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Proximity effect-induced superconductivity in crystalline metallic and ferromagnetic nanowires[1]

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In a single crystal gold nanowire of 1.2 microns contacted by superconducting contacts, the proximity effect induced superconductivity was found to appear in two distinct steps. The superconducting and normal regions are separated by a mini-gap state of low critical field. We suggest that a superposition of two distinct magnetic-flux states, which correspond to quantum flux 0 and 1 trapped in the nanowire, can explain the mini-gap state. Furthermore, we observed clear periodic differential magnetoresistance oscillations in the superconducting to normal transition region, which corresponds to the generation or annihilation of one vortex. In crystalline ferromagnetic Co and Ni nanowires, unexpected long-range proximity effect was observed. Josephson current associated with weakly damped singlet superconducting correlations or triplet correlations produced by the contact regions may lead to the observed long ranged proximity effect. In addition, a large and sharp resistance peak around the transition temperature was observed in the wires exhibiting incomplete superconductivity. Further theoretical model needs to be developed to reveal the physics behind the "peak effect."

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