

Sean M. Carroll

California Institute of Technology

Caltech MC 452-48
1200 East California Blvd.
Pasadena, CA 91125, USA

☎ 626/395-6830

☎ 626/568-8473

✉ seancarroll@gmail.com

🌐 www.preposterousuniverse.com

Current Positions

2006- **California Institute of Technology**

Research Professor (Senior Research Associate, 2006-14)

Department of Physics and Walter Burke Institute of Theoretical Physics

2019- **Santa Fe Institute**

External Professor

Research Interests

Theoretical physics. Quantum spacetime, cosmology, field theory, gravitation, statistical mechanics, emergence and complexity.

Philosophy. Foundations of quantum mechanics and statistical mechanics, philosophy of cosmology, emergence, causation, naturalism.

Education

1984-1988 **Villanova University**

B.S. Astronomy and Astrophysics, B.A. Honors Program

Magna Cum Laude; Minors in Physics, Philosophy

1988-1993 **Harvard University**

Ph.D. Astronomy (George Field, advisor)

Thesis: *Cosmological Consequences of Topological and Geometric Phenomena in Field Theories*

Previous Positions

1993-1996 **Massachusetts Institute of Technology**

Postdoctoral Researcher, Center for Theoretical Physics, and Lecturer, Physics

1996-1999 **Institute for Theoretical Physics, UC Santa Barbara**

Postdoctoral Researcher

1999-2006 **University of Chicago**

Assistant Professor, Physics and Enrico Fermi Institute

Research Highlights

Spacetime Symmetries Possible violations of spacetime symmetries provide uniquely precise tests of new physics at high energies. I pioneered the study of Lorentz violation through low-energy effective Lagrangians, including proposed observational tests [1, 18]. I also proposed some of the first experimental limits on non-commutative modifications of electromagnetism [29], and constraints on dynamical Lorentz-violating fields [35, 45, 52, 53]. On cosmological scales, I have developed frameworks in which to analyze possible large-scale deviations from cosmological isotropy [44, 46, 48, 50].

Dark Matter, Dark Energy, Dark Forces I proposed experimental constraints on dynamical dark energy through its coupling to other fields, as well as suggesting how to avoid those constraints by imposing symmetries [22]. The best-motivated models of dark energy predict cosmological birefringence at a potentially observable level, which is currently being searched for observationally. I also pioneered theories of dark matter coupled to long-range forces [19, 47, 55, 61], including the possibility of an unbroken analogue of electromagnetism in the dark sector [49].

Modified Gravity Understanding the acceleration of the universe, usually attributed to dark energy, is one of the major challenges in theoretical physics today. Since our evidence for dark energy is exclusively through its gravitational effects, I suggested that a simple modification of Einstein's equation, known as $f(R)$ gravity, could cause acceleration without dark energy [34, 37, 43]. This idea now serves as a popular testing ground for cosmological deviations from general relativity. I explored modifications of GR due to extra dimensions [28, 33, 41] and proposed observational tests [23, 30].

Origin of the Universe & the Arrow of Time One major clue to the origin of the universe is the low entropy of the early state, responsible for the arrow of time. I proposed the first time-symmetric model of a multiverse in which the thermodynamic arrow of time arises naturally [38,39]. I have developed measures of cosmological fine-tuning [59, 63, 67, 70], and studied the possibility of the universe fluctuating into a proto-inflationary state [60]. I showed for the first time how cosmic evolution could spontaneously compactify dimensions of spacetime [56].

Foundations of Quantum Mechanics In the Everett or Many-Worlds formulation of quantum mechanics, the Born rule, that probabilities are given by the amplitude squared, must be derived rather than postulated. I proposed a new solution to this problem based on the notion of self-locating uncertainty [65, 69]. Applying the Everett formulation to cosmology and gravitation, I argued that it is possible to sidestep the Boltzmann Brain problem if Hilbert space is infinite-dimensional [66], and that black hole firewalls can be avoided if there are a sufficient number of branches of the wave function [86].

Emergent Spacetime The most minimal approach to quantum theory is one where both spacetime and fields are emergent from the kinematics and dynamics of a state vector in Hilbert Space evolving under a given Hamiltonian, an approach we dubbed "Mad-Dog Everettianism" [88]. The geometry of space can be defined by the entanglement of Hilbert-space factors [76], and Einstein's equation for gravity emerges from a requirement of entanglement equilibrium [85].

Statistical Mechanics and Complexity I have argued that, while entropy increases in closed systems, natural measures of "complexity" first increase and then decrease [68]. I have proposed a new Bayesian formulation of the Second Law of Thermodynamics, which incorporates the outcomes of measurements into a tighter inequality obeyed by the evolution of open systems [74].

Honors and Awards

- Named Lectures Malmstrom Lecturer, Hamline University, 2003; Resnick Lecturer, Rensselaer Polytechnic Institute, 2003; National Science Foundation NSF Distinguished Lecturer, 2007; Kieval Lecturer, Cornell University, 2011; Brattain Lecturer, Whitman College, 2014; Keynote Address, American Humanist Association, 2014; Schrödinger Colloquium, Universität Zürich, 2014; Gifford Lectures in Natural Theology, Glasgow, 2016; Beyond Annual Lecture, Arizona State University, 2017; Patrick Suppes Lecture in Logic or Philosophy of Science, Columbia University, 2019
- 1984-1988 Villanova University Presidential Scholar
- 1988 Phi Beta Kappa
- 1988 Villanova University Academic Medallion: Bachelor of Science, Astronomy and Astrophysics; Bachelor of Arts, Honors Program
- 1988-1991 National Science Foundation Graduate Fellowship
- 1991-1993 National Aeronautics and Space Administration Graduate Fellowship
- 1996 MIT Graduate Student Council Teaching Award
- 1997 American Physical Society Congressional Fellowship (declined)
- 2000-2002 Alfred P. Sloan Foundation Fellowship
- 2000-2005 David and Lucile Packard Foundation Fellowship for Science and Engineering
- 2005 Second Place (with Jennifer Chen), Gravitational Research Foundation Essay Competition
- 2006 Villanova University College of Liberal Arts and Sciences Alumni Medallion
- 2006 Spherical Cow Award for Graduate Physics Teaching, University of Chicago
- 2009 Second Prize, Foundational Questions Institute Essay Competition
- 2010 Fellow, American Physical Society
- 2010 *From Eternity to Here*: Best books of 2010, *Wilson Quarterly*
- 2013 *The Particle at the End of the Universe*: Best books of the year, *Financial Times*, *The Guardian*, *New Scientist*, Phi Beta Kappa, *Physics World*, *The Times* (UK)
- 2013 Royal Society Winton Prize for Science Books
- 2013-15 100 Global Thought Leaders, Gottlieb Duttweiler Institute
- 2014 Emperor Has No Clothes Award, Freedom From Religion Foundation
- 2014 Andrew Gemant Award, American Institute of Physics
- 2015 Fellowship, John Simon Guggenheim Foundation
- 2016 *The Big Picture*: *New York Times* bestseller list, *AudioFile* Earphones Award, Best books of the year: Amazon.com, Goodreads, *Kirkus*, *Science Friday*, *Financial Times*, *Forbes*
- 2018 Third Prize, Foundational Questions Institute Essay Competition
- 2019 *Something Deeply Hidden*: *New York Times* bestseller list, Best books of the year: Amazon.com, Goodreads, *Sunday Times*, *Science News*, *BBC Science Focus*, *symmetry*

Activities

- Professional Societies American Physical Society, American Association for the Advancement of Science, Philosophy of Science Association, Authors Guild, Foundational Questions Institute
- 2002 JPL Advisory Committee on Gravitation and Fundamental Physics
- 2001-2002 Roadmap Team Member, NASA Structure and Evolution of the Universe Theme
- 2001-2005 Theory MRC Leader, Kavli Institute for Cosmological Physics
- 2004-2007 Executive Committee, APS Topical Group on Gravitation
- 2005-2012 Co-founder and contributor, *Cosmic Variance* blog
- 2007-2009 APS Committee on Informing the Public
- 2010-2012 Contributing Editor, *Discover* Magazine
- 2011 Juror, Alfred P. Sloan Prize, Sundance Film Festival
- 2012-2013 "Discoverers" consultant, Discovery Communications
- 2012 Judge, 3 Quarks Daily Science Blogging Prize
- 2013-present Board of Advisors, *Nautilus* magazine
- 2013 JPL Futures Strategy Committee
- 2014-2016 Judge, Buchalter Cosmology Prize
- 2014-2016 Advisory Panel, The Science Channel
- 2016-2019 Member, California Quantum Interpretation Network
- 2016-present Editor (gravitation theory), *Foundations of Physics*
- 2018-present Host, *Mindscape* podcast
- 2018-present Charter Honorary Fellow, John Bell Institute for the Foundations of Physics
- 2019-present Advisory Board Member, Santa Fe Institute Program on Complex Time
- 2019-present Editorial Board Member, *Physical Review Research*
- 2019-present Gemant Award Committee, American Institute of Physics
- 2020-present Selection Committee and Educational Advisory Board, Guggenheim Foundation

Organizing

- 1997 Organizer, 13th Pacific Coast Gravity Meeting, Santa Barbara
- 1999 Session Organizer, Cosmic Genesis and Fundamental Physics, Sonoma
- 2001 Scientific Organizing Committee, GR16, Durban, South Africa
- 2001 Working Group Co-Convenor (Astro/Cosmo/Particle Physics), Snowmass 2001: The Future of Particle Physics.
- 2001 Organizer, EFI Mini-Symposium: String Theory and Experiment, University of Chicago
- 2001 Local Organizing Committee, Workshop on Cosmological Probes of Dark Energy, Chicago
- 2002 Co-Chair, Local Organizing Committee, Cosmo-02 International Workshop on Particle Physics and the Early Universe, Chicago
- 2003 Co-Director, Short Course on Origin of Structure in the Universe, Center for Cosmological Physics, Chicago
- 2003 Program Co-Organizer, Kavli ITP Program on Superstring Cosmology, Santa Barbara

(organizing cont.)

