# CURRICULUM VITAE

*Carlton M. Caves*

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CV, updated monthly, is available at `http://info.phys.unm.edu/~caves/vita.pdf`.

## PERSONAL

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## HIGHER EDUCATION

Rice University, 1968–9 to 1972–5

BA in Physics and Mathematics, summa cum laude, 1972

California Institute of Technology, 1972–9 to 1979–5
PhD in Physics, 1979 (thesis supervisor: Kip S. Thorne)

## PRESENT POSITIONS

Distinguished Professor Emeritus, University of New Mexico, 2018–7 to present

Distinguished Visiting Research Chair, Perimeter Institute for Theoretical Physics, 2024–1 to 2026–12

Affiliated Faculty, Institute for Advanced Catholic Studies at the University of Southern California, 2023–10 to present

## PREVIOUS POSITIONS

Graduate Research Assistant, California Institute of Technology, 1975–10 to 1976–9 and 1977–10 to 1979–5

Research Fellow in Physics, California Institute of Technology, 1979–5 to 1981–12

Senior Research Fellow in Theoretical Physics, California Institute of Technology, 1982–1 to 1987–11

Associate Professor of Electrical Engineering/Electrophysics (and Physics, beginning 1989–9), University of Southern California, 1987–12 to 1992–7

Professor of Physics and Astronomy, University of New Mexico, 1992–8 to 2006–7

Director, Center for Advanced Studies, University of New Mexico, 1993–7 to 1996–6

Distinguished Professor, University of New Mexico, 2006–8 to 2018–6

Director, Center for Quantum Information and Control, University of New Mexico, 2009–8 to 2018–6

Research Professor of Physics and Astronomy, University of New Mexico, 2018–7 to 2021–6

## TEMPORARY AND VISITING POSITIONS

Member, (Kavli) Institute for Theoretical Physics, University of California, Santa Barbara, 1984–1 to 1984–6, 1996–8 to 1996–12, 2001–8 to 2001–12, 2013–1 to 2013–2

Lecturer, California Institute of Technology, 1984–10 to 1985–9

Visiting Associate in Physics, California Institute of Technology, 1987–12 to 1993–1

Visiting Professor, Santa Fe Institute, 1992–9 to 1992–12

Visiting Scholar, School of Mathematics and Physics, University of Queensland, 2007–8 to 2008–7

Visiting Professor, School of Mathematics and Physics, University of Queensland, 2011–2 to 2017–6

## FIELDS OF RESEARCH SPECIALIZATION

Quantum theory of measurement; theory of quantum noise; quantum metrology
Information, entropy, and complexity; quantum information theory; quantum chaos
Quantum optics; theory of nonclassical light

## PROFESSIONAL SOCIETIES

Member, US National Academy of Sciences (elected 2020)
Fellow and Member, American Physical Society (elected Fellow 2004)
Fellow and Member, American Association for the Advancement of Science (elected Fellow 2008)

## AWARDS, SCHOLARSHIPS, AND FELLOWSHIPS

Phi Beta Kappa, 1971
National Science Foundation Predoctoral Fellow, 1972–10 to 1975–9
Richard P. Feynman Fellow, Caltech, 1976–10 to 1977–9
First Öcsi Bácsi Fellow, Caltech, 1976–1977
Einstein Prize for Laser Science, Society for Optical and Quantum Electronics, 1990
Excellence in Teaching Award, UNM Department of Physics and Astronomy, 1998–1999, 1999–2000, and 2004–2005
Max Born Award, Optical Society of America, 2011
Lifetime Achievement Award, New Mexico International Year of Light Celebration, 2015
Quantum Communication Award, International Conference on Quantum Communication, Measurement and Computing (QCMC), 2018
2020 Outstanding Referee, American Physical Society journals
Micius Quantum Prize 2020

## SERVICE (since 2019)

Editor, *PNAS*, 2020–present
Advisory Committee, Second International Conference on Emerging Quantum Technology (ICEQT), Hefei, China, 2023–9
International Committee, Siam Quantum Science and Technology Conference (SQST), Krabi, Thailand, 2024–12

## INVITED TALKS AND LECTURES (since 2019)

Invited lecturer, Quantum-Enhanced Sensing via Quantum Control (QuSCo) First Winter School, Saarbrücken, Germany, 2019–3 (four lectures on quantum metrology)
Plenary speaker, 26th Central European Workshop on Quantum Optics (CEWQO), Paderborn University, Germany, 2019–6
Invited speaker, Workshop on Quantum Foundations and Quantum Information, Quantum Science and Technology–Argentina 2019, Puerto Madryn, Argentina, 2019–10
Keynote speaker, International Iran Conference on Quantum Information (IICQI), online, 2020–12
Invited speaker, Workshop on Recent Advances in Quantum Computation and Quantum Information Science, Bhabha Atomic Research Centre, Mumbai, online, 2021–5
Keynote speaker, Central European Workshop on Quantum Optics (CEWQO), online, 2021–6
Invited speaker, Lecture Series of Quantum Portugal Initiative, online, 2021–9
Instructor, Introduction to Precision Measurements and Quantum Metrology, International Centre for Theoretical Sciences of the Tata Institute of Fundamental Research (ICTS-TIFR), Bengaluru, India, 2023–7 (2 lectures on quantum metrology)
ICTS Distinguished Lecture, International Centre for Theoretical Sciences of the Tata Institute of Fundamental Research (ICTS-TIFR), Bengaluru, India, 2023–7
Invited speaker, 2nd International Conference on Emerging Quantum Technology (ICEQT2023), Hefei, China, online, 2023–9
Keynote speaker, Siam Quantum Science and Technology Conference (SQST), Krabi, Thailand, 2024–12
Invited panelist, Helgoland2025: 100 Years of Quantum Mechanics, Helgoland, Germany, 2025–6

## PUBLICATIONS

### I. Book-length publications

#### A. PhD thesis

*Theoretical Investigations of Experimental Gravitation*, submitted to the California Institute of Technology on 1979 May 8.

