

MATTHEW HEADRICK

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Research interests

String theory and related areas of quantum field theory, general relativity, and geometry

Employment and education

BRANDEIS UNIVERSITY, 2008–PRESENT

Assistant Professor, Martin Fisher School of Physics

Courses taught: “Mathematical physics”, “Quantum theory I”

On leave, Harvard University (fall 2009)

STANFORD UNIVERSITY, 2006–2008

Postdoctoral Scholar, Stanford Institute for Theoretical Physics

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, 2003–2006

Pappalardo Fellow, Center for Theoretical Physics

TATA INSTITUTE OF FUNDAMENTAL RESEARCH, 2002–2003

Visiting Fellow, Department of Theoretical Physics

HARVARD UNIVERSITY, 1996–2002

Ph.D. in Physics (March 2003)

Thesis: “Noncommutative solitons and closed string tachyons”

Advisor: Shiraz Minwalla

M.A. in Physics (June 1998)

Teaching fellow: “Topics in string theory”, “Mechanics and special relativity”,

“Electricity, magnetism, and waves”; Certificate of Distinction in Teaching;

Harold T. White Prize for Excellence in the Teaching of Physics (2002–2002)

Research assistant for Profs. Juan Maldacena and Shiraz Minwalla (1999–2002)

Exchange scholar, Princeton University (spring 1999)

National Science Foundation Graduate Research Fellow (1996–1999)

LYCÉE D’ÉTAT DE NDENDÉ, GABON, 1994–1996

Peace Corps Volunteer

Secondary-school mathematics, physics, and chemistry teacher

PRINCETON UNIVERSITY, 1990–1994

A.B. in Physics with Highest Honors (June 1994)

Inducted in Phi Beta Kappa and Sigma Xi (May 1994)

Kusaka Memorial Prize in Physics for senior thesis (May 1994)

Kusaka Memorial Prize in Physics for junior paper (May 1993)
 Exchange scholar, Ecole Normale Supérieure de Lyon (fall 1992)
 Research assistant for Prof. J. Richard Gott III, Department of Astrophysics
 (spring 1992)

**Schools
 attended**

Prospects in Theoretical Physics: Applications of String Theory, Institute for Advanced Study (July 2006)
 Modern Trends in String Theory II, Porto, Portugal (June 2004)
 IPM String School, Anzali, Iran (September–October 2003)
 NATO ASI: Progress in String, Field, and Particle Theory, Institut d’Etudes Scientifiques de Cargèse (June–July 2002)
 School on Quantum Gravity, Centro de Estudios Científicos, Valdivia (January 2002)
 TASI 99: Strings, Branes, and Gravity (June 1999)

**Other
 employment**

Santa Fe Institute, summer 1993
 Research assistant for Dr. Melanie Mitchell and Prof. James Crutchfield
 NSF Geometry Center, University of Minnesota, 1990–1991
 Script-writer and animator for the educational movie *Outside In* (First Place, International Congress of Mathematicians VideoMath Contest, 1998)
 University of Chicago, 1989–1990
 Research assistant for Prof. Robert Haselkorn, Department of Molecular Genetics and Cell Biology
 First Prize, Westinghouse Science Talent Search (March 1990)

**Professional
 activities**

Referee for the journals JHEP, Comm. Math. Phys., Class. Quant. Grav., Phys. Lett. B, and Phys. Rev. D
 Author of `diffgeo.m`, a *Mathematica* package that assists in computations in differential geometry and general relativity; co-author of `grassmann.m`, a package for working with Grassmann variables
 Technical reviewer, *String Theory for Dummies* by A. Z. Jones (Wiley Publishing), to appear

Invited talks

“Calabi-Yau metrics for dummies”
 Durham University (November 2009)
 Dublin Institute for Advanced Studies (October 2009)
 Tata Institute of Fundamental Research (October 2009)
 Harvard University (September 2009)
 “Progress on numerical Calabi-Yau metrics”
 Quantum Theory and Symmetries conference, University of Kentucky (July 2009)
 “Tachyon actions in string theory: a no-go theorem”
 “Fundamental aspects of superstring theory” program, Kavli Institute for Theoretical Physics (May 2009)

- Massachusetts Institute of Technology (December 2008)
Brown University (October 2008)
- “New approaches to numerical Calabi-Yau metrics”
Boston University Geometry Seminar (April 2009)
- “Ricci flow, and some applications”
Everytopic Seminar, Brandeis University Mathematics Department (November 2008)
- “Ricci flow, Kähler-Einstein manifolds, and numerical geometry”
University of California, Santa Cruz, mathematics graduate colloquium (May 2008)
- “Hedgehog black holes and the deconfinement transition”
PIMS Pacific Northwest String Seminar, University of British Columbia (April 2008)
University of California, Davis (November 2007)
University of Oxford Mathematical Institute (November 2007)
“Strong fields, integrability, and strings” program, Isaac Newton Institute (November 2007)
Queen Mary, University of London (November 2007)
Tata Institute of Fundamental Research (October 2007)
Imperial College London (June 2007)
- “Scale transformations and the dynamics of string theory”
Brandeis University Physics Colloquium (February 2007)
- “The uses of Ricci flow”
University of Texas, Austin (March 2007)
Stanford Linear Accelerator Center (March 2007)
Brandeis University (February 2007)
University of California, Berkeley (January 2007)
- “Ricci flow and black holes”
Massachusetts Institute of Technology (October 2006)
Southern California Strings Seminar, University of Southern California (September 2006)
University of California, Santa Barbara (September 2006)
“Recent advances in black holes in string theory” workshop, Aspen Center for Physics (August 2006)
University of Chicago (August 2006)
Brown University (April 2006)
- “On time dependence in string theory”
Cambridge University (May 2006)
Johns Hopkins University (April 2006)
University of Kentucky (March 2006)
- “The shape of the extra dimensions”
University of Wisconsin, Milwaukee Physics Colloquium (April 2006)
Massachusetts Institute of Technology Pappalardo Symposium (May 2005)
- “A string theorist’s adventures in numerical relativity”