- 2004 Program Committee, Moriond Conference on Exploring the Universe, La Thuile, Italy
- 2004 Scientific Organizing Committee, GR17, Dublin, Ireland
- 2005 Organizer, AAAS Symposium on Understanding Dark Energy, Washington, D.C.
- 2005 Organizer, APS April Meeting Symposium on Cosmological Constraints on Gravitation and Fundamental Physics, Tampa
- 2005 Organizing Committee, Symposium on *Why So Few Women in Science?*, University of Chicago
- 2010 Organizer, AAAS Symposium on The Arrow of Time, San Diego
- 2011 Organizing Committee, Challenges for Early Universe Cosmology, Perimeter Institute
- 2011 Organizing Committee, Foundational Questions Institute Conference, *Setting Time Aright*, Bergen/Copenhagen
- 2012 Organizer, Moving Naturalism Forward workshop, Stockbridge, MA
- 2014 Organizing Committee, Primordial Gravitational Waves & Cosmology Workshop, Caltech
- 2016 Organizing Committee, Reconciling Tests of Gravity Workshop, Caltech
- 2018 Organizing Committee, Time in Adaptive Systems Workshop, Santa Fe Institute

Courses Taught

Harvard University

- 1989 Astronomy 300, General Relativity Seminary (graduate)

Massachusetts Institute of Technology

- 1996 Physics 8.962, General Relativity (graduate)

University of Chicago

- 2002, 2004, 2005 Physics 264, Spacetime and Black Holes (undergraduate)
- 2002, 2004 Physics 300, The Teaching and Learning of Physics (graduate)
- 2000, 2001 Physics 363, Particle Physics (graduate)
- 2001, 2003, 2005 Physics 364, General Relativity (graduate)
- 2001, 2006 Physics 371, Introduction to Cosmology (graduate)
- 2004 Big Problems 246, Moments in Atheism (undergraduate)

California Institute of Technology

- 2017 Physics 125c, Quantum Mechanics (undergraduate)

Advising

Summer undergrad research students	Teodora Beloreshka (Caltech, 2000), Augusta Abrahamse (American University, 2002), Suz Tolwinski (Brown, 2004), Nicholas Scianmarello (Caltech, 2010), Aliza Malz (Caltech, 2010)
Undergrad Thesis Students	Ethan Honda (MIT, 1996), Monica Guica (Chicago, 2003), Stefan Mendez-Diez (Chicago, 2004), Abhishek Kumar (Chicago, 2004), Kevin Kuns (Caltech, 2012), Mengshuen Chua (Caltech [philosophy], 2015), Jaqueline Lodman (Caltech, 2020)
Ph.D. Students Supervised	Mark Hoffman (Chicago, 2003), Eugene Lim (Chicago, 2004), Jennifer Chen (Chicago, 2005), Ignacy Sawicky (Chicago, 2007), Lotty Ackerman (Caltech, 2009), Heywood Tam (Caltech, 2010), Chien-Yao Tseng (Caltech, 2013), Kimberly Boddy (Caltech, 2014), Jason Pollack (Caltech, 2017), Grant Remmen (Caltech, 2017), Aidan Chatwin-Davies (Caltech, 2018), ChunJun Cao (Caltech, 2018), Ashmeet Singh (Caltech, current)
Ph.D. Students co-supervised or closely worked with	Simeon Hellerman (UCSB, 2001), Laura Mersini (Wisconsin-Milwaukee, 2000), Takemi Okamoto (Chicago, 2004), James Geddes (Chicago, 2005), Vikram Duvvuri (Chicago, 2007), Jing Shu (Chicago, 2008), Adrienne Erickcek (Caltech, 2009), Moira Gresham (Caltech, 2010), Timothy Dulaney (Caltech, 2011), Charles Sebens (Michigan, 2015), Anthony Bartolotta (Caltech, 2018)
Postdocs Supervised	Manoj Kaplinghat (Chicago, 1999-2002), Cristian Armendariz-Picon (Chicago, 2001-2004), Geraldine Servant (Chicago/Argonne, 2001-2004), Matthew Johnson (Caltech, 2007-2010), Ingunn Wehus (Caltech, 2007-2010), Matthew Buckley (Caltech, 2008-2010), Stefan Leichenauer (Caltech, 2011-2014), Ning Bao (Caltech, 2014-2017)

Film/Television Consulting (with main contacts)

2007	<i>Angels and Demons</i> (Ron Howard, director; Brian Grazer, producer)
2008, 2013	<i>Bones</i> (Janet Lin, writer; Emily Silver, writer)
2009	<i>TRON: Legacy</i> (Jeffrey Silver, producer; Joseph Kosinski, director)
2009	<i>Thor</i> (Kevin Feige, producer; Kenneth Branagh, director; Don Payne, writer)
2011	<i>Fringe</i> (Glen Whitman, writer)
2013	<i>Thor: The Dark World</i> (Kevin Feige, producer; Alan Taylor, director)
2014	<i>Big Hero Six</i> (Don Hall, director)
2015	<i>Terminator: Genysis</i> (Alan Taylor, director)
2016	<i>Spectral</i> (George Nolfi, writer)
2017	<i>Downsizing</i> (Alexander Payne, director)
2018	<i>Inversion</i> (Samuel Nozick, co-producer)
2019	<i>Avengers: Endgame</i> (Russo Brothers, writers/directors)

Physics Publications

1. S.M. Carroll, G.B. Field and R. Jackiw, 1990, "Limits on A Lorentz and Parity-Violating Modification of Electrodynamics," *Phys. Rev. D* **41**, 1231.
2. E.F. Guinan and S.M. Carroll, 1990, "Eclipsing Binaries as Astrophysical Laboratories and the Strange Case of Epsilon Aurigae," in *Active Close Binaries: NATO ASI meeting at Kudasi, Turkey*, ed. C. Ibanoglu and I. Yavuz (Kluwer: Dordrecht), 7.
3. S.M. Carroll, E.F. Guinan, G.P. McCook and R.A. Donahue, 1991, "Interpreting Epsilon Aurigae," *Astrophys. J.* **367**, 278.
4. S.M. Carroll and G.B. Field, 1991, "The Einstein Equivalence Principle and the Polarization of Radio Galaxies," *Phys. Rev. D* **43**, 3789.
5. S.M. Carroll, E. Farhi and A.H. Guth, 1992, "An Obstacle to Building a Time Machine," *Phys. Rev. Lett.* **68**, 263; Erratum: **68**, 3368.
6. S.M. Carroll, W.H. Press and E.L. Turner, 1992, "The Cosmological Constant," *Ann. Rev. Astron. Astrophys.* **30**, 499.
7. W.D. Garretson, G.B. Field and S.M. Carroll, 1992, "Primordial Magnetic Fields from Pseudo-Goldstone Bosons," *Phys. Rev. D* **46**, 5346; [hep-ph/9209238](#).
8. J.A. Bryan, S.M. Carroll and T. Pyne, 1994, "A Texture Bestiary," *Phys. Rev. D* **50**, 2806; [hep-ph/9312254](#).
9. S.M. Carroll, D.Z. Freedman, M.E. Ortiz, and D.N. Page, 1994, "Physical States in Canonically Quantized Supergravity," *Nucl. Phys.* **B423**, 661; [hep-th/9401155](#).
10. S.M. Carroll and G.B. Field, 1994, "Consequences of Propagating Torsion in Connection Dynamic Theories of Gravity," *Phys. Rev. D* **50**, 3867; [gr-qc/9403058](#).
11. S.M. Carroll, E. Farhi, A.H. Guth and K.D. Olum, 1994, "Energy-Momentum Restrictions on the Creation of Gott Time Machines," *Phys. Rev. D* **50**, 6190; [gr-qc/9404065](#).
12. S.M. Carroll, D.Z. Freedman, M.E. Ortiz and D.N. Page, 1995, "Bosonic Physical States in $N = 1$ Supergravity?," in *Proceedings of the 7th Marcel Grossmann Meeting*, ed. R. Ruffini and M. Keiser (World Scientific); [gr-qc/9410005](#).
13. S.L. Baliunas *et al.* [27 authors], 1995, "Chromospheric Variations in Main-Sequence Stars. II," *Astrophys. J.* **438**, 269.
14. S.M. Carroll, M.E. Ortiz and W. Taylor IV, 1996, "A Geometric Approach to Free Variable Loop Equations in Discretized Theories of 2D Gravity," *Nucl. Phys.* **B468**, 383; [hep-th/9510199](#).
15. S.M. Carroll, M.E. Ortiz and W. Taylor IV, 1996, "Spin/Disorder Correlations and Duality in the $c = 1/2$ String," *Nucl. Phys.* **B468**, 420; [hep-th/9510208](#).
16. T. Pyne and S.M. Carroll, 1996, "Higher-Order Gravitational Perturbations of the Cosmic Microwave Background," *Phys. Rev. D* **53**, 2920; [astro-ph/9510041](#).
17. S.M. Carroll, M.E. Ortiz and W. Taylor IV, 1996, "The Ising Model with a Boundary Magnetic Field on a Random Surface," *Phys. Rev. Lett.* **77**, 3947; [hep-th/9605169](#).
18. A. Sornborger, S.M. Carroll and T. Pyne, 1997, "The Collapse of Exotic Textures," *Phys. Rev. D* **55**, 6454; [hep-ph/9701351](#).
19. S.M. Carroll and G.B. Field, 1997, "Is There Evidence for Cosmic Anisotropy in the Polarization of Distant Radio Sources?," *Phys. Rev. Lett.* **79**, 2394; [astro-ph/9704263](#).

(physics publications cont.)

20. G.W. Anderson and S.M. Carroll, 1997, "Dark Matter with Time-Dependent Mass," in *Cosmo-97, International Workshop on Particle Physics and the Early Universe*, ed. L. Roszkowski (World Scientific: Singapore), p. 227; [astro-ph/9711288](#).
21. S.M. Carroll, 1997, *Lecture Notes on General Relativity*, [gr-qc/9712019](#).
22. S.M. Carroll, M.E. Ortiz and W. Taylor IV, 1998, "Boundary Fields and Renormalization Group Flow in the Two-Matrix Model," *Phys. Rev. D* **58**, 046006; [hep-th/9711008](#).
23. S.M. Carroll and M. Trodden, 1998, "Dirichlet Topological Defects," *Phys. Rev. D* **57**, 5189; [hep-th/9711099](#).
24. S.M. Carroll, 1998, "Quintessence and the Rest of the World," *Phys. Rev. Lett.* **81**, 3067; [astro-ph/9806099](#).
25. P.M. Garnavich *et al.* [21 authors], 1998, "Supernova Limits on the Cosmic Equation of State," *Astrophys. J.* **509**, 74; [astro-ph/9806396](#).
26. S.M. Carroll and G.B. Field, 1998, "Primordial Magnetic Fields that Last?," in *33rd Rencontres de Moriond: Fundamental Parameters in Cosmology*, 17-24 January 1998, Les Arcs, France; [astro-ph/9807159](#).
27. G.B. Field and S.M. Carroll, 2000, "Cosmological Magnetic Fields from Primordial Helicity," *Phys. Rev. D* **62**, 103008; [astro-ph/9811206](#).
28. S.M. Carroll, S. Hellerman, and M. Trodden, 2000, "Domain Wall Junctions are 1/4-BPS States," *Phys. Rev. D* **61**, 65001; [hep-th/9905217](#).
29. S.M. Carroll, S. Hellerman, and M. Trodden, 2000, "BPS Domain Wall Junctions in Infinitely Large Extra Dimensions," *Phys. Rev. D* **62**, 044049; [hep-th/9911083](#).
30. S.M. Carroll, 2000, "TASI Lectures: Cosmology for String Theorists," Lectures at the 1999 Theoretical Advanced Study Institute at the University of Colorado, Boulder; [hep-th/0011110](#).
31. S.M. Carroll, 2001, "The Cosmological Constant," *Living Reviews in Relativity* **4**, 1; [astro-ph/0004075](#).
32. S.M. Carroll and L. Mersini, 2001, "Can We Live in a Self-Tuning Universe?," *Phys. Rev. D* **64**, 124008; [hep-th/0105007](#).
33. S.M. Carroll, J.A. Harvey, V.A. Kostelecký, C.D. Lane, and T. Okamoto, 2001, "Noncommutative Field Theory and Lorentz Violation," *Phys. Rev. Lett.* **87**, 141601; [hep-th/0105082](#).
34. S.M. Carroll, 2001, "Dark Energy and the Preposterous Universe," invited contribution to the SNAP (SuperNova Acceleration Probe) Yellow Book; [astro-ph/0107571](#).
35. S.M. Carroll and M. Kaplinghat, 2001, "Testing the Friedmann Equation: The Expansion of the Universe During Big-Bang Nucleosynthesis," *Phys. Rev. D* **65**, 063507; [astro-ph/0108002](#).
36. S.M. Carroll, J. Geddes, M.B. Hoffman, and R.M. Wald, 2002, "Classical Stabilization of Homogeneous Extra Dimensions," *Phys. Rev. D* **66**, 024036; [hep-th/0110149](#).
37. D.S. Akerib, S.M. Carroll, M. Kamionkowski and S. Ritz, "Particle astrophysics and cosmology: Cosmic laboratories for new physics (Summary of the Snowmass 2001 P4 working group)," in *Proc. of the APS/DPF/DPB Summer Study on the Future of Particle Physics (Snowmass 2001)* ed. N. Graf, eConf **C010630**, P4001 (2001); [hep-ph/0201178](#).