#### B. Disciplinary reports

1. K. Bartschat, D. Blume, C. M. Caves, and I. H. Deutsch, *Theoretical Atomic, Molecular, and Optical Physics: Recent Developments and a Vision for the Future* (American Institute of Physics, New York, 2012).

#### C. Edited conference proceedings

1. *Quantum Communication, Computing, and Measurement*, edited by O. Hirota, A. S. Holevo, and C. M. Caves (Plenum, New York, 1997).

### II. Technical articles

Google Scholar finds over 200 publications, but there are no citations after the first 160 or so; GS has 32,587 total citations, h-index 71, 10h-index 24, and 100h-index 9. Web of Science has 150 research articles (in All Databases without Preprints), with 21,079 citations, 141 citations/article, h-index 59, 10h-index 20, and 100h-index 6. This citation record comes almost entirely from publishing in journals whose objective is to disseminate good science, not in journals whose objective is to sell magazines.

#### A. Technical articles in refereed journals

1. D. L. Lee, C. M. Caves, W.-T. Ni, and C. M. Will, "Theoretical frameworks for testing relativistic gravity. V. Post-Newtonian limit of Rosen's theory," *Astrophysical Journal* **206**, 555–558 (1976).

2. V. B. Braginsky, C. M. Caves, and K. S. Thorne, "Laboratory experiments to test relativistic gravity," *Physical Review D* **15**, 2047–2068 (1977).

3. K. S. Thorne, R. W. P. Drever, C. M. Caves, M. Zimmermann, and V. D. Sandberg, "Quantum nondemolition measurements of harmonic oscillators," *Physical Review Letters* **40**, 667–671 (1978).

4. C. M. Caves, "Microwave cavity gravitational radiation detectors," *Physics Letters* **80B**, 323–326 (1979).

5. C. M. Caves, "Gravitational radiation and the ultimate speed in Rosen's bimetric theory of gravity," *Annals of Physics* **125**, 35–52 (1980).

6. C. M. Caves, K. S. Thorne, R. W. P. Drever, V. D. Sandberg, and M. Zimmermann, "On the measurement of a weak classical force coupled to a quantum-mechanical oscillator. I. Issues of principle," *Reviews of Modern Physics* **52**, 341–392 (1980).

7. C. M. Caves, "Quantum-mechanical radiation-pressure fluctuations in an interferometer," *Physical Review Letters* **45**, 75–79 (1980). Reprinted in *Nonclassical Effects in Quantum Optics*, edited by D. F. Walls and P. Meystre (American Institute of Physics, New York, 1991), pages 268–272.

8. C. M. Caves, "Quantum-mechanical noise in an interferometer," *Physical Review D* **23**, 1693–1708 (1981). Reprinted in *Interferometry*, edited by P. Harihan (SPIE, Bellingham, Washington, 1991), pages 507–522; in *Photon Statistics and Coherence in Nonlinear Optics*, edited by J. Peřina (SPIE, Bellingham, Washington, 1991), pages 246–261; and in *Fundamentals of Quantum Optics*, edited by G. S. Agarwal (SPIE, Bellingham, Washington, 1994).

9. C. M. Caves, "Quantum limits on noise in linear amplifiers," *Physical Review D* **26**, 1817–1839 (1982).

10. C. M. Caves and B. L. Schumaker, "New formalism for two-photon quantum optics. I. Quadrature phases and squeezed states," *Physical Review A* **31**, 3068–3092 (1985).

11. B. L. Schumaker and C. M. Caves, "New formalism for two-photon quantum optics. II. Mathematical foundation and compact notation," *Physical Review A* **31**, 3093–3111 (1985).

12. C. M. Caves, "Defense of the standard quantum limit for free-mass position," *Physical Review Letters* **54**, 2465–2468 (1985).

13. C. M. Caves, "Quantum mechanics of measurements distributed in time. A path-integral formulation," *Physical Review D* **33**, 1643–1665 (1986).

14. C. M. Caves, "Quantum mechanics of measurements distributed in time. II. Connections among formulations," *Physical Review D* **35**, 1815–1830 (1987).

15. C. M. Caves and D. D. Crouch, "Quantum wideband traveling-wave analysis of a degenerate parametric amplifier," *Journal of the Optical Society of America B* **4**, 1535–1545 (1987) [Erratum: **5**, 1343 (1988)].

16. C. M. Caves, "Squeezing more out of a laser," *Optics Letters* **12**, 971–973 (1987).

17. C. M. Caves and G. J. Milburn, "Quantum-mechanical model for continuous position measurements," *Physical Review A* **36**, 5543–5555 (1987).

18. S. L. Braunstein and C. M. Caves, "Quantum rules: An Effect can have more than one Operation," *Foundations of Physics Letters* **1**, 3–12 (1988).

19. S. L. Braunstein and C. M. Caves, "Information-theoretic Bell inequalities," *Physical Review Letters* **61**, 662–665 (1988) [Erratum: **63**, 1896 (1989)].

20. C. M. Caves, "Quantitative limits on the ability of a Maxwell demon to extract work from heat," *Physical Review Letters* **64**, 2111–2114 (1990).

21. S. Song, C. M. Caves, and B. Yurke, "Generation of superpositions of classically distinguishable quantum states from optical back-action evasion," *Physical Review A* **41**, 5261–5264 (1990).

22. S. L. Braunstein and C. M. Caves, "Wringing out better Bell inequalities," *Annals of Physics* **202**, 22–56 (1990).

23. C. M. Caves, W. G. Unruh, and W. H. Zurek, "Comment on 'Quantitative limits on the ability of a Maxwell demon to extract work from heat'," *Physical Review Letters* **65**, 1387 (1990).

24. S. L. Braunstein and C. M. Caves, "Phase and homodyne statistics of generalized squeezed states," *Physical Review A* **42**, 4115–4119 (1990).

25. C. Zhu and C. M. Caves, "Photocount distributions for continuous-wave squeezed light," *Physical Review A* **42**, 6794–6804 (1990).

