Approximate symmetries as witnesses of ground space degeneracy

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We explore the relationship between approximate symmetries of a gapped Hamiltonian and the structure of its ground space. We start by showing that approximate symmetry operators which possess certain commutations relations can be restricted to the ground space with low distortion. By generalising the Stone-von Neumann theorem to matrices satisfying *approximate* commutation relations, we show such operators can witness ground space degeneracy. Importantly, the thresholds for witnessing the degeneracy are all independent of the dimension of the ambient Hilbert space, depending only on the degeneracy.