

Center for Theoretical Physics
 Department of Physics
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Postdoctoral Appointment

Miller Fellow, Miller Institute for Basic Research in Science, UC Berkeley, 2017 – present
 Junior Fellow, Society of Fellows, Harvard University, 2017 (declined)

Education

California Institute of Technology, Walter Burke Institute for Theoretical Physics, 2012 – 2017
 Doctor of Philosophy (PhD) in Physics, June 2017
 Master of Science in Physics, June 2015
 University of Minnesota, College of Science & Engineering, 2008 – 2012
 Bachelor of Science in Physics, May 2012, *Summa cum Laude*, High Distinction, 4.0 GPA
 Bachelor of Science in Astrophysics, May 2012, *Summa cum Laude*, High Distinction, 4.0 GPA
 Bachelor of Science in Mathematics, May 2012, *Summa cum Laude*, High Distinction, 4.0 GPA

Awarded Fellowships

Hertz Foundation Graduate Fellowship	2012 – 2017
National Science Foundation Graduate Research Fellowship	2012 – 2017
Caltech Andrew E. Lange Graduate Fellowship (declined)	2012
Massachusetts Institute of Technology Fellowship (declined)	2012
University of California, Santa Barbara Broida Fellowship (declined)	2012
University of California, Santa Barbara Chancellor's Fellowship (declined)	2012
University of Chicago Michelson Fellowship (declined)	2012
University of Chicago Parker Fellowship (declined)	2012 – 2014

Honors, Awards, Achievements

Appointed as Interviewer for Hertz Foundation Fellowship	2018
American Physical Society J. J. and Noriko Sakurai Dissertation Award in Theoretical Particle Physics	2018
Caltech John Stager Stemple Memorial Prize in Physics Awarded for outstanding progress in research as demonstrated by an excellent performance on the oral Ph.D. candidacy examination	2016
Delegate to the 66 th Lindau Nobel Laureate Meeting	2016
Barry M. Goldwater Scholar	2010 – 2012
American Astronomical Society Chambliss Astronomy Achievement Student Award for exemplary research	2011
University College London Dean's Summer International Student Scholarship	2011
United States Presidential Scholar Awarded medal by President of the United States at White House ceremony White House Commission on Presidential Scholars and U.S. Department of Education	2008
National Merit Scholar	2008 – 2012
Robert C. Byrd Honors Scholar	2008 – 2011
GRE General – Quantitative: 800, Verbal: 720, Analytical Writing: 5.5	2011
GRE Physics – Perfect Score: 990	2011
SAT – Perfect Score: 2400	2008
SAT II – Perfect Scores: Math Level II and Biology – Molecular	2008

Honors, Awards, Achievements, continued

University of Minnesota Hagstrum Award in Physics	2012
University of Minnesota Outstanding Graduate in Mathematics	2012
University of Minnesota Edmond G. Franklin Scholarship in Physics	2011 – 2012
University of Minnesota Lando Scholarship in Mathematics	2011 – 2012
University of Minnesota J. Ian Richards Scholarship in Mathematics	2011 – 2012
University of Minnesota Alfred O. C. Nier Scholarship in Physics	2010 – 2011
University of Minnesota Ella Thorp Scholarship in Mathematics	2010 – 2011
University of Minnesota Undergraduate Research Scholarship	2010
University of Minnesota Jeffrey Basford Award in Physics	2009 – 2010
University of Minnesota Institute of Technology Alumni Award	2009 – 2010
University of Minnesota Institute of Technology Honors Undergraduate Research Scholarship	2009
University of Minnesota Maroon & Gold Leadership Award	2008 – 2012
University of Minnesota 3M/Alumni Award	2008 – 2012
University of Minnesota Bentson Scholar	2008 – 2012
Dean's List, University of Minnesota	2008 – 2012
College of Science & Engineering/Institute of Technology	
University of Minnesota McGraw Hill Student Achievement Recognition for Meritorious Work in General Chemistry	2008

Refereed Publications

Raphael Bousso, Yasunori Nomura, and Grant N. Remmen, “Outer entropy and quasilocal energy”, *Physical Review D*, **99**, 046002 (2019), arXiv:1812.06987

Ning Bao, Aidan Chatwin-Davies, and Grant N. Remmen, “Entanglement of Purification and Multiboundary Wormhole Geometries”, arXiv:1811.01983, accepted for publication, *Journal of High Energy Physics*

Grant N. Remmen, “New spacetimes for rotating dust in $(2 + 1)$ -dimensional general relativity”, *Physical Review D*, **98**, 124008 (2018), arXiv:1810.12305

Ning Bao, Aidan Chatwin-Davies, Jason Pollack, and Grant N. Remmen, “Traversable wormholes as quantum channels: exploring CFT entanglement structure and channel capacity in holography”, *Journal of High Energy Physics*, **11**, 071 (2018), arXiv:1808.05963