26. S. L. Braunstein, C. M. Caves, and G. J. Milburn, "Interpretation for a positive $P$ representation," *Physical Review A* **43**, 1153–1159 (1991).

27. C. M. Caves, C. Zhu, G. J. Milburn, and W. Schleich, "Photon statistics of two-mode squeezed states and interference in four-dimensional phase space," *Physical Review A* **43**, 3854–3861 (1991).

28. S. L. Braunstein, A. S. Lane, and C. M. Caves, "Maximum-likelihood analysis of multiple quantum phase measurements," *Physical Review Letters* **69**, 2153–2156 (1992).

29. R. Schack and C. M. Caves, "Information and entropy in the baker's map," *Physical Review Letters* **69**, 3413–3416 (1992).

30. A. S. Lane, S. L. Braunstein, and C. M. Caves, "Maximum-likelihood statistics of multiple quantum phase measurements," *Physical Review A* **47**, 1667–1696 (1993).

31. C. M. Caves, "Information and entropy," *Physical Review E* **47**, 4010–4017 (1993).

32. R. Schack and C. M. Caves, "Hypersensitivity to perturbations in the quantum baker's map," *Physical Review Letters* **71**, 525–528 (1993).

33. C. M. Caves and P. D. Drummond, "Quantum limits on bosonic communication rates," *Reviews of Modern Physics* **66**, 481–537 (1994).

34. S. L. Braunstein and C. M. Caves, "Statistical distance and the geometry of quantum states," *Physical Review Letters* **72**, 3439–3443 (1994).

35. R. Schack, G. M. D'Ariano, and C. M. Caves, "Hypersensitivity to perturbation in the quantum kicked top," *Physical Review E* **50**, 972–987 (1994).

36. C. A. Fuchs and C. M. Caves, "Ensemble-dependent bounds for accessible information in quantum mechanics," *Physical Review Letters* **73**, 3047–3050 (1994).

37. C. A. Fuchs and C. M. Caves, "Mathematical techniques for quantum communication theory," *Open Systems and Information Dynamics* **3**, 345–356 (1995).

38. H. Barnum, C. M. Caves, C. A. Fuchs, R. Jozsa, and B. Schumacher, "Noncommuting mixed states cannot be broadcast," *Physical Review Letters* **76**, 2818–2821 (1996).

39. S. L. Braunstein, C. M. Caves, and G. J. Milburn, "Generalized uncertainty relations: Theory, examples, and Lorentz invariance," *Annals of Physics* **247**, 135–173 (1996).

40. R. Schack and C. M. Caves, "Information-theoretic characterization of quantum chaos," *Physical Review E* **53**, 3257–3270 (1996).

41. R. Schack and C. M. Caves, "Chaos for Liouville probability densities," *Physical Review E* **53**, 3387–3401 (1996).

42. M. A. Nielsen and C. M. Caves, "Reversible quantum operations and their application to teleportation," *Physical Review A* **55**, 2547–2556 (1997).

43. C. M. Caves and R. Schack, "Unpredictability, information, and chaos," *Complexity* **3**(1), 46–57 (1997).

44. M. A. Nielsen, C. M. Caves, B. Schumacher, and H. Barnum, "Information-theoretic approach to quantum error correction and reversible measurements," *Proceedings of the Royal Society of London A: Mathematical, Physical and Engineering Sciences* **454**, 277–304 (1998).

45. G. K. Brennen, C. M. Caves, P. S. Jessen, and I. H. Deutsch, "Quantum logic gates in optical lattices," *Physical Review Letters* **82**, 1060–1063 (1999).

46. S. L. Braunstein, C. M. Caves, R. Jozsa, N. Linden, S. Popescu, and R. Schack, "Separability of very noisy mixed states and implications for NMR quantum computing," *Physical Review Letters* **83**, 1054–1057 (1999).

47. C. M. Caves, "Quantum error correction and reversible operations," *Journal of Superconductivity* **12**, 707–718 (1999).

48. R. Schack and C. M. Caves, "Classical model for bulk-ensemble NMR quantum computation," *Physical Review A* **60**, 4354–4362 (1999).

49. R. Schack and C. M. Caves, "Explicit product ensembles for separable quantum states," *Journal of Modern Optics* **47**, 387–399 (2000).

50. R. Schack and C. M. Caves, "Shifts on a finite qubit string: A class of quantum baker's maps," *Applicable Algebra in Engineering, Communication and Computing* **10**, 305–310 (2000).

51. H. Barnum, C. M. Caves, J. Finkelstein, C. A. Fuchs, and R. Schack, "Quantum probability from decision theory?" *Proceedings of the Royal Society A* **456**, 1175–1182 (2000).

52. C. M. Caves, "Predicting future duration from present age: A critical assessment," *Contemporary Physics* **41**, 143–153 (2000).

53. C. M. Caves and G. J. Milburn, "Qutrit entanglement," *Optics Communications* **179**, 439–446 (2000); reprinted in *Ode to a Quantum Physicist: A Festschrift in Honor of Marlan O. Scully*, edited by W. P. Schleich, H. Walther, and W. E. Lamb (Elsevier, Amsterdam, 2000).

54. T. A. Brun, C. M. Caves, and R. Schack, "Entanglement purification of unknown quantum states," *Physical Review A* **63**, 042309 (2001).

55. C. M. Caves, C. A. Fuchs, and P. Rungta, "Entanglement of formation of an arbitrary state of two rebits," *Foundations of Physics Letters* **14**, 199–212 (2001).

56. R. Schack, T. A. Brun, and C. M. Caves, "Quantum Bayes rule," *Physical Review A* **64**, 014305 (2001).

57. P. Rungta, V. Bužek, C. M. Caves, M. Hillery, and G. J. Milburn, "Universal state inversion and concurrence in arbitrary dimensions," *Physical Review A* **64**, 042315 (2001).

