# Curriculum Vitae

## Richard M. Schoen
Born October 23, 1950
Celina, Ohio USA
Citizen of USA

## Education:
B.S. University of Dayton 1972, summa cum laude
Ph.D. Stanford University March 1977

## Honors and Awards:
NSF Graduate Fellowship 1972-75
Sloan Postdoctoral Fellowship 1979
MacArthur Prize Fellowship 1983-88
American Academy of Arts and Sciences 1988
AMS Bôcher Prize 1989
National Academy of Sciences 1991
Fellow of Amer. Assoc. for Adv. of Science 1995
Guggenheim Fellowship 1996
Fellow of American Mathematical Society, 2012

## Fields of Interest:
Differential Geometry, Nonlinear Analysis and Calculus of Variations,
General Relativity

## Employment History:
1976-78 Lecturer, University of California, Berkeley
1978-80 Assistant Professor, Courant Institute, NYU
1980-84 Professor, University of California, Berkeley
1984-87 Professor, University of California, San Diego
1987-92 Professor, Stanford University
1992-present Bass Professor of Humanities and Sciences, Stanford University

## Visiting Positions:
1979-80 Visiting Member, Institute for Advanced Study
1984 Spring Visiting Member, Institute for Advanced Study
1989-90 Visiting Professor, Courant Institute, NYU
1992-93 Distinguished Visiting Professor, Institute for Advanced Study
1999 Autumn Visiting Professor, Harvard University
2009 Autumn Eilenberg Chair, Columbia University

## Selected major lectures:
1982 ICM Warsaw 45 minute invited lecture
1985 Porter lectures, Rice University

1986 ICM Berkeley Plenary address
1988 Morse lectures, Institute for Advanced Study
1994 Ordway lecturer, University of Minnesota
1999 Current Developments in Mathematics, Harvard University
2008 Hermann Weyl lectures, Institute for Advanced Study
2010 ICM Hyderabad Plenary address
2012 Aisenstadt Chair and lectures, CRM, Montreal
**2013 Master Lecturer, Tsinghua Sanya International Forum, Hainan Island, China**
**2013 Clay lecture, Park City**

## Mathematicians whose dissertations I directed:

Mario Micallef, Guojun Liao, Nathan Smale, Jose Escobar, Robert Kusner, Tom Wan, Will Jagy, Dong Zhang, Yng Ing Lee, William Minicozzi, Dan Pollack, Ying Shen, Jaigyoung Choe, Nicos Kapouleas, Jingyi Chen, Chikako Mese, Sumio Yamada, Hubert Bray, Ailana Fraser, Adrian Butscher, Justin Corvino, Xiaodong Wang, Xiaofeng Sun, Weiyang Qiu, Pengzi Miao, Michel Grueneberg, Yu Yan, Dan Lee, Andre Neves, Fernando Schwartz, Chad Groft, Michael Eichmair, Zachary Cohn, Lan Hsuan Huang, Man Chun Li, Tsz Ho Fong, **Xin Zhou**

## Journals for which I am an editor

**Journal of Differential Geometry, Communications in Analysis and Geometry, Calculus of Variations and PDE**

## Selected Administrative Duties:

Mathematics Department Chair from 9/1/01 to 8/31/04

Member Fachbeirat for Max Planck Institute for Gravitation in Golm, Germany from 2004 to 2010

Member Scientific Advisory Committee of MSRI from 2007 to 2012, co-chair from 2009 to 2012

Chair of committee to choose director of MSRI, 2012

**Clay Senior Scholar, PCMI, Park City, Utah, July 2013**

**Chair of review committee for National Center for Theoretical Sciences, Hsinchu, Taiwan, July 2013**

**Member of Advisory Board of the Institute of Mathematics Academia Sinica, Taiwan 2013**

**Program Committee and lecturer, Mathematical Congress of the Americas, Guanajuato, Mexico, August 2013**

**Organizer of MSRI program in Mathematical General Relativity, Fall 2013**

## Current Grant Support:

**NSF grant DMS-1105323**

# List of Publications
Richard M. Schoen

**Research Articles.**

1. Curvature estimates for minimal hypersurfaces, Acta Math **134**(1975), 275-288 (with L. Simon and S. T. Yau).

2. Harmonic maps and topology of stable hypersurfaces and manifolds of nonnegative Ricci curvature, Comm Math Helv **39**(1976), 333-341 (with S. T. Yau).

