

Werner Müller



Academic career

1977	PhD, HU Berlin
1977 - 1986	Research Scholar, Academy of Sciences of GDR, Berlin
1987 - 1989	Professor, Academy of Sciences of GDR, Berlin
1989 - 1990	Member, Institute of Advanced Study, Princeton, NJ, USA
1990 - 1993	Member, Max Planck Institute for Mathematics, Bonn
1993 - 2016	Professor (C4), University of Bonn
Since 2016	Professor Emeritus

Honours

1983	Euler-Medal, Academy of Sciences of GDR
1991	Max Planck Research Award (together with J. Cheeger, Courant Institute)
1993	Member of the Berlin-Brandenburg Academy of Sciences and Humanities
2003	Member of the German National Academy of Sciences Leopoldina
2015	Member of the Academia Europaea

Invited Lectures

1983	ICM, invited speaker, Warsaw, Poland
1988	Taneguichi Symposium, Japan
1992	ECM, invited speaker, Paris, France
1999	Conference in honor of M. Atiyah, R. Bott, F. Hirzebruch, and I. M. Singer, Harvard, MA, USA
2004	Conference in honor of J. Arthur, Toronto, ON, Canada
2008	Clay senior scholar, Lectures at MSRI, Berkeley, CA, USA
2009	Distinguished Ordway Lecturer, University of Minnesota, Minneapolis, MN, USA
2013	Conference in honor of J.-M. Bismut, Paris, France
2016	Conference in honor of J. Schwermer, Max Planck Institute for Mathematics, Bonn

Research Projects and Activities

DFG Priority Programme SPP 1154 "Global Differential Geometry"

Project leader

DFG Collaborative Research Center SFB 611 "Singular phenomena and scaling in mathematical models"

Project leader

GIF Research Project "Analytic aspects of automorphic forms and the trace formula"

Project leader, 2004 - 2008

GIF Research Project "Spectral methods in automorphic forms"

Project leader, 2008 - 2011

Research Areas A and D, DFG Cluster of Excellence "Hausdorff Center for Mathematics"

Principal Investigator

Research profile

My main interest is in global analysis and the theory of automorphic forms. Global analysis is concerned with the study of geometric differential operators on manifolds. The investigation of solutions of partial differential equations of geometric origin is the source of important connections between geometry, topology and analysis. I am especially interested in harmonic analysis on locally symmetric spaces and the theory of automorphic forms. The Arthur-Selberg trace

formula is one of the most important tools in the theory of automorphic forms.

In joint work with T. Finis and E. Lapid I have used the trace formula to study the asymptotic distribution of automorphic forms for $GL(n)$. This includes the Weyl law and the limit multiplicity problem. A crucial input is the refined spectral side of the trace formula, which was established in joint work with T. Finis and E. Lapid. A very challenging problem is to extend these results to other classical groups. Among other things, this requires detailed knowledge of the analytic properties of the L -functions occurring on the spectral side of the trace formula. To this end one can use Arthur's work on the endoscopic classification of automorphic representations of symplectic and orthogonal groups to relate the L -functions to L -functions for $GL(n)$.

Another key topic of my research in recent years has been the study of analytic torsion of compact locally symmetric manifolds. Analytic torsion is a sophisticated spectral invariant of a compact Riemannian manifold and a flat bundle over this manifold. A basic problem is the approximation of L^2 -torsion by the analytic torsion of finite coverings in a tower. This is a special case of the kind of problems studied to a great extent by W. Lück. Bergeron and Venkatesh used this to study the torsion in the cohomology of co-compact arithmetic groups if the level is increased. J. Pfaff and I studied the same problem if the arithmetic group is fixed and the local system varies.

Many arithmetic groups are not co-compact and the long-term goal is to extend these results to the finite volume case. The main tool is again the trace formula. Its application leads to problems related to the refined spectral side and the study of weighted orbital integrals, which appear on the geometric side of the trace formula.

Editorships

- Mathematische Nachrichten (1990 - 2005)
- Inventiones Mathematicae (1991 - 2007)
- Compositio Mathematicae (1993 - 1998)
- Intern. Math. Research Notices (1993 - 1998)
- Analysis & PDE (since 2008)

Research Area A The focus of my research in this area is on the study of the spectrum of geometric differential operators on manifolds and the relation to geometry. Of particular interest are classes of non-compact Riemannian manifolds with special structures at infinity such as manifolds with singularities and locally symmetric spaces of finite volume. In the non-compact case it is important to determine the structure of the continuous spectrum. The main tool is scattering theory.

In [12], we developed scattering theory for Laplace operators on manifolds of bounded curvature. In [9], we have studied scattering theory for differential forms on manifolds with cylindrical ends.

