

# Maciej Zworski

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## Research Interests

Partial Differential Equations, Microlocal Analysis, Scattering Theory.

## Education

<i>Massachusetts Institute of Technology</i> Ph.D. in Mathematics Thesis Advisor : Professor R.B. Melrose Thesis title : High Frequency Scattering by a Convex Obstacle.	<i>September 1985–June 1989</i>
<i>Massachusetts Institute of Technology</i> S.B. in Mathematics.	<i>September 1983–June 1985</i>
<i>Imperial College, London, U.K.</i> B.Sc. programme in the Department of Mathematics.	<i>October 1982–June 1983</i>

## Experience

<i>Professor of Mathematics, University of California, Berkeley</i>	<i>1998-date</i>
<i>Vice-Chair for Faculty Affairs, Mathematics, UC Berkeley</i>	<i>2006-2009</i>
<i>Professor of Mathematics, University of Toronto</i>	<i>1995–2000</i>
<i>Professor of Mathematics, The Johns Hopkins University</i>	<i>1994–1996</i>
<i>Associate Professor of Mathematics, The Johns Hopkins University</i>	<i>1992–1993</i>
<i>Benjamin Peirce Lecturer, Assistant Professor of Mathematics, Harvard University</i>	<i>1989–1992</i>

## Professional Activities

<i>Member, Conseil scientifique, Fondation mathématique Jacques Hadamard</i>	<i>2011-date</i>
<i>Member, Scientific Advisory Panel of The Fields Institute, Toronto</i>	<i>2009-date</i>
<i>Founding Editor-in-Chief, Analysis &amp; PDE (Math Sci Publishers)</i>	<i>2007-date</i>
<i>Editor, Applied Mathematics Research eXpress</i>	<i>2006-date</i>
<i>Associate Editor, Inverse problems and imaging</i>	<i>2006-date</i>
<i>Associate Editor, American Journal of Mathematics</i>	<i>2006-date</i>
<i>Associate Editor, Canadian Journal of Mathematics</i>	<i>2001-2006</i>
<i>Editor, Methods and Applications of Analysis</i>	<i>2001-date</i>
<i>Editor, American Journal of Mathematics</i>	<i>2000-2005</i>
<i>Editor, International Mathematics Research Notices</i>	<i>1998–2006</i>

**Fellowships and Honours**

Chair d'Excellence, <i>Université de Paris-Nord</i>	2011
Fellow of American Academy of Arts and Sciences	2010–date
BMC/BAMC plenary speaker	2010
ICM speaker in the PDE section	2002
Fellow of Royal Society of Canada	1999–date
Coxeter-James Prize of the Canadian Mathematical Society	1999
Fellow of Trinity College, University of Toronto	1996–date
Alfred P. Sloan Research Fellow	1991–1993
Sloan Doctoral Dissertation Fellow	1988–1989
Jon A. Bucsela Prize in Mathematics, MIT	1985

**Visiting Positions**

Visiting Professor, <i>Université de Paris-Sud, Orsay</i>	May 2009
Visiting Directeur de Recherche, CNRS, <i>École Polytechnique</i>	September–December 2004
Visiting Professor, <i>Université de Paris-Nord</i>	October 2003
Visiting Professor, <i>Université de Paris-Sud, Orsay</i>	September 2003
Programme Organizer, MSRI	January–May 2003
Visiting Professor, <i>Université de Paris-Sud, Orsay</i>	June 2002
Programme Organizer, <i>Erwin Schrödinger Institute, Vienna</i>	May–July 2001
Visiting Professor, <i>Université de Bordeaux I</i>	June 2000
Visiting Professor, <i>Université de Paris-Nord</i>	June 1999
Visiting Directeur de Recherche, CNRS, <i>École Polytechnique</i>	April–June, 1997
Visiting Professor, <i>Université de Nantes</i>	June 1996
Visiting Professor, <i>Institut Fourier, Grenoble</i>	June 1995
Visiting Professor, <i>Université de Paris-Nord</i>	June 1994
<i>Institute des Hautes Études Scientifiques</i>	September 1992–May 1993
Visiting Professor, <i>Université de Paris-Sud, Orsay</i>	May–June 1990