(physics publications cont.)

38. S.M. Carroll, 2002, "What Do We Really Know about the Expansion of the Universe?", in *Proceedings of the Second Meeting on CPT and Lorentz Symmetry*, ed. V.A. Kostelecký (World Scientific: Singapore), p. 80.
39. S.M. Carroll, M.B. Hoffman, and M. Trodden, 2003, "Can the dark energy equation-of-state parameter w be less than -1 ?", *Phys. Rev. D* **68**, 023509; [astro-ph/0301273](#).
40. S.M. Carroll and M.M. Guica, 2003, "Sidestepping the Cosmological Constant with Football-Shaped Extra Dimensions", [hep-th/0302067](#).
41. S.M. Carroll, V. Duvvuri, M. Trodden and M.S. Turner, 2004, "Is Cosmic Speed-Up Due to New Gravitational Physics?", *Phys. Rev. D* **70**, 043528; [astro-ph/0306438](#).
42. S.M. Carroll, 2003, "Why is the Universe Accelerating?" Carnegie Observatories Astrophysics Series, Vol. 2: Measuring and Modeling the Universe, ed. W. L. Freedman (Cambridge: Cambridge Univ. Press); [astro-ph/0310342](#).
43. M. Trodden and S.M. Carroll, 2004, "TASI Lectures: Introduction to Cosmology," Lectures at the 2002 and 2003 Theoretical Advanced Study Institutes at the University of Colorado, Boulder; [astro-ph/0401547](#).
44. S.M. Carroll and E.A. Lim, 2004, "Lorentz-Violating Vector Fields Slow the Universe Down," *Phys. Rev. D* **70**, 123525; [hep-th/0407149](#).
45. S.M. Carroll, A. De Felice, and M. Trodden, 2005, "Can we be tricked into thinking that w is less than -1 ?", *Phys. Rev. D* **71**, 023525; [astro-ph/0408081](#).
46. S.M. Carroll, A. De Felice, V. Duvvuri, D.A. Easson, M. Trodden, and M.S. Turner, 2004, "The Cosmology of Generalized Modified Gravity Models", *Phys. Rev. D* **71**, 063513; [astro-ph/0410031](#).
47. S.M. Carroll and J. Chen, 2004, "Spontaneous Inflation and the Origin of the Arrow of Time", [hep-th/0410270](#).
48. R. Bean, S.M. Carroll and M. Trodden, 2005, "Insights into Dark Energy: Interplay Between Theory and Observation," white paper submitted to the Dark Energy Task Force; [astro-ph/0510059](#).
49. S.M. Carroll and J. Chen, 2005, "Does inflation provide natural initial conditions for the universe?," *Gen. Rel. Grav.* **37**, 1671; [gr-qc/0505037](#).
50. S.M. Carroll and J. Shu, 2005, "Models of Baryogenesis via Spontaneous Lorentz Violation," *Phys. Rev. D* **73**, 103515; [hep-ph/0510081](#).
51. I. Sawicki and S.M. Carroll, 2005, "Cosmological Structure Evolution and CMB Anisotropies in DGP Braneworlds," [astro-ph/0510364](#).
52. S.M. Carroll, 2006, "Is our universe natural?," *Nature*, 440, 1132; [hep-th/0512148](#).
53. S.M. Carroll, I. Sawicki, A. Silvestri, and M. Trodden, 2006, "Modified-Constraint Gravity and Cosmological Structure Formation," *New J. Phys.*, **8**, 323; [astro-ph/0607458](#).
54. L. Ackerman, S.M. Carroll and M.B. Wise, 2007, "Imprints of a Primordial Preferred Direction on the Microwave Background," *Phys. Rev. D* **75**, 083502; [astro-ph/0701357](#).
55. S. M. Carroll and H. Tam, 2008, "Aether Compactification," *Phys. Rev. D* **78**, 044047; [arXiv:0802.0521](#).
56. A.L. Erickcek, M. Kamionkowski and S.M. Carroll, 2008, "A Hemispherical Power Asymmetry from Inflation," *Phys. Rev. D* **78**, 123520; [arxiv:0806.0377](#).

(physics publications cont.)

57. S.M. Carroll, S. Mantry, M.J. Ramsey-Musolf, and C.W. Stubbs, 2008, "Dark-Matter-Induced Weak Equivalence Principle Violation," *Phys. Rev. Lett.* **103**, 011301; [arxiv:0807.4363](#).
58. A.L. Erickcek, S.M. Carroll, and M. Kamionkowski, 2008, "Superhorizon Perturbations and the Cosmic Microwave Background," *Phys. Rev. D* **78**, 083012; [arxiv:0808.1570](#).
59. L. Ackerman, M.R. Buckley, S.M. Carroll, and M. Kamionkowski, 2008, "Dark Matter and Dark Radiation," *Phys. Rev. D* **79**, 023519; [arxiv:0810.5126](#).
60. S.M. Carroll, C.-Y. Tseng, and M.B. Wise, 2008, "Translational Invariance and the Anisotropy of the Cosmic Microwave Background," *Phys. Rev. D* **81**, 083501; [arxiv:0811.1086](#).
61. S.M. Carroll, 2008, "What if Time Really Exists?", entry in the Foundational Questions Institute Essay Competition on the Nature of Time; [arxiv:0811.3722](#).
62. S.M. Carroll, T.R. Dulaney, M. Gresham, and H. Tam, 2008, "Instabilities in the Aether", *Phys. Rev. D*, **79**, 065011; [arxiv:0812.1049](#).
63. S.M. Carroll, T.R. Dulaney, M. Gresham, and H. Tam, 2008, "Sigma-Model Aether", *Phys. Rev. D* **79**, 065012; [arxiv:0812.1050](#).
64. S.M. Carroll, M.C. Johnson, and L. Randall, 2009, "Extremal Limits and Black Hole Entropy," *JHEP* **0911**, 109; [arxiv:0901.0931](#).
65. S.M. Carroll, S. Mantry, and M.J. Ramsey-Musolf, 2009, "Implications of a Scalar Dark Force for Terrestrial Experiments," *Phys. Rev. D* **81**, 063507; [arxiv:0902.4461](#).
66. S. Dodelson *et al.* [212 authors], 2009, "The Origin of the Universe as Revealed Through the Polarization of the Cosmic Microwave Background," Science White Paper submitted to the US Astro2010 Decadal Survey; [arXiv:0902.3796](#).
67. S.M. Carroll, M.C. Johnson, and L. Randall, 2009, "Dynamical compactification from de Sitter space," *JHEP* **0911**, 094; [arxiv:0904.3115](#).
68. S.M. Carroll, H. Tam, and I.K. Wehus, 2009, "Lorentz Violation in Goldstone Gravity," *Phys. Rev. D* **80**, 025020; [arxiv:0904.4680](#).
69. B. Kloppenborg *et al.* [17 authors], 2010, "In the Shadow of the Transiting Disk: Imaging epsilon Aurigae in Eclipse," *Nature* **464**, 870; [arxiv:1004.2464](#).
70. S.M. Carroll and H. Tam, 2010, "Unitary Evolution and Cosmological Fine-Tuning," [arxiv:1007.1417](#).
71. A. Aguirre, S.M. Carroll, and M.C. Johnson, 2011, "Out of equilibrium: understanding cosmological evolution to lower-entropy states," *JCAP* **1202**, 024; [arxiv:1108.0417](#).
72. K. Boddy, S.M. Carroll, and M. Trodden, 2012, "Dark Matter with Density-Dependent Interactions," *Phys. Rev. D*, **86**, 123529; [arxiv:1208.4376](#).
73. K.K. Boddy and S.M. Carroll, 2013, "Can the Higgs Boson Save Us From the Menace of the Boltzmann Brains?" [arxiv:1308.4686](#).
74. G.N. Remmen and S.M. Carroll, 2013, "Attractor Solutions in Scalar-Field Cosmology," *Phys. Rev. D* **88**, 083518; [arxiv:1309.2611](#).
75. S.M. Carroll, S. Leichenauer, and J. Pollack, 2013, "A Consistent Effective Theory of Long-Wavelength Cosmological Perturbations," *Phys. Rev. D* **90**, 023518; [arxiv:1310.2920](#).

(physics publications cont.)

76. S.M. Carroll and C.T. Sebens, 2013, "Many Worlds, The Born Rule, and Self-Locating Uncertainty," in *Quantum Theory: A Two-Time Success Story, Yakir Aharonov Festschrift*, D.C. Struppa, J.M. Tollaksen, eds. (Springer-Verlag), p. 157; [arxiv:1405.7907](#).
77. K.K. Boddy, S.M. Carroll, and J. Pollack, 2014, "De Sitter Space Without Dynamical Quantum Fluctuations," *Found. Phys.* **46**, 702; [arxiv:1405.0298](#).
78. G.N. Remmen and S.M. Carroll, 2014, "How Many e -Folds Should We Expect from High-Scale Inflation?" *Phys. Rev. D* **90**, 063517; [arxiv:1405.5538](#).
79. S. Aaronson, S.M. Carroll, and L. Ouellette, 2014, "Quantifying the Rise and Fall of Complexity in Closed Systems: The Coffee Automaton," [arxiv:1405.6903](#).
80. N. Bao, C. Cao, S.M. Carroll, A. Chatwin-Davies, N. Hunter-Jones, J. Pollack, and G.N. Remmen, 2015, "Consistency Conditions for an AdS/MERA Correspondence," *Phys. Rev. D* **91**, 125036; [arxiv:1504.06632](#).
81. K.K. Boddy, S.M. Carroll, and J. Pollack, 2015, "Why Boltzmann Brains Don't Fluctuate Into Existence From the De Sitter Vacuum," in *The Philosophy of Cosmology*, K. Chamcham, J. Silk, J.D. Barrow, and S. Saunders, ed. (Cambridge University Press); [arxiv:1505.02780](#).
82. A. Chatwin-Davies, A.S. Jermyn, and S.M. Carroll, 2015, "How to Recover a Qubit That Has Fallen Into a Black Hole," *Phys. Rev. Lett.* **115**, 261302; [arXiv:1507.03592](#).
83. A. Bartolotta, S.M. Carroll, S. Leichenauer, and J. Pollack, 2015, "The Bayesian Second Law of Thermodynamics," *Phys. Rev. E* **94**, 022102; [arxiv:1508.02421](#).
84. S.M. Carroll and G.N. Remmen, 2016, "What is the Entropy in Entropic Gravity?" *Phys. Rev. D* **93**, 124052; [arxiv:1601.07558](#).
85. C. Cao, S.M. Carroll, and S. Michalakis, 2016, "Space from Hilbert Space: Recovering Geometry from Bulk Entanglement," *Phys. Rev. D* **95**, 024031; [arxiv:1606.08444](#).
86. K.K. Boddy, S.M. Carroll, and J. Pollack, 2016, "How Decoherence Affects the Probability of Slow-Roll Eternal Inflation," *Phys. Rev. D* **96**, 023539; [arxiv:1612.04894](#).
87. N. Bao, C. Cao, S.M. Carroll, and L. McAllister, 2017, "Quantum Circuit Cosmology: The Expansion of the Universe Since the First Qubit," [arxiv:1702.06959](#).
88. S.M. Carroll and A. Chatwin-Davies, 2017, "Cosmic Equilibration: A Holographic No-Hair Theorem from the Generalized Second Law," *Phys. Rev. D* **97**, 046012; [arxiv:1703.09241](#).
89. S.M. Carroll and G.N. Remmen, 2017, "A Nonlocal Approach to the Cosmological Constant Problem," *Phys. Rev. D* **95**, 123504; [arxiv:1703.09715](#).
90. N. Bao, S.M. Carroll, and A. Singh, 2017, "The Hilbert Space of Quantum Gravity is Locally Finite-Dimensional," *Intl. J. Mod. Phys. D* **26**, 1743013; [arxiv:1704.00066](#).
91. A. Singh and S.M. Carroll, 2017, "Quantum Decimation in Hilbert Space: Coarse-Graining without Structure," *Phys. Rev. A* **97**, 032111; [arxiv:1709.01066](#).
92. N. Bao, C. Cao, S.M. Carroll, and A. Chatwin-Davies, 2017, "De Sitter Space as a Tensor Network: Cosmic No-Hair, Complementarity, and Complexity," *Phys. Rev. D* **96**, 123536; [arxiv:1709.03513](#).
93. C. Cao and S.M. Carroll, 2017, "Bulk Entanglement Gravity without a Boundary: Towards Finding Einstein's Equation in Hilbert Space," *Phys. Rev. D* **97**, 086003; [arxiv:1712.02803](#).