Yasunori Nomura and Grant N. Remmen, “Area law unification and the holographic event horizon”, *Journal of High Energy Physics*, **8**, 063 (2018), arXiv:1805.09339

Venkatesa Chandrasekaran, Grant N. Remmen, and Arvin Shahbazi Moghaddam, “Higher-point positivity”, *Journal of High Energy Physics*, **11**, 015 (2018), arXiv:1804.03153

Clifford Cheung, Junyu Liu, and Grant N. Remmen, “Proof of the weak gravity conjecture from black hole entropy”, *Journal of High Energy Physics*, **10**, 004 (2018), arXiv:1801.08546

Ning Bao, Sean M. Carroll, Aidan Chatwin-Davies, Jason Pollack, and Grant N. Remmen, “Branches of the black hole wave function need not contain firewalls”, *Physical Review D*, **97**, 126014 (2018), arXiv:1712.04955

Chris Akers, Raphael Bousso, Illan F. Halpern, and Grant N. Remmen, “Boundary of the future of a surface”, *Physical Review D*, **97**, 024018 (2018), arXiv:1711.06689

Clifford Cheung, Grant N. Remmen, Chia-Hsien Shen, and Congkao Wen, “Pions as gluons in higher dimensions”, *Journal of High Energy Physics*, **4**, 129 (2018), arXiv:1709.04932

Clifford Cheung and Grant N. Remmen, “Hidden simplicity of the gravity action”, *Journal of High Energy Physics*, **9**, 002 (2017), arXiv:1705.00626

Sean M. Carroll and Grant N. Remmen, “A nonlocal approach to the cosmological constant problem”, *Physical Review D*, **95**, 123504 (2017), arXiv:1703.09715

Refereed Publications, continued

Ning Bao and Grant N. Remmen, “Bulk connectedness and boundary entanglement”, *EPL (Europhysics Letters)* **121**, 60007 (2018), Editor’s Choice, arXiv:1703.00018

Clifford Cheung and Grant N. Remmen, “Twofold symmetries of the pure gravity action”, *Journal of High Energy Physics*, **1**, 104 (2017), arXiv:1612.03927

Clifford Cheung and Grant N. Remmen, “Positivity of Curvature-Squared Corrections in Gravity”, *Physical Review Letters*, **118**, 051601 (2017), arXiv:1608.02942

Grant N. Remmen, Ning Bao, and Jason Pollack, “Entanglement conservation, ER=EPR, and a new classical area theorem for wormholes”, *Journal of High Energy Physics*, **7**, 048 (2016), arXiv:1604.08217

Sean M. Carroll and Grant N. Remmen, “What is the entropy in entropic gravity?”, *Physical Review D*, **93**, 124052 (2016), arXiv:1601.07558

Clifford Cheung and Grant N. Remmen, “Positive signs in massive gravity”, *Journal of High Energy Physics*, **4**, 002 (2016), arXiv:1601.04068

Ning Bao, Jason Pollack, and Grant N. Remmen, “Wormhole and entanglement (non-)detection in the ER=EPR correspondence”, *Journal of High Energy Physics*, **11**, 126 (2015), arXiv:1509.05426

Brando Bellazzini, Clifford Cheung, and Grant N. Remmen, “Quantum gravity constraints from unitarity and analyticity”, *Physical Review D*, **93**, 064076 (2016), arXiv:1509.00851

Ning Bao, Jason Pollack, and Grant N. Remmen, “Splitting Spacetime and Cloning Qubits: Linking No-Go Theorems across the ER=EPR Duality”, *Fortschritte der Physik (Progress of Physics)*, **63**, 705 (2015), arXiv:1506.08203

Ning Bao, ChunJun Cao, Sean M. Carroll, Aidan Chatwin-Davies, Nicholas Hunter-Jones, Jason Pollack, and Grant N. Remmen, “Consistency conditions for an AdS multiscale entanglement renormalization ansatz correspondence”, *Physical Review D*, **91**, 125036 (2015), arXiv:1504.06632

Clifford Cheung and Grant N. Remmen, “Infrared consistency and the weak gravity conjecture”, *Journal of High Energy Physics*, **12**, 087 (2014), arXiv:1407.7865

Grant N. Remmen and Sean M. Carroll, “How many e -folds should we expect from high-scale inflation?”, *Physical Review D*, **90**, 063517 (2014), arXiv:1405.5538

Clifford Cheung and Grant N. Remmen, “Naturalness and the Weak Gravity Conjecture”, *Physical Review Letters*, **113**, 051601 (2014), arXiv:1402.2287

Grant N. Remmen and Sean M. Carroll, “Attractor solutions in scalar-field cosmology”, *Physical Review D*, **88**, 083518 (2013), arXiv:1309.2611

