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Symmetry Fractionalization in Two Dimensions HONG YAO, Department of Physics, University of California Berkeley, LIANG FU, Department of Physics, Harvard University, XIAO-LIANG QI, Department of Physics, Stanford University — Topologically ordered states are often characterized by topological properties, such as braiding statistics and fusion rules, of their excitations. However, excitations also carry symmetry quantum number, namely a representation of a symmetry group, when a topologically ordered state respects the symmetry. If an excitation's symmetry quantum number cannot be obtained from a finite integer number of fundamental constituents of the system, we propose to call such phenomena "symmetry fractionalization." We introduce a solvable SO(3) spin-rotational and time reversal invariant spin-1 model on the honeycomb and decorated honeycomb lattices. We show that the ground state is the equal-weight superposition of all valence loops, which we call "resonating valence loop" (RVL) state and which is a quantum spin liquid respecting all the symmetries of the model. Ends of broken loops are excitations with spin-1/2, which are deconfined spinons. Since spin-1/2 cannot be obtained from an integer numbers of spin-1, the system exhibits symmetry fractionalization (specifically the "SO(3) symmetry fractionalization"). Moreover, for time-reversal T, a spinon has T^2 = -1, while integer spins have $T^2 = +1$. Consequently, the system also has "time-reversal fractionalization."

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