(physics publications cont.)

94. N. Bao, S.M. Carroll, A. Chatwin-Davies, J. Pollack, and G. Remmen, 2017, "Branches of the Black Hole Wave Function Need Not Contain Firewalls," *Phys. Rev. D* **97**, 126014; [arxiv:1712.04955](#).
95. S.M. Carroll and A. Singh, 2018, "Mad-Dog Everettianism: Quantum Mechanics at Its Most Minimal," in *What Is Fundamental?*, ed. A. Aguirre, B. Foster, and Z. Merali (Springer), p. 95. [arxiv:1801.08132](#).
96. A. Singh and S.M. Carroll, 2018, "Modeling Position and Momentum in Finite-Dimensional Hilbert Spaces via Generalized Clifford Algebra," [arxiv:1806.10134](#).

Philosophy Publications

1. S.M. Carroll, 2005, "Why (Almost All) Cosmologists Are Atheists", *Faith and Philosophy* **22**, p. 622.
2. S.M. Carroll, 2012, "Does the Universe Need God?," in *The Blackwell Companion to Science and Christianity*, ed. J.B. Stump and A.G. Padgett (Wiley-Blackwell: West Sussex, UK), p. 185.
3. C.T. Sebens and S.M. Carroll, 2014, "Self-Locating Uncertainty and the Origin of Probability in Everettian Quantum Mechanics," *The British Journal for the Philosophy of Science* **69**, 25; [arxiv:1405.7577](https://arxiv.org/abs/1405.7577).
4. S.M. Carroll, 2014, "In What Sense Is the Early Universe Fine-Tuned?," to appear in *Time's Arrows and the Probability Structure of the World*, B. Loewer, E. Winsberg and B. Weslake, eds. (Harvard University Press); [arxiv:1406.3057](https://arxiv.org/abs/1406.3057).
5. S.M. Carroll 2017, "Why Boltzmann Brains Are Bad," to appear in *Current Controversies in the Philosophy of Science*, S. Dasgupta and B. Weslake, eds.; [arxiv:1702.00850](https://arxiv.org/abs/1702.00850).
6. S.M. Carroll, 2018, "Purpose, Freedom, and the Laws of Physics," in *Neuroexistentialism: Meaning, Morals, and Purpose in the Age of Neuroscience*, ed. G. Caruso and O. Flanagan (Oxford University Press), p. 298.
7. S.M. Carroll, 2018, "Beyond Falsifiability: Normal Science in a Multiverse," in *Epistemology of Fundamental Physics: Why Trust a Theory?*, R. Dawid, R. Dardashti, and K. Thébault, eds. (Cambridge), pp. 300-314; [arxiv:1801.05016](https://arxiv.org/abs/1801.05016).
8. S.M. Carroll, 2018, "Why Is There Something Rather than Nothing?" to appear in *The Routledge Companion to the Philosophy of Physics*, E. Knox and A. Wilson, eds. (Routledge); [arxiv:1802.02231](https://arxiv.org/abs/1802.02231).

Books

1. S.M. Carroll, 2003, *Spacetime and Geometry: An Introduction to General Relativity* (Addison-Wesley).
2. S.M. Carroll, 2010, *From Eternity to Here: The Quest for the Ultimate Theory of Time* (Dutton). Editions in Bulgarian, English, Hebrew, Hungarian, Italian, Persian, Polish, Spanish, Russian, Turkish.
3. S.M. Carroll, 2012, *The Particle at the End of the Universe: How the Search for the Higgs Boson Leads Us to the Edge of a New World* (Dutton). Editions in Bulgarian, Chinese, Croatian, Czech, English, Finnish, French, Italian, Korean, Polish, Portuguese, Russian, Spanish, Ukrainian.
4. S.M. Carroll and W.L. Craig (authors), R.B. Stewart (editor), 2016, *God and Cosmology* (Greer-Hard Lectures).
5. S.M. Carroll, 2016, *The Big Picture: On the Origins of Life, Meaning, and the Universe Itself* (Dutton). Editions in Arabic, Chinese, Finnish, Japanese, Korean, Polish, Romanian, Russian, Spanish, Turkish, Ukrainian.
6. S.M. Carroll, 2019, *Something Deeply Hidden: Quantum Worlds and the Emergence of Spacetime* (Dutton).

Lecture Courses

1. S.M. Carroll, 2007, *Dark Matter, Dark Energy: the Dark Side of the Universe* (The Great Courses).
2. S.M. Carroll, 2012, *Mysteries of Modern Physics: Time* (The Great Courses).
3. S.M. Carroll, 2015, *The Higgs Boson and Beyond* (The Great Courses).

Other Publications

1. S.M. Carroll, 2000, "Cosmological Constant", *Encyclopedia of Astronomy and Astrophysics*, P. Murdin, editor (Institute of Physics Publishing: London).
2. S.M. Carroll, 2000, "Is the Universe Still Accelerating?", *Matters of Gravity* **15**, 29; gr-qc/0002027.
3. S.M. Carroll, 2000, "Cosmic microwave background anisotropies: tantalizingly close to expectations", *Matters of Gravity* **16**, 3; gr-qc/0009060.
4. S.M. Carroll, 2002, Review of *Time Travel in Einstein's Universe* by J. Richard Gott, *Physics Today*, July 2002, p. 60.
5. S.M. Carroll, 2002, Review of *The Extravagant Universe* by Robert P. Kirshner, *Nature*, 24 October 2002, p. 784.
6. S.M. Carroll, 2003, "Filling in the background" (News and Views on *WMAP*), *Nature*, 6 March 2003, p. 26.
7. S.M. Carroll, 2003, Review of *Echo of the Big Bang* by Michael Lemonick, *Nature*, 24 July 2003, p. 373.
8. S.M. Carroll, 2003, "Quantum Gravity: An Astrophysical Constraint" (News and Views on Lorentz violation), *Nature*, 28 August 2003, p. 1007.
9. S.M. Carroll, 2004, "Insignificance" (Concepts essay on dark matter and dark energy), *Nature*, 6 May 2004, p. 27.
10. S.M. Carroll, 2004, "Cosmology Primer," <http://preposterousuniverse.com/writings/cosmologyprimer/>.
11. S.M. Carroll, 2005, "Dark Energy and the Preposterous Universe," *Sky and Telescope*, March 2005, p. 32.
12. S.M. Carroll, 2005, "Review of *The Future of Theoretical Physics and Cosmology: Celebrating Stephen Hawking's 60th Birthday*," eds. G. W. Gibbons, E. P. S. Shellard, and S. J. Rankin, *Am. J. Phys.* **73**, 479.
13. S.M. Carroll, 2005, "60 Seconds: Extra Dimensions," *symmetry*, June/July 2005, back cover.
14. S.M. Carroll, 2005, Review of *Warped Passages* by Lisa Randall and *Parallel Worlds* by Michio Kaku, *American Scientist* **93**, 550, November-December 2005.
15. S.M. Carroll, 2005, "Cosmological Constant," *World Book Online Reference Center*, 20 October 2005.
16. S.M. Carroll, 2006, "Science in the Dock" (discussion with Noam Chomsky and Lawrence Krauss), *Science and Theology News Online*, www.stnews.org/Commentary-2680.htm.
17. S.M. Carroll, 2006, "Welcome to the Blogosphere," *APS News*, May 2006, p. 12.
18. S.M. Carroll, 2006, "Time Before Time," *Seed*, September 2006, p. 43.
19. S.M. Carroll, 2006, "Focus on Dark Energy," *New Journal of Physics*, **8**.
20. S.M. Carroll, 2006, "Review: *The Trouble With Physics* by Lee Smolin," *New Scientist*, 30 September 2006, issue 2571, p. 58.
21. S.M. Carroll, 2006, "The Universe, Too Quickly Toured," review of *The Quantum Zoo* by Marcus Chown, *Science* **313**, 1391.

(other publications cont.)

22. S.M. Carroll, 2006, "Dark Matter is Real," *Nature Physics* **2**, 653.
23. S.M. Carroll, 2007, " Blogging for Physics," *Physics World*, Jan. 2007, p. 14.
24. S.M. Carroll, 2007, "Quantum Interrogation," in *The Open Laboratory: The Best Writing on Science Blogs 2006*, ed. B. Zivkovic (Lulu: Morrisville, NC), p. 123.
25. S.M. Carroll, 2007, "String Theory: It's Not Dead Yet," *New Scientist*, 19 May 2007, p. 25.
26. S.M. Carroll, 2008, "Being a Heretic is Hard Work," *Edge World Question Center 2008*.
27. S.M. Carroll, 2008, "Take the tube for the voyage of your lifetime," review of *The New Time Travelers* by David Toomey, *Times Higher Education Supplement*, 4 January 2008.
28. S.M. Carroll, 2008, "Pulling Power," review of *The Universal Force: Gravity, Creator of Worlds* by Louis A. Girifalco, *Nature* **451**, 130.
29. S.M. Carroll, 2008, "The Universe is Structured Like a Language," "The Cash Value of Astronomical Ideas," and "Dark Matter Exists," reprinted in *Ultimate Blogs: Masterworks from the Wild Web*, ed. Sarah Boxer (Vintage: New York), p. 42.
30. S.M. Carroll, 2008, "The Rise and Fall of Time," in *Year Million: Science at the Far Edge of Knowledge*, ed. Damien Broderick (Atlas: New York), p. 253.
31. S.M. Carroll, 2008, "The Cosmic Origins of Time's Arrow," *Scientific American*, June 2008, p. 48.
32. S.M. Carroll, 2008, "Lost in Space," review of *The Black Hole War* by Leonard Susskind, *The Wall Street Journal*, 28 July 2008.
33. S.M. Carroll, 2009, "Being a Heretic is Hard Work," in *What Have You Changed Your Mind About?*, ed. John Brockman (Harper Perennial: New York).
34. S.M. Carroll, 2009, "The First Quantum Cosmologist," in *The Open Laboratory 2008*, ed. Jennifer Rohn (Lulu: Morrisville, NC), p. 54.
35. S.M. Carroll, 2009, "Our Place in an Unnatural Universe," in *What's Next: Dispatches on the Future of Science*, ed. Max Brockman (Vintage: New York).
36. S.M. Carroll, 2009, "Why Not?," in *50 Voices of Disbelief: Why We Are Atheists*, ed. R. Blackford and U. Schuklenk (Wiley-Blackwell: New York).
37. S.M. Carroll, 2010, "How to Travel Through Time," *Discover*, March 2010.
38. S.M. Carroll, 2010, "The Elastic Universe," in *Findings on Elasticity*, ed. H. Aardse and A. van Baalen (Pars Foundation, Lars Muller Publishers: Amsterdam), p. 194.
39. S.M. Carroll, 2010, "The Grid of Disputation," in *The Open Laboratory 2009*, ed. Scicurious (Lulu: Morrisville, NC), p. 71.
40. S.M. Carroll, 2010, "Time and Change in an Eternal Universe," in *One Book, The Whole Universe: Plato's Timaeus Today*, ed. R.D. Mohr and B.M. Sattler (Parmenides Publishing: Las Vegas), p. 373.
41. S.M. Carroll, 2010, "The 'Why?' Questions, Chapter and Multiverse," review of *The Grand Design* by Stephen Hawking and Leonard Mlodinow, *The Wall Street Journal*, 24 September 2010, p. W17.
42. S.M. Carroll, 2011, "Calling You On Your Crap," in *Is The Internet Changing The Way You Think?*, ed. J. Brockman (Harper Perennial: New York), p. 111.

