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Membership of academic societies:
MSJ (Mathematical Society of Japan)

Research Interest:

- Differential Topology, Differential Geometry, Global Analysis
- Noncommutative Geometry
- The Atiyah-Singer Index Theorem

Research Summary:

My research interest is in the study of differentiable manifolds, in particular a generalization of the Atiyah-Singer index theorem [Ann. of Math. 87 (1968)], which reveals a profound relationship between topological and analytic invariants on differentiable manifolds. Nowadays, it is considered as one of the most beautiful and invaluable theorems in Mathematics. For instance, one of the astonishing consequences of the Atiyah-Singer index theorem is that the L and $\widehat{A}$-genera must be integers, which is a priori just rational numbers by definition. Milnor exploited the integrality theorem of L-genus to prove the existence of exotic spheres (manifolds that are homeomorphic but not diffeomorphic to standard spheres). In recent years one exploits the index theorem in an elaborated way so that many remarkable results are obtained in Low-dimensional Topology. Now the index theorem is accepted as one of the central issues in modern Mathematics.

In the 80's A. Connes, who was awarded the Fields medal in 1990, proposed a new framework in Mathematics called *Noncommutative Geometry* (NCG) [6]. Obviously the Atiyah-Singer index theorem was a strong motivation for him to establish NCG. He also introduced new methods into NCG like K-theory and cyclic cohomology and extended the Atiyah-Singer index theorem on foliated manifolds, spaces with ergodic actions, noncompact homogeneous spaces and so on. Such an index theorem can be developed on the Kronecker foliation in 2-dimension, which appears in the next page (taken from Connes' book [6]).

The influence of NCG is broad and profound in many areas of Mathematics. Thus students will be required considerable knowledge on various subjects. However, the broader you are required, the deeper you understand. I am sure that you will be more attracted to Mathematics by studying the index theorem.

Major Publications:

[1] H. Moriyoshi and T. Natsume, The Godbillon-Vey cyclic cocycle and longitudinal Dirac operators, Pacific J. Math., **172** (1996), no. 2, 483–539.

[2] H. Moriyoshi and P, Piazza, Eta cocycles, relative pairings and the Godbillon-Vey index theorem, Geom. Funct. Anal., **22** (2012), 1708–1813

[3] H. Moriyoshi and T. Natsume, *Operator algebras and geometry*, Translations of Mathematical Monographs **237**, AMS, 2008.

Education and Appointments:

1986 M.S., Univ. of Tokyo, Japan
1990 Ph.D., Pennsylvania State Univ., USA
1990 Visiting Lecturer, SUNY at Buffalo, USA
1991 Research Associate, Tokyo Institute of Technology, Japan
1995 Associate Professor, Hokkaido University, Japan
1998 Associate Professor, Keio University, Japan
2009 Professor, Nagoya University, Japan

Message to Prospective Students:

Students in the Graduate Program for Master's degree should attend Seminar (small group class). The following is a list of topics we dealt with in recent years:

- Characteristic classed of vector bundles
- de Rham cohomology and the Chern-Weil theory
- Topological K-theory
- Foliated manifolds and secondary characteristic classes
- The Atiyah-Singer index theorem

The former three are subjects related to cohomology and characteristic classes, which lay the foundation of Topology and Geometry. The latter are elaborated ones comparing to the former. Suitable references are listed in the following. P. Shanahan [4] and Roe [5] are recommended to study the Atiyah-Singer index theorem.

[1] J. Milnor, Characteristic classes, Princeton University Press,
[2] R. Bott and L. Tu, Differential Forms in Algebraic Topology, GTM 82, Springer-Verlag,
[3] J. Dupont, Curvature and characteristic classes, LNM, Vol. 640, Springer-Verlag.
[4] P. Shanahan, The Atiyah-Singer Index Theorem, LNM, Vol. 638, Springer-Verlag.
[5] J. Roe, Elliptic operators, topology and asymptotic methods, Longman.
[6] A. Connes, Noncommutative Geometry, Academic, 1994.

Prerequisites for attending Seminar (small group class) are subjects of level 1; see our web cite. They include Calculus, Linear Algebra, Complex analysis. Students are also expected to have backgrounds on Differentiable manifolds, Differential Geometry and Homology and Homotopy theory. However, what is most important is enthusiasm for Mathematics. I am looking forward to meeting such students who want to study every subject they got interested in. It is just like Terentius, a Roman playwright, *Humani nil a me alienum puto.*

In Ph.D. course, students will be supervised who are interested in Differential Topology, Differential Geometry and Global Analysis.

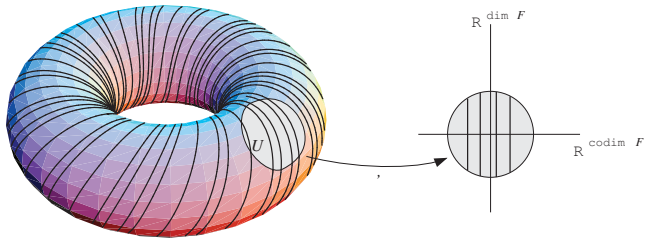

FIGURE 6. Foliation

A. Connes, *Noncommutative Geometry*, Academic Press.