58. H. Barnum, C. M. Caves, C. A. Fuchs, R. Jozsa, and B. Schumacher, "On quantum coding for ensembles of mixed states," *Journal of Physics A* **34**, 6767–6785 (2001).

59. C. M. Caves, C. A. Fuchs, and R. Schack, "Quantum probabilities as Bayesian probabilities," *Physical Review A* **65**, 022305 (2002).

60. N. C. Menicucci and C. M. Caves, "Local realistic model for the dynamics of bulk-ensemble NMR information processing," *Physical Review Letters* **88**, 167901 (2002).

61. C. M. Caves, C. A. Fuchs, and R. Schack, "Unknown quantum states: The quantum de Finetti representation," *Journal of Mathematical Physics* **43**, 4537–4559 (2002) [Erratum: **49**, 19902 (2008)].

62. R. Blume-Kohout, C. M. Caves, and I. H. Deutsch, "Climbing Mount Scalable: Physical-resource requirements for a scalable quantum computer," *Foundations of Physics* **32**, 1641–1670 (2002).

63. C. M. Caves, C. A. Fuchs, and R. Schack, "Conditions for compatibility of quantum-state assignments," *Physical Review A* **66**, 062111 (2002).

64. P. Rungta and C. M. Caves, "Concurrence-based entanglement measures for isotropic states," *Physical Review A* **67**, 012307 (2003).

65. A. J. Scott and C. M. Caves, "Entangling power of the quantum baker's map," *Journal of Physics A* **36**, 9553–9576 (2003).

66. C. M. Caves, C. A. Fuchs, K. K. Manne, and J. M. Renes, "Gleason-type derivations of the quantum probability rule for generalized measurements," *Foundations of Physics* **34**, 193–209 (2004).

67. J. M. Renes, R. Blume-Kohout, A. J. Scott, and C. M. Caves, "Symmetric informationally complete quantum measurements," *Journal of Mathematical Physics* **45**, 2171–2180 (2004).

68. C. M. Caves and K. Wódkiewicz, "Classical phase-space descriptions of continuous-variable teleportation," *Physical Review Letters* **93**, 040506 (2004).

69. C. M. Caves, I. H. Deutsch, and R. Blume-Kohout, "Physical-resource requirements and the power of quantum computation," *Journal of Optics B: Quantum and Semiclassical Optics* **6**, S801–S806 (2004).

70. C. M. Caves and K. Wódkiewicz, "Fidelity of Gaussian channels," *Open Systems and Information Dynamics* **11**, 309–323 (2004).

71. C. M. Caves and R. Schack, "Properties of the frequency operator do not imply the quantum probability postulate," *Annals of Physics* **315**, 123–146 (2005) [Corrigendum: **321**, 504–505 (2006)].

72. T. E. Tessier, C. M. Caves, I. H. Deutsch, B. Eastin, and D. Bacon, "Optimal classical-communication-assisted local model of $n$-qubit Greenberger-Horne-Zeilinger correlations," *Physical Review A* **72**, 032305 (2005).

73. A. Datta, S. T. Flammia, and C. M. Caves, "Entanglement and the power of one qubit," *Physical Review A* **72**, 042316 (2005).

74. S. T. Flammia, A. Silberfarb, and C. M. Caves, "Minimal informationally complete measurements for pure states," *Foundations of Physics* **35**, 1985–2006 (2005).

75. A. J. Scott, T. A. Brun, C. M. Caves, and R. Schack, "Hypersensitivity and chaos signatures in the quantum baker's maps," *Journal of Physics A* **39**, 13405–13433 (2006).

76. S. Boixo, C. M. Caves, A. Datta, and A. Shaji, "On decoherence in quantum clock synchronization," *Laser Physics* **16**, 1525–1532 (2006).

77. J. Barrett, C. M. Caves, B. Eastin, M. B. Elliott, and S. Pironio, "Modeling Pauli measurements on graph states with nearest-neighbor classical communication," *Physical Review A* **75**, 012103 (2007).

78. S. Boixo, S. T. Flammia, C. M. Caves, and JM Geremia, "Generalized limits for single-parameter quantum estimation," *Physical Review Letters* **98**, 090401 (2007).

79. C. M. Caves, C. A. Fuchs, and R. Schack, "Subjective probability and quantum certainty," *Studies in History and Philosophy of Modern Physics* **38**, 255–274 (2007).

80. A. Datta, S. T. Flammia, A. Shaji, and C. M. Caves, "Constrained bounds on measures of entanglement," *Physical Review A* **75**, 062117 (2007).

81. A. Shaji and C. M. Caves, "Qubit metrology and decoherence," *Physical Review A* **76**, 032111 (2007).

82. S. Boixo, A. Datta, S. T. Flammia, A. Shaji, E. Bagan, and C. M. Caves, "Quantum-limited metrology with product states," *Physical Review A* **77**, 012317 (2008).

83. A. Datta, A. Shaji, and C. M. Caves, "Quantum discord and the power of one qubit," *Physical Review Letters* **100**, 050502 (2008).

84. K. K. Manne and C. M. Caves, "Entanglement of formation of rotationally symmetric states," *Quantum Information and Computation* **8**, 295–310 (2008).

85. M. B. Elliott, B. Eastin, and C. M. Caves, "Graphical description of the action of Clifford operators on stabilizer states," *Physical Review A* **77**, 042307 (2008).

86. S. Boixo, A. Datta, M. J. Davis, S. T. Flammia, A. Shaji, and C. M. Caves, "Quantum metrology: Dynamics vs. entanglement," *Physical Review Letters* **101**, 040403 (2008).

87. A. J. Scott and C. M. Caves, "Teleportation fidelity as a probe of sub-Planck phase-space structure," *Annals of Physics* **323**, 2685–2708 (2008).

88. M. J. Woolley, G. J. Milburn, and C. M. Caves, "Nonlinear quantum metrology using coupled nanomechanical resonators," *New Journal of Physics* **10**, 125018 (2008).