3. Existence and regularity theorems for some geometric variational problems, PhD thesis, Stanford University 1976.

4. On univalent harmonic maps between surfaces, Invent Math **44**(1978), 165-178 (with S. T. Yau).

5. Regularity and singularity estimates on hypersurfaces minimizing parametric elliptic variational integrals, Acta math **139**(1977), 217-265 (Part I- with L. Simon, Part II-F. J. Almgren Jr.).

6. Existence of incompressible minimal surfaces and the topology of three dimensional manifolds with nonnegative scalar curvature, Annals of Math **110**(1979), 127-142 (with S. T. Yau).

7. Compact group actions and the topology of manifolds with nonpositive curvature, Topology **18**(1979), 361-380 (with S. T. Yau).

8. On the proof of the positive mass conjecture in general relativity, Comm Math Phys **65**(1979), 45-76 (with S. T. Yau).

9. Incompressible minimal surfaces, three-dimensional manifolds with nonnegative scalar curvature, and the positive mass conjecture in general relativity, Proc Nat'l Acad Sci **75**(1978), 2567 (with S. T. Yau).

10. Proof of the positive action conjecture in quantum relativity, Phys Rev Let **42**(Feb 1979), 547-548 (with S. T. Yau).

11. On the structure of manifolds with positive scalar curvature, Manus Math **28**(1979), 159-183 (with S. T. Yau).

12. Geometric bounds on the low eigenvalues of a compact surface, Proc Symp Pure Math, Vol 36, 1980, 279-285 (with S. Wolpert and S. T. Yau).

13. The structure of complete stable minimal surfaces in 3-manifolds of nonnegative scalar curvature, Comm Pure Appl Math **33**(1980), 199-211 (with D. Fischer-Colbrie).

14. Positivity of the total mass of a general space-time, Phys Rev Let **43** (Nov 1979), 1457-59 (with S. T. Yau).

15. The energy and the linear momentum of space-times in general relativity, Comm Math Phys **79**(1981), 47-51 (with S. T. Yau).

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16. A new proof of the regularity theorem for rectifiable currents which minimize parametric elliptic functionals, Indiana Math J **31**(1982), 415-434 (with L. Simon).

17. Regularity of stable minimal hypersurfaces, Comm Pure Appl Math **34**(1981), 741-797 (with L. Simon).

18. Estimates for stable minimal surfaces in three dimensional manifolds, Annals of Math Studies, 103, edited by E. Bombieri, 1983, 111-126.

19. Regularity of simply connected surfaces with quasiconformal Gauss map, Annals of Math Studies, 103, edited by E. Bombieri, 1983, 127-146 (with L. Simon).

20. Complete three dimensional manifolds with positive Ricci curvature and scalar curvature, Annals of Math Studies, 102, 1982 (with S. T. Yau).

21. On the proof of the positive mass conjecture II, Comm Math Phys **79** (1981), 231-260 (with S. T. Yau).

22. On the existence of harmonic diffeomorphisms between surfaces, Invent Math **66**(1982), 353-359 (with J. Jost).

23. A regularity theory for harmonic maps, J Diff Geom **17**(1982), 307-335 (with K. Uhlenbeck).

24. A lower bound for the first eigenvalue of a negatively curved manifold, J Diff Geom **17**(1982), 233-238.

25. On the Gauss map of complete surfaces of constant mean curvature in $R^3$ and $R^4$, Comm Math Helv **57**(1982), 519-531 (with D. Hoffman and R. Osserman).

26. A remark on minimal hypercones, Proc Nat'l Acad Sci **79**(July 1982), 4523-4524.

27. Boundary regularity and the Dirichlet problem for harmonic maps, J Diff Geom **18**(1983), 253-268 (with K. Uhlenbeck).

28. Uniqueness, symmetry, and embeddedness of minimal surfaces, J Diff Geom **18**(1983), 791-809.

29. Minimal surfaces and positive scalar curvature, Proc ICM, Warsaw, 1982, 575-578.

30. The existence of a black hole due to condensation of matter, Comm Math Phys **90**(1983), 575-579 (with S. T. Yau).

31. $L^p$ and mean value properties of subharmonic functions on Riemannian manifolds, Acta Math **153**(1984), 279-301 (with P. Li).

32. On the isoperimetric inequality for minimal surfaces, Ann Scuola Norm Sup Pisa **9**(1984), 237-244 (with P. Li and S. T. Yau).

