

CURRICULUM VITA OF PHILIP DAVID MANNHEIM

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vita updated: April 13, 2022

Birthdate: August 24, 1943

Birthplace: Liverpool, England (Naturalized U. S. Citizen)

Education:

1964 B. A., Oxford University, England
1967 M. Sc., Weizmann Institute, Israel
1971 Ph. D., Weizmann Institute, Israel

Experience:

1970-72 Research Associate, Universite Libre de Bruxelles, Belgium
1972-74 Research Associate, Institute for Advanced Study, Princeton
1974-75 Research Associate, Lawrence Berkeley Laboratory, Berkeley
1975-76 Research Associate, Stanford Linear Accelerator Center, Stanford
1976-79 Adjunct Assistant Professor, University of Oregon
1979-82 Associate Professor in Residence, University of Connecticut
1982-85 Associate Professor, University of Connecticut
1985- Professor, University of Connecticut

Professional Societies: Life member, American Physical Society

Honors or Distinctions:

1961 Exhibition Scholar, New College, Oxford
1969 Ettore Majorana Memorial Prize, Erice Summer School, Erice, Italy
1971 Ettore Majorana Memorial Prize, Erice Summer School, Erice, Italy
1980 Yale University Visiting Faculty Fellow
1982-2000 Principal Investigator, DOE High Energy Physics Research Grant
1985 NASA/ASEE Summer Faculty Fellow, GSFC, Greenbelt, MD
1987 National Academy of Science NRC Fellow at NASA GSFC, Greenbelt, MD
1988 Member, Organizing and Editorial Committees, Fourth Meeting of the
Division of Particles and Fields of the American Physical Society
1990 NASA/ASEE Summer Faculty Fellow, GSFC, Greenbelt, MD
2000 Visiting Scientist, Laboratory for Nuclear Science, MIT
2016 Honorable Mention, Gravity Research Foundation Awards for Essays on Gravitation
2017 Honorable Mention, Gravity Research Foundation Awards for Essays on Gravitation
2019 Honorable Mention, Gravity Research Foundation Awards for Essays on Gravitation
2020 Honorable Mention, Gravity Research Foundation Awards for Essays on Gravitation
2021 Honorable Mention, Gravity Research Foundation Awards for Essays on Gravitation

Field of Specialization: Theoretical Physics

Research Interests: Elementary Particle Theory, Quantum Field Theory, Many Body Theory, General Relativity, Cosmology, Astrophysics, Branes, Conformal Gravity, Mössbauer Effect

Philip David Mannheim – Research Articles

1. P. D. Mannheim, *Influence of force-constant changes on the lattice dynamics of cubic crystals with point defects*, Physical Review **165**, 1011 (1968).
2. P. D. Mannheim and A. Simopoulos, *Influence of force-constant changes and localized modes on the $V : Fe^{57}$ Mössbauer system*, Physical Review **165**, 845 (1968).
3. E. Gotsman, P. D. Mannheim and U. Maor, *Photoproduction of vector mesons in a Regge-pole model*, Physical Review **186**, 1703 (1969).
4. P. D. Mannheim and H. Friedmann, *Theory of optical absorption by diatomic molecules embedded in rare gas crystals*, Physica Status Solidi **39**, 409 (1970).
5. P. D. Mannheim and U. Maor, *ρ -meson mass shift in photoproduction processes*, Physical Review D **2**, 2105 (1970).
6. P. D. Mannheim, *Spin independent pomeron in πN scattering*, Lettere Nuovo Cimento **3**, 781 (1970).
7. P. D. Mannheim and S. Nussinov, *Current conservation, VDM and decay processes*, Nuovo Cimento A **1**, 619 (1971).
8. P. D. Mannheim, *Is there a vector-dominance frame problem?*, Physical Review D **3**, 2840 (1971).
9. P. D. Mannheim, *VDM, PCAC and the decoupling of $\pi\rho\omega$* , Physical Review D **4**, 2936 (1971).
10. P. D. Mannheim and S. S. Cohen, *Force-constant changes in the crystal impurity problem*, Physical Review B **4**, 3748 (1971).
11. P. D. Mannheim, *Localized modes and cell-model limit in the crystal impurity problem*, Physical Review B **5**, 745 (1972).
12. P. D. Mannheim, *On the validity of the use of the cell-model in impurity-matrix absorption spectra calculations*, Journal of Chemical Physics **56**, 1006 (1972).
13. J. A. C. Loodts, P. D. Mannheim and R. Brout, *$\eta \rightarrow 3\pi$ and electromagnetic tadpoles*, Nuclear Physics B **40**, 375 (1972).
14. P. D. Mannheim, *Is $\eta \rightarrow 3\pi$ a short-distance problem?*, Physical Review D **9**, 3438 (1974).

15. P. D. Mannheim, *An infrared bootstrap for the electron mass in finite quantum electrodynamics*, Physical Review D **10**, 3311 (1974).
16. P. D. Mannheim, *Structure of the vertex function in finite quantum electrodynamics*, Physical Review D **11**, 3472 (1975).
17. P. D. Mannheim, *Dynamical symmetry breaking as a bootstrap*, Physical Review D **12**, 1772 (1975).
18. P. D. Mannheim, *Dynamical generation of extended structures in field theory*, Physical Review D **14**, 2072 (1976).
19. P. D. Mannheim, *Dynamical basis for the Poincare stresses*, Nuclear Physics B **143**, 285 (1978).
20. N. G. Deshpande, R. C. Hwa and P. D. Mannheim, *Nonconservation of muon number in a broken $SU(4) \times U(1)$ gauge theory*, Physical Review Letters **39**, 256 (1977).
21. N. G. Deshpande, R. C. Hwa and P. D. Mannheim, *$SU(4) \times U(1)$ gauge theory: I. Muon number nonconservation*, Physical Review D **19**, 2686 (1979).
22. N. G. Deshpande, R. C. Hwa and P. D. Mannheim, *$SU(4) \times U(1)$ gauge theory: II. CP nonconservation*, Physical Review D **19**, 2703 (1979).
23. N. G. Deshpande, R. C. Hwa and P. D. Mannheim, *$SU(4) \times U(1)$ gauge theory: III. New approach to Cabibbo mixing*, Physical Review D **19**, 2708 (1979).
24. P. D. Mannheim, *Parity violation and the masslessness of the neutrino*, Physics Letters B **85**, 253 (1979).
25. P. D. Mannheim, *Neutrino pairing as the origin of parity violation in a chiral flavor theory of weak interactions*, Physical Review D **22**, 1729 (1980).
26. N. G. Deshpande and P. D. Mannheim, *Grandunified model with a stable proton and no axion problem*, Physics Letters B **94**, 355 (1980).
27. N. G. Deshpande and P. D. Mannheim, *Grandunification and proton stability based on a chiral $SU(8)$ theory*, Physical Review D **24**, 2923 (1981).
28. A. Davidson, K. C. Wali and P. D. Mannheim, *Multigenerational flavor-color-hypercolor unification*, Physical Review Letters **45**, 1135 (1980).
29. A. Davidson, P. D. Mannheim and K. C. Wali, *Extended hypercolor and the Cabibbo angle*, Physical Review Letters **47**, 149 (1981), E**47**, 620 (1981).

30. A. Davidson, P. D. Mannheim and K. C. Wali, *Hypercolor, extended hypercolor and the generation problem*, Physical Review D **26**, 1133 (1982).
31. P. D. Mannheim, *The physics behind path integrals in quantum mechanics*, American Journal of Physics **51**, 328 (1983).
32. P. D. Mannheim, *Effective low energy custodial symmetry and Weinberg mixing*, Physics Letters B **125**, 282 (1983).
33. P. D. Mannheim, *Quantization of classical Grassmann spin*, Physics Letters B **137**, 385 (1984).
34. P. D. Mannheim, *Introduction to Majorana masses*, International Journal of Theoretical Physics **23**, 643 (1984).
35. P. D. Mannheim, *Spontaneously broken local Pauli-Gursey invariance and constraints on proton decay*, Physical Review D **29**, 1520 (1984).
36. P. D. Mannheim, *Classical spin and its quantization*, Physical Review D **32**, 898 (1985).
37. P. D. Mannheim, *Approximate Weinberg mixing*, International Journal of Theoretical Physics **24**, 505 (1985).
38. P. D. Mannheim, *Klein-Gordon propagator via first quantization*, Physics Letters B **166**, 191 (1986).
39. P. D. Mannheim, *Non-local quantum numbers in field theory*, Nuovo Cimento A **93**, 185 (1986).
40. P. D. Mannheim and D. Kazanas, *Energy-momentum tensor of fields in the standard cosmology*, General Relativity and Gravitation **20**, 201 (1988).
41. Y. Deng and P. D. Mannheim, *Black-body radiation in a curved Robertson-Walker background*, Astrophysics and Space Science **135**, 261 (1987).
42. Y. Deng and P. D. Mannheim, *Self-consistent solution for a scalar field coupled conformally to a Robertson-Walker geometry*, Astrophysical Journal **324**, 1 (1988).
43. Y. Deng and P. D. Mannheim, *Perfect Maxwell fluids in the standard cosmology*, General Relativity and Gravitation, **20**, 969 (1988).
44. P. D. Mannheim, *Derivation of the formalism for neutrino matter oscillations from the neutrino relativistic field equations*, Physical Review D **37**, 1935 (1988).

