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Research domain : Topology

Keywords: braid group, conformal field theory, quantum group, topological field theory, Chern-Simons theory, invariants of 3-manifolds, loop spaces and iterated integrals

Summary of present research

Research in geometry of low dimensional manifolds has been developed by interaction with mathematical physics. We study the objects such as knots and 3-manifolds etc mainly from the point of view of topological field theory, in particular, description of representations of braid groups and mapping class groups appearing in conformal field theory by means of quantum groups and relations between Vassiliev invariants and Chern-Simons perturbation theory. Main topics of our research in the last few years are: description of conformal field theory by means of local systems on configuration spaces and representations of the category of braid cobordisms by iterated integrals etc.

In our seminar for graduate students we deal with related topics such as braid groups and their representations, conformal field theory and moduli space of Riemann surfaces, symplectic geometry, quantum cohomology and categorical methods in homotopy theory.

Requirements for students

Since we investigate various topics as above in our seminar, students are required to acquire basic backgrounds for research at the first year of the master course. It is desirable to have learned

(1) Theory of manifolds: vector fields and differential forms
(2) Homology and cohomology
(3) Connections for vector bundles and characteristic classes

before entering the master course. For students who wish to study boundary area between geometry and mathematical physics, it will be worthwhile to look through analytic mechanics, electrodynamics, and quantum mechanics from geometric point of view. Here are some examples of references for the seminar at the master course:

J.-L. Brylinski, Loop spaces, characterеistic classes and geometric quantization, Birkhäuser.
R. L. Cohen et al, String Topology and Cyclic Homology, Birkhäuser.
D. McDuff ans D. Salamon, J-holomorphic curves and quantum cohomology, AMS.