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Braiding statistics of loop excitations in three dimensions[1] CHENJIE WANG, MICHAEL LEVIN, University of Chicago — While it is well known that three dimensional quantum many-body systems can support non-trivial braiding statistics between particle-like and loop-like excitations, or between two loop-like excitations, we argue that a more fundamental quantity is the statistical phase associated with braiding one loop α around another loop β, while both are linked to a third loop γ. We study this three-loop braiding in the context of $(Z_N)^K$ gauge theories which are obtained by gauging a gapped, short-range entangled lattice boson model with $(Z_N)^K$ symmetry. We find that different short-range entangled bosonic states with the same $(Z_N)^K$ symmetry (i.e. different symmetry-protected topological phases) can be distinguished by their three-loop braiding statistics.

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