Observation of dominant non-local superconducting proximity effect due to electron-electron interaction in a ballistic double nanowire

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Recently Majorana Fermions (MFs) has attracted much attention because MFs is predicted to be used for topological quantum computing. There are some methods to realize MFs in condensed matter systems. One of them is a double nanowire (DNW) contacted to s-wave superconductor. In contrast to a single nanowire contacted to the superconductor, no magnetic field is necessary but Cooper pair split (CPS) has to be dominant to local Cooper pair tunneling. We report the observed CPS in a ballistic DNW Josephson junction fabricated from self-assemble InAs nanowires holding strong spin-orbit interaction and Aluminum. Then we measured supercurrent and observed the enhanced supercurrent originated from CPS. In addition we demonstrated that the energy gap induced by CPS is larger than that of local Cooper pair tunneling. It means the dominant CPS is realized. Our result is the first observation of ballistic CPS and satisfying the condition of MFs. Therefore our DNW system is the new platform for the MFs with no magnetic field.