

## CURRICULUM VITAE

Blake Temple

### EDUCATION

Ph.D. University of Michigan	June, 1980	Mathematics
M.S. University of Michigan	June, 1976	Mathematics/Education
B.A. University of Michigan	June, 1973	Philosophy

### APPOINTMENTS

• Distinguished Professor, Mathematics	July 2012
• Chair, Graduate Group in Appl. Math. <i>University of California, Davis</i>	July 2004-July 2007
• Professor <i>University of California, Davis</i>	July 1990-
• Chair, Graduate Group in Appl. Math. <i>University of California, Davis</i>	July 1988-July 1990
• Assistant Professor <i>University of California, Davis</i>	July 1986-July 1988
• Van Vleck Assistant Professor <i>University of Wisconsin</i>	Sept. 1984-June 1986
• Research Fellowship <i>MRC, University of Wisconsin</i>	Sept. 1983-Sept.1986
• Visiting Member <i>Courant Institute</i>	June 1982-Sept.1983
• N.S.F. Postdoctoral Fellow <i>Rockefeller University</i>	Sept. 1980-July 1982

### HONORS

- *Guggenheim Fellow*, 1994-95
- *Five-Year NSF Award*, 2007-2012
- *Frederick W. and Lois B. Gehring Professor of Mathematics*, U-Mich, 2007
- *Distinguished Visiting Professor*, Taiwan and Hong Kong, 2009
- *Public Lecture to the National Academy of Sciences*, IISC, India, 2006
- *Visiting Scholar*, Konstanz University, Germany, 2008
- *Visiting Scholar*, Newton Institute, Cambridge, England, 2003
- *Visiting Scholar*, IHES, Paris, France, 2002
- *First Graduate Math Teaching Award*, UC-Davis, 1993

## GRANTS:

- 2007-2012 NSF Applied Mathematics DMS-070-7532  
Title: Shock-Free and Shock-Wave Dynamics  
in General Relativity and Classical Fluids  
Funding Level: \$482,665
- 2004-07 NSF Applied Mathematics DMS-040-6096  
Title: Shock waves and geometry  
Funding Level: \$183,307
- 2001-04 NSF Applied Mathematics DMS-010-2493  
Title: Shock waves and geometry  
Funding Level: \$117,000
- 1998-01 NSF Applied Mathematics DMS-98-02473  
Title: Shock waves and geometry  
Funding Level: \$117,000
- 1995-98 NSF Applied Mathematics DMS-95-000694  
Title: The Geometry of Shock-waves  
Funding Level: \$92,000  
(Plus \$7800 matching funds from Office of Research)
- 1999-00 Faculty Research Grant Award  
Title: Shock-waves  
Funding Level: \$3,000
- 1995-96 Faculty Research Grant Award  
Title: Shock-waves and Geometry  
Funding Level: \$3,000
- 1996-97 Faculty Research Grant Award  
Title: Shock-waves and Geometry  
Funding Level: \$3,000

- 1995-96 Faculty Research Travel Award  
Funding Level: \$700
- 1994-95 US NAVY N00014-94-1-0691  
Title: Multi-Dimensional Shock-Waves for Relativistic Fluids  
(with J. Smoller)  
Funding Level: \$42,339
- 1992-95 NSF Applied Mathematics DMS-92-06631  
Title: Shock Waves and Conservation Laws  
Funding Level: \$91,000
- 1990-92 NSF Applied Mathematics DMS-8657319  
Title: Shock Waves and Conservation Laws  
Funding Levels: \$45,400
- 1987-90 NSF US-China Cooperative Research Grant DMS-8657319  
Title: Numerical and Analytical Studies in Nonlinear Waves  
(with R. Leveque)  
Funding Level: \$12,128
- 1987-90 NSF Applied Mathematics DMS-8613450  
Title: Systems of Conservation Laws: Analysis and Computation  
Funding Level: \$55,000
- 1986-94 86/90/92/94 UC-Davis Research Travel Grants
- 1987-88 Microcomputer research grant, UC-Davis

**RESEARCH AREAS:**

- Shock Waves
- General Relativity
- Partial Differential Equations
- Numerical Analysis
- Applied Mathematics