45. P. D. Mannheim, *Conformal cosmology with no cosmological constant*, General Relativity and Gravitation **22**, 289 (1990).
46. P. D. Mannheim and D. Kazanas, *Exact vacuum solution to conformal Weyl gravity and galactic rotation curves*, Astrophysical Journal **342**, 635 (1989).
47. Y. Deng and P. D. Mannheim, *Shear-free spherically symmetric inhomogeneous cosmological model with heat flow and bulk viscosity*, Physical Review D **42**, 371 (1990).
48. D. Kazanas and P. D. Mannheim, *General structure of the gravitational equations of motion in conformal Weyl gravity*, Astrophysical Journal Supplement Series **76**, 431 (1991).
49. P. D. Mannheim and D. Kazanas, *Probing the Higgs vacuum with general relativity*, Astrophysics and Space Science **185**, 167 (1991).
50. P. D. Mannheim, *General relativity and fifth force experiments*, Astrophysics and Space Science **181**, 55 (1991).
51. P. D. Mannheim, *Potential signal for black hole formation*, Astrophysics and Space Science (Letter) **176**, 323 (1991).
52. Y. Deng and P. D. Mannheim, *Acceleration-free spherically symmetric inhomogeneous cosmological model with shear viscosity*, Physical Review D **44**, 1722 (1991).
53. P. D. Mannheim and D. Kazanas, *Solutions to the Reissner-Nordstrom, Kerr and Kerr-Newman problems in fourth order conformal Weyl gravity*, Physical Review D **44**, 417 (1991).
54. P. D. Mannheim, *Conformal gravity and the flatness problem*, Astrophysical Journal **391**, 429 (1992).
55. P. D. Mannheim, *Dynamical mass and geodesic motion*, General Relativity and Gravitation, **25**, 697 (1993).
56. P. D. Mannheim, *Linear potentials and galactic rotation curves*, Astrophysical Journal, **419**, 150 (1993). (hep-ph/9212304)
57. P. D. Mannheim and D. Kazanas, *Newtonian limit of conformal gravity and the lack of necessity of the second order Poisson equation*, General Relativity and Gravitation **26**, 337 (1994).
58. P. D. Mannheim, *Open questions in classical gravity*, Foundations of Physics **24**, 487 (1994). (gr-qc/9306025)

59. P. D. Mannheim, *Linear potentials in galaxies and clusters of galaxies*, April 1995. (astro-ph/9504022)
60. P. D. Mannheim, *Cosmology and galactic rotation curves*, November 1995. (astro-ph/9511045)
61. P. D. Mannheim, *Conformal cosmology and the age of the universe*, January 1996. (astro-ph/9601071)
62. P. D. Mannheim and J. Kmetko, *Linear potentials and galactic rotation curves - detailed fitting*, February 1996. (astro-ph/9602094)
63. P. D. Mannheim, *Are galactic rotation curves really flat?*, *Astrophysical Journal* **479**, 659 (1997). (astro-ph/9605085)
64. P. D. Mannheim, *Classical underpinnings of gravitationally induced quantum interference*, *Physical Review A* **57**, 1260 (1998). (gr-qc/9611037)
65. P. D. Mannheim, *Local and global gravity*, *Foundations of Physics* **26**, 1683 (1996). (gr-qc/9611038)
66. P. D. Mannheim, *Curvature and cosmic repulsion*, March 1998. (astro-ph/9803135)
67. P. D. Mannheim, *Implications of cosmic repulsion for gravitational theory*, *Physical Review D* **58**, 103511 (1998). (astro-ph/9804335)
68. P. D. Mannheim, *Cosmic acceleration as the solution to the cosmological constant problem*, *Astrophysical Journal* **561**, 1 (2001). (astro-ph/9910093)
69. P. D. Mannheim, *Attractive and repulsive gravity*, *Foundations of Physics* **30**, 709 (2000). (gr-qc/0001011)
70. P. D. Mannheim and A. Davidson, *Fourth order theories without ghosts*, January 2000. (hep-th/0001115)
71. P. D. Mannheim, *Constraints on brane-localized gravity*, *Physical Review D* **63**, 024018 (2001). (hep-th/0005226)
72. P. D. Mannheim, *Constraints on 5D anti-de Sitter embeddings*, *Physical Review D* **64**, 065008 (2001). (hep-th/0009065)
73. A. Davidson and P. D. Mannheim, *Dynamical localization of gravity*, September 2000. (hep-th/0009064)

74. P. D. Mannheim, *Delta function singularities in the Weyl tensor at the brane*, Physical Review D **64**, 068501 (2001). (hep-th/0101047)
75. P. D. Mannheim, *How recent is cosmic acceleration?*, International Journal of Modern Physics D **12**, 893 (2003). (astro-ph/0104022)
76. M. Y. Hu, W. Sturhahn, T. S. Toellner, P. D. Mannheim, D. E. Brown, J. Zhao, and E. E. Alp, *Measuring velocity of sound with nuclear resonant inelastic x-ray scattering*, Physical Review B **67**, 094304 (2003). (cond-mat/0212387)
77. P. D. Mannheim and A. Davidson, *Dirac quantization of the Pais-Uhlenbeck fourth order oscillator*, Physical Review A **71**, 042110 (2005). (hep-th/0408104)
78. P. D. Mannheim, *Alternatives to dark matter and dark energy*, Progress in Particle and Nuclear Physics **56**, 340 (2006). (astro-ph/0505266)
79. H. J. Lipkin and P. D. Mannheim, *Bounds on localized modes in the crystal impurity problem*, Physical Review B **73**, 174105 (2006). (cond-mat/0510542)
80. P. D. Mannheim, *Arbitrary force-constant changes in the crystal impurity problem*, Physical Review B **73**, 184103 (2006). (cond-mat/0512188)
81. P. D. Mannheim, *Gauge invariant treatment of the energy carried by a gravitational wave*, Physical Review D **74**, 024019 (2006). (gr-qc/0601032)
82. P. D. Mannheim and I. Simbotin, *Completeness of non-normalizable modes*, Journal of Physics A **39**, 13783 (2006). (hep-th/0607090)
83. P. D. Mannheim, *Solution to the ghost problem in fourth order derivative theories*, Foundations of Physics **37**, 532 (2007). (hep-th/0608154)
84. P. D. Mannheim, *Schwarzschild limit of conformal gravity in the presence of macroscopic scalar fields*, Physical Review D **75**, 124006 (2007). (gr-qc/0703037)
85. C. M. Bender and P. D. Mannheim, *No-ghost theorem for the fourth-order derivative Pais-Uhlenbeck oscillator model*, Physical Review Letters **100**, 110402 (2008). (arXiv:0706.0207 [hep-th])
86. C. M. Bender and P. D. Mannheim, *Giving up the ghost*, Journal of Physics A **41**, 304018 (2008). (arXiv:0807.2607 [hep-th])
87. C. M. Bender and P. D. Mannheim, *Exactly solvable PT-symmetric Hamiltonian having no Hermitian counterpart*, Physical Review D **78**, 025022 (2008). (arXiv:0804.4190 [hep-th])