(other publications cont.)

43. S.M. Carroll, 2011, "Welcome to the Multiverse," *Discover*, October 2011.
44. S.M. Carroll, 2011, "Physics and the Immortality of the Soul," *Free Inquiry*, October/November 2011, p. 48.
45. S.M. Carroll, 2011, "Are There Mysterious Forces Lurking in Our Atoms and Galaxies?" *Discover*, November 2011.
46. S.M. Carroll, 2011, "Unwinding Time," *The Wall Street Journal*, December 18, 2011.
47. S.M. Carroll, 2012, "The Pointless Universe," in *This Will Make You Smarter: New Scientific Concepts to Improve Your Thinking*, ed. J. Brockman (Harper Perennial: New York), p. 9.
48. S.M. Carroll, 2012, "After the Higgs Boson: What Scientists Will Do With the Discovery," *The Daily Beast*, <http://thebea.st/MP09Sa>, July 6, 2012.
49. S.M. Carroll, 2012, "How the Higgs can lead us to the dark universe," CNN.com, <http://bit.ly/Q9SWPe>, July 24, 2012.
50. S.M. Carroll, 2012, "Digging Up the Early Universe," *Discover*, October 2012, p. 74.
51. S.M. Carroll, 2012, "Ask Me Anything," *Reddit.com*, <http://bit.ly/TD6Yq1>, 13 Nov. 2012.
52. S.M. Carroll, 2013, "Physics Enters a New Era," *Popular Science*, January 2013.
53. S.M. Carroll, 2013, "Einstein Explains that Gravity Is Universal," in *This Explains Everything: Deep, Beautiful, and Elegant Theories of How the World Works*, ed. J. Brockman (Harper Perennial: New York), p. 40.
54. S.M. Carroll, 2013, "Foreword," *The Realm of the Nebulae*, E. Hubble (Yale University Press: New Haven), p. xiii.
55. S.M. Carroll, 2013, "Science and Religion Can't Be Reconciled," *Slate*, <http://slate.me/13FGYjx>, 9 May 2013.
56. D. Goldberg and S.M. Carroll, 2013, "When Talking About Science, We Need More Tony Stark and Less Big Bang Theory," *Wired.com*, <http://bit.ly/1609Jeo> 2 August 2013.
57. S.M. Carroll, 2013, "Philosophy from the Preposterous Universe," interview with Richard Marshall, *3:AM Magazine*, <http://bit.ly/13CIS2G>, 3 August 2013.
58. S.M. Carroll, 2013, "No Physicist Is an Island," *New York Times* online and *International Herald Tribune*, 8 October 2013.
59. S.M. Carroll, 2013, "The Nobel Prize for Peter Higgs recognises truth in an ancient Greek idea," *The Independent* (UK), 10 December 2013.
60. S.M. Carroll, 2014, "When Nature Looks Unnatural," *New York Times* Opinionator online, 23 March 2014.
61. S.M. Carroll, 2014, "Five Questions Interview," in *Science and Religion: 5 Questions*, ed. G.D. Caruso (Automatic Press), p. 25.
62. S.M. Carroll, 2014, "What BICEP Found," *Engineering and Science*, Summer 2014, p. 17.
63. S.M. Carroll, 2014, "Why Does the Universe Look the Way it Does?," in *The Universe: Leading Scientists Explore the Origin, Mysteries and Future of the Cosmos*, ed. J. Brockman (Harper Perennial), p. 94.
64. S.M. Carroll, 2014, "Afterword," in *Twins in Time*, Z. Weinersmith and C. Jones (Little Universe).

(other publications cont.)

65. S.M. Carroll, 2015, "What Does 'Happy New Year' Even Mean?", *Smithsonian Magazine*, January 2015.
66. S.M. Carroll, 2015, "Falsifiability," in *This Idea Must Die*, ed. J. Brockman (Harper Perennial), p. 124.
67. S.M. Carroll, 2015, review of *Time in Powers of Ten*, by G. 't Hooft and S. Vandoren, *Am. J. Phys* **83**, 95.
68. S.M. Carroll, 2015, "We Are All Machines That Think," in *What to Think About Machines That Think: Today's Leading Thinkers on the Age of Machine Intelligence*, ed. J. Brockman (Harper Perennial), p. 56.
69. S.M. Carroll, 2016, "All Physics Is Local," *The Atlantic* online, <http://theatltn.tc/2GvyW61>, 12 Feb. 2016.
70. S.M. Carroll, 2016, "Zombies Must Be Dualists," *Nautilus*, 037, <http://bit.ly/1Pwf1Be>, 16 June 2016.
71. S.M. Carroll, 2017, "We Know All the Particles and Forces We're Made Of," in *Know This: Today's Most Interesting and Important Scientific Ideas, Discoveries, and Developments*, ed. J. Brockman (Harper Perennial), p. 121.
72. S.M. Carroll, 2017, "Cosmic Uncertainty: Your Skull Is an Amazing Physics Lab," *New Scientist*, <http://bit.ly/2mgyfFD>, 6 March 2017.
73. S.M. Carroll, 2017, "The Big Bang—or the Big Bounce?," *Financial Times*, <http://on.ft.com/2GxzUin>, 17 March 2017.
74. S.M. Carroll, 2017, "Marching for the Right to Be Wrong," *The Atlantic* online, <http://theatltn.tc/2D0IozQ>, 21 April 2017.
75. S.M. Carroll, 2018, "Bayes's Theorem," in *This Idea Is Brilliant: Lost, Overlooked, and Underappreciated Science Everyone Should Know*, ed. J. Brockman (Harper Perennial), p. 297.
76. S.M. Carroll, 2018, "In Memoriam: Joe Polchinski, 1954–2018," *Scientific American* online, <http://bit.ly/2nUtcu1>, 8 February 2018.
77. S.M. Carroll, 2018, "Foreword," in *Alice and Bob Meet the Wall of Fire: Science from Quanta*, ed. T. Lin (MIT Press).
78. S.M. Carroll, 2018, "Stephen Hawking's Most Profound Gift to Physics," *The New York Times* online, <http://nyti.ms/2DADqWz>, 15 March 2018.
79. S.M. Carroll, 2018, "Stephen Hawking Was Very Particular About His Tea," *The Atlantic* online, <http://theatltn.tc/2plePQk>, 16 March 2018.
80. S.M. Carroll, 2019, "Mindscape Podcast: Philosophy Outside Academia," *Blog of the APA*, <http://bit.ly/31VH89U>, 16 January 2019.
81. S.M. Carroll, 2019, "Reality Remains Intact," *Daily Nous*, <http://bit.ly/2KMTzyR>, 21 March 2019.
82. S.M. Carroll, 2019, "The Physicist Who Made Sense of the Universe," *The New York Times* online, <https://nyti.ms/2YRm3vx>, 28 May 2019.
83. S.M. Carroll, 2019, "Foreword," in *Fire, Ice, and Physics: The Science of Game of Thrones*, R.C. Thompson (MIT Press).

(other publications cont.)

84. S.M. Carroll, 2019, "Even Physicists Don't Understand Quantum Mechanics," *The New York Times*, <https://nyti.ms/31kTQ1X>, 7 September 2019.
85. S.M. Carroll, 2019, "Where Quantum Probability Comes From," *Quanta*, <http://bit.ly/31kTMzf>, 9 September 2019.
86. S.M. Carroll, 2019, "What Is Space-Time?" *New Scientist*, <http://bit.ly/31srXF6>, 11 September 2019.
87. S.M. Carroll, 2019, "Splitting the Universe," *Aeon*, <http://bit.ly/2kNf8oK>, 11 September 2019.
88. S.M. Carroll, 2019, "The Big Idea: Sean Carroll," *Whatever*, <http://bit.ly/2k1D7eI>, 12 September 2019.
89. S.M. Carroll, 2019, "If You Existed in Multiple Universes, How Would You Act In This One?," *Literary Hub*, <http://bit.ly/2140k3B>, 23 September 2019.

Research Talks

- 1989 Harvard-Smithsonian Center for Astrophysics Theory Seminar
- 1991 MIT Center for Theoretical Physics Seminar
 - Brown University Physicso, Seminar
 - Harvard-Smithsonian Center for Astrophysics Theory Seminar
 - Villanova University Astrophysics Colloquium
 - Canadian Institute for Theoretical Astrophysics Seminar
- 1992 University of Alberta Physics Seminar
 - Contributed Talk, GR13 Conference, Cordoba, Argentina
 - MIT Center for Theoretical Physics Seminar
 - Institute for Advanced Study Astrophysics Seminar
 - Princeton University Particle Astrophysics Seminar
 - Fermilab Theoretical Astrophysics Seminar
- 1993 CfA/Tufts/MIT Cosmology Seminar ($\times 2$)
 - Brown University Physics Colloquium
 - Center for Particle Astrophysics (Berkeley) Seminar
 - Lawrence Berkeley Labs Theory Seminar
 - Harvard Astronomy Ph.D. Colloquium
- 1995 Penn State Center for Gravitational Physics and Geometry Seminar
 - Villanova University Astrophysics Colloquium
 - Tufts University Cosmology Seminar
 - Joint CfA/Tufts/MIT Cosmology Seminar
 - MIT Center for Theoretical Physics Seminar
- 1996 University of Virginia Physics Colloquium
 - Joint Harvard/MIT/Boston University Theory Seminar
 - Cornell University High Energy Theory Seminar
 - MIT Applied Mathematics Seminar
 - Tufts University Cosmology Seminar
 - University of Chicago Particle Theory Seminar
 - University of Chicago Relativity Seminar
 - California Institute of Technology Theory Seminar
 - University of Washington Particle Theory Seminar
 - Institute for Theoretical Physics (UC Santa Barbara) Theory Seminar
- 1997 Joint Harvard/MIT/Boston University Theory Seminar
 - Institute for Theoretical Physics (UC Santa Barbara) Theory Seminar
 - Contributed Talk, Cosmo-97 Conference, Ambleside, England
 - Imperial College (London) Theory Seminar
 - Institute for Theoretical Physics (UC Santa Barbara) Blackboard Lunch Seminar
 - Caltech Theoretical Astrophysics and Relativity Seminar

(research talks cont.)