## RESEARCH RECORD

- 2011 Invited Lecture Special Session *Conservation Laws*, AMS, San Diego
- 2010 Invited Lecture *Quantum Theory and GR*, Regensburg, Germany
- 2010 Contributed Talk, *Numerical Relativity*, SIAM Philadelphia
- 2010 Three Plenary Talks, PDE Conference, Wyoming
- 2010 Invited Lecture, CIMAT, Guanajuato, Mexico
- 2010 Geometry Seminar, Stanford
- 2010 Colloquium, Mechanical Engineering, UC-Davis
- 2009 Contributed Talk, *PDE of Fluids*, AMS Miami
- 2009 Distinguished Visiting Professor, Taiwan/Hong Kong
- 2009 Colloquium, National University of Taiwan
- 2009 Colloquium, Institute of Mathematics, Taiwan
- 2009 Colloquium, Central University of Taiwan
- 2009 Colloquium, City University of Hong Kong
- 2009 Distinguished Lecture, NPS
- 2009 PDE Seminar, UC Berkeley
- 2008 Applied Math Colloquium, Cal Tech
- 2008 Colloquium, Penn State
- 2008 Visiting Professor, Konstanz University, Germany
- 2008 Colloquium, Konstanz University, Germany
- 2008 Speaker, *Free Boundary Problems*, KTH Stockholm
- 2007 Contributed Talk, *Numerical Relativity*, AMS New Orleans
- 2007 Gehring Professor, (Three Lectures), University of Michigan
- 2007 Two Invited Lectures, University of Wyoming
- 2007 Invited Participant, IMA *Numerical Relativity*
- 2006 Public Lecture, National Academy of Sciences, India
- 2006 Visiting Professor, (Four Lectures), Indian Institute of Sciences
- 2006 Invited Lecture, Dept of Theoretical Physics, Chennai, India
- 2006 Conference Co-organizer *General Relativity and Shock Waves*, Stanford
- 2006 Talk, Georgetown University
- 2005 Colloquium, UC-Santa Cruz
- 2005 PDE Seminar, Georgia Tech
- 2004 Contributed Speaker, *Analysis of PDE*, AMS Los Angeles
- 2004 Colloquium, University of Mass, Amherst
- 2004 Plenary Talk: *Tenth Int'l Conference on Hyperbolic Problems*, Osaka, Japan

## RESEARCH RECORD (Cont.)

- 2004 Plenary Talk: *Analysis, Modeling and Computation of PDE's*, SUNY Stony Brook  
2003 *Evaluation Panel for NSF DMS Mathematical Analysis*  
2003 Invited Speaker, (Four Lectures), *Newton Institute, Cambridge University*,  
2003 *Gehring Visiting Professor*, University of Michigan, (Offer Declined)  
2001 Invited speaker, conference in honor of Constantine Dafermos, Heidelberg, DE  
2001 Visiting Scholar, IHES, Paris  
2001 Hour talk, *VII Workshop on Partial Differential Equations*, IMPA, Brazil  
2000 *MacArthur Fellows Program*, Nominator  
2000 *Evaluation Panel for NSF DMS Applied Mathematics*  
1999 Two Talks/Lecture Notes, *Systems of Conservation Laws*, EU Summerschool, Pfalz, DE  
1999 Lecture, *Conference on Diff. Eqns. from Mechanics*, IMS, (organized by S.T. Yau)  
1999 Hour Talk, *VI Workshop on Partial Differential Equations*, IMPA, Brazil  
1999 *Evaluation Panel for NSF DMS Mathematical Analysis*  
1999 Invited Speaker, *Analysis and Math. Phy.*, (Lars Garding on his 80'th B'day), Lund, SE  
1999 Invited Participant, Oberwolfach  
1996-98 *Evaluation Panel for NSF Postdoctoral Fellowships*  
1995-99 *Mathematics Association of America Visiting Lecturer*  
1998 Organizer, *National Conference and Special Session of AMS, UC-Davis*  
1998 Invited Speaker, *Eighth ICCAM-98*, Leuven, Belgium  
1997 One Month Visit, *Institut Mittag-Leffler*, Djursholm, Sweden  
1997 Colloquium, Courant Institute, NYU  
1995-96 *Professeur des Universites*, France  
1995 Plenary Talk, *Saint-Jean-De-Monts*, France  
1995 Invited Speaker, *IV International Workshop on PDE*, IMPA, Brazil  
1995 Invited Participant, *In Honor of James Glimm on His 60'th Birthday*, SUNY, Stony Brook  
1995-2005 Two Colloquia, Chico State University  
1994 Visiting Scholar, Irwin Schrodinger Institute, Vienna, Austria.  
1994 Invited Lecture, *ESI Conference on Mathematical Relativity*, Vienna, Austria.  
1994 Plenary Talk, *Tenth Annual UC Conference on Nonlinear Science*, Davis CA  
1994-95 **GUGGENHEIM FELLOW**  
1991-92 *Sabbatical, University of Michigan*  
1988-90 *Chair, Graduate Group in Applied Mathematics*  
1982-83 Visiting Member, Courant Institute  
1980-82 *NSF Postdoctoral Research Fellow*, (First Year of the Award), Rockefeller University

