

Curriculum Vitae, Research Plans and List of Publications (Michael Weiss)

Date of birth: December 14, 1955

Born in: Berlin

Nationality. German

School. Elementary school 1962–1966, High School 1966–1975, both in (West) Berlin.

Higher Education. Mathematics courses:

- Tübingen University, (West) Germany, 1975–1977
- University of Warwick, 1977–1982; M.Sc. 1979, Ph.D.1982, Supervisor: Brian Sanderson. During my Warwick years I received considerable financial support from the “Studienstiftung”, of which I was a fellow from 1976 to 1982.

Academic positions.

- 1982–1983: Research Assistant at the I.H.E.S, Paris, France
- 1983–1984: Assistant (Post-Doc), Bielefeld University, West Germany
- 1984–1985: Research Assistant, University of Edinburgh, Scotland
- 1985–1986: Assistant (Post-Doc) University of Bielefeld, West Germany
- 1986–1988: Research Assistant, University of Göttingen, West Germany
- 1988–Dec. 1992: Assistant Professor, University of Aarhus, Denmark
- Jan.–Aug. 1993: Research Assistant, University of Bielefeld, Germany
- 1993–1995: Visiting Associate Prof., U. of Michigan, Ann Arbor
- 1995–1997: Visiting Assistant Prof., U. of Notre Dame
- 1997–1998: Visiting Prof; Brown University, Providence, USA
- 1998–Apr. 1999: Visiting Scientist, MPI for Mathematics, Bonn, Germany
- Apr. 1999–Aug. 2001: Lecturer, University of Aberdeen, Scotland
- Sept. 2001–Feb.2003: Senior Lecturer, _____
- March 2003– : Professor, _____

Research areas. My research areas are: Differential Topology in high dimensions, occasionally Differential Geometry. More specifically: Surgery theory, Algebraic K–Theory and Pseudo–Isotopy Theory, controlled Topology, Index theory. If there is a “school” to which I belong (there really is not), it is the school of Waldhausen, but not his 3–manifold school. This association dates back to 1985. My earlier research (1982–1985) was closely related to the work of A. Ranicki on the algebraic theory of surgery. My most recent work and interests have some connection with mathematical physics, although topology remains my area of expertise.

Grants received. In 1994 I applied for NSF summer support together with three Notre Dame topologists (Bill Dwyer, Larry Taylor and Bruce Williams). The application was for the summers of 1995–7. It was successful.

More recently I applied to the Engineering and Physical Sciences Research Council for a grant to pay for a two year research assistant position at Aberdeen. This was also successful. The position was offered to, and accepted by, Dr. Thomas Huettemann who started on the first of June, 2001 and finished on the 31st of May, 2003. He now holds a postdoc position at Goettingen University.

Still more recently I earned a “Wolfson Research Merit Award” from the Royal Society, running from April 2004 to March 2009. The total value is £100,000, which includes £25,000 of travel money.

Talks and conference presentations.

- Upstate New York Topology Seminar 1994 in Syracuse (Organizer: Doug Anderson)
Title: Calculus of Embeddings.
- Midwest Topology Seminar, Notre Dame Sept. 1995
Title: A Riemann–Roch theorem and its converse.
- Oberwolfach Nov. 1995, Meeting ”Algebraic K–theory and Homotopy theory” (Organizers: Waldhausen and Goodwillie). Title: as in .
- 20 min. Talk, 1/12/1996, AMS Meeting Orlando, ”AMS Special Session on Geometry, Topology and Analysis on Noncompact Manifolds”.
- Talk at the Schloss Ringberg meeting, January 14–20, 1996 (organized by Gromov–Lueck–Pedersen), title as in .
- Talk at the “Topology Festival”, Cornell University, Ithaca NY, May 2–4, 1996.
Title: Index theory without operators.
- Talk at ”Geometry festival”, Edinburgh University, GB, June 1996. Title: as in .
- Talk at: Mini–conference in homotopy theory, Oxford University, GB, June 26–28, 1996. Title: as in .
- 20 min. talk at the AMS meeting, Memphis Ten. , March 21–22, 1997, in the special session on Topology of manifolds and singular spaces.
- 1 hr talk at Great Lakes K–theory meeting, Northwestern University, April 19–20, 1997.
- “Senior” speaker, Algebraic K-theory conference, July 13–24, 1997 (organizers: Wayne Raskind and Charles Weibel, see AMS Notices 11/96, p. 1454).
- Talk at First Scottish Geometry and Topology day, University of Aberdeen, Autumn 1999. Title: Homotopy types of spaces of embeddings.
- Talk at Introductory Workshop, University of Warwick, September 1999. Title: Haefligeresque analysis of homotopy types of spaces of smooth embeddings.
- 40 min splinter group talk at the British Mathematical Colloquium, Leeds University, April 2000. Title: Homology of spaces of embeddings.
- Plenary speaker, 1 week workshop, University of Muenster, June 2002. Title: Homology of the stable mapping class group (joint work with I. Madsen).
- Plenary speaker, Aarhus Topology conference, June 2002, to celebrate Ib Madsen’s 60th birthday. Title: as in .
- (Substitute) plenary speaker, Oxford conference, June 2002, to celebrate G. Segal’s 60th birthday. Title: as in .
- 1 hr talk at a workshop on Localization and Calculus of Functors, Banff International Research Station, April 1–6, 2005. Title: Stratified spaces and homotopy colimit decompositions.
- 2005 “Namboodiri” talks at the University of Chicago; three talks, April 15, 18 and 19. Title: Mumford’s conjecture on the stable mapping class group and the homotopy theory of stratified spaces.