**Publications**

- [1] “On the Representation of  $P_0$ -lattices Being  $P$ -algebras.” (with J. Klukowski), *Demonstratio Mathematica*, **18**(1) (1985), 103–114.
- [2] “Distribution of poles for scattering on the real line” *J. of Funct. Anal.* **73**(3) (1987), 277–296.
- [3] “Decomposition of normal currents.” *Proc. Amer. Math. Soc.* **102** (4)(1988), 831–839.
- [4] “Sharp polynomial bounds on the number of scattering poles of radial potentials.” *J. of Funct. Anal.* **82**(2) (1989), 370–403.
- [5] “Sharp polynomial bounds on the number of scattering poles.” *Duke Math. J.* **59**(2) (1989), 311–323.
- [6] “High frequency scattering by a convex obstacle.” *Duke Math. J.* **61**(2) (1990), 545–634.
- [7] “Shift of the shadow boundary in high frequency scattering.” *Comm. Math. Phys.* **136** (1991), 141–156
- [8] “Complex scaling and the distribution of scattering poles.” (with J. Sjöstrand), *Jour. Amer. Math. Soc.* **4**(4) (1991), 729–769.

- [9] “Distribution of scattering poles near the real axis.”(with J. Sjöstrand), *Comm.PDE* **17** (1992), 1021-1035.
- [10] “The remainder estimate in spectral accumulation for degenerating hyperbolic surfaces.”(with L. Ji), *J. of Func. Anal.* **114** (1993), 412-420.
- [11] “Lower bounds on the number of scattering poles.”(with J. Sjöstrand), *Comm.PDE* **18** (1993), 847-858.
- [12] “Estimates on the number of scattering poles near the real axis for strictly convex obstacles.”(with J. Sjöstrand), *Ann. Inst. Fourier* **43**(3)(1993), 769-790.
- [13] “Semilinear diffraction of conormal waves (joint work with Melrose and Sá Barreto).” Séminaire E.D.P. 1992-1993, École Polytechnique, II-1-II-21.
- [14] “Finite volume surfaces with resonances far from the unitarity axis.” (with R. Froese), *Int. Math. Research Notices* **10**(1993), 275-277.
- [15] “Lower bounds on the number of scattering poles II.” (with J. Sjöstrand), *J. Func. Anal.* **123**(2)(1994), 336-367.
- [16] “Scattering matrix for asymptotically flat manifolds” Journées “Equations aux dérivées partielles” 1994, Saint-Jean-de-Monts, XVII-1-XVII-14.
- [17] “The complex scaling method for scattering by strictly convex obstacles.” (with J. Sjöstrand), *Ark. för Math.* **33**(1)(1995), 135-172.
- [18] “Upper bounds on the number of resonances on noncompact Riemann surfaces.” (with L. Guillopé), *J. Func. Anal.* **129**(1995), 364-389.
- [19] “Semilinear diffraction of conormal waves.” (with R.B. Melrose and A. Sá Barreto), *Astérisque* **240**(1996).
- [20] “An example of new singularities in semilinear interaction of a cusp and a plane.” *Comm.PDE.* **19**(5&6)(1994), 901-909.
- [21] “Polynomial bounds on the number of resonances for some complete spaces of constant negative curvature near infinity.” (with L. Guillopé), *Asymp. Anal.* **11**(1995) 1-22.
- [22] “Counting scattering poles.” *Proceedings of the Taniguchi International Workshop Spectral and Scattering Theory*, M. Ikawa ed., Marcel Dekker, New York, Basel, Hong Kong, 1994.
- [23] “Spectral asymptotics for manifolds with cylindrical ends.” (with T. Christiansen), *Ann. Inst. Fourier* **45**(1)(1995), 251-263.
- [24] “Existence of resonances in three dimensions.” (with A. Sá Barreto), *Comm. Math. Phys.* **173**(2)(1995), 401-415.
- [25] “Ergodicity of eigenfunctions for ergodic billiards.” (with S. Zelditch), *Comm. Math. Phys.* **175**(3)(1996), 673-682.
- [26] “Scattering metrics and geodesic flow at infinity.” (with R.B. Melrose), *Invent. Math.* **124**(1996), 389-436.
- [27] Appendix to “Density of resonances for strictly convex analytic obstacles.” by J. Sjöstrand, *Can. J. Math.* **48**(2)(1996), 437-446.
- [28] “Generic simplicity of resonances.” (with F. Klopp), *Helv. Phys. Acta* **68**(1995), 531-538.
- [29] “Harmonic functions of polynomial growth on some complete manifolds.” (with T. Christiansen), *Geom. and Func. Anal.* **6**(4)(1996), 619-627.
- [30] “Existence of resonances in potential scattering.” (with A. Sá Barreto), *Comm. Pure and Applied Math.* **49**(12)(1996), 1271-1280.
- [31] “Scattering asymptotics for Riemann surfaces.” (with L. Guillopé), *Annals of Math.* **145**(1997), 597-660.