## TALKS BY COLLABORATOR SMOLLER ON JOINT WORK

- 2010 Applied Math Colloquium, MIT
- 2010 Colloquium, Chinese University of HK
- 2010 Keynote Speaker, KAIST, (MIT of Korea)
- 2009 Joint Harvard-MIT-Brandeis Colloquium
- 2009 Colloquium, Indiana University
- 2009 Colloquium, University of Michigan
- 2004 Morningside Lecture, *Int'l Congress of Chinese Math's*, Hong Kong
- 2004 Invited Speaker, *Workshop in Hyperbolic Problems*, Stanford
- 2003 Plenary Lecture, *Int'l Conf. on Nonlin. Evol. Eqn's*, Evanston IL
- 2003 Rothschild Lecture, *Hyperbolic Models in Astrophysics and Cosmology*, Newton Institute, Cambridge University, U.K.
- 2001 Morningside Lecture, *Intern'l Congress of Chinese Math's*, Taipei
- 2001 Plenary Talk, *Int'l Conf. on Nonlin. Evol. PDE*, Yellow Mt., China
- 2001 Patton Lecture, Indiana University, Bloomington, IN
- 2000 Plenary Talk, *Conference for Burt Wendroff*, Los Alamos , NM
- 2000 Plenary Talk, *Eighth Int'l Conf. on Hyp. Probs*, Magdeburg, DE
- 2000 Analysis Seminar, MIT
- 2000 Colloquium, McGill University
- 1999 Plenary Talk, *IMS Conf. on Diff. Eqn's from Mech's*, Hong Kong
- 1999 Plenary Talk, *UAB-GIT Int'l Conf. on Math. Phys.*, Birmingham, AL
- 1999 Geometry Seminar, Harvard
- 1998 Seminar, Stanford University
- 1998 Plenary Talk, *Int'l Conf. on PDE and Num. Anal.*, Beijing, China
- 1997 Enrico Fermi Institute (University of Chicago)

## RECENT PUBLICATIONS:

- [i] *Simulation of general relativistic shock waves by a locally inertial Godunov Method*, with Zeke Vogler, Proc. Roy. Soc A, Published online April 4, 2012, doi: 10.1098/rspa.2011.0355.
- [ii] *Points of general relativistic shock wave interaction are “regularity singularities” where space-time is not locally flat*, with Moritz Reintjes, Proc. R. Soc. A, Published online before print May 16, 2012, doi: 10.1098/rspa.2011.0360.
- [iii] *Expanding wave solutions of the Einstein equations that induce an anomalous acceleration into the Standard Model of Cosmology*, Blake Temple and Joel Smoller, PNAS, vol. 106, no. 34, pp 14218-14218 (August 25, 2009).
- [iv] *General relativistic self-similar waves that induce an anomalous acceleration into the standard model of cosmology*, with Joel Smoller, Preprint.
- [v] *Periodic solutions of the Euler equations: A paradigm for time-periodic sound wave propagation in the compressible Euler equations*, with Robin Young, MAA (To Appear).
- [vi] *Time periodic linearized solutions of the compressible Euler equations and a problem of small divisors* with R. Young, SIMA (To Appear).
- [vii] *Linear waves that express the simplest possible periodic structure of the compressible Euler equations* with R. Young, Acta Mathematica Scientia, Vol. 29, Ser. B, No. 6 (1749-1766)
- [viii] *A Liapunov-Schmidt reduction for time-periodic solutions of the compressible Euler equations* with R. Young, MAA (To Appear).
- [ix] *A shock wave cosmology*, Patrika: Newsletter of the Indian Academy of Sciences, No. 43, pp 8-9, March 2006.
- [x] *Proposal for a numerical refinement of a finite mass shock wave cosmology*, abstracts of the AMS national meeting, New Orleans, January 2007.
- [xi] *Shock-wave cosmology inside a black hole*, with J. Smoller, Proc. Nat. Acad. Sci., September 30, 2003, Vol. 100, no. 20, (11216-11218).
- [xii] *How inflationary spacetimes might evolve into spacetimes of finite total mass*, with J. Smoller, Methods and Applications of Analysis, Vol. 12, No. 4, pp. 451-464 (2005).

[xiii] *Shock-wave refinement of the Friedman-Robertson-Walker metric*, with J. Smoller, Encyclopedia of Mathematical Physics, Elsevier, 2006.

[xiv] *Cosmology, black holes, and shock-waves beyond the Hubble length*, with J. Smoller, Methods and Applications of Analysis, Vol. 11, No. 1, pp. 077-132 (2004).

[xv] *Shock-wave solutions of the Einstein equations: Existence and consistency by a locally inertial Glimm scheme*, with J. Groah, Memoirs of the AMS, Vol. 172, No. 813 (2004).

[xvi] *A bound on the total variation of the conserved quantities for solutions of a general resonant nonlinear balance law*, with J. Hong, SIAM J. Appl. Math., Vol. 64, No. 3, pp. 819-857 (2004).

