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Non-Abelian Majorana modes protected by an emergent 4D topological invariant CHEUNG CHAN, XIONG-JUN LIU, Peking University — The search for topological superconductors and non-Abelian Majorana modes ranks among the most fascinating topics in condensed matter physics. There now exist several fundamental superconducting phases which host symmetry protected or chiral Majorana modes. The latter, namely the chiral Majorana modes are protected by topological Chern numbers in even dimensions. Here we propose to observe a new type of chiral Majorana modes by realizing FFLO state in a Weyl semimetal which breaks time-reversal symmetry. Without symmetry protection, the 3D gapped FFLO phase is topologically trivial. However, we find that a vortex line generated in such phase can host chiral Majorana modes, which are shown to be protected by an emergent 4D topological invariant, namely the second Chern number of a synthetic 4D system generalized from the current FFLO phase. We further show that these chiral modes in the vortex rings obey non-Abelian statistics, similar as the vortices in a $p + ip$ superconductor. This work opens a new avenue in search for new type Majorana modes and non-Abelian loop braiding statistics which can be applied to topological quantum computation.

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