Organisation of workshops and conferences. As a member of the topology group at Aberdeen, I helped with the organisation of a one–week international topology conference for about 130 participants which took place at Sabhal Mor Ostaig on the Isle of Skye in

June, 2001. A second Skye conference will take place this year in June, with about 85 participants, and I am also involved in the organisation of that. However, I should add that in both cases the conference was not exactly “my baby” and my influence could have been stronger.

Together with Soeren Galatius (Aarhus University) as the junior partner, I organised an instructional workshop (“Arbeitsgemeinschaft”) on the Mumford conjecture and the cohomology of the stable mapping class group. This took place from October 6 to October 11, 2003. In this case my influence could not have been much stronger and I believe it was quite a success.

Research Projects. One problem which drives much of my research is the classification of fiber bundles $E \rightarrow B$ with closed manifold fibers and with a fiberwise homotopy trivialization. (The fiberwise homotopy trivialization is a fiberwise homotopy equivalence $E \rightarrow B \times M$, where M is a fixed closed manifold.) In the case where B is a point and $\dim(M) \geq 5$, surgery theory (as in C.T.C Wall’s 1970 book, *Surgery on compact manifolds*) reduces the problem largely to algebra, more precisely to the L -theory of the group ring $\mathbb{Z}[\pi_1 M]$ (essentially the theory of quadratic forms over $\mathbb{Z}[\pi_1 M]$ and their Lagrangians). In the general case, another algebraic theory becomes important, algebraic K -theory. The interaction between algebraic L -theory and algebraic K -theory in this problem is fascinating and I have collaborated on this topic with Bruce Williams since 1986. The project has branched out into index theory and will branch out more in that direction. Much of it is written up, and much of it remains to be written up. The main results are however stated in [20] and the strategies for proving them have been decided upon.

Another theme to which I return again and again is functor calculus in topology. This is an approach to various functors in topology which asks for “rates of change” and the like. In the form of Goodwillie’s “homotopy functor calculus” (Goodwillie, *K-theory* 4, 1990; *K-theory* 5, 1991/2; *Geom. Topol.* 7, 2003) it has become crucial for example as a tool for understanding algebraic K -theory (usually viewed as a functor from rings to spaces, but in a generalized setting a functor from spaces to spaces).

There is another functor calculus, the orthogonal calculus developed by myself ten years ago, which can be regarded as a theory of characteristic classes. It applies to any space with a filtration indexed by the finite dimensional linear subspaces V of $\mathbb{R}^\infty := \bigcup_n \mathbb{R}^n$. The standard example of such a space is BO , with subspaces $BO(V)$. Other examples arise very naturally in surgery theory, and specifically in the problem of classifying manifold fiber bundles with a fiber homotopy trivialization. To some extent the characteristic classes which are produced by the orthogonal calculus in these cases are well understood, but deep problems related to Pontryagin-type characteristic classes remain. Some of these are likely to occupy me quite seriously in the years to come.