- [32] “Distribution of resonances for spherical black holes.” (with A. Sá Barreto), *Math. Res. Lett.* **4**(1)(1997), 103-121.
- [33] “Poisson formulæ for resonances” Séminaire E.D.P. 1996-1997, École Polytechnique, XIII-1-XIII-12.
- [34] “Distribution of resonances for convex co-compact hyperbolic surfaces” Journées “Equations aux dérivées partielles” 1997, Saint-Jean-de-Monts, XVIII-1-XVIII-9.
- [35] “Dimension of the limit set and the density of resonances for convex co-compact hyperbolic surfaces”, *Invent. Math.* **136** (1999), 353-409.
- [36] “From quasimodes to resonances” (with S.-H. Tang), *Math. Res. Lett.* **5** (1998), 261-272.
- [37] “Wave trace for Riemann surfaces” (with L. Guillopé), *Geom. and Func. Anal.* **6** (1999), 1156-1168.
- [38] “Asymptotic distribution of resonances for convex obstacles” (with J. Sjöstrand), *Acta Math.*, **183**(2) (1999), 191-253.
- [39] “Poisson formula for resonances in even dimensions”, *Asian J. Math.* **2**(3), (1998), 615-624.
- [40] “Spacing between phase shifts in a simple scattering problem”, (with S. Zelditch), *Comm. Math. Phys.* **204** (1999), 709-729.
- [41] “Breit-Wigner approximation and the distribution of resonances near the real axis”, (with V. Petkov), *Comm. Math. Phys.* **204** (1999), 329-351.
- [42] “Resonances in Physics and Geometry”, *Notices Amer. Math. Soc.* **46**(3)(1999), 319-328.
- [43] “Singular part of the scattering matrix determines the obstacle”, *Osaka J. Math.* **38**(2001), 13-20.
- [44] “Distribution of resonances for asymptotically Euclidean manifolds”, (with J. Wunsch), *J. Diff. Geom.* **55**(2000), 43-82.
- [45] “Resonant rigidity of  $S^2$ ” (with A. Hassell), *J. Funct. Analysis.*, **169** (1999), 604-609.
- [46] “The FBI transform on compact  $C^\infty$  manifolds”, (with J. Wunsch), *Trans. Amer. Math. Soc.* **353** (2001), 1151-1167.
- [47] “Semi-classical estimates in asymptotically euclidean scattering” (with A. Vasy), *Comm. Math. Phys.* **212**(2000), 205-217.
- [48] “Resonance wave expansions: two hyperbolic examples” (with T. Christiansen), *Comm. Math. Phys.* **212**(2000), 323-336.
- [49] “Resonance wave expansions of scattered waves” (with S.H. Tang), *Comm. Pure Appl. Math.* **53**(2000), 1305-1334.
- [50] “Scattering matrices and scattering geodesics of locally symmetric spaces” (with L. Ji), *Ann. Sci. Ec. Norm. Sup.* **34**(2001), 441-469.
- [51] “A remark on a paper by E.B. Davies”, *Proc. A.M.S.* **29**(2001), 2955-2957.
- [52] “Resonance expansions in semi-classical propagation” (with N. Burq), *Comm. Math. Phys.* **232** (2001), 1-12.
- [53] “Resonance expansions of scattered waves” Séminaire E.D.P. 1999-2000, École Polytechnique, XXII-1-XXII-8.
- [54] Erratum “Breit-Wigner approximation and the distribution of resonances near the real axis”, (with V. Petkov), *Comm. Math. Phys.* **214** (2000), 733-735.
- [55] “A remark on isopolar potentials”, *SIAM J. Math. Anal.* **32**(6)(2001), 1823-1826.
- [56] “Semi-classical estimates on the scattering determinant” (with V. Petkov), *Ann. H. Poincaré*, **2**(2001), 675-711.

