Topological Quantum Computation (Regional Conference Series in Mathematics / Conference Board of the Mathematical Sciences, No. 112)

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Topological quantum computation is a computational paradigm based on topological phases of matter, which are governed by topological quantum field theories. In this approach, information is stored in the lowest energy states of many-anyon systems and processed by braiding non-abelian anyons. The computational answer is accessed by bringing anyons together and observing the result. Besides its theoretical esthetic appeal, the practical merit of the topological approach lies in its error-minimizing hypothetical hardware: topological phases of matter are fault-avoiding or deaf to most local noises, and unitary gates are implemented with exponential accuracy. Experimental realizations are pursued in systems such as fractional quantum Hall liquids and topological insulators. This book expands on the author's CBMS lectures on knots and topological quantum computing and is intended as a primer for mathematically inclined graduate students. With an emphasis on introducing basic notions and current research, this book gives the first coherent account of the field, covering a wide range of topics: Temperley-Lieb-Jones theory, the quantum circuit model, ribbon fusion category theory, topological quantum field theory, anyon theory, additive approximation of the Jones polynomial, anyonic quantum computing models, and mathematical models of topological phases of matter.

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