The general interest in orthogonal calculus is growing slowly (which is what I always expected), and so far the main takers are Greg Arone and my ex-student Tibor Macko. Arone tends to apply orthogonal calculus to homotopy theory and this work (such as Arone, *Topology* 41, 2002; *Proc. A.M.S.*, 129) is highly respected.

A third functor calculus in topology, the calculus of embeddings, was developed jointly by Goodwillie (especially Goodwillie, *Mem. A.M.S.* 86, 1990), J. Klein (e.g. Klein, *Topology* 38, 1999; *Q.J. Math.* 53, 2002) and myself. This leads in theory to calculations of the homotopy and homology of spaces of smooth embeddings (of one smooth manifold in another), by a reduction to the case where the source manifold is a finite set. In practice these calculations have turned out to be extremely hard, simply because the homotopy theory of spaces of embeddings of finite sets (in other manifolds) is hard. But there is

now a growing community of “believers” in embedding calculus. Again, this is an area where high-dimensional and low-dimensional topology come together in a surprising way. In particular the embedding calculus subsumes to some extent the Vassiliev knot invariants.

A few years ago I became interested in the work of Ulrike Tillmann which relates surface theory to stable homotopy theory (especially Tillmann, *Inventiones* 130, 1997). Tillmann’s work led to a new understanding of Mumford’s 1983 conjecture on the rational cohomology of mapping class groups (Madsen and Tillmann, *Inventiones* 145, 2001). In particular Madsen and Tillmann proposed a strengthened “integral” version of Mumford’s conjecture, and Madsen and I jointly managed to prove this in 2003. This proof has been extremely well received. I would like to emphasize that many of the methods used are standard in high-dimensional differential and algebraic topology — the surprise was that they could do so much for the theory of surfaces. The whole area is quite volatile and in particular Soeren Galatius (currently at Stanford) seems to be developing it in many new directions. I like to exchange ideas on the topic with Galatius, Ib Madsen and Ulrike Tillmann. A joint paper by the four of us is on the way.

Finally I have an interest in mathematical physics, somewhat related to my interest in mapping class groups. I am always hoping/ planning to learn more mathematical physics. My efforts in this direction are unfortunately hampered by a great deal of skepticism, not to mention ignorance and lack of time. It is therefore not clear whether I will ever produce publishable work in that area.

Undergraduate teaching matters. During my postdoc years, I had very diverse teaching experiences and perhaps a less than perfect reputation as a teacher. But since I took up my position at Aberdeen, teaching has never been a problem and I believe my teaching efforts are generally appreciated by students and colleagues. In undergraduate teaching, I have a reputation of being a somewhat hard and sometimes impatient teacher. I rarely see words like “bored” or “boring” in student evaluations of my teaching.

I make a real effort to suppress pronouncements of type “maths undergraduates in country X are much better than British maths undergraduates” and I even question such statements. But I do believe that British maths undergraduates generally are not sufficiently independent. In the long-standing debate “solution sheets or not” I firmly take the “no solution sheets” side. If the local law is that solution sheets should always be provided, I will naturally respect the law, but I will always vote against it where I can. I am for liberalism in teaching. That’s also part of an education towards independence.

Supervision of research students. Tibor Macko from Slovakia worked for a Ph.D. thesis under my supervision, and finished with a Ph.D. in October 2003, after 3 years. I continue to take a strong interest in his research and we are currently working on a joint paper. In October 2002, Revaz Kurdiani from Georgia became my second Ph.D. student, and in October 2003, Lukas Vokrinek from the Czech Republic became the third.

Membership of professional organizations. I am a member of the American Mathematical Society, the Deutsche Mathematiker-Vereinigung, the Edinburgh Mathematical Society and the London Mathematical Society.

Administration. I am currently (since 2004) the Head of Research at our department, as well as library representative (since September 2000). With the recent reorganisation of Aberdeen University into “Colleges”, the HoR job has become a rather light responsibility. But it does imply that I am on a few committees where I can to some extent influence strategic decisions.

Publications.