89. S. Boixo, A. Datta, M. J. Davis, A. Shaji, A. B. Tacla, and C. M. Caves, "Quantum-limited metrology and Bose-Einstein condensates," *Physical Review A* **80**, 032103 (2009).

90. C. M. Caves and A. Shaji, "Quantum-circuit guide to optical and atomic interferometry," *Optics Communications* **283**, 695–712 (2010).

91. M. B. Elliott, B. Eastin, and C. M. Caves, "Graphical description of Pauli measurements on stabilizer states," *Journal of Physics A* **43**, 025301 (2010).

92. M. Tsang and C. M. Caves, "Coherent quantum-noise cancellation for optomechanical sensors," *Physical Review Letters* **105**, 123601 (2010).

93. M. D. Lang and C. M. Caves, "Quantum discord and the geometry of Bell-diagonal states," *Physical Review Letters* **105**, 150501 (2010).

94. A. B. Tacla, S. Boixo, A. Datta, A. Shaji, and C. M. Caves, "Nonlinear interferometry with Bose-Einstein condensates," *Physical Review A* **82**, 053636 (2010).

95. M. Tsang, H. M. Wiseman, and C. M. Caves, "Fundamental quantum limit to waveform estimation," *Physical Review Letters* **106**, 090401 (2011).

96. A. B. Tacla and C. M. Caves, "Entanglement-based perturbation theory for highly anisotropic Bose-Einstein condensates," *Physical Review A* **84**, 153606 (2011).

97. M. D. Lang, C. M. Caves, and A. Shaji, "Entropic measures of non-classical correlations," *International Journal of Quantum Information* **9**, 1553–1586 (2011).

98. M. Tsang and C. M. Caves, "Evading quantum mechanics: Engineering a classical subsystem within a quantum environment," *Physical Review X* **2**, 031016 (2012).

99. C. M. Caves, J. Combes, Z. Jiang, and S. Pandey, "Quantum limits on phase-preserving linear amplifiers," *Physical Review A* **86**, 063802 (2012).

100. Z. Jiang, M. Piani, and C. M. Caves, "Ancilla models for quantum operations: For what unitaries does the ancilla state have to be physical?" *Quantum Information Processing* **12**, 1999–2017 (2013).

101. S. Rahimi-Keshari, C. M. Caves, and T. C. Ralph, "Measurement-based method for verifying quantum discord," *Physical Review A* **87**, 012119 (2013).

102. A. B. Tacla and C. M. Caves, "Mean-field dynamics of two-mode Bose-Einstein condensates in highly anisotropic potentials: Interference, dimensionality, and entanglement," *New Journal of Physics* **15**, 023008 (2013).

103. S. Pandey, Z. Jiang, J. Combes, and C. M. Caves, "Quantum limits on probabilistic amplifiers," *Physical Review A* **88**, 033852 (2013).

104. Z. Jiang, M. D. Lang, and C. M. Caves, "Mixing nonclassical pure states in a linear-optical network almost always generates modal entanglement," *Physical Review A* **88**, 044301 (2013).

105. M. D. Lang and C. M. Caves, "Optimal quantum-enhanced interferometry using a laser power source," *Physical Review Letters* **111**, 173601 (2013).

106. J. Combes, C. Ferrie, Z. Jiang, and C. M. Caves, "Quantum limits on postselected, probabilistic quantum metrology," *Physical Review A* **89**, 052117 (2014).

107. A. B. Tacla and C. M. Caves, "Reduced dimensionality and spatial entanglement in highly anisotropic Bose-Einstein condensates," *Physical Review A* **90**, 013605 (2014).

108. M. D. Lang and C. M. Caves, "Optimal quantum-enhanced interferometry," *Physical Review A* **90**, 025802 (2014).

109. S. A. Haine, S. S. Szigeti, M. D. Lang, and C. M. Caves, "Heisenberg-limited metrology with information recycling," *Physical Review A* **91**, 041802(R) (2015).

110. S. Rahimi-Keshari, T. C. Ralph, and C. M. Caves, "Operational discord measure for Gaussian states with Gaussian measurements," *New Journal of Physics* **17**, 063037 (2015).

111. J. A. Gross, N. Dangniam, C. Ferrie, and C. M. Caves, "Novelty, efficacy, and significance of weak measurements for quantum tomography," *Physical Review A* **92**, 062133 (2015).

112. Z. Jiang and C. M. Caves, "Particle-number-conserving Bogoliubov approximation for Bose-Einstein condensates using extended catalytic states," *Physical Review A* **93**, 033623 (2016).

113. N. Li, C. Ferrie, J. A. Gross, A. Kalev, and C. M. Caves, "Fisher-symmetric informationally complete measurements for pure states," *Physical Review Letters* **116**, 180402 (2016).

114. J. Combes, N. Walk, A. P. Lund, T. C. Ralph, and C. M. Caves, "Models of reduced-noise, probabilistic linear amplifiers," *Physical Review A* **93**, 052310 (2016).

115. S. Rahimi-Keshari, T. C. Ralph, and C. M. Caves, "Sufficient conditions for efficient classical simulation of quantum optics," *Physical Review X* **6**, 021039 (2016).

116. Z. Jiang, A. B. Tacla, and C. M. Caves, "Bosonic particle-correlated states: A nonperturbative treatment beyond mean field," *Physical Review A* **96**, 023621 (2017).

117. T. G. Downes, J. R. van Meter, E. Knill, G. J. Milburn, and C. M. Caves, "Optimal estimation of parameters of classical spacetimes," *Physical Review D* **96**, 105004 (2017).

118. J. A. Gross, C. M. Caves, G. J. Milburn, and J. Combes, "Qubit models of weak continuous measurements: Markovian conditional and open-system dynamics," *Quantum Science and Technology* **3**, 024005 (2018) [Corrigendum: **7**, 029501 (2022)].

119. S. Rahimi-Keshari, S. Baghbanzadeh, and C. M Caves, "*In situ* characterization of linear-optical networks in randomized boson sampling," *Physical Review A* **101**, 043809 (2020).

