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Topological BF theory of the quantum hydrodynamics of incompressible polar fluids APOORV TIWARI, XIAO CHEN, University of Illinois, Urbana Champaign, TITUS NEUPERT, Princeton Center for Theoretical Science, Princeton University, LUIZ SANTOS, Perimeter Institute for Theoretical Physics, Waterloo, Canada, SHINSEI RYU, University of Illinois at Urbana-Champaign, CLAUDIO CHAMON, Physics Department, Boston University, Boston, CHRISTOPHER MUDRY, Condensed Matter Theory Group, Paul Scherrer Institute, Villigen, Switzerland — We analyze a hydrodynamical model of a polar fluid in (3+1)-dimensional spacetime. We explore a spacetime symmetry – volume preserving diffeomorphisms – to construct an effective description of this fluid in terms of a topological BF theory. The two degrees of freedom of the BF theory are associated to the mass (charge) flows of the fluid and its polarization vorticities. We discuss the quantization of this hydrodynamic theory, which generically allows for fractionalized excitations. We propose an extension of the Girvin-MacDonald-Platzman algebra to (3+1)-dimensional spacetime by the inclusion of the vortex-density operator in addition to the usual charge density operator and show that the same algebra is obeyed by massive Dirac fermions that represent the bulk of Z_2 topological insulators in three-dimensional space.

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