- University of Kentucky Center for Computational Sciences (March 2006)
- “Closed string tachyon dynamics”
Perimeter Institute (December 2005)
- “Numerical Ricci-flat metrics on $K3$ ”
Biséminaire ENS/IHP de Physique et de Mathématiques, Paris (July 2005)
Zhejiang University Center of Mathematical Sciences (April 2005)
Brandeis University Math/CS/Physics Everyyperson Seminar (February 2005)
Harish-Chandra Research Institute (December 2004)
- “Closed string tachyon condensation on C/Z_n ”
Modern Trends in String Theory II, Porto (June 2004)
Harvard University (March 2004)
University of Texas, Austin (February 2004)
- “Progress in closed string tachyon condensation”
IPM String Workshop, Anzali, Iran (October 2003)
Tata Institute of Fundamental Research Theoretical Physics Colloquium (September 2003)
Harish-Chandra Research Institute (September 2003)
- “Spacetime energy decreases under world-sheet RG flow”
University of Chicago (December 2002)
Perimeter Institute (November 2002)
- “String interactions from perturbative Yang-Mills theory”
Stanford University (October 2002)
- “String interactions in the BMN correspondence”
Massachusetts Institute of Technology (October 2002)
University of Pennsylvania (September 2002)
- “Time travel in general relativity”
MIT Media Lab (March 1997)

- Publications** M. Headrick and A. Nassar, “Energy functionals for Calabi-Yau metrics,” 0908.2635 [hep-th]
- M. Headrick, S. Kitchen, and T. Wiseman, “A new approach to static numerical relativity, and its application to Kaluza-Klein black holes,” 0905.1822 [gr-qc]
- M. Headrick, “A solution manual for Polchinski’s *String Theory*,” 0812.4408 [hep-th]
- M. Headrick, “A note on tachyon actions in string theory,” 0810.2809 [hep-th], Phys. Rev. D79: 046009 (2009)
- M. Headrick, “Hedgehog black holes and the Polyakov loop at strong coupling,” 0712.4155 [hep-th], Phys. Rev. D77: 105017 (2008)
- M. Headrick and T. Wiseman, “Numerical Kähler-Ricci soliton on the second del Pezzo,” 0706.2329 [math.DG]
- M. Headrick and T. Takayanagi, “A holographic proof of the strong subadditivity of entanglement entropy,” 0704.3719 [hep-th], Phys. Rev. D76: 106013 (2007)

- C. Doran, M. Headrick, C.P. Herzog, J. Kantor, and T. Wiseman, “Numerical Kähler-Einstein metric on the third del Pezzo,” hep-th/0703057, *Comm. Math. Phys.* 282, 357 (2008)
- M. Headrick and T. Wiseman, “Ricci flow and black holes,” hep-th/0606086, *Class. Quant. Grav.* 23: 6683 (2006)
- D.Z. Freedman, M. Headrick, and A. Lawrence, “On closed string tachyon dynamics,” hep-th/0510126, *Phys. Rev. D* 73: 066015 (2006)
- M. Headrick and T. Wiseman, “Numerical Ricci-flat metrics on $K3$,” hep-th/0506129, *Class. Quant. Grav.* 22: 4931 (2005)
- M. Headrick and J. Raeymaekers, “The large N limit of C/Z_N and supergravity,” hep-th/0411148, *JHEP* 0502:054 (2005)
- M. Headrick, S. Minwalla, and T. Takayanagi, “Closed string tachyon condensation: An overview,” hep-th/0405064, *Class. Quant. Grav.* 21: S1539 (2004)
- M. Headrick, “Decay of C/Z_n : exact supergravity solutions,” hep-th/0312213, *JHEP* 0403:025 (2004)
- M. Gutperle, M. Headrick, S. Minwalla, and V. Schomerus, “Spacetime energy decreases under world-sheet RG flow,” hep-th/0211063, *JHEP* 0301:073 (2003)
- N.R. Constable, D.Z. Freedman, M. Headrick, and S. Minwalla, “Operator mixing and the BMN correspondence,” hep-th/0209002, *JHEP* 0210:068 (2002)
- N.R. Constable, D.Z. Freedman, M. Headrick, S. Minwalla, L. Motl, A. Postnikov, and W. Skiba, “PP-wave string interactions from perturbative Yang-Mills theory,” hep-th/0205089, *JHEP* 0207:017 (2002)
- J.R. David, M. Gutperle, M. Headrick, and S. Minwalla, “Tachyon condensation on twisted circles,” hep-th/0111212, *JHEP* 0202:041 (2002)
- R. Gopakumar, M. Headrick, and M. Spradlin, “On noncommutative multi-solitons,” hep-th/0103256, *Comm. Math. Phys.* 233: 355 (2003)
- R. Gopakumar, M. Headrick, and M. Spradlin, “Noncommutative solitons I,” *Proceedings of Strings 2001, Mumbai*
- M. Headrick and J.R. Gott III, “(2+1)-dimensional spacetimes containing closed timelike curves,” *Phys. Rev. D* 50: 7244 (1994)