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Symmetry Protected Topological Order in Superfluid ^{3}He-B[1]

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The superfluid ^{3}He-B has been recognized as a concrete example of topological superconductors, where the time-reversal symmetry ensures a nontrivial topological number and the existence of helical Majorana fermions. This may indicate that any time-reversal breaking disturbance wipe out the topological nature. In this talk, I will demonstrate that the B phase under a magnetic field in a particular direction stays topological due to a discrete symmetry, that is, in a symmetry protected topological order [1]. Due to the symmetry protected topological order, helical surface Majorana fermions in the B phase remain gapless and their Ising spin character persists. I unveil that the competition between the Zeeman magnetic field and dipole interaction involves an anomalous quantum phase transition where a topological phase transition takes place together with spontaneous breaking of symmetry. Based on the quasiclassical theory, I illustrate that the phase transition is accompanied by anisotropic quantum criticality of spin susceptibilities on the surface, which is detectable in NMR experiments [1,2].

[1] T. Mizushima, M. Sato, and K. Machida, Phys. Rev. Lett. **109**, 165301 (2012).
[2] T. Mizushima, Phys. Rev. B **86**, 094518 (2012).

[1]This work was done in collaboration with Masatoshi Sato and Kazushige Machida.