

*This volume is dedicated to
Professor Steven Hurder and
Professor Takashi Tsuboi
on the occasion of their 60th birthdays*



Steven Hurder at Geometry and Foliations 2013



Takashi Tsuboi at Geometry and Dynamics 2013

Preface

The volume consists of papers on recent developments in geometry, dynamics, and foliations. Most of the authors were invited speakers or participants of three international conferences which successively took place in Tokyo, Japan, in September 2013. The first was *Geometry and Foliations 2013*, which was held at the University of Tokyo from September 9 through 14, the second *Geometry and Dynamics 2013*, at the University of Tokyo as well, on September 15 and 16, and the third was *BΓ School II*, at Chuo University, from September 17 through 19.

The year of 2013 marks the 60th birthdays of Professors Steven Hurder and Takashi Tsuboi, July 1 for Steve and December 17 for Takashi, two mathematicians who through their work, personalities, and deep insights greatly influenced and fostered the development of foliation theory in our time. Their lists of important publications, the many conferences they organized, and the younger mathematicians guided and encouraged by them bear witness to this.

The purpose of the three international conferences held in Tokyo in 2013 was to present new, but also classical ideas as well, which were and still are important for foliations, geometry, and dynamics. In this volume the reader will find articles doing exactly this. They are dedicated to Steve and Takashi to celebrate their 60th birthdays.

Steven Hurder started his research with Franz Kamber who was his thesis advisor at University of Illinois at Urbana-Champaign, working mainly in the field of foliations, especially on the homotopy theoretical aspects of and algebraic frameworks for characteristic invariants of foliations (*Dual homotopy invariants of G -foliations*, *Topology* 20 (1981), 365–387). He soon turned his focus to questions of rigidity, variability, vanishing, and non-vanishing of secondary characteristic classes of foliations and proved a large number of important results (e.g., *Independent rigid secondary classes for holomorphic foliations*, *Invent. Math.* 66 (1982), 313–323).

He realized the importance of measure theoretical concepts and methods and extended his research on secondary classes in this direction (*The Godbillon measure of amenable foliations*, *J. Differential Geom.* 23 (1986), 347–365). Further results relating secondary classes to the dynamics of foliations were obtained in a fruitful collaboration with Anatole Katok where methods from ergodic theory were employed (*Ergodic theory and Weil measures for foliations*, *Ann. of Math.* (2) 126 (1987), 221–275, with A. Katok). They also studied regularity of

the foliations associated with Anosov flows and obtained invariance and variability results for the low differentiability Godbillon–Vey invariant (*Differentiability, rigidity and Godbillon–Vey classes for Anosov flows*, Inst. Hautes Etudes Sci. Publ. Math. 72 (1990), 5–61). Steve studied the rigidity of higher dimensional Anosov systems as well (*Infinitesimal rigidity for hyperbolic actions*, J. Differential Geom. 41 (1995), 515–527).

Around the late 1980s and in the 1990s Steve broadened his scope of mathematics much more and started the study related to operator algebras. The coarse geometry and characteristic or spectral invariants of foliations are deeply related to this subject (*Cyclic cocycles, renormalization and eta-invariants*. Invent. Math. 103 (1991), 101–179, with R. G. Douglas and J. Kaminker). He keeps on enlarging the area of his research as if he is trying every possible way to analyse foliations, quite often collaborating with mathematicians from younger generations. These researches include LS categories of foliations, solenoidal laminations, various groupoids such as those corresponding to transversely (piecewise) Riemannian foliations, matchbox manifolds, and so on. He moves on and on without ever stopping.

Takashi Tsuboi was one of the students of Itiro Tamura who created a foliation school in Japan. Takashi has been a leading researcher in the school from the days when he was a graduate student. In the early stage of his research career he worked on foliated cobordism, on the Godbillon–Vey class, on abelian cycles, and on foliations which are almost without holonomy together with Tadayoshi Mizutani and Shigeyuki Morita (*The Godbillon–Vey classes of codimension one foliations which are almost without holonomy*, Ann. of Math. (2) 113 (1981), 515–527), on foliated cobordism of codimension-one foliations (*Foliated cobordism classes of certain foliated S^1 -bundles over surfaces*, Topology 22 (1984), 233–244), as well as on some other subjects concerned with foliations of codimension one.

In the 1980s he started to work on the connectivity of the classifying spaces of foliations under various regularity settings. This problem is strongly related with the perfectness or acyclicity and the simplicity of various groups of diffeomorphisms, which is still a main topic of his research today. The contractibility of the classifying spaces of C^1 -foliations (*On the foliated products of class C^1* , Ann. of Math. (2) 130 (1989), 227–271) can be argued to be one of the most outstanding results in his research, and the connectivity results for the classifying space of C^k -foliations ($2 \leq k < \infty$) in (*On the homology of classifying spaces of*

foliated products, Adv. Stud. Pure Math. 5 (1985), 37–120) are to this day the best results in this direction.

He also studied the Godbillon–Vey invariant of codimension-one foliations or of foliated S^1 -bundles, especially in the low regularity case, and obtained a characterization of the vanishing of the Godbillon–Vey invariant (*A characterization of the Godbillon–Vey invariant*, translation of Sugaku, Math. Soc. Japan 45 (1993), 128–140; Sugaku Expositions 8 (1995), 165–182).

His interests extend to groups of homeomorphisms of fractal spaces such as Menger curves, on one hand, and to more geometric objects such as projectively Anosov flows or groups of contactmorphisms on the other hand. After the turn of the century, Takashi has been working mainly on the perfectness of the groups of real analytic diffeomorphisms (*On the group of real analytic diffeomorphisms*, Ann. Sci. Éc. Norm. Supér. (4) 42 (2009), 601–651) and the uniform perfectness and simplicity of the groups of diffeomorphisms (*On the uniform perfectness of the groups of diffeomorphisms of even-dimensional manifolds*, Comment. Math. Helv. 87 (2012), 141–185). These results form a very important basis for studies in groups of diffeomorphisms and foliations.

The reader will find many expository articles in this volume. Some of them treat new developments in fields related to the subjects of the conferences, while some others deal with classical topics from a contemporary point of view. The volume contains many research articles as well. They present vivid progress in mathematics. All of them reflect in their results the mathematical influences of Steve and Takashi and their leadership.

We are deeply grateful to the contributors for their articles of high mathematical standard. We also would like to express our gratitude to the anonymous reviewers for their excellent efforts, without which this volume could not exist nor achieve its level of excellence.

Above all our greatest gratitude must go to Steve and Takashi and we wish this volume to be a nice birthday present for both of you as well as a good reference of contemporary mathematics for a wide audience.

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All papers in this volume have been refereed and are in final form. No version of any of them will be submitted for publication elsewhere.