Grant N. Remmen, Kris Davidson, and Andrea Mehner, “Unexpected Ionization Structure in Eta Carinae’s ‘Weigelt Knots’”, *Astrophysical Journal*, **773**, 27 (2013), arXiv:1302.2659

Grant N. Remmen and Kinwah Wu, “Complex orbital dynamics of a double neutron star system revolving around a massive black hole”, *Monthly Notices of the Royal Astronomical Society*, **430** (3), 1940–1955 (2013), arXiv:1301.2836

Grant Remmen and Elwood McCreary, “Measurement of the Speed and Energy Distribution of Cosmic Ray Muons”, *Journal of Undergraduate Research in Physics*, **25** (2012)

Grant Remmen, “A New Assessment of Dark Matter in the Milky Way Galaxy”, *Journal of Undergraduate Research in Physics*, **23** (2010)

Conferences and Presentations

- Invited talk: January 2019, University of California, Davis
Joint Theory Seminar
- Invited talk: November 2018, Harvard University
Black Hole Initiative Colloquium
- Invited talk: October 2018, Cornell University
Particle Theory Seminar
- Invited talk: October 2018, Institute for Advanced Study, Princeton
High Energy Theory Seminar
- Invited talk: September 2018
Vistas over the Swampland conference, Instituto de Física Teórica, UAM-CSIC, Madrid, Spain
- Invited talk: June 2018, King's College London
Special Seminar, Theoretical Particle Physics & Cosmology
- Invited talk: June 2018
Gravity, Cosmology & Physics Beyond the Standard Model conference, LPNHE, UPMC, Paris, France
- Invited talk: April 2018
American Physical Society April Meeting, Columbus, OH
Sakurai Thesis Prize Talk: "Quantum Gravity Constraints for Effective Field Theories"
- Invited talk: April 2018, University of Illinois, Urbana-Champaign
Mathematical and Theoretical Physics Seminar
- Invited talk: March 2018, McGill University
Skype talk, High Energy Theory Group
- Invited talk: February 2018, California Institute of Technology
High Energy Theory Seminar, Walter Burke Institute for Theoretical Physics
- Invited talk: February 2018, California Institute of Technology
Quantum Spacetime Meeting, Walter Burke Institute for Theoretical Physics
- Invited talk: February 2018, University of California, Berkeley
String Seminar, Berkeley Center for Theoretical Physics
- Invited talk: January 2018, Stanford University
Stanford Institute for Theoretical Physics Seminar
- Invited talk: October 2017, SLAC National Accelerator Laboratory
Elementary Particle Physics Theory Seminar
- Invited talk: October 2017, Institute for Advanced Study, Princeton
High Energy Theory Seminar
- Invited talk: May 2017, Massachusetts Institute of Technology
String/Gravity Theory Seminar, MIT Center for Theoretical Physics
- Invited talk: April 2017, California Institute of Technology
Theoretical Physics Research Group Meeting
- Invited talk: April 2017, California Institute of Technology
Theoretical Physics Journal Club
- Invited talk: February 2017, University of California, Berkeley
String Seminar, Berkeley Center for Theoretical Physics
- Invited talk: December 2016, University of California, Los Angeles
QCD Meets Gravity Workshop
- Invited talk: November 2016, California Institute of Technology
Theoretical Physics Research Group Meeting
- Invited talk: October 2016, California Institute of Technology
Theoretical Physics Research Group Meeting
- Invited talk: October 2016, Johns Hopkins University
High Energy Theory/Cosmology Seminar

Conferences and Presentations, continued

Conference participation: June 2016

American Delegate, 66th Lindau Nobel Laureate Meeting
Lindau, Germany

Invited talk: May 2016, California Institute of Technology
Theoretical Physics Research Group Meeting

Invited talk: April 2016, Harvard University
Particle Theory Seminar, Center for the Fundamental Laws of Nature

Invited talk: April 2016, New York University
High Energy Seminar, Center for Cosmology and Particle Physics

Invited talk: February 2016, California Institute of Technology
Theoretical Physics Research Group Meeting

Invited talk: November 2015, California Institute of Technology
Theoretical Physics Research Group Meeting

Invited talk: October 2015, California Institute of Technology
Theoretical Physics Journal Club

Invited talk: April 2015, California Institute of Technology
Theoretical Physics Research Group Meeting

Invited talk: February 2015, California Institute of Technology
Theoretical Physics Research Group Meeting

Invited talk: October 2014, California Institute of Technology
Theoretical Physics Research Group Meeting

Invited talks: October 2014, California Institute of Technology
Parts I and II, Theoretical Physics Journal Club

Contributed talk: June 2014

20th International Symposium on Particles, Strings and Cosmology (PASCOS 2014), Warsaw, Poland