- Invited Talk, UCSB Conference on CMB Data Analysis and Parameter Extraction
- 1998 Invited Talk at Moriond Conference on Fundamental Parameters in Cosmology, Les Arcs, France
- University of Wisconsin-Milwaukee Physics Colloquium
- Institute for Theoretical Physics (UC Santa Barbara) Blackboard Lunch Seminar
- Harvard-Smithsonian Center for Astrophysics Theory Seminar
- Case Western Reserve University Theoretical Physics Seminar
- Invited Talk at Fermilab Workshop on Missing Energy in the Universe
- University of Chicago Relativity Seminar
- Northwestern University Astrophysics Seminar
- Oxford University Theoretical Physics Seminar
- University of Alberta Physics Colloquium
- University of Alberta Gravitational Theory Seminar
- Joint CfA/Tufts/MIT Cosmology Seminar (at MIT)
- University of Chicago Astronomy and Astrophysics Colloquium
- Contributed Talk, Cosmo-98 Conference, Monterey, California
- 1999 Invited Parallel Talk at APS Division of Particles and Fields Meeting, UCLA
- University of Washington Astronomy Colloquium
- University of California, Santa Barbara, Physics Colloquium
- University of British Columbia Theoretical Physics Seminar
- Rutgers University Theoretical Physics Seminar
- Invited Talk, Centenary Meeting of the American Physical Society, Atlanta
- University of Kentucky Physics Colloquium
- Canadian Institute for Theoretical Physics Seminar
- Northwestern University Physics Colloquium
- MIT Nuclear and Particle Physics Colloquium
- Fermilab Theoretical Astrophysics Seminar
- Notre Dame Astrophysics Seminar
- University of Wisconsin, Milwaukee, Relativity Seminar
- University of Alabama Theoretical Physics Seminar
- University of Illinois, Urbana-Champaign, Theoretical Physics Seminar
- Invited Talk at Cosmic Genesis and Fundamental Physics, Sonoma, California
- 2000 Los Alamos National Laboratory Physics Colloquium
- Los Alamos National Laboratory Theory Seminar
- University of California Santa Cruz/Stanford Joint Theory Seminar (at UCSC)
- University of Michigan Theory Seminar
- Syracuse University Physics Colloquium
- Syracuse University Relativity Seminar

(research talks cont.)

- Fermilab Physics Colloquium
- Argonne National Lab High Energy Theory Seminar
- Argonne National Lab Physics Colloquium
- University of Wisconsin, Milwaukee, Relativity Seminar
- Villanova University Astronomy and Astrophysics Colloquium
- Stanford Linear Accelerator Theoretical Physics Seminar
- University of Texas Particle Theory Seminar
- Ohio State University Physics Colloquium
- University of Maryland Relativity Seminar
- Purdue University Theoretical Physics Seminar
- Case Western Reserve University Physics Colloquium
- Case Western Reserve University Particle Astrophysics Seminar
- Penn State Gravitational Physics Seminar
- Scuola Normale Superiore (Pisa, Italy) Theory Seminar
- 2001 University of Chicago Physics Colloquium
- University of Minnesota Theoretical Physics Institute Seminar
- Joint Harvard/MIT/Boston University Theory Seminar (at BU)
- University of Wisconsin Physics Colloquium
- Invited talk at Institute for Advanced Study Workshop on Galaxies and the Dark Matter Problem
- College de France Cosmology Seminar
- Invited talk at Physics and Astrophysics of Extra Dimensions, IAP, Paris
- Invited talks (two parallel, one brief plenary summary) at Snowmass 2001 Workshop on the Future of Particle Physics
- Parallel talk at GR16, Durban, South Africa
- Invited talk at 2nd Meeting on CPT and Lorentz Symmetry, Indiana University
- University of Illinois, Urbana-Champaign, Astronomy Colloquium
- University of Notre Dame Physics Colloquium
- Columbia University Institute for Strings, Cosmology and Astroparticle Physics Seminar
- Invited Talk at Workshop on Cosmological Probes of Dark Energy, Chicago
- 2002 Contributed talk, AAS meeting, Washington, DC
- Michigan State University Physics Colloquium
- Invited talk at Aspen Winter Conference on Particle Physics
- Center for Advanced Studies Seminar, University of New Mexico
- University of New Mexico Physics Colloquium
- Institute For Theoretical Physics, Santa Barbara, Colloquium
- Fermilab Colloquium
- UC San Diego Physics Colloquium

(research talks cont.)

- University of Florida Astrophysics Seminar
- Argonne National Laboratory HEP Seminar
- Invited Talk, New York State Section APS Meeting, Syracuse, NY
- William and Mary Physics Colloquium
- University of Maryland Astronomy Colloquium
- Invited Talk, Carnegie Observatories Centennial Cosmology Symposium
- Duke University Physics Colloquium
- 2003 Indiana University Physics Colloquium
- Northwestern University Physics Colloquium
- University of Illinois, Chicago, Physics Colloquium
- Center for Cosmological Physics, University of Chicago, Colloquium
- Invited Talk, Topical Session on the Physics of Extra Dimensions, AAAS Meeting, Denver
- Florida International University Physics Colloquium
- Goddard Space Flight Center High-Energy Astrophysics Seminar
- CfA/Tufts/MIT Cosmology Seminar (at Radcliffe Institute, Harvard)
- Invited Talk, Seven Pines Symposium, Minnesota
- Invited Talk, AAS meeting, Nashville, TN
- Invited Talk, Decennial Conference, Center for Gravitational Physics and Geometry, Penn State
- Invited Talk, Itzykson Meeting on the Early Universe, Paris
- Invited Talk, Cosmology and Fundamental Physics Meeting, Marseilles
- Invited Talk, American Linear Collider Workshop, Cornell
- Invited Talk, SLAC Summer Institute Workshop
- University of British Columbia Theory Seminar
- KITP Blackboard Lunch Seminar
- Columbia University Physics Colloquium
- Renaissance Technologies Colloquium
- University of California, Santa Cruz, Physics Colloquium
- Invited Talk, National Academy of Sciences Frontiers Symposium, Irvine
- KITP String Cosmology Program Seminar
- 2004 Space Telescope Science Institute Colloquium
- Invited Talk, American Linear Collider Physics Group Workshop, SLAC
- University of Wisconsin, Madison, Physics Colloquium
- University of Michigan Physics Colloquium
- Perimeter Institute Seminar
- University of Waterloo Physics Colloquium
- University of North Carolina Theoretical Physics Seminar
- University of North Carolina Physics Colloquium

(research talks cont.)

Invited Talk, NOAO Workshop on Observing Dark Energy
University of Rochester Physics Colloquium
Invited Talk, Mitchell Symposium on Observational Cosmology
Swarthmore College Physics Colloquium
University of Chicago High Energy Physics Seminar
Invited Talk, Meeting of the APS Division of Particles and Fields, Riverside
Brandeis University Physics Colloquium
Brandeis University Theory Seminar
University of Arizona Physics Colloquium
University of Illinois, Urbana-Champaign, Physics Colloquium
University of Pennsylvania Physics Colloquium
Johns Hopkins Physics and Astronomy Colloquium
Johns Hopkins Theoretical Particle Physics Seminar
Caltech High Energy Theory/Experiment Joint Seminar
UC San Diego Theory Seminar
Invited Talk, Philosophy of Science Association meeting, Austin
Lund University (Sweden), Joint Physics and Astronomy Colloquium
Stockholm University, Physics Colloquium
Stockholm University, Theoretical Physics Seminar
Joint CfA/Tufts/MIT Cosmology Seminar (Tufts)
Invited Talk, Pacific Institute for Theoretical Physics Meeting, The Arrows of Time
2005 Invited Talk, Dark Energy Symposium, AAAS Meeting, Washington DC
New York University Theory Seminar
Goddard Space Flight Center Scientific Colloquium
University of Southern California Physics Colloquium
Lawrence College Scientific Colloquium
ESSENCE Collaboration Meeting Talk, Harvard-Smithsonian Center for Astrophysics
Invited Talk, IAP Colloquium on Mass Profiles and Shapes of Cosmological Structures
Saclay/SPhT Physics Seminar
Syracuse University Physics Colloquium
Syracuse High Energy/Relativity/Cosmology Seminar
MIT Physics Colloquium
Joint CfA/Tufts/MIT Cosmology Seminar (MIT)
Rutgers University Physics Colloquium
University of Washington Physics Colloquium
University of Washington Theory Seminar
Invited Talk, Geometry and the Universe Symposium, Stony Brook
UC Berkeley Theory Seminar

(research talks cont.)

- Caltech Physics Colloquium
- Harvard University Theory Seminar
- University of Illinois-Chicago Physics Colloquium
- Invited Talk, SNAP collaboration meeting, Fermilab
- Invited Talk, New Views of the Universe conference, Chicago
- 2006 University of Pennsylvania Theoretical Physics Seminar
- University of British Columbia Theory Seminar
- UC Riverside Physics Seminar
- UCLA Physics Colloquium
- University of Toronto Physics Colloquium
- CITA Theory Seminar
- University of New Mexico Physics and Astronomy Colloquium
- Two Invited Talks, APS April Meeting, Dallas
- Johns Hopkins Theory Seminar
- Invited Talk, NASA Meeting on Fundamental Physics in Space, Washington DC
- Invited Talk, Cosmology Workshop, Perimeter Institute
- Invited Talk, NASA Institute for Advanced Concepts Meeting
- NYU Physics Colloquium
- UC Santa Barbara High-Energy Theory Seminar
- Lensing Program Colloquium, KITP
- Washington University Physics Colloquium
- Villanova University Astronomy and Astrophysics Colloquium
- SLAC Colloquium
- Arizona State University Physics Colloquium
- University of Nottingham Physics Colloquium
- Invited Talk, UK Annual Particle Theory Meeting, Durham
- 2007 Duke University Physics Colloquium
- University of Colorado Theory Seminar
- University of Colorado Physics Colloquium
- National Science Foundation Mathematics and Physical Sciences Distinguished Lecture
- Invited Talk, Rethinking Gravity conference, University of Arizona
- Caltech Theoretical Astrophysics and Relativity Seminar
- Carnegie Observatories Colloquium
- Purdue University Physics Colloquium
- Perimeter Institute Colloquium
- York University Physics Colloquium
- University of Oregon Physics Colloquium
- Georgia Tech Physics Colloquium

(research talks cont.)

UC Santa Cruz Physics Colloquium

University of Cincinnati Physics Colloquium

Caltech Cosmology Seminar

Harvey Mudd College Physics Colloquium

Invited Talk, National Academy of Sciences Kavli Frontiers of Science Meeting

University of Maryland High Energy/Gravitation Seminar

University of Maryland Physics Colloquium

Invited Talk, Northeast String Cosmology Meeting

2008 UCLA Theory Seminar

University of Washington Physics Colloquium

Caltech Observational Cosmology Group Meeting

Caltech Theoretical Cosmology Group Meeting

UC Santa Barbara/KITP Theory Seminar

Invited Talk, Workshop on Cosmological Frontiers, Paris

Plenary Talk, American Astronomical Society meeting, St. Louis

Plenary Talk, Cosmo-08, Madison

Theoretical Cosmology Seminar, Imperial College, London

Caltech Astronomy Colloquium

Plenary Talk, Texas Symposium on Relativistic Astrophysics, Vancouver

2009 Fermilab Colloquium

Annual Lecture Series, Center for the Philosophy of Science, University of Pittsburgh

Caltech Particle Theory Group Meeting

Invited Talk, Philosophy and Cosmology conference, Oxford

Ohio State University Physics Colloquium

Kenyon College Physics Colloquium

Caltech Physics Colloquium

CfA Institute for Theory and Computation Colloquium

MIT Physics Colloquium

Invited Talk, Cosmology and Particle Astrophysics conference, Melbourne

University of Adelaide Physics Colloquium

Invited Talk, Penn Cosmology Center Inaugural Symposium

2010 Invited Talk, Physics of the Universe Summit, Caltech

UC San Diego Physics Colloquium

Invited Talk, AAAS Annual Meeting

UCLA Physics Colloquium

Case Western Physics Colloquium

University of British Columbia Physics Colloquium

Simon Fraser University Physics Colloquium

(research talks cont.)