120. C. M. Caves, "Reframing SU(1,1) interferometry," *Advanced Quantum Technologies* **3**(11), 1900138 (2020).

121. J. A. Gross and C. M. Caves, "One from many: Estimating a function of many parameters," *Journal of Physics A* **54**, 014001 (2021).

122. C. S. Jackson and C. M. Caves, "How to perform the coherent measurement of a curved phase space by continuous isotropic measurement. I. Spin and the Kraus-operator geometry of SL(2,C)," *Quantum* **7**, 1085 (2023).

123. C. S. Jackson and C. M. Caves, "Simultaneous measurements of noncommuting observables: Positive transformations and instrumental Lie groups," *Entropy* **25**, 1254 (2023).

124. C. S. Jackson and C. M. Caves, "Simultaneous momentum and position measurement and the instrumental Weyl-Heisenberg group," *Entropy* **25**, 1221 (2023).

## B. Other technical articles

1. V. B. Braginsky, C. M. Caves, and K. S. Thorne, "Laboratory experiments to test general relativity," in *Experimental Gravitation*, edited by B. Bertotti (Accademia Nazionale dei Lincei, Rome, 1977), pages 49–72.

2. K. S. Thorne, C. M. Caves, V. D. Sandberg, M. Zimmermann, and R. W. P. Drever, "The quantum limit for gravitational-wave detectors and methods of circumventing it," in *Sources of Gravitational Radiation*, edited by L. Smarr (Cambridge University Press, Cambridge, England, 1979), pages 49–68.

3. C. M. Caves, "Quantum nondemolition measurements," in *Quantum Optics, Experimental Gravitation, and Measurement Theory*, edited by P. Meystre and M. O. Scully (Plenum, New York, 1983), pages 567–626.

4. B. L. Schumaker and C. M. Caves, "A new formalism for two-photon quantum optics," in *Coherence and Quantum Optics V*, edited by L. Mandel and E. Wolf (Plenum, New York, 1984), pages 743–750.

5. C. M. Caves, "Quantum nondemolition measurements," in *Foundations of Quantum Mechanics in the Light of New Technology*, edited by S. Kamefuchi, H. Ezawa, Y. Murayama, M. Namiki, S. Nomura, Y. Ohnuki, and T. Yajima (Physical Society of Japan, Tokyo, 1984), pages 195–205.

6. C. M. Caves, "Amplitude and phase in quantum optics," in *Coherence, Cooperation and Fluctuations*, edited by F. Haake, L. M. Narducci, and D. F. Walls (Cambridge University Press, Cambridge, England, 1986), pages 192–205.

7. C. M. Caves and B. L. Schumaker, "Broadband squeezing," in *Quantum Optics IV*, edited by J. D. Harvey and D. F. Walls (Springer, Berlin, 1986), pages 20–30.

8. C. M. Caves, "Measurements distributed in time," in *Quantum Measurement and Chaos*, edited by E. R. Pike and S. Sarkar (Plenum, New York, 1987), pages 195–207.

9. C. M. Caves, "Application of squeezed-state light to laser stabilization," in *Laser Spectroscopy VIII*, edited by W. Persson and S. Svanberg (Springer, Berlin, 1987), pages 146–149.

10. C. M. Caves, "Laser stabilization using squeezed light," in *Squeezed and Nonclassical Light*, edited by P. Tombesi and E. R. Pike (Plenum, New York, 1989), pages 29–38.

11. S. L. Braunstein and C. M. Caves, "Wringing out better Bell inequalities," in *Proceedings of the International Symposium on Spacetime Symmetries*, edited by Y. S. Kim and W. W. Zachary, *Nuclear Physics B (Proceedings Supplements Section)* **6**, 211–221 (1989).

12. S. L. Braunstein and C. M. Caves, "Chained Bell inequalities," in *Bell's Theorem, Quantum Theory and Conceptions of the Universe*, edited by M. Kafatos (Kluwer, Dordrecht, 1989), pages 27–36.

13. S. Song, C. M. Caves, and B. Yurke, "Schrödinger kittens from optical back-action evasion," in *Coherence and Quantum Optics VI*, edited by J. H. Eberly, L. Mandel, and E. Wolf (Plenum, New York, 1989), pages 1107–1111.

14. C. Zhu and C. M. Caves, "Photostatistics of continuous-wave squeezed light," in *Coherence and Quantum Optics VI*, edited by J. H. Eberly, L. Mandel, and E. Wolf (Plenum, New York, 1989), pages 1279–1283.

15. C. M. Caves, "Entropy and information: How much information is needed to assign a probability?" in *Complexity, Entropy, and the Physics of Information*, Santa Fe Institute Studies in the Sciences of Complexity, Proceedings Vol. VIII, edited by W. H. Zurek (Addison-Wesley, Redwood City, California, 1990), pages 91–115.

16. S. L. Braunstein and C. M. Caves, "Wringing out better Bell inequalities," in *Foundations of Quantum Mechanics in the Light of New Technology*, edited by S. Kobayashi, H. Ezawa, Y. Murayama, and S. Nomura (Physical Society of Japan, Tokyo, 1990), pages 161–170.

17. P. D. Drummond and C. M. Caves, "Wideband quantum communication: A new frontier?" in *Quantum Measurements in Optics*, edited by P. Tombesi and D. F. Walls (Plenum, New York, 1992), pages 279–294.

18. R. Schack and C. M. Caves, "Information and available work in the perturbed baker's map," in *Workshop on Physics and Computation: PhysComp '92*, edited by D. Matzke (IEEE Computer Society, Los Alamitos, CA, 1993), pages 69–74.

19. C. M. Caves, "Information, entropy, and chaos," in *Physical Origins of Time Asymmetry*, edited by J. J. Halliwell, J. Pérez-Mercader, and W. H. Zurek (Cambridge University Press, Cambridge, England, 1994), pages 47–89.