[xvii] *The generic solution of the Riemann problem in a neighborhood of a point of resonance for systems of nonlinear balance laws*, with J. Hong, Methods and Applications of Analysis, Vol. 10, No. 2, pp. 279-294 (2003).

**Book:**

[xviii] *Shock wave interactions in general relativity: a locally inertial Glimm scheme for spherically symmetric spacetimes*, with J. Groah and J. Smoller, Springer, 2007, VIII, 152 p, ISBN: 978-0-387-35073-8.

**Recent Student Dissertations:**

[xix] *Shock Wave Interactions in General Relativity and the Emergence of Regularity Singularities*, Moritz Reintjes, UC-Davis Doctoral Dissertation, 2011.

[xx] *The numerical simulation of general relativistic shock waves by a locally inertial Godunov method featuring dynamical time dilation*, Zeke Vogler, UC-Davis Doctoral Dissertation, 2010.

[xxi] *Global solution of the relativistic Euler equations in the ultra-relativistic limit*, Brian Wissman, UC-Davis Doctoral Dissertation, 2007. (Brian accepted a tenure track position at University of Hawaii in the Fall of 2007.)

## PUBLICATIONS

- [1] *Solutions in the large for the nonlinear hyperbolic conservation laws of gas dynamics*, (Thesis), Jour. Diff. Eqs., Vol 41, No.1, July 1981, pp. 96-161.
- [2] *Stability and error bounds for a fractional step scheme to compute weak solutions to the waterhammer problem*, Presented at the University of Maryland, Feb. 6, 1981.
- [3] *Global solution of the Cauchy problem for a class of  $2 \times 2$  non-strictly hyperbolic conservation laws*, Adv. Appl. Math. 3, 1982, pp. 335-375.
- [4] *The existence of a global weak solution of the waterhammer problem*, with M. Luskin, Comm. Pure Appl. Math. Vol. 35, 1982, pp. 697-735.
- [5] *Systems of conservation laws with coinciding shock and rarefaction waves*, Contemporary Mathematics, Vol. 17, 1983, pp. 141-151.
- [6] *Systems of conservation laws with invariant submanifolds*, Trans. Amer. Math. Soc., Vol 280, No. 2, 1983, pp. 781-795.
- [7] *No  $L^1$  contractive metrics for systems of conservation laws*, Trans. Amer. Math. Soc., Vol. 288, No.2, 1985, pp. 471-480.
- [8] *Stability of Godunov's method for a class of  $2 \times 2$  systems of conservation laws*, with R. Leveque, Trans. Amer. Math. Soc., Vol. 288, No.1, 1985, pp. 115-123.
- [9] *Examples and classification of non-strictly hyperbolic systems of conservation laws*, with E. Isaacson, Abstracts of AMS, January 1985. (Start of program.)
- [10] *Analysis of a singular hyperbolic system of conservation laws*, with E. Isaacson, Jour. Diff. Eqs., Vol.65, No.2., 1986, pp 250-286.
- [11] *Decay with a rate for noncompactly supported solutions of conservation laws*, Trans. Am. Math. Soc., Vol. 298, No.1, 1986, pp. 43-82.

- [12] *Stability and decay in systems of conservation laws*,  
Lecture Notes in Mathematics, A. Dold and B. Eckmann, Springer-Verlag, 1986,  
(Proceedings of the First International Conference on Hyperbolic Problems).
- [13] *Degenerate systems of conservation laws*,  
Contemporary Mathematics, Vol. 60, 1987, pp 125-133.
- [14] *Continuous dependence in systems of conservation laws*,  
in *Atlas Do Decimo Quinto Coloquio Brasileiro de Matematica*  
(Proceedings of the Brazilian Math. Society), 1987, pp. 67-83.
- [15] *On weak continuity and the Hodge decomposition*, with J. Robbin and R. Rogers,  
Trans. Am. Math. Soc., Vol. 303, No. 2, 1987, pp. 609-618.
- [16] *On the role of the characteristic set in the method of compensated compactness*,  
with R. Rogers, Davis Preprint.
- [17] *The Riemann problem near a hyperbolic singularity: the classification of  
solutions of quadratic Riemann problems I*, with E. Isaacson,  
D. Marchesin, B. Plohr, SIAM Jour. Appl. Math. Vol. 48, No. 5, 1988, pp. 1009-1032.
- [18] *Classification of quadratic Riemann problems II*, with E. Isaacson,  
SIAM Jour. Appl. Math. Vol. 48, No.6, 1988, pp.1287-1301.
- [19] *Classification of quadratic Riemann problems III*, with E. Isaacson,  
SIAM Jour. Appl. Math. Vol. 48, No.6, 1988, pp. 1302-1318.
- [20] *A characterization of the weakly continuous polynomials in the method  
of compensated compactness*, with R. Rogers, Trans. Am. Math. Soc.,  
Vol. 310, No. 1, 1988, pp. 405-417.
- [21] *The  $L^1$ -norm distinguishes the strictly hyperbolic from the non-strictly hyperbolic  
theory of the initial value problem for systems of conservation laws*,  
in *Notes on Numerical Fluid Mechanics*, Vol. 24, 1988, pp. 608-616.

