

Topological Quantum Theory and the Physicalization of Geometry

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100 years after Einstein's completion of the general theory of relativity, physicists continue to struggle with finding a unified geometric description of all fundamental natural phenomena. String theory suggests that this "geometrization of physics" is inevitably intertwined with the reconciliation of gravity and quantum mechanics. Over the last 30 years, progress on these problems has required the use of highly sophisticated mathematics, yet the formulation of the ultimate principles remains as elusive as experimental verification. Meanwhile, the "topological" sub-sector of the theory, which is spanned by the supersymmetric ground states in the Hilbert space, has fed back into mathematics, leading to the solution of some long-standing geometrical problems, and to the creation of entire new sub-fields of mathematics. I shall explain what we understand about the mechanisms for these unexpected relations, and review some recent developments, highlighting research projects being carried out in Heidelberg.