20. S. L. Braunstein and C. M. Caves, "Geometry of quantum states," in *Fundamental Problems in Quantum Theory: A Conference Held in Honor of Professor John A. Wheeler*, edited by D. Greenberger and A. Zeilinger, *Annals of the New York Academy of Sciences* **755**, 786–797 (1995).

21. C. A. Fuchs and C. M. Caves, "Bounds for accessible information in quantum mechanics," in *Fundamental Problems in Quantum Theory: A Conference Held in Honor of Professor John A. Wheeler*, edited by D. Greenberger and A. Zeilinger, *Annals of the New York Academy of Sciences* **755**, 706–714 (1995).

22. S. L. Braunstein and C. M. Caves, "Geometry of quantum states," in *Quantum Communications and Measurement*, edited by V. P. Belavkin, O. Hirota, and R. L. Hudson (Plenum, New York, 1995), pages 21–30.

23. C. M. Caves and C. A. Fuchs, "Quantum information: How much information in a state vector?" in *The Dilemma of Einstein, Podolsky and Rosen — 60 Years Later: An International Symposium in Honour of*

*Nathan Rosen, Haifa, March 1995*, edited by A. Mann and M. Revzen (Institute of Physics Publishing, London, 1996), pages 226–257 (*Annals of the Israel Physical Society*, Vol. 12).

24. R. Schack and C. M. Caves, "Hypersensitivity to perturbation: An information-theoretical characterization of classical and quantum chaos," in *Quantum Communication, Computing, and Measurement*, edited by O. Hirota, A. S. Holevo, and C. M. Caves (Plenum, New York, 1997), pages 317—330.

25. R. Schack and C. M. Caves, "An information-theoretic characterization of quantum chaos," in *Quantum Classical Correspondence*, Proceedings of the 4th Drexel Symposium on Quantum Nonintegrability, edited by D. H. Feng and B. L. Hu (International Press, Cambridge, Massachusetts, 1997), pages 339–355.

26. R. Schack and C. M. Caves, "Separable states of $N$ quantum bits," in *ISTET99*, Proceedings of the Tenth International Symposium on Theoretical Electrical Engineering, edited by W. Mathis and T. Schindler (Otto-von-Guericke University, Magdeburg, Germany, 1999), pages 73–78.

27. I. H. Deutsch, G. K. Brennen, J. Grondalski, C. M. Caves, P. S. Jessen, S. E. Hamann, D. L. Haycock, and G. Klose, "Sideband cooling, state control, and quantum logic in optical lattices," in *Laser Spectroscopy: XIV International Conference*, edited by R. Blatt, J. Eschner, D. Leibfried, and F. Schmidt-Kaler (World Scientific, Singapore, 1999), pages 366–368.

28. P. Rungta, W. J. Munro, K. Nemoto, P. Deuar, G. J. Milburn, and C. M. Caves, "Qudit entanglement," in *Directions in Quantum Optics: A Collection of Papers Dedicated to the Memory of Dan Walls*, edited by H. J. Carmichael, R. J. Glauber, and M. O. Scully (Springer, Berlin, 2001), pages 149–164.

29. C. M. Caves, I. H. Deutsch, and R. Blume-Kohout, "Physical-resource demands for scalable quantum computation," in *Fluctuations and Noise in Photonics and Quantum Optics*, edited by D. Abbott, J. H. Shapiro, and Y. Yamamoto (SPIE, Bellingham, Washington, 2003), pages 425–433.

30. C. M. Caves, "Predicting future duration from present age: Revisiting a critical assessment of Gott's rule," `arXiv:0806.3538 [astro-ph]`.

31. S. Boixo, A. Datta, M. J. Davis, S. T. Flammia, A. Shaji, A. B. Tacla, and C. M. Caves, "Quantum metrology from an information theory perspective," in *Quantum Communication, Measurement and Computing (QCMC 2008)*, edited by A. Lvovsky, AIP Conference Proceedings, Vol. 1110 (American Institute of Physics, Melville, New York, 2009), pages 427–432.

32. S. Boixo, A. Datta, M. J. Davis, S. T. Flammia, A. Shaji, A. B. Tacla, and C. M. Caves, "Quantum metrology with Bose-Einstein condensates," in *Quantum Communication, Measurement and Computing (QCMC 2008)*, edited by A. Lvovsky, AIP Conference Proceedings, Vol. 1110 (American Institute of Physics, Melville, New York, 2009), pages 423–426.

33. S. Pandey, Z. Jiang, J. Combes, and C. M. Caves, "Noise in phase-preserving linear amplifiers," in *Quantum Communication, Measurement and Computation (QCMC 2012)*, edited by J. Schmiedmayer and P. Walther, AIP Conference Proceedings, Vol. 1633 (AIP Publishing, Melville, New York, 2014), pages 53–58.

34. J. Combes, C. Ferrie, C. Cesare, M. Tiersch, G. J. Milburn, H. J. Briegel, and C. M. Caves, "In-situ characterization of quantum devices with error correction," `arXiv:1405.5656 [quant-ph]`.

## III. Other publications

### A. Oral histories

1. Interview of Carlton Caves by David Zierler on 2020 July 16, Niels Bohr Library & Archives, American Institute of Physics, College Park, Maryland, USA, `https://www.aip.org/history-programs/niels-bohr-library/oral-histories/46314`.

### B. Opinion pieces

1. C. M. Caves, "High-impact-factor syndrome," *APSNews* **23**(10), 8,6 (November 2014).

### C. Encyclopedia articles

1. C. M. Caves, "Optical squeezing," in *1989 McGraw-Hill Yearbook of Science and Technology*, edited by S. P. Parker (McGraw-Hill, New York, 1988), pages 255–257.

### D. Biographical essays

1. C. Caves, "Drever, Ronald William Prest [Ron] (1931–2017)," *Oxford Dictionary of National Biography* (2021), `https://doi.org/10.1093/odnb/9780198614128.013.90000380211`.

