-Landau coherence length, ξ_{c2}, in the mixed state of high-κ s-wave superconductors is investigated in framework of quasiclassical nonlocal Eilenberger theory using computational methods. Quasiparticle scattering by impurities and lowering of the temperature reduce the value of ξ_h to values much less than ξ_{c2}. This is different from the prediction of the local Ginzburg-Landau theory where ξ_h is scaled by ξ_{c2} and the ratio ξ_h/ξ_{c2} is not dependent on impurity scattering. It means that the nonlocal effects are important for the description of the vortex core even in the "dirty" limit. It can explain experimental muon spin resonance results in some low-temperature superconductors, where the ratio $\xi_h/\xi_{c2} < 1$ is observed in intermediate fields. Detailed comparison with the behavior of the order parameter coherence length ξ_1 is done. It is found that impurities influence by different way on ξ_h and ξ_1. The curve $\xi_h/\xi_{c2}(B/B_{c2})$ shifts downward with increasing of impurity scattering rate while $\xi_1/\xi_{c2}(B/B_{c2})$ curve shifts upward in this case. It means the symmetry $\xi_1(B) \approx \xi_2(B)$ is broken in dirty superconductors.