- Invited Talk, Rutgers Workshop on Time, Ontology, and Quantum Mechanics
University of Arizona Physics Colloquium
University of California, Davis, Physics Colloquium
Theory Seminar, University of Texas
University of Texas Physics Colloquium
Invited Talk, CA/NV Regional APS Meeting
Invited Talk, Philosophy of Science Association Meeting, Montreal
Union College Physics Colloquium
Syracuse University Physics Colloquium
- 2011 Invited Talks, Princeton Workshop on Foundational Questions in Inflationary Cosmology
Carnegie Mellon University Physics Colloquium
Reed College Physics Seminar
Invited Talk, Problems Old and New in Theoretical Cosmology Conference, Avignon, France
Caltech Theory Informal Seminar
Jet Propulsion Laboratory Colloquium
Invited Talk, Perimeter Institute Workshop on Challenges in Early Universe Cosmology
Plenary Talk, Setting Time Aright Conference, Bergen/Copenhagen
Kieval Lecture, Cornell University
- 2012 William and Mary College Physics Colloquium
University of Southern California Physics Colloquium
Invited Talk, UC San Diego Workshop on the Physics and Philosophy of Time
Invited Talk, Symposium on the Philosophy of Cosmology, Florence
Invited Talk, Yakir Aharonov 80th Birthday Conference, Chapman University
Occidental College Physics Colloquium
UC Berkeley Physics Colloquium
Caltech Particle Phenomenology Seminar
Caltech Institute for Quantum Information and Matter Seminar
University of Wisconsin, Milwaukee, Particle Theory Seminar
Join MIT/CfA/Tufts Cosmology Seminar, MIT
Panel discussions, Moving Naturalism Forward Workshop, Stockbridge, Massachusetts
Tufts University Physics Colloquium
ESSC Colloquium, Jet Propulsion Laboratory, Pasadena
- 2013 Invited Talks, Oxford Philosophy of Cosmology Miniseries, "Is God Explanatory?"
University of Nottingham Physics Colloquium
Case Western Reserve University Physics Colloquium
Mt. Stromolo Observatory Astronomy Colloquium
UC Riverside Physics Colloquium
Lectures on the Origin of the Universe, UC Santa Cruz Workshop on Philosophy of Cosmology

(research talks cont.)

- New York University Physics Colloquium
- NY/NJ Philosophy of Science Group Seminar, NYU
- Astrophysics Seminar, CEA-Saclay
- Institut Astrophysique d'Paris, Colloquium
- 2014 Invited Talk, FQXI conference on The Physics of Information, Vieques, Puerto Rico
- Invited Talk, Santa Barbara Gravity Workshop II
- Invited Talk, IBM Workshop on Quantum Foundations of a Classical Universe, Yorktown Heights
- Invited Talk, Philosophy of Cosmology Workshop, Tenerife
- Physics Colloquium, UC Santa Barbara
- Schrödinger Colloquium, Universität Zürich
- 2015 Caltech Phenomenology Group Seminar
- Informal Talk, Caltech Physics Club
- Invited Talk, American Physical Society March Meeting
- Triangle Philosophy of Science Colloquium
- Philosophy Seminar, University of North Carolina
- University of North Carolina Physics Colloquium
- Columbia University Theoretical Physics Seminar
- NYU Physics Colloquium
- UC San Diego Physics Colloquium
- Lectures on General Relativity, Caltech Gravitational-Wave Summer School
- 2016 Arizona State Physics Colloquium
- Texas A&M Philosophy Seminar
- Texas A&M Physics Colloquium
- Georgia Tech Physics Colloquium
- New York Institute for Philosophy Colloquium
- Invited Lecture, Special Session on Testability in Cosmology, American Astronomical Society Meeting, San Diego
- Invited Talk, Conference on Time in Cosmology, Perimeter Institute, Canada
- Invited Talk, FQXi Meeting, Banff
- Invited Lecture, Hertz Fellows Retreat, Ben Lomond, California
- Invited Talk, Jet Propulsion Laboratory
- Invited Lecture, Workshop in Honor of Georges Lemaitre, Rome, Italy
- MIT Physics Colloquium
- 2017 Invited Plenary Talk, American Astronomical Society Meeting, Dallas
- Invited Talk, Arizona State Workshop on Complexity and Biology
- Stanford Institute for Theoretical Physics Colloquium
- SoCal Philosophy of Physics Seminar
- Invited Talk, Workshop on Probing the Structure of Spacetime, SISSA, Trieste, Italy

(research talks cont.)

- Invited Talk, California Quantum Interpretation Network Meeting
- Maxwell Lecture, Kings College London
- Joint MIT/Tufts Cosmology Seminar
- Invited Talk, Santa Fe Institute Workshop on the Limits of Understanding
- 2018 Caltech Phenomenology Group Talk
- UC Santa Barbara Physics Colloquium
- Institute for Quantum Information and Matter Seminar, Caltech
- Haverford College Physics Colloquium
- University of Pennsylvania High-Energy Physics Seminar
- Villanova University Physics and Astrophysics Colloquium
- Rutgers Foundations of Probability Seminar
- Invited Talk, Time and the Observer Workshop, La Jolla
- Invited Talk, Time in Adaptive Systems Workshop, Santa Fe Institute
- Plenary Talk, Oskar Klein Institute 10th Anniversary Workshop, Stockholm
- Invited Talk, Analytic Methods In Cosmology Workshop, Institut Henri Poincare, Paris
- Invited Talk, The Universe as a Quantum Lab Conference, Astroparticle Cosmology Laboratory, Paris
- Ehrenfest Colloquium, University of Leiden
- Physics Seminar, City College of New York
- Invited Talk, Columbia Workshop on the Foundations of Physics
- Symposium Talk, Philosophy of Science Association Meeting, Seattle
- 2019 Google X Theory Seminar
- Invited Talk, Philosophy of Fine-Tuning Workshop, USC
- Invited Talk, Quantum Interpretations Session, APS March Meeting, Boston
- Invited Talk, Philosophy of Dark Energy Workshop, UC Irvine
- Invited Talk, CERN Workshop on Quantum Gravity and Quantum Information
- CERN Theory Colloquium
- Invited Talk, Kavli Salon on Space, Time, and Brain, Costa Rica
- Invited Talk, HartleFest, Kavli Institute for Theoretical Physics, UC Santa Barbara
- Invited Talk, FQXi Conference, Mind Matters: Intelligence and Agency in the Physical World
- Invited Talk, Workshop on Foundations of Physics in Honor of David Albert
- Patrick Suppes Memorial Lecture on Logic or Philosophy of Science, Columbia University

Other Presentations

- 1995 Volunteer Lecturer, Boston Public Schools
- 1996-1998 Docent/Lecturer, UC Santa Barbara University Art Museum
- 1999 Theoretical Advanced Study Institute Lectures: Cosmology for String Theorists
Guest Class, Adler Planetarium
- 2000 Lecturer/Discussion Leader, Midwest Faculty Seminar "New Cosmologies."
Advanced Study Institute on Techniques and Concepts of High Energy Physics Lectures: Cosmology for Particle Physicists
Lecturer/Discussion Leader, Workshop on Teaching at Chicago
Model Class, Parents Weekend, University of Chicago
- 2001 Panel Discussion, Basic Teaching Skills Workshop, University of Chicago
Sigma Xi Dinner Talk, Swarthmore College
University of Chicago Graham School Lecture: 21st Century Science — Cosmology
Public Lecture, Science Weekend, Snowmass 2001 Workshop on the Future of Particle Physics
Talk to Chicago Astronomical Society
Lecturer/Discussion Leader, Workshop on Teaching at Chicago
Invited Talk, Packard Fellows Meeting
Model Class, Parents Weekend, University of Chicago
Chautauqua Lecture, "The New Cosmology: From Quantum Fuzz to the Accelerating Universe", University of Chicago
JASON Project Fall Meeting Lecture
- 2002 Cosmology Review Lectures, MIT Theory Retreat
Public Lecture, American Physical Society Meeting, Albuquerque, NM
Theoretical Advanced Study Institute Lectures: Cosmology for Particle Physicists
Public Lecture, New York State Section APS Meeting, Syracuse, NY
Public Lecture/Colloquium, Jefferson Labs, Virginia
Model Class, Parents Weekend, University of Chicago
- 2003 Adler Planetarium "Far Out Friday" Lecture
University of Chicago Alumni Weekend Lecture
Invited Talk, Russian-Anglo-American Conference on Cosmology and Theology, Notre Dame
Lunch Talk, Franke Institute for the Humanities, University of Chicago
Tevatron University Lecture, Fermilab
Malmstrom Lecture, Hamline University
Dinosaur Expedition Presentation for Project Exploration
Resnick Lecture, Rensselaer Polytechnic Institute
Council for the Advancement of Science Writing Meeting, Knoxville
Einstein in Chicago Panel Discussion, Illinois Institute of Technology

(other presentations cont.)

- 2004 Einstein Exhibit Lecture, Field Associates, Field Museum of Natural History, Chicago
Current Affairs Seminar, DePauw University
Public Lecture, DePauw University
University of Chicago Alumni Lecture
Quadrangle Club Fireside Chat (University of Chicago)
Dinosaur Expedition Presentation for Project Exploration
European Forum Alpach, Cosmology Seminar (with Robert Wald)
Model Class, Parents Weekend, University of Chicago
Society of Physics Students Lunch Talk, University of Chicago
- 2005 Science Day Talk, Willows Academy
National Conference of Black Physics Students Lecture, Chicago
Public Lecture, Aspen Center for Physics
Invited Presentation, Science, Theatre, Audience, Reader: Theoretical Physics in Drama and Narrative, Santa Barbara
Keynote address, Society of Physics Students regional meeting, University of Michigan
Literary Lecture, Remy Bumpo Theatre Company, Chicago
Invited Talk, Cosmology at the Interface Between Physics and Philosophy, Notre Dame
Academic Lectures, CERN
Guest Lecture, Creation and Creativity, Franke Institute for the Humanities, University of Chicago
Literary Lecture, Victory Gardens Theater, Chicago
SLAC Summer Institute Lectures: Introduction to General Relativity
Invited Talk, Packard Fellows Meeting
Short Course for Planetarians Lecture, Kavli Institute for Cosmological Physics, University of Chicago
Invited Talk, World Year of Physics Symposium, Fermilab
Invited Talk, Einstein Symposium, Parker School, Chicago
- 2006 Draft Innovation Workshop, Chicago
Blackstone House Fireside Chat, University of Chicago
Cafe Scientifique, Chicago
Midwest Faculty Seminar, University of Chicago
Science and Religion Discussion Group, Augustana Lutheran Church, Chicago
Renaissance Weekend, Quebec City
Lectures on Introductory Cosmology, ICTP Summer School, Trieste
Keynote Address, Midwestern Regional American Association of Physics Teachers
Villanova University Center for Liberal Education Lecture
- 2007 Invited Talk, Conference on Communicating Science, Math, and Engineering to Broader Audiences, University of Nebraska
Lectures on Dark Energy, SIGRAV Summer School on Gravitation, Como, Italy

(other presentations cont.)