33. Positive harmonic functions on manifolds of negative curvature, Annals of Math **121**(1985), 429-461 (with M. Anderson).

34. Regularity of minimizing harmonic maps into the sphere, Invent Math **78**(1984), 89-100 (with K. Uhlenbeck).

35. The space of minimal embeddings of a surface into a three dimensional manifold of positive Ricci curvature, Invent Math **81**(1985), 387-394 (with H. I. Choi).

36. Conformal deformation of a Riemannian metric to constant scalar curvature, J Diff Geom **20**(1984), 479-495.

37. Conformal metrics with prescribed scalar curvature, Invent Math **86**(1986), 243-254 (with J. F. Escobar).

38. Analytic aspects of the harmonic map problem, Seminar on Nonlinear PDE, MSRI Publication, edited by S. S. Chern, Springer-Verlag, 1984, 321-358.

39. Recent progress in geometric partial differential equations, Proc ICM, Berkeley 1986, 121-130.

40. Conformally flat manifolds, Kleinian groups, and scalar curvature, Invent Math **92**(1988), 47-71 (with S. T. Yau).

41. The existence of weak solutions with prescribed singular behavior for a conformally invariant scalar equation, Comm Pure Appl Math **41**(1988), 317-392.

42. Variational theory for the total scalar curvature functional for Riemannian metrics and related topics, Topics in Calculus of Variations, Lecture Notes 1365, edited by M. Giaquinta, Springer 1988, 120-155.

43. On the number of constant scalar curvature metrics in a conformal class, Differential Geometry, edited by Lawson and Tenenblat, Longman Scientific and Technical 1991, 311-320.

44. A report on some recent progress on nonlinear problems in geometry, Surveys in Differential Geometry **1**(1991), 204-241.

45. Harmonic maps into singular spaces and p-adic superrigidity for lattices in groups of rank one, IHES Publ Math **76**(1992), 165-246 (with M. Gromov).

46. The role of harmonic mappings in rigidity and deformation problems, Complex Geometry, edited by Komatsu and Sakane, lecture notes in pure and appl math **143**(1993), Marcel Dekker, 179-200.

47. Sobolev spaces and harmonic maps for metric space targets, Comm Anal Geom **1**(1993), 561-659 (with N. Korevaar).

48. On the conformal and CR automorphism groups, GAFA **5**(1995), 464-481.

49. Prescribed scalar curvature on the n-sphere, Calc. Var **4**(1996) 1-25 (with D. Zhang).

50. The effect of curvature on the behavior of harmonic functions and mappings, article in *Nonlinear Partial Differential Equations in Differential Geometry*, edited by R. Hardt and M. Wolf, IAS/Park City Math Series, AMS,1996, 127-185.

51. Global existence theorems for harmonic maps to nonlocally compact spaces, Comm Anal Geom **5**(1997), 333-387 (with N. Korevaar).

52. Theorems of Barth-Lefschetz type and Morse theory on the space of paths, 1996, Math Z **229**(1998), 77-89 (with J. Wolfson).

53. Minimizing volume among Lagrangian submanifolds, Proc Symp Pure Math **65**(1999), 181-199 (edited by J. Shatah), (with J. Wolfson).

54. Refined asymptotics for constant scalar curvature metrics with isolated singularities, Invent Math **135**(1999), 233-272 (with N. Korevaar, R. Mazzeo, and F. Pacard).

55. Global existence theorems for harmonic maps: finite rank spaces and an approach to rigidity for smooth actions, 20 page preprint 1999 (with N. Korevaar).

56. Recent proofs of the Riemannian Penrose conjecture in General Relativity, Current developments in mathematics, 1999 (Cambridge, MA), 1–36, Int. Press, Somerville, MA, 1999. (with H. Bray).

57. Minimizing area among lagrangian surfaces: The mapping problem, J. Diff. Geom. **58**(2001), 1-86 (with J. Wolfson).

58. Mean curvature in geometry and general relativity, Global Theory of Minimal Surfaces, 113–136, Proceedings of the 2001 Clay Summer School, edited by D. Hoffman, Clay Mathematics Insitute, Cambridge, MA, 2005.

59. Special lagrangian submanifolds, Global Theory of Minimal Surfaces, 655–666, Proceedings of the 2001 Clay Summer School, edited by D. Hoffman, Clay Mathematics Insitute, Cambridge, MA, 2005.