In particular, we have given a cohomological interpretation of the Eisenbud-Wigner time delay operator. In [8], I have extended the Selberg trace formula to non-unitary representations of the fundamental group. This has applications to dynamical zeta functions.

Research Area DE

In joint work with T. Finis and E. Lapid [3], we settled the limit multiplicity problem for the groups $GL(n)$ and $SL(n)$. In [6] I studied with S. Marshall the growth of the torsion subgroup in the cohomology of a compact arithmetic hyperbolic 3-manifold. With J. Pfaff [4] we extended this partially to other compact arithmetic locally symmetric manifolds. With J. Matz we have introduced the analytic torsion for congruence quotients of $SL(n, R)/SO(n)$ and studied the approximation of the L^2 -torsion.

Supervised theses

Master theses: 10
Diplom theses: 12
PhD theses: 14

Selected PhD students

Werner Hoffmann (1986): “Die Spurformel für Hecke-Operatoren über Gittern vom Rang”,
 now Professor, University of Bielefeld

Gorm Salomonsen (1996): “Dirac operators and analysis on open manifolds”

Boris Vaillant (2001): “Index and Spectral Theory for Manifolds with Fibred Cusps”

Jörn Müller (2008): “Zur Kohomologie und Spektraltheorie des Hodge-Laplaceoperators von Mannigfaltigkeiten mit gefaseter Spitzenmetrik”,
 now Research Assistant , HU Berlin

Clara Aldana (2009): “Inverse Spectral Theory And Relative Determinants Of Elliptic Operators On Surfaces With Cusps”,
 now Postdoctoral Researcher, Mathematics Research Unit, University of Luxembourg, Luxembourg

Jonathan Pfaff (2012): “Selberg and Ruelle zeta functions and the relative analytic torsion on complete odd-dimensional hyperbolic manifolds of finite volume”

Ksenia Fedosova (2016): “Selber zeta functions and relative analytic torsion for hyperbolic odd-dimensional orbifolds”,
 now Research Assistant, University of Freiburg

Habilitations

Kai Köhler (1999), now Professor (C3), University of Düsseldorf

Selected publications

- [1] Werner Müller Jasmin Matz. Approximation of l^2 -analytic torsion for arithmetic quotients of the symmetric space *arXiv: 1709:07764*, 2017.
- [2] Werner Müller Jasmin Matz. Analytic torsion of arithmetic quotients of the symmetric space *arXiv: 1607:04676*, to appear in *GAF*, 2016.
- [3] Tobias Finis, Erez Lapid, and Werner Müller. Limit multiplicities for principal congruence subgroups of $GL(n)$ and $SL(n)$. *J. Inst. Math. Jussieu*, 14(3):589–638, 2015.
- [4] Werner Müller and Jonathan Pfaff. On the growth of torsion in the cohomology of arithmetic groups. *Math. Ann.*, 359(1-2):537–555, 2014.
- [5] Werner Müller and Jonathan Pfaff. Analytic torsion and L^2 -torsion of compact locally symmetric manifolds. *J. Differential Geom.*, 95(1):71–119, 2013.
- [6] Simon Marshall and Werner Müller. On the torsion in the cohomology of arithmetic hyperbolic 3-manifolds. *Duke Math. J.*, 162(5):863–888, 2013.
- [7] Tobias Finis, Erez Lapid, and Werner Müller. On the spectral side of arthur’s trace formula—absolute convergence. *Ann. of Math. (2)*, 174(1):173–195, 2011.
- [8] Werner Müller. A selberg trace formula for non-unitary twists. *Int. Math. Res. Not. IMRN*, (9):2068–2109, 2011.
- [9] Werner Müller and Alexander Strohmaier. Scattering at low energies on manifolds with cylindrical ends and stable systoles. *Geom. Funct. Anal.*, 20(3):741–778, 2010.
- [10] Erez Lapid and Werner Müller. Spectral asymptotics for arithmetic quotients of $SL(n, \mathbb{R})/SO(n)$. *Duke Math. J.*, 149(1):117–155, 2009.
- [11] Werner Müller. Weyl’s law for the cuspidal spectrum of SL_n . *Ann. of Math. (2)*, 165(1):275–333, 2007.
- [12] Werner Müller and Gorm Salomonsen. Scattering theory for the laplacian on manifolds with bounded curvature. *J. Funct. Anal.*, 253(1):158–206, 2007.
- [13] Werner Müller. Analytic torsion and r-torsion for unimodular representations. *J. Amer. Math. Soc.*, 6(3):721–753, 1993.
- [14] Werner Müller. The trace class conjecture in the theory of automorphic forms. *Ann. of Math. (2)*, 130(3):473–529, 1989.