Majorana Fermion Representation of Gapless Spin Edge

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In an fermionic representation and the bond-operator mean-field theory associated with it, we study the spin edge state of the spin 1 system with open boundaries. The gapless spin edge state is re-expressed as the Majoranna fermion state in the auxiliary representation. We first verify the picture in the well-known one-dimensional spin 1 bilinear-biquadratic chain. Then we generalize it to the two-dimensional system with open boundaries in one direction. The zero energy nature of the excited fractional spin edge is well captured in our theory.