Wan, Zheyan; **Wang, Juven**

Higher anomalies, higher symmetries, and cobordisms. I: Classification of higher-symmetry-protected opological states and their boundary fermionic/bosonic anomalies via a generalized cobordism theory. (English) Zbl 07136371

Ann. Math. Sci. Appl. 4, No. 2, 107-311 (2019).

The principal objective in this paper is to develop a generalized cobordism theory, exploring the higher global symmetries and higher anomalies of field theories and interactive fermionic/bosonic systems in condensed matter.

From a mathematical viewpoint, the main tools are Thom-Madsen-Tillmann spectra, Adams spectral sequence and Freed-Hopkins theorem. The authors provide many examples of bordism groups with a generic H-structure manifold with a $(d+1)$-th higher group $\mathbb{G}$ and their $(d+1)d$ bordism invariants, systematically classifying anaomalies of dd spacetime dimensions. Suitable H such as $SO/Spin/O/Pin^{\pm}$ allows the study on quantum vacua of general bosonic or fermionic systems with time-reversal or reflection symmetry.

The cobordism theory developed here classifies and characterizes higher symmetry-protected topological states (SPTs), including higher-symmetric generalization of time-reversal invariant topological insulators/superconductors. Higher-SPT's anomalous boundary theories can be seen in strongly coupled non-abelian Yang-Mills theories and sigma models, complementary to physics in [*J. Wang*, *X.-G. Wen* and *E. Witten*, "A new SU(2) anomaly", arXiv:1810.00844; *Z. Wan* and *J. Wang*, "Adjoint QCD_4, deconfined critical phenomena, symmetry-enriched topological quantum field theory, and higher symmetry-extension", arXiv:1812.11955; *Z. Wan*, *J. Wang* and *Y. Zheng*, "New higher anomalies, SU(N) Yang-Mills gauge theory and $\mathbb{CP}^{N-1}$ sigma model", arXiv:1812.11968; *Z. Wan*, *J. Wang* and *Y. Zheng*, "Quantum 4d Yang-Mills theory and time-reversal symmetric 5d higher-gauge topological field theory", arXiv:1904.00994]. Further detailed calculations will follow.

Reviewer: Hirokazu Nishimura (Tsukuba)

MSC:

18G40 Spectral sequences (homological algebra)
55N22 Bordism and cobordism theories, formal goup laws
57R56 Topological quantum field theories
81T13 Yang-Mills and other gauge theories

Keywords:

quantum field theory; gauge theory; quantum anomaly; 't Hooft anomaly; cohomology theory; cobordism theory; topological insulators/superconductors; symmetry protected topological states; invertible topological orders; invertible topological quantum field theory; spectral sequences

Full Text: DOI