- [22] *The structure of asymptotic states in a singular system of conservation laws*, with E. Isaacson, *Adv. Appl. Math.*, Vol. 11, pp. 205-219 (1990)
- [23] *Weak stability in the global  $L^1$ -norm for systems of hyperbolic conservation laws*, *Trans. Am. Math. Soc.*, Vol. 317, No. 2, 1990, pp. 673-685.
- [24] *Instability of rarefaction shocks for systems of conservation laws*, with J. Smoller and Z.P. Xin, *Arch. Rational Mech. Anal.*, Vol. 112, 1990, pp. 63-81.
- [25] *Nonlinear resonance in inhomogeneous systems of conservation laws*, with E. Isaacson, *Mathematics of Nonlinear Science*, Contemporary Mathematics, Vol. 108, 1990, pp. 63-77, (edited by M. S. Berger).
- [26] *A connection for Fermi Transport in the theory of general relativity*, with G. Martin, Davis preprint.
- [27] *Supnorm estimates in Glimm's method*, *J. Diff. Eqs.*, Vol. 83, No.1, 1990, pp. 79-84.
- [28] *On blowup in a resonant nonstrictly hyperbolic system*, by L. Lin, J.B. Temple and J. Wang, *Matematica Contemporanea*, IMPA, R. Iorio Jr. and D. Marchesin, Vol. 3, 1991, pp. 67-89. (Second Workshop on PDE).
- [29] *On the convergence of Glimm's method and Godunov's method when wave speeds coincide*, *Proceedings of the Second Int. Conf. on PDE*, May 15-18, 1991.
- [30] *From Newton to Einstein*, with C. Tracy, *Am. Math. Monthly* (Cover article), Vol. 99, No. 6, 1992, pp. 507-521.
- [31] *Multiphase flow models with singular Riemann problems*, with E. Isaacson, D. Marchesin and B. Plohr, *Comp. and Appl. Math.*, Vol. 11, 1992, pp. 147-167.
- [32] *Nonlinear resonance in systems of conservation laws*, with E. Isaacson, *SIAM Jour. Appl. Math.*, Vol. 52, 1992, pp. 1260-1278.

- [33] *Global solutions of the relativistic Euler equations*, with J. Smoller, Comm. Math. Phys., Vol. 156, 1993, pp. 67-99.
- [34] *Multi-dimensional shock waves for relativistic fluids*, with J. Smoller, Proceedings of Conference on Shock Waves and Conservation Laws, Beijing, China, June, 1993.
- [35] *Shock-wave solutions of the Einstein equations: The Oppenheimer-Snyder model of gravitational collapse extended to the case of non-zero pressure*, with J. Smoller, Arch. Rat. Mech. Anal., Vol. 128, 1994, pp 249-297.
- [36] *Shock Waves and General Relativity*, with J. Smoller, *Journees Equations Aux Derivees Partielles*, Saint-Jean-De-Monts, June 1994, (6 pages).
- [37] *Shock-waves in general relativity- A generalization of the Oppenheimer-Snyder model for gravitational collapse*, in *Nonlinear PDE and their applications*, College de France, Seminar Vol. **X**, edited by Brezis and Lions, 1994, (15 pages).
- [38] *A comparison of convergence rates for Godunov's method and Glimm's method in resonant nonlinear systems of conservation laws*, with L.Lin and J. Wang., SIAM J. Numer. Anal., Vol. 32, No. 3, 1995, pp. 824-840.
- [39] *Convergence of the  $2 \times 2$  Godunov method for a general resonant nonlinear balance law*, with E. Isaacson, SIAM Jour. Appl. Math., Vol. 55, No. 3, 1995 pp. 625-640.
- [40] *Suppression of oscillations in Godunov's method for a resonant non-strictly hyperbolic system*, with L. Lin and J. Wang, SIAM J. Numer. Anal., Vol. 32, No. 3, June 1995.
- [41] *Astrophysical shock wave solutions of the Einstein equations*, with Joel Smoller, Phys. Rev. D, Vol. 51, No. 6 (March 1995).
- [42] *The large time existence of periodic solutions for the compressible Euler equations*, with R. Young, *Contemporanea Mathematica*, IMPA, 1995, (Proceedings of the Fourth International Workshop on PDE).