88. C. M. Bender and P. D. Mannheim, *PT symmetry and necessary and sufficient conditions for the reality of energy eigenvalues*, Physics Letters A **374**, 1616 (2010). (arXiv:0902.1365 [hep-th])
89. P. D. Mannheim, J. G. O'Brien and D. E. Cox, *Limitations of the standard gravitational perfect fluid paradigm*, General Relativity and Gravitation **42**, 2561 (2010). (arXiv:0903.4381 [gr-qc])
90. P. D. Mannheim, *Comprehensive solution to the cosmological constant, zero-point energy, and quantum gravity problems*, General Relativity and Gravitation **43**, 703 (2011). (arXiv:0909.0212 [hep-th])
91. P. D. Mannheim, *PT symmetry as a necessary and sufficient condition for unitary time evolution*, Philosophical Transactions of the Royal Society A **371**, 20120060 (2013). (arXiv:0912.2635[hep-th])
92. P. D. Mannheim, *Intrinsically quantum-mechanical gravity and the cosmological constant problem*, Modern Physics Letters A **26**, 2375 (2011). (arXiv:1005.5108 [hep-th])
93. P. D. Mannheim and J. G. O'Brien, *Impact of a global quadratic potential on galactic rotation curves*, Physical Review Letters **106**, 121101(2011). (arXiv: 1007.0970 [astro-ph.CO])
94. P. D. Mannheim and J. G. O'Brien, *Fitting galactic rotation curves with conformal gravity and a global quadratic potential*, Physical Review D **85**, 124020 (2012). (arXiv: 1011.3495 [astro-ph.CO])
95. P. D. Mannheim, *Making the case for conformal gravity*, Foundations of Physics **42**, 388 (2012). (arXiv: 1101.2186 [hep-th])
96. C. M. Bender and P. D. Mannheim, *PT symmetry in relativistic quantum mechanics*, Physical Review D **84**, 105038 (2011); **84**, 129902(E) (2011). (arXiv:1107.0501 [hep-th])
97. J. G. O'Brien and P. D. Mannheim, *Fitting dwarf galaxy rotation curves with conformal gravity*. Monthly Notices of the Royal Astronomical Society **421**, 1273 (2012). (arXiv:1107.5229 [astro-ph.CO])
98. P. D. Mannheim, *Cosmological perturbations in conformal gravity*, Physical Review D **85**, 124008 (2012). (arXiv:1109.4119 [gr-qc])
99. P. D. Mannheim *Astrophysical Evidence for the Non-Hermitian but PT-symmetric Hamiltonian of Conformal Gravity*, Fortschritte der Physik **61**, 140 (2013). (arXiv:1205.5717 [hep-th])
100. P. D. Mannheim and J. G. O'Brien, *Galactic rotation curves in conformal gravity*, Journal of Physics: Conference Series **437**, 012002 (2013). (arXiv:1211.0188 [astro-ph.CO])

101. L. Fabbri and P. D. Mannheim, *Continuity of the torsionless limit as a selection rule for gravity theories with torsion*, Physical Review D **90**, 024042 (2014). (arXiv:1405.1248 [gr-qc])
102. P. D. Mannheim and J. J. Poveromo, *Gravitational analog of Faraday's law via torsion and a metric with an antisymmetric part*, General Relativity and Gravitation **46**, 1795 (2014). (arXiv:1406.1470 [gr-qc])
103. P. D. Mannheim, *Torsion, magnetic monopoles and Faraday's law via a variational principle*, Journal of Physics: Conference Series **615**, 012004 (2015). (arXiv:1406.2265 [hep-th])
104. P. D. Mannheim, *PT symmetry, conformal symmetry, and the metrication of electromagnetism*, Foundations of Physics **47**, 1229 (2017). (arXiv:1407.1820 [hep-th])
105. P. D. Mannheim, *Living without supersymmetry – the conformal alternative and a dynamical Higgs boson*, Journal of Physics G **44**, 115003 (2017). (arXiv:1506.01399 [hep-ph])
106. P. D. Mannheim, *Comment on "Problems with Mannheim's conformal gravity program"*, Physical Review D **93**, 068501 (2016). (arXiv:1506.02479 [gr-qc])
107. P. D. Mannheim, *Colloquium on the 2013 Nobel Prize in Physics awarded to Francois Englert and Peter Higgs*, arXiv:1506.04120 [physics.pop-ph], June 2015.
108. P. D. Mannheim, *Advancing the case for PT symmetry – the Hamiltonian is always PT symmetric*, arXiv:1506.08432 [quant-ph], June 2015.
109. P. D. Mannheim, *Extension of the CPT Theorem to non-Hermitian Hamiltonians and unstable states*, Physics Letters B **753**, 288 (2016). (arXiv:1512.03736 [quant-ph])
110. P. D. Mannheim, *Antilinearity rather than Hermiticity as a guiding principle for quantum theory*, Journal of Physics A **51**, 315302 (2018). (arXiv:1512.04915 [hep-th])
111. P. D. Mannheim, *Conformal invariance and the metrication of the fundamental forces*, International Journal of Modern Physics D **25**, 1644003 (2016). (arXiv:1603.08405 [gr-qc])
112. P. D. Mannheim, *Critical scaling and a dynamical Higgs boson*, Journal of Physics: Conference Series **1239**, 012017 (2019). (arXiv:1604.07696 [hep-ph])
113. P. D. Mannheim, *Mass generation, the cosmological constant problem, conformal symmetry, and the Higgs boson*, Progress in Particle and Nuclear Physics **94**, 125 (2017). (arXiv:1610.08907 [hep-ph])
114. P. D. Mannheim, *Anomalous dimensions and the renormalizability of the four-Fermion interaction*, Physics Letters B **773**, 604 (2017). (arXiv:1611.09129 [hep-th])

115. P. D. Mannheim, *Is the cosmological constant problem properly posed?*, International Journal of Modern Physics D **26**, 1743009 (2017). (arXiv:1703.09286 [hep-th])
116. J. G. O'Brien, T. L. Chiarelli and P. D. Mannheim, *Universal properties of galactic rotation curves and a first principles derivation of the Tully-Fisher relation*, Physics Letters B **782**, 433 (2018). (arXiv:1704.03921 [astro-ph.GA])
117. P. D. Mannheim, *Appropriate inner product for PT-Symmetric Hamiltonians*, Physical Review D **97**, 045001 (2018). (arXiv:1708.01247 [quant-ph])
118. P. D. Mannheim, *Unitarity of loop diagrams for the ghostlike $1/(k^2 - M_1^2) - 1/(k^2 - M_2^2)$ propagator*, Physical Review D **98**, 045014 (2018). (arXiv:1801.03220 [hep-th])
119. A. Amarasinghe, M. G. Phelps and P. D. Mannheim, *Cosmological perturbations in conformal gravity. II.*, Physical Review D **99**, 083527 (2019). (arXiv:1805.06807 [gr-qc])
120. P. D. Mannheim, *Goldstone bosons and the Englert-Brout-Higgs mechanism in non-Hermitian theories*, Physical Review D **99**, 045006 (2019). (arXiv:1808:00437 [hep-th])
121. J. G. O'Brien, T. L. Chiarelli, P. D. Mannheim, M. A. Falcone, M. H. AlQurashi and J. Carter, *Radial acceleration and Tully-Fisher relations in conformal gravity*, Journal of Physics: Conference Series **1239**, 012009 (2019). (arXiv:1812.03152 [astro-ph.GA])
122. P. D. Mannheim, *Is dark matter fact or fantasy? – clues from the data*, International Journal of Modern Physics D **28**, 1944022 (2019). (arXiv:1903.11217 [astro-ph.GA])
123. P. D. Mannheim, P. Lowdon and S. J. Brodsky, *Structure of light front vacuum sector diagrams*, Physics Letters B **797** 134916 (2019). (arXiv:1904.05253 [hep-ph])
124. P. D. Mannheim, *Equivalence of light-front quantization and instant-time quantization*, Physical Review D **102**, 025020 (2020). (arXiv:1909.03548 [hep-ph])
125. M. Phelps, A. Amarasinghe and P. D. Mannheim, *Three-dimensional and four-dimensional scalar, vector, tensor cosmological fluctuations and the cosmological decomposition theorem*, General Relativity and Gravitation **52**, 114 (2020). (arXiv:1912.10448 [gr-qc])
126. P. D. Mannheim, *Light-front quantization is the same as instant-time quantization*, Proceedings of Science (LC2019)062 (2019). (arXiv:2001.04603 [hep-th])
127. P. D. Mannheim, *Ghost problems from Pauli-Villars to fourth-order quantum gravity and their resolution*, International Journal of Modern Physics D **29**, 2043009 (2020). (arXiv:2004.00376 [hep-th])
128. P. D. Mannheim, P. Lowdon and S. J. Brodsky, *Comparing light-front quantization with instant-time quantization*, Physics Reports **891**, 1 (2021). (arXiv:2005.00109 [hep-ph])

129. P. D. Mannheim, *Exact solution to perturbative conformal cosmology in the recombination era*, Physical Review D **102**, 123535 (2020). (arXiv:2009.06841 [gr-qc])
130. A. Amarasinghe and P. D. Mannheim, *Cosmological fluctuations on the light cone*, Physical Review D **103**, 103517 (2021). (arXiv:2011.02440 [gr-qc])
131. A. Amarasinghe, T. Liu, D. A. Norman and P. D. Mannheim, *Exact solution to perturbative conformal cosmology from recombination until the current era*, Physical Review D **103**, 104022 (2021). (arXiv:2101.02608 [gr-qc])
132. P. D. Mannheim and J. W. Moffat, *External field effect in gravity*, International Journal of Modern Physics D **30**, 2142009 (2021). (arXiv: 2103.13972 [gr-qc])
133. P. D. Mannheim, *Antilinear symmetry and the ghost problem in quantum field theory*, Proceedings of Virtual Seminar Series on Pseudo-Hermitian Hamiltonians in Quantum Physics, Journal of Physics Conference Series **2038**, 012018 (2021). (arXiv: 2104.03708 [hep-th])
134. P. D. Mannheim, *Critique of the use of geodesics in astrophysics and cosmology*, arXiv:2105.08556 [gr-qc]
135. P. D. Mannheim, *Structure of conformal gravity in the presence of a scale breaking scalar field*, arXiv:2105.14679 [gr-qc]
136. P. D. Mannheim, *Extension of the Goldstone and the Englert-Brout-Higgs mechanisms to non-Hermitian theories*, arXiv:2109.08714 [hep-th]
137. P. D. Mannheim, *Solution to the ghost problem in higher-derivative gravity*, Proceedings of the Workshop on Quantum Gravity, Higher Derivatives and Nonlocality, Il Nuovo Cimento C, in press. (arXiv:2109.12743 [hep-th])