60. The volume functional for Lagrangian submanifolds, Lectures on partial differential equations, 181–191, New Stud. Adv. Math., 2, Int. Press, Somerville, MA, 2003. (with J. Wolfson).

61. On the asymptotics for the vacuum Einstein constraint equations, J Diff Geom **73**(2006), 185-217 (with J. Corvino).

62. KIDS are non-generic, Ann. Henri Poincaré **6**(2005), 155-194 (joint with R. Beig and P. Chrusciel).

63. Entire spacelike hypersurfaces of prescribed Gauss curvature in Minkowski space, J. reine angew. Math. **595**(2006), 167-188 (joint with B. Guan and H. Jian).

64. A generalization of Hawking's black hole topology theorem to higher dimensions, Comm Math Phys **266**(2006), 571-576 (with G. Galloway).

65. The mathematics of general relativity: Problems and progress, Contemporary Mathematics, Volume 395, 150 Years of Mathematics at Washington University in St. Louis, 119–132, edited by G. Jensen and S. Krantz, 2006.

66. A compactness theorem for the Yamabe problem, J Diff Geom **81**(2009), 143–196 (with M. Khuri and F. Marques).

67. Manifolds with 1/4-pinched curvature are space forms, J Amer Math Soc **22** (2009), 287–307 (with S. Brendle).

68. Classification of manifolds with weakly 1/4-pinched curvatures, Acta Math **200**(2008), 1-13 (with S. Brendle).

69. Minimal submanifolds in higher codimension, Matemática Contemporânea, Volume 30, 2006, 169-199, edited by J. Barbosa and K. Tenenblat.

70. On static $n$-body configurations in relativity, 10 page preprint (2008), Classical and Quantum Gravity **26**(2009), 7pp (with Robert Beig).

71. Gravitating opposites attract, Classical and Quantum Gravity **26**(2009), 12pp (with R. Beig and G. Gibbons).

72. Sphere theorems in geometry, Surveys in differential geometry. Vol. XIII. Geometry, analysis, and algebraic geometry: forty years of the Journal of Differential Geometry, 49–84, Surv. Differ. Geom., 13, Int. Press, Somerville, MA, 2009 (with S. Brendle).

73. The first Steklov eigenvalue, conformal geometry, and minimal surfaces, arXiv:0912.5392, Adv. in Math. **226**(2011), 4011–4030 (with A. Fraser).

74. Curvature, sphere theorems, and the Ricci flow, arXiv:1001.2278, Bull. AMS **48**(2011), 1–32 (with S. Brendle).

75. Riemannian manifolds of positive curvature, Proceedings of the International Congress of Mathematicians. Volume I, 449475, Hindustan Book Agency, New Delhi, 2010 (with S. Brendle).

76. Specifying angular momentum and center of mass for vacuum initial data sets, arXiv:1008.4996, Comm Math Phys **306**(2011), 785–803 (with L. Huang and M. Wang).

77. Isoperimetric inequality for flat surfaces, Proceedings of the 13th International Workshop on Differential Geometry and Related Fields [Vol. 13], 103109, Natl. Inst. Math. Sci. (NIMS), Taejon, 2009 (with Jaigyoung Choe).

78. On the existence of Hamiltonian stationary Lagrangian submanifolds in symplectic manifolds, Amer J Math **133**(2011), 1067–1092 (with D. Joyce and Y. I. Lee).

79. The spacetime positive mass theorem in dimensions less than eight, arXiv:1110.2087, 42 page preprint, submitted (with M. Eichmair, L. H. Huang, and D. A. Lee).

**80. Convexity of reduced energy and mass angular momentum inequalities, Ann. Inst. Henri Poincaré 14 (2013), 1747-1773 (with X. Zhou).**

**81. Sharp eigenvalue bounds and minimal surfaces in the ball, arXiv:1209.3789, 48 page preprint, submitted (with A. Fraser).**

**82. Minimal surfaces and eigenvalue problems, Contemporaty Mathematics 599 (2013), 105-122 (with A. Fraser).**

**83. Existence and geometric structure of metrics on surfaces which extremize eigenvalues, Bull. Braz. Math. Soc., New Series 44 (2013), 1-31.**

**Books and Lecture Notes.**

1. *Lectures on Differential Geometry*, International Press Inc., Boston, 1994 (235 pages), (with S. T. Yau).

2. *Lectures on Harmonic Maps*, International Press Inc., Boston, 1997 (393 pages), (with S. T. Yau).