- [43] *Shock-wave explosions in general relativity*, with J. Smoller, *Journées Equations Aux Derivées Partielles*, Saint-Jean-De-Monts, XVII, 1995, pp. 1-20.
- [44] *Shock-Waves and irreversibility in Einstein's theory of gravity*, with J. Smoller, *Hyperbolic Problems: Theory, Numerics, Applications*, edited by J. Glimm, M.J. Graham, J.W. Grove, and B.J. Plohr, 1996, pp. 81-90.
- [45] *Solutions to the Euler Equations with Large Data*, with R. Young, *Hyperbolic Problems: Theory, Numerics, Applications*, edited by J. Glimm, M.J. Graham, J.W. Grove, and B.J. Plohr, 1996, p. 258-267.
- [46] *The large time stability of sound waves*, with R. Young, *Comm. Math. Phys.*, Vol. 179, 1996, pp. 417-466.
- [47] *General relativistic shock-waves that extend the Oppenheimer-Snyder model*, with J. Smoller, *Arch. Rat. Mech. Anal.*, Vol. 138, 1997, 239-277.
- [48] *Shock-waves in general relativity*, with J. Smoller, *Harmonic Analysis and Nonlinear Differential Equations: A Volume in Honor of Victor Shapiro*, M. L. Lapidus, et al., *Contemporary Mathematics*, Vol. 208, 1997.
- [49] *Multi-dimensional shock-waves for relativistic fluids*, with J. Smoller, *AMS/IP Studies in Advanced Mathematics*, Vol. 3, 1997, pp. 377-391.
- [50] *Solutions of the Oppenheimer-Volkoff equations inside 9/8'ths of the Schwarzschild radius*, with J. Smoller, *Comm. Math. Phys.*, Vol. 184, 1997, pp. 597-617.
- [51] *Shock-waves near the Schwarzschild radius and the stability limit for stars*, with J. Smoller, *Physical Review D*, Vol. 55, No. 12, 1997 pp. 7518-7528.
- [52] *Shock-wave solutions in closed form and the Oppenheimer-Snyder limit in general relativity*, with J. Smoller, *SIAM J. Appl. Math.*, Vol. 58, No. 1, 1998, pp. 15-33.

- [53] *On the Oppenheimer-Volkov equations in general relativity*, with J. Smoller, Arch. Rat. Mech. Anal., Vol. 142, 1998, pp. 177-191.
- [54] *Applications of shock-waves in general relativity*, Proceedings of the VII Int'l Conf. on Hyperbolic Problems, Theory, Numer. and Appl., ETH Zurich, February, 1998.
- [55] *Shock-wave solutions of the Einstein equations: A general theory with examples*, with J. Smoller, Proceedings of European Union Research Network's 3rd Annual Summerschool, Lambrecht (Pfalz) Germany, May 16-22, 1999.
- [56] *Theory of a Cosmic Shock Wave*, with J. Smoller, Meth. Appl. of Anal., Vol. 8, no. 4, 2001, pp. 599-608.
- [57] *Cosmology with a Shock-Wave*, with J. Smoller, Comm. Math. Phys. Vol. 210, 2000, pp. 275-308.
- [58] *Shock-wave cosmology*, with J. Smoller, AMS/IP Studies in Advanced Mathematics, Vol. 16, 2000, pp. 351-359.
- [59] *A shock-wave formulation of the Einstein equations*, with J. Groah, Methods and Applications of Analysis, Vol. 7, no. 4, 2000, pp. 793-812.
- [60] *A locally inertial Glimm scheme for General Relativity*, with J. Groah, Seventh Workshop on Partial Differential Equations, Matematica Contemporanea, Vol. 22, 2002, pp. 163-179, edited by P. Dias, D. Marchesin, A. Nachbin, C. Tomei.
- [61] *Lipschitz continuous metrics that solve the Einstein equations*, with J. Groah and J. Smoller, Handbook of Mathematical Fluid Dynamics, 2003, (series by Elsevier).
- [62] *Shock-wave cosmology inside a black hole*, with J. Smoller, PNAS, Vol. 100, no. 20, 2003, pp. 11216-11218.