- [57] “Numerical linear algebra and solvability of partial differential equations”, *Comm. Math. Phys.* **229** (2002), 293-307.
- [58] “Quantum resonances in chaotic scattering,” (with Kevin Lin), *Chem. Phys. Lett.* 355(2002), 201-205.
- [59] “Quantum monodromy and semiclassical trace formulae,” (with Johannes Sjöstrand), *J. Math. Pure Appl.* 81 (2002), 1-33.
- [60] “Correction and supplements to: Scattering matrices and scattering geodesics of locally symmetric spaces [Ann. Sci. École Norm. Sup. (4) 34 (2001), no. 3, 441–469]” *Ann. Sci. École Norm. Sup.*(4) 35 (2002), no. 6, 897–901.
- [61] “Scattering matrix in conformal geometry,” (with C. Robin Graham ), Séminaire E.D.P. 2000-2001, École Polytechnique, XXII-1-XXII-8.
- [62] “Scattering matrix in conformal geometry,” (with C. Robin Graham ), *Invent. Math.* 152(2003), 89-118.
- [63] “Birkhoff normal forms in semi-classical inverse problems” (with Alexei Iantchenko and Johannes Sjöstrand), *Math. Res. Lett.* 9(2002), 337-362.
- [64] “Pseudospectra in automorphic scattering” (with Tanya Christiansen), *Forum Math.* 16(2004), 681-694
- [65] “Fractal Weyl laws for chaotic open systems” (with Wentao Lu and Srinivas Sridhar), *Phys. Rev. Lett.* **91**(2003), 154101.
- [66] “Resonance expansions of propagators in the presence of potential barriers” (with Shu Nakamura and Plamen Stefanov), *J. Funct. Anal.*, **205**(2003), 180-205.
- [67] “Quantum resonances and partial differential equations” Proc. I.C.M. 2002, vol III, 243-252.
- [68] “The Selberg zeta function for convex co-compact Schottky groups” (with L. Guillopé and K. Lin), *Comm. Math. Phys.* 245 (2004), 149 - 176.
- [69] “Pseudospectra of semiclassical (pseudo)differential operators” (with N. Dencker and J. Sjöstrand), *Comm. Pure. Appl. Math.* **57**(2004), 384-415.
- [70] “Geometric control in the presence of a black box” (with N. Burq), *Journal of A.M.S.*, 17 (2004), 443-471.
- [71] “Bouncing ball modes and quantum chaos” (with N. Burq), *SIAM Review*, 47(5), 2005, 43-49.
- [72] “Elementary linear algebra for advanced spectral problems” (with J. Sjöstrand), *Annales de l’Institut Fourier*, 57(2007), 2095–2141.
- [73] “Growth of the zeta function for a quadratic map and the dimension of the Julia set” (with John Strain), *Nonlinearity*, 17(5), 2004, 1607–1622.
- [74] “Instability for the semi-classical non-linear Schrödinger operator” (with Nicolas Burq), *Comm. Math. Phys.*, 260(2005), 45-58.
- [75] “Control theory and high energy eigenfunctions”, (with Nicolas Burq), Journées “Équations aux Dérivées Partielles”, Exp. No. XIII, 10 pp., École Polytech., Palaiseau, 2004.
- [76] “Fractal Weyl laws for quantum resonances.” Séminaire: Équations aux Dérivées Partielles. 2004–2005, Exp. No. IV, 29 pp., École Polytech., Palaiseau, 2005.
- [77] “Quantum decay rates in chaotic scattering”, (with S. Nonnenmacher), Séminaire: Équations aux Dérivées Partielles. 2005–2006, Exp. No. XXII, 6 pp., École Polytech., Palaiseau, 2006.
- [78] “Fractal upper bounds on the density of semiclassical resonances” (with Johannes Sjöstrand), *Duke Math. J.* 137 (2007), 381–459.
- [79] “Distribution of resonances for open quantum maps”, (with Stephane Nonnenmacher), *Comm. Math. Phys.* 269(2007), 311-365.