Philip David Mannheim – Conference Proceedings

1. A. Davidson, P. D. Mannheim and K. C. Wali, *Flavor-color-hypercolor unification based on $SO(10)_V \times SO(10)_H$* , in Gauge theories, massive neutrinos, and proton decay, Proceedings of Orbis Scientiae, University of Miami, January 1981. Studies in the natural sciences Vol. **18**, edited by B. Kursunoglu and A. Perlmutter, Plenum Press, N. Y. (1981).
2. P. D. Mannheim, *Phonons: interactions with electromagnetic waves*, in Encyclopedia of Materials Science and Engineering, edited by M. Bever, Pergamon Press, N. Y. (1986).
3. P. D. Mannheim, *Symmetry and spontaneously broken symmetry in the physics of elementary particles*, Computers and Mathematics with Applications **12B**, 169 (1986). Republished in Symmetry: unifying human understanding, International series in modern applied mathematics and computer science Vol. 10, edited by I. Hargittai, Pergamon Press, N.Y. (1986).
4. P. D. Mannheim and D. Kazanas, *Exact vacuum solution to fourth order Weyl gravity*, in Proceedings of the Storrs meeting, the fourth meeting (new series) of the Division of Particles and Fields of the American Physical Society, University of Connecticut, August 1988. Edited by K. Haller, D. C. Caldi, M. M. Islam, R. L. Mallett, P. D. Mannheim, and M. S. Swanson, World Scientific Press, Singapore (1989).
5. K. Haller, D. C. Caldi, M. M. Islam, R. L. Mallett, P. D. Mannheim and M. S. Swanson, joint editors, *Proceedings of the Storrs meeting*, the fourth meeting (new series) of the Division of Particles and Fields of the American Physical Society, University of Connecticut, August 1988. Published by World Scientific Press, Singapore (1989).
6. P. D. Mannheim, *Some exact solutions to conformal Weyl gravity*, in Nonlinear Problems in Relativity and Cosmology, Proceedings of the Sixth Florida Workshop on Nonlinear Astronomy, University of Florida, October 1990. Edited by J. R. Buchler, S. L. Detweiler, and J. R. Ipser, Annals of the New York Academy of Sciences, Vol. **631**, 194 (1991).
7. P. D. Mannheim and D. Kazanas, *Current status of conformal Weyl gravity*, in Proceedings of the “After the First Three Minutes” Workshop, University of Maryland, October 1990. A. I. P. Conference Proceedings No. **222**, edited by S. S. Holt, C. L. Bennett, and V. Trimble, A. I. P., N. Y. (1991).
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9. P. D. Mannheim, *Conformal gravity, cosmology and Newton's law*, in Proceedings of the XXth International Conference on Differential Geometric Methods in Theoretical Physics, Baruch College/CUNY, New York, June 1991. Edited by S. Catto and A. Rocha, World Scientific Press, Singapore (1992).
10. P. D. Mannheim, *Four dimensional conformal gravity, confinement, and galactic rotation curves*, in Proceedings of "PASCOS 94", the Fourth International Symposium on Particles, Strings and Cosmology, Syracuse, New York, May 1994. Edited by K. C. Wali, World Scientific Press, Singapore (1995). (gr-qc/9407010)
11. P. D. Mannheim and D. Kazanas, *Higgs mechanism and the structure of the energy-momentum tensor in Einstein gravity and conformal gravity*, in Proceedings of the Seventh Marcel Grossmann Meeting on General Relativity, Stanford, California, July 1994. Edited by R. T. Jantzen, G. M. Keiser and R. Ruffini, World Scientific Press, Singapore (1996). (gr-qc/9409050)
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13. P. D. Mannheim, *Linear potentials in the cores of clusters of galaxies*, in Proceedings of "Clusters, Lensing, and the Future of the Universe", University of Maryland, June 1995. Astronomical Society of the Pacific Conference Series, Vol. **88**, edited by V. Trimble and A. Reisenegger, A. S. P., San Francisco (1996). (astro-ph/9508045)
14. P. D. Mannheim, *Dark matter: a challenge to standard gravity or a warning?*, in Proceedings of "Eighteenth Texas Symposium on Relativistic Astrophysics", University of Chicago, December 1996. Edited by A. V. Olinto, J. A. Frieman, and D. N. Schramm, World Scientific Press, Singapore (1998). (astro-ph/9701128)
15. P. D. Mannheim, *Imprint of the global Hubble flow on galactic rotation curves*, in Proceedings of "Galactic Halos: A UC Santa Cruz Workshop", University of California at Santa Cruz, August 1997. Astronomical Society of the Pacific Conference Series, Vol. **136**, edited by D. Zaritsky, A. S. P., San Francisco (1998). (astro-ph/9712090)
16. P. D. Mannheim, *How we got into the dark matter fix and how we can get out*, in Proceedings of "PASCOS 98", the Sixth International Symposium on Particles, Strings and Cosmology, Northeastern University, Boston, March 1998. Edited by P. Nath, World Scientific Press, Singapore (1999). (astro-ph/9807122)
17. P. D. Mannheim, *The equivalence principle in classical mechanics and quantum mechanics*, in "Contemporary Fundamental Problems". Edited by Valeri Dvoeglazov, Nova Science Publishers, New York (1999). (gr-qc/9810087)

18. P. D. Mannheim, *Curvature, galactic dynamics and cosmic repulsion*, in Proceedings of the International Conference on Galaxy Dynamics, Rutgers University, August 1998. Astronomical Society of the Pacific Conference Series, Vol. **182**, edited by D. Merritt, J. A. Sellwood and M. Valluri, A. S. P., San Francisco (1999). (astro-ph/9811256)
19. G. V. Dunne, L. P. Horwitz, M. M. Islam, and P. D. Mannheim, joint guest editors of 3 special monthly festschrift sections of Foundations of Physics in honor of the Seventieth Birthday of Kurt Haller, Foundations of Physics, **30**, Nos 3, 4, 5 (2000).
20. P. D. Mannheim, *Conformal gravity and a naturally small cosmological constant*, Proceedings of "20th Texas Symposium on Relativistic Astrophysics", Austin, December 2000, J. C. Wheeler and H. Martel (Eds.), American Institute of Physics, NY (2001). (astro-ph/9901219)
21. P. D. Mannheim, *Cosmic acceleration and a natural solution to the cosmological constant problem*, Proceedings of "The Role of Neutrinos, Strings, Gravity and Variable Cosmological Constant in Elementary Particle Physics", Coral Gables Conference, December 2000, B. N. Kursunoglu, S. L. Mintz and A. Perlmutter (Eds.), Kluwer Academic/Plenum Publishers, NY (2001). (gr-qc/9903005)
22. P. D. Mannheim, *Is cosmic acceleration really recent?*, Proceedings of "Cosmology and Elementary Particle Physics", Coral Gables Conference, December 2001, B. N. Kursunoglu, S. L. Mintz and A. Perlmutter (Eds.), American Institute of Physics, NY (2002). (astro-ph/0204202)
23. P. D. Mannheim, *Localization issues for Robertson-Walker branes*, Proceedings of "Cosmology and Elementary Particle Physics", Coral Gables Conference, December 2001, B. N. Kursunoglu, S. L. Mintz and A. Perlmutter (Eds.), American Institute of Physics, NY (2002). (arXiv:0807.3685 [hep-th])
24. P. D. Mannheim, *Options for cosmology at redshifts above one*, Proceedings of "Short Distance Behavior of Fundamental Interactions", Coral Gables Conference, December 2002, B. N. Kursunoglu, M. Camcigil, S. L. Mintz and A. Perlmutter (Eds.), American Institute of Physics, NY (2003). (astro-ph/0302362)
25. P. D. Mannheim, *The work of Behram Kursunoglu*, Proceedings of "The Launching of La Belle Epoque of High Energy Physics and Cosmology", Coral Gables Conference, December 2003, T. Curtright, S. Mintz and A. Perlmutter (Eds.), World Scientific Publishing Company, Singapore (2004). (gr-qc/0405035)
26. P. D. Mannheim, *Dark matter and dark energy – fact or fantasy*, Montreal-Rochester-Syracuse-Toronto Conference, Montreal, Canada, May 2004. International Journal of Modern Physics **A19**, 5333 (2004).