- [63] *The generic solution of the Riemann problem in a neighborhood of a point of resonance for systems of nonlinear balance laws*, with J. Hong, *Methods and Applications of Analysis*, Vol. 10, No. 2, 2003, pp. 279-294.
- [64] *Shock-wave solutions of the Einstein equations: Existence and consistency by a locally inertial Glimm Scheme*, with J. Groah, *Memoirs of the AMS*, Vol. 172, No. 813, November 2004.
- [65] *Cosmology, Black Holes, and Shock Waves beyond the Hubble Length*, with J. Smoller, *Meth. and Appl. of Anal.*, Vol. 11, No. 1, 2004, pp. 077-132.
- [66] *A bound on the total variation of the conserved quantities for solutions of a general resonant nonlinear balance law*, with J. Hong, *SIAM J. Appl. Math.*, Vol. 64, No. 3, 2004, pp. 819-857.
- [67] *Shock wave cosmology inside a black hole: The case of non-critical expansion*, with J. Smoller, *Journal of Hyperbolic Differential Equations*, Vol. 1, 2004, pp.429-443.
- [68] *Shock waves and cosmology*, with J. Smoller, *Third International Conference of Chinese Mathematicians*, Chinese University of Hong Kong, 2004.
- [69] *How inflationary spacetimes might evolve into spacetimes of finite total mass*, with J. Smoller, *Methods and Applications of Analysis*, Vol. 12, No. 4, 2005, pp. 451-464.
- [70] *A shock wave refinement of the Friedmann Robertson Walker spacetime*, with J. Smoller, *Encyclopedia of Mathematical Physics*, Elsevier, 2006.
- [71] *How inflation is used to resolve the flatness problem*, with J. Smoller, *Jour. of Hyp. Diff. Eqns.*, Vol. 3, no. 2, 2006, pp. 375-386.
- [72] *Shock wave cosmology inside a Black Hole: A computer visualization*, with J. Smoller and Zeke Vogler, *Hyperbolic Problems: Theory, Numerics and Applications*, Vol. 1, F. Asakura, Yokahama Publishers (2006).

- [73] *A Shock Wave Cosmology*, Patrika: Newsletter of the Indian Academy of Sciences, No. 43, pp 8-9, March 2006.
- [74] *A Proposal to Numerically Simulate a Cosmic Shock Wave by Use of a Locally Inertial Glimm Scheme*, Abstracts of the AMS, *Numerical Relativity*, AMS New Orleans, 2007. (Beginning of program to simulate GR expansion waves.)
- [75] *Shock wave interactions in general relativity: a locally inertial Glimm scheme for spherically symmetric spacetimes*, with J. Groah and J. Smoller, Springer, 2007, VIII, 152 p, ISBN: 978-0-387-35073-8.
- [76] *Linear waves that express the simplest possible periodic structure of the compressible Euler equations* with R. Young, *Acta Mathematica Scientia*, Vol. 29, Ser. B, no. 6, 2010, pp. 1749-1766.
- [77] *Periodic Solutions of the Euler Equations: A paradigm for time-periodic sound wave propagation in the compressible Euler equations*, with Robin Young, *Meth. Appl. of Anal.* (To Appear).
- [78] *Time periodic linearized solutions of the compressible Euler equations and a problem of small divisors* with R. Young, *SIAM Jour. of Math. Anal.* (To Appear).
- [79] *A Liapunov-Schmidt Reduction for Time-Periodic Solutions of the Compressible Euler Equations*, with Robin Young, *Meth. Appl. of Anal.*, (To Appear).
- [80] *Expanding wave solutions of the Einstein equations that induce an anomalous acceleration into the Standard Model of Cosmology*, Blake Temple and Joel Smoller, *PNAS*, Vol.106, no.34, 2009, pp.14218-14218.
- [81] *Answers to Questions Posed by Reporters*, Blake Temple and Joel Smoller, (Supplement to [76], [82] prepared August 19, 2009.)
- [82] *General Relativistic Self-Similar Waves that induce an Anomalous Acceleration into the Standard Model of Cosmology*, with Joel Smoller, arXiv:submit/0044499 [gr-qc] 20 May 2010.

- [83] *The “Big Wave” Theory for Dark Energy*, with Joel Smoller, Proceedings: Quantum Field Theory and Gravity, Regensburg, Germany, Sept. 28-Aug. 1, 2010.
- [84] *Simulation of general relativistic shock waves by a locally inertial Godunov Method*, with Zeke Vogler, Proc. Roy. Soc A, Published online April 4, 2012, doi: 10.1098/rspa.2011.0355.
- [85] *A One Parameter family of expanding wave solutions of the Einstein Equations that induce an anomalous acceleration into the standard model of cosmology*, with Joel Smoller, AMS/IP Studies in Advanced Mathematics Volume 51, 2011.
- [86] *Points of general relativistic shock wave interaction are “regularity singularities”* where space-time is not locally flat, with Moritz Reintjes, Proc. R. Soc. A, Published online before print May 16, 2012, doi: 10.1098/rspa.2011.0360.
- [87] *Nash-Moser for Newton Euler*, with Robin Young, preprint.
- [88] *A proof of convergence for the numerical approximations generated by the locally inertial Godunov method in general relativity*, with Zeke Vogler, preprint. arXiv:submit/0044499 [gr-qc] 20 May 2010.
- [89] *General Relativistic Self-Similar Waves that induce an Anomalous Acceleration into the Standard Model of Cosmology*, with Joel Smoller, arXiv:submit/0044499 [gr-qc] 20 May 2010.

## STUDENTS

**2012** *Shock Wave Interactions in General Relativity and the Emergence of Regularity Singularities*, Moritz Reintjes, UC-Davis Doctoral Dissertation, December, 2011.