- Dinosaur Expedition Presentation for Project Exploration
- Invited Talk, Science Panel, YearlyKos 2007
- Invited Talk, International Congress on Logic, Methodology, and Philosophy of Science, Beijing
- Categorically Not, Santa Monica
- Invited Talk, Plato's Timaeus Today Conference, University of Illinois
- Invited Talk, Beyond Belief II, Salk Institute
- National Academy of Sciences Colloquium on 50 Years of Space
- Modern Physics and the Mystery of Reality, Shaw Center for the Arts, Baton Rouge
- 2008 Invited Talk, National Academy of Sciences Symposium, Washington DC
- Invited Lecture, Pulmonary Research Conference, Palm Springs, California
- Public Lecture, Center for Inquiry, Los Angeles
- Invited Talk, Origins Conference, Skeptic Society, Pasadena
- The God Debate, Literary and Historical Society, University College Dublin
- Public Lecture in Second Life, Meta Institute for Computational Astrophysics
- Authors @ Google Talk, Santa Monica
- Panel Discussion, The Day the Earth Stood Still, Caltech
- 2009 Public Lecture, Claremont Senior Center
- Caltech Undergraduate Seminar
- WSF Spotlight Event, World Science Festival, New York
- Time Since Einstein Panel, World Science Festival, New York
- SLAC Summer Institute Lectures: Inflation and Dark Energy
- Invited Talk, Science, Narrative, and Performance conference, Ohio State
- Panel Discussion, Canadian Broadcast Corporation Quirks and Quarks radio show
- Public Lecture, Quantum to Cosmos Festival, Perimeter Institute
- Public Lecture, McGill University, Montreal
- Public Lecture, University of Sydney
- Public Lecture, University of Melbourne
- Public Lecture, University of Adelaide
- 2010 Multiple presentations, Renaissance Weekend, Charleston
- Meta Institute for Computational Astrophysics Public Lecture, Second Life
- Skylight Books, Los Angeles
- The Book Works, Del Mar, California
- IEEE Keynote Lecture, Big Sky, Montana
- Friends of Griffith Observatory Lecture
- Caltech Associates Meeting
- Joseph Beth Booksellers, Cleveland
- Public Lecture, Smith College, Massachusetts
- Invited Panel Discussion, Ad Hoc Vox, New York

(other presentations cont.)

- Invited Panel Discussion, LA Time Festival of Books
- Public Lecture, LA City College
- Public Lecture, American Museum of Natural History, New York
- Panel Discussion, San Diego Comic-Con
- Invited Talk, Discovery Communications Board Meeting
- Public Lecture, Google, Mountain View
- Multiple presentations, SETIcon, Santa Clara
- Public Lecture, Jet Propulsion Laboratory, Pasadena
- Invited talk, Idea Festival, Louisville
- Public Lecture, Union College
- Public Lecture, France/Stanford Center Workshop on Dark Energy
- Panel Discussion, The Science of TRON: Legacy, Los Angeles
- 2011 Public Lecture, Alhambra Public Library
- Invited Talk, TEDxCaltech: Feynman's Vision
- Public Lecture, Villanova University
- Panel Discussion, Sundance Film Festival
- Public Lecture, Skeptic Society, Caltech
- Invited Talk, Los Angeles Institute for the Humanities
- Public Lecture, Reed College
- Invited Presentation (with Jennifer Ouellette), San Diego Science Festival
- Invited Presentation (with Jane Hirshfeld), ALOUD, LA Public Library
- Public Lecture, Pasadena Seniors Society
- Invited Lecture, Disney Animation Studios
- Panel Discussion, Huntington Library
- Public Lecture, Mindshare LA
- Invited Talk, Discovery Retreats, Gateway Colorado
- Invited Talk, World Conference of Science Journalists, Doha, Qatar
- Session Organizer and Speaker, SciFoo, Google
- Public Lecture, Santa Monica College
- Invited Talk, Council of American Science Writers
- Public Lecture, Chapman University
- 2012 Science on Tap, Science and Entertainment Exchange, Los Angeles
- Saturday Morning Physics: Einstein on the Beach (Panel Discussion with Philip Glass), University of Michigan
- Multiple presentations, Renaissance Weekend, Santa Monica
- "The Great Debate," Skeptic's Society, Pasadena
- Panel Discussion, Los Angeles Times Festival of Books
- Invited Talk, The Amazing Meeting, Las Vegas

(other presentations cont.)

- USC Honors Program presentation
- Invited Talk, Director's Guild of America symposium
- Keynote Lecture, Visual Effects Society Summit
- Public Lecture, Math/Bio Symposium, Madison, Wisconsin
- Invited Talk, Chief of Naval Operations Strategic Studies Group
- Plenary Talk, Skepticon, Springfield, Missouri
- Uncorked* performance with Matt Haimovitz and Flea, Muse/Ique, Pasadena
- Public Lecture, Skeptic's Society, Pasadena
- Public Lecture, Linus Pauling Memorial Lecture Series, Portland, Oregon
- The Higgs and Beyond: Brave New Physics*, University of Toronto
- 2013 Public Lecture, Royal Institution, London
- Public Lecture, University of Nottingham
- Public Lecture, Ohio State University
- Explorer Series Lecture, Cleveland Museum of Natural History
- Public Lecture, Center for Inquiry, Los Angeles
- Public Lecture, Institute for Figuring, Los Angeles
- Public Lecture, California Polytechnic School, Pasadena
- Public Lecture, Australia National University, Canberra
- Ideas Talk, University of Sydney
- Public Lecture, UNC Charlotte
- Paul Bartlett Sr. Lecture, Linda Hall Library, Kansas City
- Panel Discussion, LA Times Festival of Books
- Public Lecture, UC Davis Cosmology Workshop
- Discussion with Jim Holt, LA Public Library
- Keynote Address, American Humanist Association meeting, San Diego
- Public Event, *Icarus at the Edge of Time*, Seattle Science Festival
- Public Lecture, Fermilab Users Meeting
- Muse/Ique concert with Ellis Hall, Caltech
- Technical Talk, Mentor Graphics, Fremont, California
- Invited Talk, Time for Everyone conference, Caltech
- UK National Physics Colloquium, York University
- Public Science Night, Royal Society, London
- 2014 Veritas Forum (with Hans Halvorson), Caltech
- Public Lectures, Scientific American Insight Cruises
- Greer-Heard Forum (Debate with William Lane Craig), New Orleans Baptist Theological Seminary
- Night School Los Angeles
- Q&A with Walter Murch, *Particle Fever* screening, Los Angeles
- Brattain Lecture and Encounters Lecture, Whitman College

(other presentations cont.)

- Dean's College Invited Lecture, University of Texas at Austin
Intelligence Squared Debate: "Death Is Not Final," New York
Panel Discussions, World Science Festival, New York
Invited Talks, Cheltenham Science Festival, UK
Public Lecture, Imperial College, London
Public Lecture (with Jennifer Ouellette), Royal Institution, London
Public Lecture, Embry-Riddle Aeronautical University, Florida
Public Lecture, *Copenhagen* reading, A Noise Within Theatre, Pasadena
Award Lecture, Freedom From Religion Foundation Annual Conference, Los Angeles
Science Soireé Los Angeles, Caltech
- 2015 Gemant Award Lecture, RH Fleet Science Center, San Diego
Hound Tall with Moshe Kasher, Upright Citizen's Brigade, Los Angeles
Invited Lecture, Chancery Club of Los Angeles
Public Lecture, St. Andrews School, Delaware
Discussion with Wendy Freedman, LA Public Library
Harold Improv with Ian Brennan, Upright Citizen's Brigade, Los Angeles
Infinite Monkey Cage with Brian Cox and Robin Ince, Los Angeles
Panel Discussion on The Science of *Interstellar*, Jet Propulsion Laboratory
Story Collider, Cambridge MA
Invited Talk, Cambridge Science Festival
Invited Talk, Pasadena Literary Festival
Panel Discussion on General Relativity, KPCC, Pasadena
Panel Discussion on Quantum Mechanics, Milken Scholars Meeting
Invited Talk, Texas Instruments, Santa Clara
Invited Talk, SciComm workshop, Malibu
Invited Talk, Centenary of General Relativity celebration, University of Southern California
- 2016 Multiple panels, World Science Festival, Brisbane, Australia
Panel Discussion, Association of Writers and Publishers Conference
First Friday Panel Discussion, Natural History Museum, Los Angeles
Secret Science Club, Brooklyn
Reading, Harvard Book Store, Cambridge MA
Smithsonian Associates Lecture, Washington DC
Public Lecture, Seattle Science Center
Google Tech Talk, Mountain View
Public Lecture, Silicon Valley Commonwealth Club
Public Lecture, Berkeley Arts and Letters
Public Lecture, Natural History Museum Los Angeles
IVY Public Lecture, Los Angeles

(other presentations cont.)

Public Lecture, Center for Inquiry, Los Angeles

Science Speed Dating, Banff, Canada

Curiosity Retreat, Gateway Junction, Colorado

How-To Academy Public Talk, London

Public Lecture, Royal Institution, London

Gifford Lectures on Natural Theology, Glasgow, Scotland

Talk to Secular Student Alliance, UC Riverside

Panel on Science and Entertainment, American Academy of Arts and Sciences, Los Angeles

Public Talk, Century Books, Pasadena

Panel Discussion on The Machine, HPE Discover, London

2017 Keynote Lecture, LogicCal-LA

Beyond Lecture, University of Arizona

Dialogue Between a Buddhist Scholar and a Theoretical Physicist, San Francisco

Writers with Drinks, San Francisco

Public Lecture, San Jacinto College

Public Lecture, Cal Poly Pomona

J. James Woods Lecture, Butler University, Indiana

Invited Talk, March for Science LA

Panel Discussion, LA Times Festival of Books

Ottawa Writer's Festival, Ottawa, Canada

Interview with Janna Levin, LA Public Library

Summer App Science Program Lecture, Caltech

Public Lecture and Stargazing Evening, Caltech

Plenary Talk, New Scientist Live, London

Public Lecture, MIT

Public Lecture, Charity Event, Toronto, Canada

Caltech Social Media Lecture

Physics Club Lecture, Colgate University

2018 InAmerica Education Lecture

Caltech Alumni Webinar

Live Discussion with Sam Harris, Portland, Oregon

Public Talk, American Physical Society Tweetup

APS Panel Discussion on Science and Hollywood

Invited Panel on the Future of Artificial Intelligence, SXSW

Haverford Distinguished Visitor Public Lecture

Birmingham Interdisciplinary Lunch Seminar, Villanova University

Discussion with David Eagleman, Rubin Museum of Art, New York

Public Lecture, Alliance Francaise, Pasadena

(other presentations cont.)

Invited Talk, Science Board/Trustees Symposium, Santa Fe Institute

Panel Discussion, Lensic Theatre, Santa Fe

Invited Talk, Kent Presents Festival

Panel Discussion, USC Harman Academy for Polymathic Study

Panel Discussion with Katherine Freese, Oskar Klein Institute, Stockholm

Invited Talk, How the Light Gets In Festival, London

Invited Talk, New Scientist Live, London

Invited Talk, Sonophilia, Los Angeles

Colsoy-Blank Lecture, City College of New York

Guest lecture, Julliard School of Music

Plenary Talk, National Association of Biology Teachers Conference, San Diego

2019 Caltech Associates Lecture

Google X Public Lecture

Invited Talk, Public Outreach Session, APS March Meeting, Boston

Multiple Panel Discussions, Sony at South By SouthWest, Austin

Invited Lecture, National Science Teachers Association Meeting, St. Louis

Science and Cocktails Public Lecture, Copenhagen

After-Dinner Talk, Glenn Foundation for Medical Research Conference

Panel Discussion, Santa Fe InterPlanetary Festival

Public Talk, Secret Science Club North, New York

Public Talk, The Midtown Scholar, Harrisburg PA

Public Talk, University of Wisconsin, Milwaukee

Public Talk, Bookshop West Portal, San Francisco

Public Talk, Commonwealth Club, Palo Alto

Public Talk, Los Angeles Public Library

Google Tech Talk, Venice CA

IVY Masterclass, Los Angeles

Panel discussion with Annalee Newitz, Skylight Books, Los Angeles

Public Talk, University of Washington

Public Talk, Harvard University

Invited Lecture, Harvard Club of Boston

Invited Talk, Chicago Humanities Festival

Public Talk, Hunter College