27. P. D. Mannheim, *Causality in the brane world*, Presentation at the 26th International Colloquium on Group Theoretical Methods in Physics, New York City, June 2006. (hep-th/0607041)
28. P. D. Mannheim, *Dynamical symmetry breaking and the cosmological constant problem*, Proceedings of the 34th International Conference in High Energy Physics (ICHEP08), Philadelphia, 2008, eConf C080730. (arXiv:0809.1200 [hep-th])
29. P. D. Mannheim, *Why do we believe in dark matter and dark energy – and do we have to?*, in "Questions of Modern Cosmology – Galileo's Legacy", M. D'Onofrio and C. Burigana (Eds.), Springer Publishing Company, Heidelberg (2009).
30. P. D. Mannheim, *Conformal Gravity Challenges String Theory*, Proceedings of the Second Crisis in Cosmology Conference, CCC-2, Astronomical Society of the Pacific Conference Series Vol. 413. (F. Potter, Ed.), San Francisco (2009). (arXiv:0707.2283 [hep-th])
31. P. D. Mannheim, *Intrinsically quantum-mechanical gravity and the cosmological constant problem*, to appear in Proceedings of the International Conference on Two Cosmological Models, Universidad Iberoamericana, Mexico City, November, 2010 (J. Auping-Birch and A. Sandoval-Villalbaz, Eds.). (arXiv:1005.5108 [hep-th])
32. P. D. Mannheim, *Making the case for conformal gravity*, Proceedings of the International Conference on Two Cosmological Models, Universidad Iberoamericana, Mexico City, November, 2010 (J. Auping-Birch and A. Sandoval-Villalbaz, Eds.). (arXiv: 1101.2186 [hep-th])
33. P. D. Mannheim, *CPT symmetry without Hermiticity*, Proceedings of ICHEP2016, the 38th International Conference on High Energy Physics, Chicago, August 2016. (arXiv:1611.02100 [hep-th])

Philip David Mannheim – Monographs

1. P. D. Mannheim, *Brane-localized gravity*, Full length monograph, World Scientific Publishing Company, Singapore (2005). (<http://www.worldscibooks.com/physics/5975.html>)

Philip David Mannheim – Recent Seminars

2000

1. Cosmic acceleration as the solution to the cosmological constant problem, seminar presented at MIT at joint MIT-CFA-Tufts cosmology seminar, February, 2000.
2. Conformal gravity I, seminar presented at MIT, March, 2000.
3. Conformal gravity II, seminar presented at MIT, March, 2000.
4. Cosmic acceleration as the solution to the cosmological constant problem, seminar presented at Brandeis University, March, 2000.
5. How good is Newton's law of gravity?, colloquium presented at University of Miami, April, 2000.
6. How we got into the dark matter fix and how we can get out, seminar presented at MIT, May, 2000.
7. Cosmic acceleration as the solution to the cosmological constant problem, seminar presented at Boston University, May, 2000.
8. Conformal gravity III, seminar presented at MIT, May, 2000.
9. Brane-localized gravity: could there be a macroscopically sized fifth dimension?, seminar presented at University of Connecticut, Storrs, September, 2000.
10. Dynamical localization of gravity, seminar presented at University of Connecticut, Storrs, September, 2000.
11. The crystal impurity problem and the Mossbauer effect, seminar presented at Argonne National Laboratory, November, 2000.
12. Gravitationally induced quantum interference, seminar presented at Argonne National Laboratory, November, 2000.
13. Brane-localized gravity, seminar presented at Argonne National Laboratory, November, 2000.
14. Cosmic acceleration and a natural solution to the cosmological constant problem, conference seminar presented at Orbis Scientiae 2000, Fort Lauderdale, Florida, December 2000.
15. Conformal gravity and a naturally small cosmological constant, poster presentation at 20th Texas Symposium on Relativistic Astrophysics, Austin, Texas, December 2000.

2001

1. The crystal impurity problem and the Mossbauer effect, seminar presented at University of Connecticut, Storrs, January, 2001.

2. Brane cosmology, seminar presented at MIT, February, 2001.
3. Cosmic acceleration as the solution to the cosmological constant problem, seminar presented at Texas A and M, March, 2001.
4. How we got into the dark matter fix and how we can get out, colloquium presented at University of Texas, March, 2001.
5. How recent is cosmic acceleration?, seminar presented at University of Connecticut, Storrs, May, 2001.
6. Recent developments in the crystal impurity problem, seminar presented at Argonne National Laboratory, Argonne, July 2001.
7. How recent is cosmic acceleration?, seminar presented at Argonne National Laboratory, Argonne, July 2001.
8. Gravitationally induced quantum interference, colloquium presented at Argonne National Laboratory, November 2001.
9. Localization issues for Robertson-Walker branes, conference seminar presented at Coral Gables 2001, Fort Lauderdale, Florida, December 2001.
10. Is cosmic acceleration really recent?, conference seminar presented at Coral Gables 2001, Fort Lauderdale, Florida, December 2001.

2002

1. How recent is cosmic acceleration?, seminar presented at Yale University, April 2002.
2. How we got into the dark matter fix and how we can get out, seminar presented at University of St. Andrews, St. Andrews Scotland, August 2002.
3. How we got into the dark energy fix and how we can get out, seminar presented at University of St. Andrews, St. Andrews Scotland, August 2002.
4. How recent is cosmic acceleration?, invited presentation at Cross-Channel Conference, Plymouth, England, August 2002.
5. The accelerating universe, colloquium presented at Daytona Beach Community College, Daytona, November 2002.
6. How we got into the dark matter fix and how we can get out, seminar presented at SLAC, Stanford University, December 2002.
7. Living with a large cosmological constant, seminar presented at SLAC, Stanford University, December 2002.
8. How recent is cosmic acceleration?, seminar presented at LBL, Berkeley, December 2002.

9. The accelerating universe, colloquium presented at San Francisco State University, December 2002.
10. Options for cosmology at redshifts above one, invited presentation at Coral Gables 2002 Conference, Fort Lauderdale, Florida, December 2002.

2003

1. How recent is cosmic acceleration?, seminar presented at Liverpool University, England, January 2003.
2. How we got into the dark matter fix and how we can get out, seminar presented at University of Florida, Gainesville, April 2003.
3. Living with a large cosmological constant, seminar presented at University of Florida, Gainesville, April 2003.
4. Living with a large cosmological constant, invited presentation at the 8th Wigner symposium, CUNY, New York City, May 2003.
5. Dark matter and dark energy - fact or fantasy, colloquium presented at University of Oxford, Oxford, England, August 2003.
6. Living with a large cosmological constant, seminar presented at University of Oxford, Oxford, England, August 2003.
7. Living with a large cosmological constant, invited seminar presented at Cosmo-03 Conference, Ambleside, England, August 2003.
8. The work of Behram Kursunoglu, invited seminar presented at Coral Gables Conference, Fort Lauderdale, December 2003.
9. Dark matter and dark energy - fact or fantasy, invited seminar presented at Coral Gables Conference, Fort Lauderdale, December 2003.

2004

1. Dark matter and dark energy - fact or fantasy, seminar presented at University of Cardiff, Cardiff, Wales, January 2004.
2. Dark matter and dark energy - fact or fantasy, seminar presented at University of Bristol, Bristol, England, January 2004.
3. Dark matter and dark energy - fact or fantasy, colloquium presented at Louisiana State University, Baton Rouge, January 2004.

4. The most expensive way to measure the velocity of sound, seminar presented at University of Connecticut, Storrs, February 2004.
5. Dark matter and dark energy - fact or fantasy, invited seminar presented at MRST Conference, Montreal, Canada, May 2004.
6. Dark matter and dark energy – fact or fantasy, seminar presented at Ben Gurion University of the Negev, Beersheva, Israel, July 2004.
7. Bounds on localized modes in the crystal impurity problem, seminar presented at the Budnickfest, University of Connecticut, Storrs, September 2004.
8. Quantizing acceleration dependent Lagrangians, seminar presented at the University of Connecticut, Storrs, November 2004.