Moritz Rientes. Moritz is working on the problem of determining the regularity of the gravitational metric at points of shock wave interaction in Groah-Temple shock wave theory.

**2010** *The Numerical Simulation of General Relativistic Shock Waves by a Locally Inertial Godunov Method Featuring Dynamical Time Dilation*, Zeke Vogler, UC-Davis Doctoral Dissertation,, Winter 2010.

**2007**: *Global solution of the relativistic Euler equations in the ultra-relativistic limit*, Brian Wissman, UC-Davis Doctoral Dissertation, 2007. Now tenure track, Univ. of Hawaii.

**2003**: *A new large total variation stability result for the quadratic nonlinear system associated with the compressible Euler equations*, Thaddeus Edens, UC-Davis Doctoral Dissertation, NSF Postdoctoral Research Fellow 2004-06. Instructor at McGill University, Montreal.

**2002**: *General relativistic shock waves propagating at the speed of light*, Michael Scott, UC-Davis Doctoral Dissertation, Postdoc at Kansas State, 2002-04, currently teaching at CSU Monterey Bay.

**2000**: *An extension of Glimm's method to inhomogeneous systems of conservation laws*, John Hong, UC-Davis Doctoral Dissertation, Postdoc at UCLA, 2000-03, Tenured Professor, National Central University, Taiwan, 2008-.

**1996**: *On the precession of planetary orbits induced by a Kerr metric*, Mathew Nelson, UC-Davis Masters Thesis.

**1995**: *Solution of the Relativistic Euler Equations in Non-flat Spacetimes*, Jeff Groah, UC-Davis Doctoral Dissertation. Groah did a three year VRAP in Department of Mathematics, UC-Davis, is currently a tenured professor at Lone Star College in Texas..

**1995**: *On the Failure of the Hawking Singularity Theorem in the Smoller-Temple Shock-wave Model*, Richard Kavinoky, UC-Davis Doctoral Dissertation. Richard is currently teaching at Santa Rosa College.

**1993**: *A Functional Integral Approach to Bounding Wave Strengths in Spherically Symmetric Solutions of the Compressible Euler Equations*, Tong Yang, UC-Davis Doctoral Dissertation. Tong spent 93-94 as a Postdoctoral Fellow at the Institute for Advanced Study at Princeton University, and currently

holds a Chaired Professorship at City University of Hong Kong. Thesis publication in Comm. Math. Phys. Recipient of four silver Morningside Medals at the First International Congress of Chinese Mathematicians, Beijing, December 1998.

**1991:** *An Extension of Glimm's Method to Third Order*, Robin Young, UC-Davis Doctoral Dissertation. (Winner of UC-Davis Marr Prize and Winner of SIAM's DiPrima Prize for outstanding thesis in Applied Mathematics, 7-92. Young spent 91-94 as a Visiting Member at the Courant Institute, 94-7 as a postdoc working with James Glimm at Stony Brook, and is now full professor at Univ. of Mass. Thesis publication: *Supnorm stability for Glimm's scheme*, Comm. Pure and Appl. Math., Vol. XLVI, 1993, pp. 903-948.

**1991:** *A numerical study of conservation laws*, David L. Farschman, UC-Davis Masters Dissertation, (with M. Hafez).

#### **PH.D COMMITTEES: 1986-2010**

Wissam Barakat, GGAM; David Stuart, Physics; Donald Johnson, Math; Raymond C. Sim, Math; Sangbong Lee, Engineering-Applied Science; Gary Oas, Physics; Morris Beatty, Math; Fethi BenJemaa, Civil Engineering; Jim Kelly, Physics; Bihn Truong, GGAM; Raymond Sim, Math; Robin Young, Math; Richard Kavinoke, Math; Jeff Groah, Math; Yang Tong, GGAM; Matthew Blank, Mech. Eng.; Ronald Sobey, Physics; Joseph Wisgirda, Physics; Patrick Martin, Physics; Danny Sorenson, Physics; Ralph Heygood, Math; Meng-Kai (John) Hong, Math; Lan Hong, Applied Math; Younsha Chan, Math; Paul Covello, Physics; Patrick Martin, Physics; Samuel Chan, Math; Thad Edens, Math; Michael Scott, Math; Brandon Murakami, Physics; Michael Scott, Math; Jim Pierce, Math; Jim Van Meter, Physics; Yong-Seon Song, Physics, Randy Nelson, Physics; Mike Yan, Math; Yuan-Kai Huang, Physics; Brendan Farrell, Math; James Peirce, Math; Spyridon Michalakis, Math; Vivian Zhang, Math; Pengchong Yan, Math; Zhihua Zhang, Math; Samuel Chan, Math; Arthur Cheng, Math; John Thoo, Math; Brian Wissman, Math; Zeke Vogler, Math; Martha Shott, Applied Math; Moritz Rientes, Applied Math.