Invited talk: May 2014, California Institute of Technology
Theoretical Physics Research Group Meeting

Workshop participation: May 2014

Burke Institute Workshop on Primordial Gravitational Waves and Cosmology
California Institute of Technology

Invited talk: February 2014, California Institute of Technology
Theoretical Physics Journal Club

Invited talk: February 2014, California Institute of Technology
Theoretical Physics Research Group Meeting

Invited talk: September 2013, California Institute of Technology
Theoretical Physics Journal Club

Poster presentation: August 2013

The Hertz Foundation 50th Anniversary Symposium (Hertz Graduate Fellowship), College Park, MD

Contributed talk: April 2013

American Physical Society April Meeting, Denver, CO

Invited talk: August 2011, Mullard Space Science Laboratory, United Kingdom

Invited talk: August 2011

Dean's Summer International Student Day of Talks, University College London, United Kingdom

Poster presentation: January 2011

217th Meeting of the American Astronomical Society, Seattle, WA

"A New Assessment of Dark Matter in the Milky Way Galaxy", Bulletin of the American Astronomical Society, **43**, 2 (2011)

Received American Astronomical Society Chambliss Astronomy Achievement Student Award for this work.

Doctoral Thesis

“Defining Gravity: Effective Field Theory, Entanglement, and Cosmology”, Grant N. Remmen, 2017.

Thesis Defense: California Institute of Technology, Pasadena, CA. May 17, 2017.

Thesis advisors: Prof. Clifford Cheung and Prof. Sean M. Carroll, California Institute of Technology.

Thesis committee: Prof. Clifford Cheung, Prof. Sean M. Carroll, Prof. Mark B. Wise, Prof. Alan J. Weinstein.

Received American Physical Society J. J. and Noriko Sakurai Dissertation Award in Theoretical Particle Physics.

Undergraduate Honors Theses

“Dynamics of a Rigid Spinning Ring in the Schwarzschild Metric: A Solution to a Gravitational Problem in Mathematical Physics”, G. N. Remmen, 2012.

Thesis Defense: University of Minnesota, Minneapolis, MN. May 3, 2012.

Approved as *summa cum laude*, mathematics.

Thesis advisor: Dr. Willard Miller, School of Mathematics, University of Minnesota.

Research supervised by Dr. Kinwah Wu, Head of Theory, Mullard Space Science Laboratory, University College London, UK.

“*Hubble Space Telescope* Subpixel Modeling of Anomalous High-Excitation Emission Lines in the Ejecta of Eta Carinae”, G. N. Remmen, 2011.

Thesis Defense: University of Minnesota, Minneapolis, MN. December 15, 2011.

Approved as *summa cum laude*, astrophysics.

Thesis advisor: Dr. Kris Davidson, Minnesota Institute for Astrophysics, University of Minnesota.

“Distortion of Black Holes caused by Motion relative to the Cosmic Microwave Background”, G. Remmen, 2010.

Thesis Defense: University of Minnesota, Minneapolis, MN. April 30, 2010.

Approved as *summa cum laude*, physics.

Thesis advisor: Dr. Robert Gehr, Director, Minnesota Institute for Astrophysics, University of Minnesota.

Scientific, Professional, and Honorary Affiliations

American Physical Society

American Astronomical Society

International Society on General Relativity and Gravitation

Golden Key International Honour Society

Sigma Pi Sigma, National Physics Honor Society

Society of Physics Students

Teaching Experience

University of Minnesota, Institute of Technology, Department of Astronomy – Fall 2009

Teaching assistant to Dr. Robert Gehr, Department Chair

Assisted with Astrophysics 2001 course, graded all homework and exams, responded to student queries concerning coursework, formulated all answer keys, and provided input on problem sets.

Extracurricular Activities and Community Service

California Institute of Technology Graduate Student Council Board of Directors – 2013 – 2017

Member, Academics Committee and Director at Large – 2016 – 2017

Member, Academics Committee and Physics Representative – 2013 – 2016

California Institute of Technology Faculty Library Committee, Student Representative – 2013 – 2017

Co-author/-composer of a two-act musical, *Boldly Go!*, a musical parody based upon *Star Trek*

Music director of Caltech production of *Boldly Go!*: mainstage production – 2016, public reading – 2015

Public science outreach: presented talks on dark matter to physics classes in rural Minnesota – 2011

University Study Abroad May Seminar: Great Minds of the Renaissance, Italy – 2011

Examined history of Renaissance scientists (Galileo, daVinci, et al.) and their relationship to society

University of Minnesota Gospel Choir – 2008 – 2010

Detroit Lakes Community Summer Band Program – 2008 – 2010

University of Minnesota Honors Student Association

University of Minnesota volunteer caller for Admissions Office – 2008 – 2009

U.S. Department of Education volunteer: assembled hygiene kits for Washington, D.C. homeless – 2008