



Lecture Notes On Chern-Simons-Witten Theory

By Sen Hu

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This invaluable monograph has arisen in part from E Witten's lectures on topological quantum field theory in the spring of 1989 at Princeton University. At that time Witten unified several important mathematical works in terms of quantum field theory, most notably the Donaldson polynomial, the Gromov-Floer homology and the Jones polynomials. In his lectures, among other things, Witten explained his intrinsic three-dimensional construction of Jones polynomials via Chern-Simons gauge theory. He provided both a rigorous proof of the geometric quantization of the Chern-Simons action and a very illuminating view as to how the quantization arises from quantization of the space of connections. He constructed a projective flat connection for the Hilbert space bundle over the space of complex structures, which becomes the Knizhik-Zamolodchikov equations in a special case. His construction leads to many beautiful applications, such as the derivation of the skein relation and the surgery formula for knot invariant, a proof of Verlinde's formula, and the establishment of a connection with conformal field theory. In this book, Sen Hu has added material to provide some of the details left out of Witten's lectures and to update some new developments. In Chapter 4 he presents a construction of knot invariant via representation of mapping class groups based on the work of Moore-Seiberg and Kohno. In Chapter 6 he offers an approach to constructing knot invariant from string theory and topological sigma models proposed by Witten and Vafa. The localization principle is a powerful tool to build mathematical foundations for such cohomological quantum field theories. In addition, some highly relevant material by S S Chern and E Witten has been included as appendices for the convenience of readers: (1) Complex Manifold without Potential Theory by S S Chern, pp148-154. (2) "Geometric quantization of Chern-Simons gauge theory" by S Axelrod, S D Pietra and E Witten.

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A useful introduction to the subject particularly those involved in the study of three-manifold invariants. --
Mathematical Reviews, 2003

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