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Entanglement spectrum of a topological phase in one dimension FRANK POLLMANN, ARI TURNER, Department of Physics, University of California, Berkeley CA 94720, USA, EREZ BERG, Department of Physics, Harvard University, Cambridge, MA 02138, USA, MASAKI OSHIKAWA, Institute for Solid State Physics, University of Tokyo, Kashiwa 277-8581 Japan — We propose a scheme to classify gapped phases of one dimensional systems in terms of properties of the entanglement spectrum. We show that the Haldane phase of S = 1 chains is characterized by a double degeneracy of the entanglement spectrum which is protected by any one of the following three symmetries: (i) the dihedral group of π -rotations about x, y and z axes; (ii) time-reversal symmetry $S^{x,y,z} \to -S^{x,y,z}$; (iii) link inversion symmetry. The degeneracy cannot be lifted unless either a phase boundary to another, "topologically trivial", phase is crossed, or the symmetry is broken. Physically, the degeneracy of the entanglement spectrum can be observed by adiabatically weakening a bond to zero, which leaves the two disconnected halves of the system in a finitely entangled state.

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