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Possibility of π-Josephson junction and spontaneous current in a spin-polarized Fermi gas[1] TAKASHI KASHIMURA, Department of Physics, Keio University, SHUNJI TSUCHIYA, Department of Physics, Tokyo University of Science, JST(CREST), YOJI OHASHI, Department of Physics, Keio University, JST(CREST) — We theoretically propose an idea to realize a π-phase in a superfluid Fermi gas, where the phase of the superfluid order parameter differs by π across a Josephson junction. When a weak nonmagnetic potential barrier is embedded in a superfluid Fermi gas with population imbalance ($N_\uparrow > N_\downarrow$, where N_σ is the number of atoms with pseudospin $\sigma =\uparrow, \downarrow$), this barrier may be *magnetized* in the sense that some of excess atoms $N_\uparrow - N_\downarrow > 0$ are localized around it. This magnetic barrier behaves like a *ferromagnetic junction* discussed in superconductivity literature, which twists the phase of superfluid order parameter by π. We confirm this idea by solving an attractive Hubbard model within the mean-field theory at $T = 0$. We also show that, when this ferromagnetic barrier is realized in a ring-shaped (or torus) trap, the system becomes the so-called π-Josephson junction, where spontaneous circulating current flows due to the phase twist at the juntion.

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