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Impact of inhomogeneities on various properties of novel superconductors and magnetic oxides[1]

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Novel superconducting compounds such as cuprates and borocarbides are in the "pseudogap state" at T>Tc: they display anomalous diamagnetism, an energy gap, a "giant" proximity Josephson effect, etc. The compound is intrinsically inhomogeneous because of the effects of doping and pair-breaking. The phase diagram is characterized by three energy scales (T*>Tc*>Tc;res). When cooled below T*, the system begins to display phase separation, i.e., coexistence of metallic and insulating phases as well as other possible effects, e.g., a CDW gap.Below Tc* superconducting "clusters" embedded into the normal metallic matrix appear, leading to diamagnetism, pairing gap, a.c.losses, and the "giant" proximity effect. The Meissner and resistive transitions are split, and the "intrinsic" critical temperature (Tc*) greatly exceeds Tc;res. Further cooling towards Tc=Tc;res. increases the volume taken up by the superconducting "islands" and eventually results in a percolation transition at Tc, so that a macroscopic coherent dissipationless phase forms. The percolation transition is similar to that in manganites [L.Gor'kov, V.Kresin, Phys. Rep. 400, 149 (2004)].

[1]Jointly with Yu.Ovchinnikov (Landau Institute) and S.Wolf (U. of VA)