2005

1. Dark matter and dark energy – fact or fantasy, seminar presented at University of Lancaster, Lancaster, England, March 2005.
2. Dark matter and dark energy – fact or fantasy, seminar presented at Rockefeller University, New York, May 2005.
3. Bounds on localized modes in the crystal impurity problem, seminar presented at Argonne National Laboratory, October 2005.
4. Alternatives to dark matter and dark energy, seminar presented at Kavli Institute, University of Chicago, October 2005.
5. Dark matter and dark energy – fact or fiction, seminar presented at University of Connecticut, Storrs, November 2005.
6. Dark matter and dark energy – fact or fiction, colloquium presented at Perimeter Institute, Waterloo, Canada, November 2005.
7. Dark matter and dark energy – fact or fiction, seminar presented at University of Toronto, Canada, November 2005.
8. Bounds on localized modes in the crystal impurity problem, seminar presented at University of Connecticut, Storrs, November 2005.
9. Dark matter and dark energy – fact or fiction, seminar presented at University of Liverpool, England, December 2005.
10. Dark matter and dark energy – fact or fiction, seminar presented at University of Manchester, England, December 2005.

2006

1. Gauge invariant treatment of the energy of a gravitational wave, seminar presented at University of Connecticut, Storrs, January 2006.
2. Dark matter and dark energy – fact or fiction, seminar presented at Imperial College, London, England, February 2006.
3. Dark matter and dark energy – fact or fiction, seminar presented at Fermilab, March 2006.
4. Causality in the brane world, seminar presented at Fermilab, March 2006.
5. Conformal gravity and dark energy, invited plenary presentation at Alternative Gravities and Dark Matter Workshop, Edinburgh, Scotland, April 2006.
6. Dark matter and dark energy – fact or fiction, seminar presented at Syracuse University, May 2006.
7. Cosmology in the Dvali-Gabadaze-Porrati brane world, seminar presented at Cornell/Syracuse Dark Energy Workshop, Syracuse University, May 2006.
8. Dark matter and dark energy – fact or fiction, seminar presented at Cornell University, May 2006.
9. Solution to the ghost problem in fourth order derivative theories, seminar presented at the 2006 Biennial Meeting of the International Association for Relativistic Dynamics, Storrs, May 2006.
10. Grassmann extension of the Stuckelberg proper time formulation of quantum mechanics, seminar presented at the 2006 Biennial Meeting of the International Association for Relativistic Dynamics, Storrs, May 2006.
11. Causality in the brane world, seminar presented at the 26th International Colloquium on Group Theoretical Methods in Physics, New York City, June 2006.
12. Dark matter and dark energy – fact or fiction, seminar presented at University of Pennsylvania, November 2006.
13. The 2006 Nobel prize in physics, colloquium presented at University of Connecticut, Storrs, November 2006.
14. Dark matter and dark energy – fact or fiction, seminar presented at McGill University, Montreal, November 2006.
15. Einstein’s incredible legacy, colloquium presented at Bishop’s University, Sherbrooke, Quebec, November 2006.
16. Einstein’s incredible legacy, colloquium presented at Stockton College, Pomona, New Jersey, December 2006.
17. Causality and completeness issues in the brane world, seminar presented at New York University, December 2006.

18. Introduction to the brane world, seminar presented at SUNY Stony Brook, December 2006.
19. Alternatives to dark matter and dark energy, seminar presented at SUNY Stony Brook, December 2006.
20. Causality and completeness issues in the brane world, seminar presented at the Miami 2006 Conference, Fort Lauderdale, December 2006.

2007

1. Dark matter and dark energy – fact or fiction, invited talk presented at the "Open Questions for the Standard Cosmological Model" conference, Imperial College London, March 2007.
2. Dark matter and dark energy – fact or fiction, seminar presented at Los Alamos National Laboratory, May 2007.
3. Conformal gravity challenges string theory, invited talk presented at Pascos-07 symposium, Imperial College London, July 2007.
4. Dark matter and dark energy – fact or fiction, colloquium presented at University of Kansas, October 2007.
5. Dark matter and dark energy – fact or fiction, seminar presented at University of Wisconsin, October 2007.
6. Conformal gravity challenges string theory, seminar presented at University of Minnesota, October 2007.
7. Conformal gravity challenges string theory, invited talk presented at the Miami 2007 Conference, Fort Lauderdale, December 2007.

2008

1. Dark matter and dark energy – fact or fiction, seminar presented at University of Durham, Durham UK, February 2008.
2. Conformal gravity challenges string theory, seminar presented at University of Oxford, Oxford, February 2008.
3. Conformal gravity challenges string theory, seminar presented at California Institute of Technology, Pasadena, March 2008.
4. Conformal gravity challenges string theory, seminar presented at University of California at Los Angeles, March 2008.
5. Einstein's incredible legacy, colloquium presented at Fresno State University, Fresno, California, March 2008.

6. Quantum mechanics off the beaten track, colloquium presented at Washington University, St. Louis, April 2008.
7. Dark matter and dark energy – fact or fiction, colloquium presented at University of Nebraska, May 2008.
8. Conformal gravity challenges string theory, invited talk presented at Pascos-08 symposium, Perimeter Institute, Waterloo Canada, June 2008.
9. Conformal gravity challenges string theory, invited talk presented at 34th International Conference on High Energy Physics (ICHEP 2008), Philadelphia, July 2008.
10. Does the cosmological constant problem presage a paradigm shift in gravitational theory?, invited talk presented at the Second Crisis in Cosmology Conference, Port Angeles WA, September 2008.
11. Doing physics with non-diagonalizable Hamiltonians and the solution to the ghost problem in fourth-order derivative theories, seminar presented at Syracuse University, September 2008.
12. Quantum mechanics off the beaten track, colloquium presented at University of Connecticut, Storrs, October 2008.
13. The 2008 Nobel prize in physics, seminar presented at University of Connecticut, Storrs, November 2008.
14. Doing physics with non-diagonalizable Hamiltonians and the solution to the ghost problem in fourth-order derivative theories, seminar presented at Perimeter Institute, Waterloo Canada, November 2008.
15. Doing physics with non-diagonalizable Hamiltonians and the solution to the ghost problem in fourth-order derivative theories, invited talk presented at Miami 2008 Conference, Fort Lauderdale, December 2008.

2009

1. Does the cosmological constant problem presage a paradigm shift in gravitational theory?, invited talk at Intertwining Theory and Observational Evidence in Contemporary Cosmology, Wuppertal Germany, February 2009.
2. Spacetime curvature and quantum gravity, seminar presented at University of Connecticut Physics Club, Storrs, March 2009.
3. Doing physics with non-diagonalizable Hamiltonians and the solution to the ghost problem in fourth-order derivative theories, invited talk presented at Quantum Mechanics in the Complex Domain, St. Louis, March 2009.
4. Doing physics with non-diagonalizable Hamiltonians and the solution to the ghost problem in fourth-order derivative theories, seminar at the University of Chicago, April 2009.

5. Comprehensive Solution to the Cosmological Constant, Zero-Point Energy, and Quantum Gravity Problems, seminar at University of Pennsylvania, September 2009.
6. Quantum Gravity, colloquium at the University of Connecticut, October 2009.
7. Quantum Gravity – The Details, seminar at the University of Connecticut, October 2009.
8. Comprehensive Solution to the Cosmological Constant, Zero-Point Energy, and Quantum Gravity Problems, invited talk presented at the Miami 2009 Conference, Fort Lauderdale, December 2009.

2010

1. Quantum Conformal Gravity and Grandunification, seminar at Syracuse University, February 2010.
2. Comprehensive Solution to the Cosmological Constant, Zero-Point Energy, and Quantum Gravity Problems, seminar at Syracuse University, February 2010.
3. Comprehensive Solution to the Cosmological Constant, Zero-Point Energy, and Quantum Gravity Problems, seminar at University of Minnesota, February 2010.
4. Comprehensive Solution to the Cosmological Constant, Zero-Point Energy, and Quantum Gravity Problems, seminar at University of Wisconsin, February 2010.
5. Comprehensive Solution to the Cosmological Constant, Zero-Point Energy, and Quantum Gravity Problems, seminar at Imperial College, London, March 2010.
6. Classical Aspects of the Dark Matter and Dark Energy Problems, seminar at SUNY Stony Brook, April 2010.
7. Quantum Aspects of the Dark Matter and Dark Energy Problems, seminar at SUNY Stony Brook, April 2010.
8. Comprehensive Solution to the Cosmological Constant, Zero-Point Energy, and Quantum Gravity Problems, seminar at Brookhaven National Laboratory, April 2010.
9. Intrinsically Quantum-Mechanical Curvature and the Cosmological Constant Problem, seminar at Oxford University, June 2010.
10. Doing Physics with Non-Hermitian and Non-Diagonalizable Hamiltonians, seminar at Oxford University, June 2010.
11. Intrinsically Quantum-Mechanical Curvature and the Cosmological Constant Problem, seminar at Vanderbilt University, August 2010.
12. Impact of a Global Quadratic Potential on Galactic Rotation Curves, seminar at Vanderbilt University, August 2010.

