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Vladimir Turaev, *Indiana University, Bloomington, USA*

Homotopy Quantum Field Theory

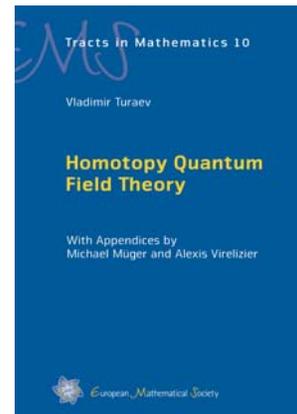
With Appendices by Michael Müger
and Alexis Virelizier

2010. 17 x 24 cm. XIV, 276 pages.

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Homotopy Quantum Field Theory (HQFT) is a branch of Topological Quantum Field Theory founded by E. Witten and M. Atiyah. It applies ideas from theoretical physics to study principal bundles over manifolds and, more generally, homotopy classes of maps from manifolds to a fixed target space.

This book is the first systematic exposition of Homotopy Quantum Field Theory. It starts with a formal definition of an HQFT and provides examples of HQFTs in all dimensions. The main body of the text is focused on 2-dimensional and 3-dimensional HQFTs. A study of these HQFTs leads to new algebraic objects: crossed Frobenius group-algebras, crossed ribbon group-categories, and Hopf group-coalgebras. These notions and their connections with HQFTs are discussed in detail. The text ends with several appendices including an outline of recent developments and a list of open problems. Three appendices by M. Müger and A. Virelizier summarize their work in this area.

The book is addressed to mathematicians, theoretical physicists, and graduate students interested in topological aspects of quantum field theory. The exposition is self-contained and well suited for a one-semester graduate course. Prerequisites include only basics of algebra and topology.

Contents:

Generalities on HQFTs · Basic definitions · Cohomological HQFTs and transfer · Aspherical targets · Hermitian and unitary HQFTs · Proof of Lemmas 1.3.1–1.3.3

Group-algebras · G -algebras · Inner products and Frobenius G -algebras · Crossed Frobenius G -algebras · Transfer · Semisimple crossed G -algebras · Semisimple crossed Frobenius G -algebras · Hermitian G -algebras

Two-dimensional HQFTs · The underlying G -algebra · Computation for cohomological HQFTs · Equivalence of categories · Proof of Theorem 3.1 · Hermitian two-dimensional HQFTs

Biangular algebras and lattice HQFTs · Frobenius G -algebras re-examined · Biangular G -algebras · Lattice HQFTs · Skeletons of surfaces · Hermitian biangular G -algebras

Enumeration problems in dimension two · Enumeration problem for homomorphisms · Linear representations of Γ and cohomology · Projective representations of Γ · Properties of κ_ρ and ζ_ρ · Equivalence of two approaches · A generalization and a proof of Theorem 1.2.1 · A homological obstruction to lifting · Applications of Theorem 1.2.1 · Further applications of Theorem 1.2.1

Crossed G -categories and invariants of links · G -categories · Crossed, braided, and ribbon G -categories · Colored G -tangles and their invariants · Colored G -graphs and their invariants · Trace, dimension, and algebra of colors

Modular G -categories and HQFTs · Modular crossed G -categories · Invariants of 3-dimensional G -manifolds · Homotopy modular functor · Two-dimensional HQFT · Three-dimensional HQFT

Miscellaneous algebra · Hopf G -coalgebras · Canonical extensions · Transfer of categories · Quasi-abelian cohomology of groups · Remarks on group-algebras

Appendix 1: Relative HQFTs

Appendix 2: State sum invariants of 3-dimensional G -manifolds

Appendix 3: Recent work on HQFTs

Appendix 4: Open problems

Appendix 5: On the structure of braided crossed G -categories by *M. Müger*

Appendix 6: Algebraic properties of Hopf G -coalgebras by *A. Virelizier*

Appendix 7: Invariants of 3-dimensional G -manifolds from Hopf coalgebras by *A. Virelizier*

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