- [80] “Fractal Weyl laws in discrete models of chaotic scattering” (with Stéphane Nonnenmacher), *Journal of Physics A*, 38 (2005), 10683-1070
- [81] “On dissipation induced destabilization and brake squeal: a structured pseudospectral perspective” (with Oliver O’Reilly, Patrick Kessler, and Annelise Raphael), *Journal of Sound and Vibration*, 308(2007), 1-11.
- [82] “Fast soliton scattering by delta impurities” (with Justin Holmer and Jeremy Marzuola), *Comm. Math. Phys.* 274(2007), 187-216.
- [83] “Soliton splitting by external delta potentials” (with Justin Holmer and Jeremy Marzuola), *J. of Nonlinear Science*, 17(2007), 349-367.
- [84] “Semiclassical  $L^p$  estimates” (with Herbert Koch and Daniel Tataru), *Annales Henri Poincaré* 8(2007), 885-916.
- [85] “Slow soliton interaction with external delta potentials” (with Justin Holmer), *J. of Modern Dynamics*, 1(2007), 689–718.
- [86] “Symmetry of bound and antibound states in the semiclassical limit” (with David Bindel), *Lett. Math. Phys.* 81(2007), 107-117.
- [87] “Theory and computation of resonances in 1d scattering” (with David Bindel), online presentation, including MATLAB codes, <http://www.cims.nyu.edu/~dbindel/resonant1d/>
- [88] “Soliton interaction with slowly varying potentials” (with Justin Holmer), *Int. Math. Res. Notices*, 2008 (2008), Art. ID rnn026, 36 pp.
- [89] “Breathing patterns in nonlinear relaxation” (with Justin Holmer), *Nonlinearity*, 22(2009), 1259–1301.
- [90] “A mathematical formulation of the Mahaux-Weidenmüller formula for the scattering matrix” (with Tanya J. Christiansen), *J. Phys. A: Math. Theor.*, 42(2009) 415202.
- [91] “Quantum decay rates in chaotic scattering” (with Stéphane Nonnenmacher), *Acta Mathematica*, 203(2)(2009), 149–233.
- [92] “Semiclassical resolvent estimates in chaotic scattering” (with Stéphane Nonnenmacher), *Applied Mathematics Research eXpress* 2009; doi: 10.1093/amrx/abp003.
- [93] “Probabilistic Weyl laws for quantized tori” (with Tanya J. Christiansen), *Comm. Math. Phys.* 299(2)(2010), 305-334.
- [94] “Effective dynamics of double solitons for perturbed mKdV” (with Justin Holmer and Galina Perelman), *Comm. Math. Phys.* 305(3)(2011), 363–425.
- [95] “Resolvent estimates for normally hyperbolic trapped sets” (with Jared Wunsch), *Ann. Inst. Henri Poincaré (A)*, 12(7)(2011), 1349–1385.
- [96] “From open quantum systems to open quantum maps” (with Stéphane Nonnenmacher and J. Sjöstrand), *Comm. Math. Phys.* 304(1)(2011), 1–48.
- [97] “Fractal Weyl law for open quantum chaotic maps” (with Stéphane Nonnenmacher and J. Sjöstrand), [arXiv:1105.3128](https://arxiv.org/abs/1105.3128).
- [98] “Control for Schrödinger operators on tori” (with N. Burq), [arXiv:1106.0774](https://arxiv.org/abs/1106.0774), to appear in *Math. Res. Lett.*
- [99] “Weighted eigenfunction estimates with applications to compressed sensing” (with N. Burq, S. Dyatlov and R. Ward), [arXiv:1111.2383](https://arxiv.org/abs/1111.2383).
- [100] “Semiclassical Analysis”, book to appear in *Graduate Studies in Mathematics*, *American Mathematical Society*.

### Personal Information

Born in 1963 in Wrocław, Poland. Polish and Canadian Citizenships, U.S. Permanent Resident.