13. Intrinsically Quantum-Mechanical Curvature and the Cosmological Constant Problem, invited talk presented at the International Conference on Two Cosmological Models, Universidad Iberoamericana, Mexico City, November 2010.
14. Impact of a Global Quadratic Potential on Galactic Rotation Curves, invited talk presented at the International Conference on Two Cosmological Models, Universidad Iberoamericana, Mexico City, November 2010.
15. Intrinsically Quantum-Mechanical Curvature and the Cosmological Constant Problem, seminar at McGill University, November 2010.
16. Intrinsically Quantum-Mechanical Curvature and the Cosmological Constant Problem, seminar at Universite de Montreal, November 2010.
17. Alternatives to Dark Matter, colloquium at Universite de Montreal, November 2010.
18. Impact of a Global Quadratic Potential on Galactic Rotation Curves, invited talk presented at the Miami 2010 Conference, Fort Lauderdale, December 2010.

2011

1. Observational Evidence for the Non-Diagonalizable Hamiltonian of Conformal Gravity, invited talk at the Quantum Physics with Non-Hermitian Operators Conference, Dresden, June 2011.
2. Observational Evidence for the Non-Diagonalizable Hamiltonian of Conformal Gravity, invited talk at the PT Quantum Mechanics Conference, Heidelberg, September 2011.
3. Why We Believe in Dark Matter and Dark Energy – and Do We Have To?, colloquium at Rutgers, October 2011.
4. Why We Believe in Dark Matter and Dark Energy – and Do We Have To?, colloquium at Wesleyan, November 2011.
5. The 2011 Nobel Prize in Physics, colloquium at University of Connecticut, Storrs, November 2011.
6. Cosmological Perturbations in Conformal Gravity, seminar at Universite de Montreal, November 2011.
7. Making the Case for Conformal Gravity, invited talk at the Miami 2011 Conference, Fort Lauderdale, December 2011.

2012

1. Making the Case for Conformal Gravity, seminar at Perimeter Institute, Waterloo Canada, July 2012.
2. Making the Case for Conformal Gravity, seminar at University of Utrecht, Netherlands, August 2012.

3. PT Symmetry as a Necessary and Sufficient Condition for Unitary Time Evolution, invited talk at the PHHQ XI: Non-Hermitian Operators in Quantum Physics, Paris, August 2012.
4. Why We Believe in Dark Matter and Dark Energy – and Do We Have To?, colloquium at Concordia University, Montreal, November 2012.
5. Making the Case for Conformal Gravity, seminar at Universite de Montreal, November 2012.
6. Solution to the Ghost Problem in Fourth-Order Derivative Theories and its Implications for Gravity and Astrophysics, seminar at McGill University, Montreal, November 2012.
7. PT Symmetry as a Necessary and Sufficient Condition for Unitary Time Evolution, invited talk at the Miami 2012 Conference, Fort Lauderdale, December 2012.

2013

1. Consistency of Conformal Gravity as a Microscopic Theory and its Implications for Gravity and Astrophysics as a Macroscopic One, seminar at Yale University April 2013.
2. Why there is a Cosmological Constant Problem, and what we can do about it, invited talk at Tales of Lambda Conference, Nottingham England, July 2013.
3. Why there is a Cosmological Constant Problem, and what we can do about it, seminar at Washington University, September 2013.
4. The 2013 Nobel Prize for the Higgs Boson, colloquium at the University of Connecticut, Storrs, November 2013.
5. Why there is a Cosmological Constant Problem, and what we can do about it, seminar at Syracuse University, November 2013.
6. Why Gravity cannot be Quantized Canonically, and what we can do about it, invited talk at the Miami 2013 Conference, Fort Lauderdale, December 2013.

2014

1. The Crisis in Fundamental Physics, colloquium at the University of New Haven, May 2014.
2. Introduction to PT Symmetry, invited talk at the 9th Biennial Meeting of the International Association for Relativistic Dynamics, Storrs CT, June 2014.
3. Torsion: what it is and how to constrain it, invited talk at the 9th Biennial Meeting of the International Association for Relativistic Dynamics, Storrs CT, June 2014.
4. PT Symmetry, Conformal Symmetry, and the Metrication of the Fundamental Forces, seminar at City University, London, July 2014.

5. PT Symmetry, Conformal Symmetry, and the Metrication of the Fundamental Forces, invited talk at the New England Section of the American Physical Society Meeting, Wentworth Institute of Technology, Boston, November 2014.
6. PT Symmetry, Conformal Symmetry, and the Metrication of the Fundamental Forces, seminar at the University of Connecticut, Storrs, November 2014.
7. PT Symmetry, Conformal Symmetry, and the Metrication of the Fundamental Forces, invited talk at the Discrete 2014 Conference, King's College London, December 2014.
8. PT Symmetry, Conformal Symmetry, and the Metrication of the Fundamental Forces, invited talk at the Miami 2014 Conference, Fort Lauderdale, December 2014.

2015

1. Why physicists are interested in Differential Geometry, seminar at the University of Connecticut, Storrs, February, 2015.
2. Advancing the case for PT Symmetry – the Hamiltonian is always PT Symmetric, invited talk at Quantum (and Classical) Physics with Non-Hermitian Operators (PHHQP13), Jerusalem, July 2015.
3. Living Without Supersymmetry – the Conformal Alternative and a Dynamical Higgs Boson, seminar at Washington University, November 2015.
4. Living Without Supersymmetry – the Conformal Alternative and a Dynamical Higgs Boson, invited talk at the Miami 2015 Conference, Fort Lauderdale, December 2015.

2016

1. Neutrino Oscillations – The 2015 Nobel Prize in Physics, colloquium at the University of Connecticut, Storrs, January 2016.
2. Living Without Supersymmetry – the Conformal Alternative and a Dynamical Higgs Boson, seminar at Imperial College London, May 2016.
3. Living Without Supersymmetry – the Conformal Alternative and a Dynamical Higgs Boson, seminar at King's College London, May 2016.
4. CPT Symmetry Without Hermiticity, invited talk at ICHEP2016, the 38th International Conference on High Energy Physics, Chicago, August 2016.
5. Antilinearity Rather than Hermiticity as a Guiding Principle for Quantum Theory, seminar at the University of Connecticut, Storrs, November 2016.
6. Antilinearity Rather than Hermiticity as a Guiding Principle for Quantum Theory, invited talk at the Miami 2016 Conference, Fort Lauderdale, December 2016.

2017

1. Antilinearity Rather than Hermiticity as a Guiding Principle for Quantum Theory, invited talk at Pseudo-Hermitian Hamiltonians in Quantum Physics (PHHQP17), Bad Honnef, Germany, May 2017.
2. Living Without Supersymmetry – the Conformal Alternative and a Dynamical Higgs Boson, seminar at Niels Bohr Institute, Copenhagen, May 2017.
3. Living Without Supersymmetry – the Conformal Alternative and a Dynamical Higgs Boson, seminar at the University of Liverpool, May 2017.
4. Living Without Supersymmetry – the Conformal Alternative and a Dynamical Higgs Boson, seminar at the University of Manchester, May 2017.
5. The Crisis in Fundamental Physics, SUNY Albany, September 2017.
6. Quantum Conformal Gravity, seminar at University of Utrecht, Netherlands, October 2017.
7. Antilinearity Rather than Hermiticity as a Guiding Principle for Quantum Theory, seminar at Wien Technical University, Vienna, October 2017.
8. Quantum Conformal Gravity, seminar at Wien Technical University, Vienna, October 2017.
9. Is the Cosmological Constant Problem Properly Posed?, seminar at CERN, October, 2017.
10. The 2017 Nobel Prize in Physics, Colloquium at the University of Connecticut Physics Department, November, 2017.
11. The 2017 Nobel Prize in Physics, colloquium at the University of Connecticut Mathematics Department, December, 2017.
12. Anomalous Dimensions and the Renormalizability of the Four-Fermion Interaction, invited talk at the Miami 2017 Conference, Fort Lauderdale, December 2017.

2018

1. Quantum Conformal Gravity, seminar at the University of Cambridge, United Kingdom, June 7, 2018.
2. Quantum Conformal Gravity, seminar at Stanford University, Stanford Linear Accelerator Center Particle Theory Group, August 21, 2018.
3. Quantum Conformal Gravity, seminar at Chapman University Physics Department, August 30, 2018.
4. Why Physicists are Interested in Differential Geometry, seminar at Chapman University Mathematics Department, August 31, 2018.
5. Is Dark Matter Fact or Fantasy? – Clues From the Data, Stanford University, Stanford Linear Accelerator Center KAVLI Astrophysics Institute, September 7, 2018.