- (1) *Surgery and Bordism Invariants*, A. M. S. Bull. **9** (1983), 223–226.
- (2) *Surgery and the generalized Kervaire Invariant I*, Proc. Lond. Math. Soc. **51** (1985), 146–192.
- (3) *Surgery and the generalized Kervaire Invariant II*, Proc. Lond. Math. Soc. **51** (1985), 193–230.
- (4) (with A.Ranicki) *Chain complexes and assembly*, Math. Z. **204** (1990), 157–185.
- (5) *Visible L-theory*, Forum. Math. **4** (1992), 465–498.
- (6) *Sphères exotiques et l'espace de Whitehead*, C. R. Acad. Sci. Paris, Série 1, **303**/17 (1986), 885–888. (With bad misprints; see my homepage for a corrected and translated version.)
- (7) (with B.Williams) *Automorphisms of manifolds and algebraic K-theory, Part 1*, K-theory **1** (1988), 575–626.
- (8) (with B.Williams) *Automorphisms of manifolds and algebraic K-theory, Part 2*, J. of Pure and Appl. Algebra **62** (1989), 47–107.
- (9) *Pinching and Concordance Theory*, J. Diff. Geom. **38** (1993), 387–416.
- (10) *Orthogonal Calculus*, Trans. Amer. Math. Soc. **347** (1995), 3743–3796 ; see also *Erratum*, Trans. Amer. Math. Soc. February 1998.
- (11) *Curvature and finite domination*, Proc. Amer. Math. Soc. **124** (1996), 615–622.
- (12) *Calculus of Embeddings*, Bull. Amer. Math. Soc. **33** (1996), 177–187.
- (13) (with B.Williams) *Assembly*, in Proceedings of 1993 Oberwolfach conf. on Novikov Conjectures, Index Theorems and Rigidity, vol. 2, eds. Ferry–Ranicki–Rosenberg, Cambridge University Press, pp. 333–352.
- (14) (with B.Williams) *Pro-excisive Functors*, in Proceedings of 1993 Oberwolfach conf. on Novikov Conjectures, Index Theorems and Rigidity, vol. 2, eds. Ferry–Ranicki–Rosenberg, Cambridge University Press, pp. 353–364
- (15) *Hammock localization in Waldhausen categories*, J. Pure Appl. Algebra **138** (1999), 185–195.
- (16) (with B.Williams) *Duality in Waldhausen categories*, Forum Math. **10** (1998), 533–603.
- (17) (with B.Williams) *Products and Duality in Waldhausen categories*, Trans. Amer. Math. Soc. **352** (2000), 689–709.
- (18) *Embeddings from the point of view of immersion theory, Part I*, Geom. and Topology **3** (1999), 67–101. See <http://www.maths.warwick.ac.uk/gt> .
- (19) (with T.Goodwillie) *Embeddings from the point of view of immersion theory, Part II*, Geom. and Topology **3** (1999), 103–118. See <http://www.maths.warwick.ac.uk/gt> .
- (20) (with B.Williams) *Automorphisms of manifolds*, in: Surveys on Surgery Theory, Vol. 2, Annals of Math. Studies **149** (2001) Princeton University Press; 165–220.
- (21) (with W.Dwyer and B.Williams) *A parametrized index theorem for the algebraic K-theory Euler class*, to appear in Acta Math., May 2003
- (22) (with J.Klein and T.Goodwillie) *Spaces of smooth embeddings, disjunction and surgery*, in: Surveys on Surgery Theory, Vol. 2, Annals of Math. Studies **149** (2001) Princeton University Press; 221–284.
- (23) (with J.Klein and T.Goodwillie) *A Haefliger style description of the embedding calculus tower*, Topology **42** (2003), 509–524
- (24) *Excision and restriction in controlled K-theory*, Forum Math. **14** (2002), 85–119
- (25) *Homology of spaces of smooth embeddings*, Quart. J. Math. **55** (2004), 499–504.

- (26) *Cohomology of the stable mapping class group*, in: *Topology, Geometry and Quantum Field Theory*, 379–404, Londo. Math. Soc. Lecture Note Ser., 308, Cambridge University Press, 2004.
- (27) (with I.Madsen) *The stable moduli space of Riemann surfaces: Mumford's conjecture*, **preprint** 95 pages, submitted for publication July 2003, available at arXiv: math.AT/0212321 .
- (28) (with I.Madsen) *The stable mapping class group and stable homotopy theory*, **preprint** 22 pages, to appear in: *Proceedings of the 2004 European Congress of Mathematics in Stockholm*, expected June 2005.
- (29) *What does the classifying space of a category classify ?*, **preprint** 8 pages, submitted for publication January 2005.