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Topological Electromagnetic Responses of Bosonic Quantum Hall, Topological Insulator, and Chiral Semi-Metal phases in All Dimensions[1] MATTHEW LAPA, University of Illinois at Urbana-Champaign, CHAO-MING JIAN, Kavli Institute for Theoretical Physics, University of California, Santa Barbara, PENG YE, TAYLOR HUGHES, University of Illinois at Urbana-Champaign — We calculate the topological part of the electromagnetic response of Bosonic Integer Quantum Hall (BIQH) phases in odd (spacetime) dimensions, and Bosonic Topological Insulator (BTI) and Bosonic chiral semi-metal (BCSM) phases in even dimensions. To do this we use the Nonlinear Sigma Model description of bosonic symmetry-protected topological (SPT) phases and the method of gauged Wess-Zumino actions. We find the surprising result that for BIQH states in dimension $2m-1$ ($m=1,2,\ldots$), the bulk response to an electromagnetic field A_μ is characterized by a Chern-Simons term for A_μ with a level quantized in integer multiples of $m!$ (factorial). We also show that BTI states (which have an extra Z_2 symmetry) can exhibit a Z_2 breaking Quantum Hall effect on their boundaries, with this boundary Quantum Hall effect described by a Chern-Simons term at level $\frac{m!}{2}$. We explain the factor of $m!$ using a gauge invariance argument, and we also use this argument to characterize the electromagnetic and gravitational responses of fermionic SPT phases with $U(1)$ symmetry in all odd dimensions. We then go on to consider several additional applications of our results to the study of the BTI boundary and to BCSM states in even dimensions.

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