### E. Obituaries

1. C. M. Caves and R. E. Spero, "Ronald William Prest Drever," *Physics Today* **70**(12), 59–60 (2017).

### F. Book reviews

1. C. M. Caves, review of *Systems with Small Dissipation*, by V. B. Braginsky, V. P. Mitrofanov, and V. I. Panov, in *Classical and Quantum Gravity* **3**, 1276–1277 (1986).

2. C. M. Caves and B. L. Schumaker, review of *Generalized Coherent States and Their Applications*, by A. Perelomov, in *IEEE Journal of Quantum Electronics* **QE-24**, 118 (1988).

3. C. Caves, "Maxwell's demon: From physics outlaw to potent teacher," review of *Maxwell's Demon: Entropy, Information, Computing*, edited by H. S. Leff and A. F. Rex, in *Physics World* **4**(3), 51 (1991 March).

4. C. M. Caves, review of *The Detection of Gravitational Waves*, edited by D. G. Blair, in *Physics Today* **45**(5), 59–60 (1992 May).

5. C. M. Caves, review of *Quantum Theory: Concepts and Methods*, by A. Peres, in *Foundations of Physics* **24**, 1583–1585 (1994).

6. C. M. Caves, "History found in a grain of sand," review of *Ubiquity: The Science of History . . . or Why the World is Simpler than We Think*, by M. Buchanan, in *Physics World* **13**(11), 45–46 (2000 November).

### G. Semi-popular articles

1. C. M. Caves, "A tale of two cities," *Science* **282**, 637–638 (1998); Perspective on Quantum Teleportation in *Science*'s Compass.

2. C. M. Caves, "Quantum information science: Emerging no more," in *OSA Century of Optics* (The Optical Society, Washington, 2015), pages 320–323.

### H. Discussions, debates, and interviews

1. D. Abbott, C. R. Doering, C. M. Caves, D. M. Lidar, H. E. Brandt, A. R. Hamilton, D. K. Ferry, J. Gea-Banacloche, S. M. Bezrukov, and L. B. Kish, "Dreams Versus Reality: Plenary Debate Session on Quantum Computing," *Quantum Information Processing* **2**, 449–472 (2003).

2. M. Landry, "Realizing squeezing: An interview with Carlton Caves," *LIGO Magazine*, No. 3, 16–18 (September 2013).

### I. Letters to journals

1. H. Barnum, C. M. Caves, C. Fuchs, and R. Schack, *Physics Today* **47**(11), 11–13 (1994 November) [letter commenting on J. Lebowitz, "Boltzmann's Entropy and Time's Arrow," *Physics Today* **46**(9), 32–38 (1993 September)].

## DISSERTATIONS AND THESES SUPERVISED

1. B. L. Schumaker, *Theoretical Investigations in Nonlinear Quantum Optics, Theory of Measurement, and Pulsations of General Relativistic Models of Neutron Stars*, PhD in Physics, California Institute of Technology, 1985. Co-supervised with K. S. Thorne.

2. S. L. Braunstein, *Novel Quantum States and Measurements*, PhD in Physics, California Institute of Technology, 1988.

3. D. D. Crouch, *A Theoretical Study of the Generation of Squeezed-State Light via Degenerate Parametric Amplification*, PhD in Applied Physics, California Institute of Technology, 1988.

4. C. Zhu, *Photon and Photocount Statistics for Nonclassical Light*, PhD in Physics, University of Southern California, 1992.

5. S. Song, *Squeezing and Recycling in Interferometric Gravitational-Wave Detectors*, PhD in Physics, University of Southern California, 1994.

6. D. Steinbach, *Information-Theoretic Hypersensitivity to Perturbations in Quantum Dynamics*, Diplomarbeit, Universität Ulm, 1995.

7. C. A. Fuchs, *Distinguishability and Accessible Information in Quantum Theory*, PhD in Physics, University of New Mexico, 1996.

8. H. N. Barnum III, *Quantum Information Theory*, PhD in Physics, University of New Mexico, 1999.

9. M. A. Nielsen, *Quantum Information Theory*, PhD in Physics, University of New Mexico, 1999.

10. M. M. Tracy, *The Classical Limit of the Quantum Baker's Map*, PhD in Physics, University of New Mexico, 2003. Co-supervised with A. J. Scott.

11. P. Rungta, *Theoretical Investigations of Separability and Entanglement of Bipartite Quantum Systems*, PhD in Physics, University of New Mexico, 2003.

12. J. M. Renes, *Frames, Designs, and Spherical Codes in Quantum Information Theory*, PhD in Physics, University of New Mexico, 2005.

13. S. T. Flammia, *Informationally Complete Quantum Measurements and Entanglement Bounds*, PhD in Physics, University of New Mexico, 2008.

14. B. Eastin, *Error Channels and the Threshold for Fault-Tolerant Quantum Computation*, PhD in Physics, University of New Mexico, 2008.

15. A. Datta, *Studies on the Role of Entanglement in Mixed-State Quantum Computation*, PhD in Physics, University of New Mexico, 2009.

16. M. B. Elliott, *Stabilizer States and Local Realism*, PhD in Physics, University of New Mexico, 2009.

17. S. Boixo, *Nonlinear Quantum Metrology*, PhD in Physics, University of New Mexico, 2009.

18. A. B. Tacla, *Nonlinear Interferometry with Bose-Einstein Condensates*, PhD in Physics, University of New Mexico, 2012.

19. Z. Jiang, *Particle Correlations in Bose-Einstein Condensates*, PhD in Physics, University of New Mexico, 2014.

20. M. D. Lang, *Measures of Nonclassical Correlations and Quantum-Enhanced Interferometry*, PhD in Physics, University of New Mexico, 2015.

21. N. Dangniam, *Quantum Phase Space Representations and Their Negativities*, PhD in Physics, University of New Mexico, 2018. Co-supervised with C. Ferrie and C. S. Jackson.

22. J. A. Gross, *Weak Measurements for Quantum Characterization and Control*, PhD in Physics, University of New Mexico, 2018.