6. Quantum Conformal Gravity, seminar at Lawrence Berkeley Laboratory, University of California at Berkeley, September 12, 2018.
7. Quantum Conformal Gravity, seminar at University of California at Santa Cruz Center for Particle Theory, October 2, 2018.
8. Is the Cosmological Constant Problem Properly Posed?, seminar at Lawrence Berkeley Laboratory, University of California at Berkeley, October 3, 2018.
9. Quantum Conformal Gravity, seminar at Stanford University Physics Department, October 9, 2018.
10. Quantum Conformal Gravity, seminar at Washington University Physics Department, October 18, 2018.
11. Is Dark Matter Fact or Fantasy? – Clues From the Data, seminar at Washington University Physics Department, October 19, 2018.
12. Quantum Conformal Gravity, seminar at Johns Hopkins University Physics Department, November 5, 2018.
13. Is Dark Matter Fact or Fantasy? – Clues From the Data, seminar at NASA Goddard Space Flight Center, Greenbelt, Maryland, November 8, 2018.
14. Quantum Conformal Gravity, seminar at Ecole Polytechnique Federal de Lausanne, Lausanne, Switzerland, November 23, 2018.
15. Living Without Supersymmetry, seminar at Discrete 2018 Conference, Vienna, Austria, November 28, 2018.
16. PT and CPT Symmetry as a Dynamics, seminar at Discrete 2018 Conference, Vienna, Austria, November 29, 2018.
17. Quantum Conformal Gravity, seminar at University of Florida Physics Department, Gainesville, December 11, 2018.
18. Is Dark Matter Fact or Fantasy? – Clues From the Data, seminar at Miami 2018, Fort Lauderdale, December 16, 2018.

2019

1. PT and CPT Symmetry as a Dynamics – Application to the Goldstone Theorem, seminar at King’s College London, United Kingdom, January 25, 2019.
2. Making Sense of the Nambu-Jona-Lasinio Model Via Scale Invariance, seminar at Scale Invariance in Particle Physics and Cosmology Conference, CERN, Geneva, Switzerland, February 1, 2019.
3. Quantum Conformal Gravity, seminar at University of Massachusetts Physics Department, Amherst Massachusetts, February 22, 2019.

4. Is Dark Matter Fact or Fantasy? – Clues From the Data, colloquium presented at University of Connecticut, Storrs Connecticut, March 1, 2019.
5. Making Sense of the Nambu-Jona-Lasinio Model Via Scale Invariance, seminar at the Stanford Linear Accelerator Center, Stanford California, July 10, 2019.
6. Making Sense of the Nambu-Jona-Lasinio Model Via Scale Invariance, seminar at the Light Cone 2019 - QCD on the light cone: from hadrons to heavy ions Conference, Paris, France, September 18, 2019.
7. Light-front Quantization is Instant-time Quantization, seminar at the Light Cone 2019 - QCD on the light cone: from hadrons to heavy ions Conference, Paris, France, September 20, 2019.
8. The 2019 Nobel Prize in Physics, colloquium at the University of Connecticut, Storrs Connecticut, October 18, 2019
9. Is Dark Matter Fact or Fantasy? – Clues From the Data, seminar at University of Texas, Austin Texas, November 18, 2019.
10. Light-front Quantization is Instant-time Quantization, seminar at New Mexico State University, Las Cruces New Mexico, November 20, 2019.
11. Is Dark Matter Fact or Fantasy? – Clues From the Data, seminar at New Mexico State University, Las Cruces New Mexico, November 21, 2019.
12. Is Dark Matter Fact or Fantasy? – Clues From the Data, seminar at University of Saint Andrews, Saint Andrews United Kingdom, November 27 (2019).
13. Quantum Mechanics off the Beaten Track, seminar at University of Saint Andrews, Saint Andrews United Kingdom, November 28, 2019.
14. Quantum Conformal Gravity, seminar at University of Saint Andrews, Saint Andrews United Kingdom, November 29, 2019.
15. Quantum Mechanics off the Beaten Track, seminar at University of Central Florida, Orlando Florida, December 9, 2019.
16. Is Dark Matter Fact or Fantasy? – Clues From the Data, seminar at University of Central Florida, Orlando Florida, December 10, 2019.
17. Light-front Quantization is Instant-time Quantization, seminar at Miami 2019, Fort Lauderdale Florida, December 12, 2019.

2020

1. Ghost problems from Pauli-Villars to fourth-order quantum gravity and their resolution, virtual invited talk at Quantum Physics with Non-Hermitian Operators (PHHQP2020), May 21, 2020.

2. Ghost problems from Pauli-Villars to fourth-order quantum gravity and their resolution, virtual invited talk at International Association of Relativistic Dynamics Conference, June 1, 2020.
3. Ghost problems from Pauli-Villars to fourth-order quantum gravity and their resolution, virtual invited talk at Newton 1665 CERN Conference, June 29, 2020.
4. Is Dark Matter Fact or Fantasy? – Clues From the Data, virtual seminar at San Francisco State University Astronomy Group, September 20, 2020.
5. Comparing light-front quantization with instant-time quantization. virtual invited talk at the International Light Cone Advisory Committee (ILCAC) Conference, November 25, 2020.
6. Is the cosmological constant problem properly posed?, virtual Invited talk at Miami 2020, University of Miami, December 12, 2020.

2021

1. Making Sense of the Nambu-Jona-Lasinio Model Via Scale Invariance, virtual presentation at Third Proton Mass Workshop, Argonne National Laboratory, January 14, 2021.
2. Is Dark Matter Fact or Fantasy? – Clues From the Data, virtual seminar at University of Connecticut, January 27, 2021.
3. Is Dark Matter Fact or Fantasy? – Clues From the Data, virtual colloquium at San Francisco State University, February 8, 2021.
4. Quantum Mechanics off the Beaten Track, colloquium at University of Connecticut, March 5, 2021.
5. Solution to the ghost problem in higher derivative gravity, virtual presentation at Workshop on Quantum Gravity, Higher Derivatives and Nonlocality, March 8, 2021.
6. PT Symmetry, virtual seminar at Czech Technical University in Prague, Prague, Czech Republic, June 4, 2021.
7. Solution to the ghost problem in higher-derivative gravity, virtual seminar at Czech Technical University in Prague, Prague, Czech Republic, June 11, 2021.
8. Solution to the ghost problem in higher-derivative gravity, virtual seminar at University of Marseille, France, June 18, 2021.
9. Making Sense of the Nambu-Jona-Lasinio Model Via Scale Invariance, virtual seminar at University of Marseille, France, July 2, 2021.
10. Extension of the Goldstone and the Englert-Brout-Higgs mechanisms to non-Hermitian theories, virtual invited talk at the 15th Analytic and Algebraic Methods in Physics Conference, Prague, Czech Republic, September 3, 2021.

11. Extension of the Goldstone and the Englert-Brout-Higgs mechanisms to non-Hermitian theories, virtual invited talk at Quantum Physics with Non-Hermitian Operators (PHHQP2020), September 9, 2021.
12. Light-Front Quantization From Then Until Now, virtual invited talk at the Light Cone 2021 - Physics of Hadrons on the Light Front Conference, Jeju Island, Korea, November 30, 2021.
13. Critique of the Use of Geodesics in Astrophysics and Cosmology, virtual Invited talk at Miami 2021, University of Miami, December 16, 2021.

2022

1. Solution to the ghost problem in higher-derivative gravity, virtual seminar at King's College London, United Kingdom, January 12, 2022.
2. How to quantize gravity and how not to quantize gravity, virtual presentation at Quantum Gravity, Cosmology and Black Holes Conference, March 17, 2022.
3. How to quantize gravity and how not to quantize gravity, virtual presentation at General Relativity, Quantum Mechanics and Everything in Between, April 25, 2022.

Recent Refereeing and Reviewing

Served as a reviewer for Physical Review D, Physical Review Letters, Physical Review A, Physics Letters A, Physics Letters B, Journal of Physics A, Classical and Quantum Gravity, General Relativity and Gravitation, Europhysics Letters, International Journal of Theoretical Physics, European Physical Journal C, Hacettepe Journal of Mathematics and Statistics, Journal of Magnetism and Magnetic Materials, Monthly Notices of the Royal Astronomical Society, Physica Scripta, Symmetry Integrability and Geometry: Methods and Applications, Central European Journal of Physics, National Science and Engineering Council of Canada, Journal of Nonlinear Mathematical Physics

Magazine Articles in which I am featured

"Gravity's dark side", Physics World June 2006. (<http://physicsweb.org/articles/world/19/6/5/1>)

"Particle physicist takes on Newton and Einstein", New Scientist, April 2007.

(<http://space.newscientist.com/article/mg19426014.200-particle-physicist-takes-on-newton-and-einstein.html>)

"The Great Cosmology Debate", Astronomy Now, June 2007 and July 2007.

Philip David Mannheim – Recent Presentations to Community Groups

2000

1. "Einstein's Incredible Legacy", University of Connecticut Family Weekend, Storrs CT, October 2000.
2. "The Big Bang Theory", Fitch High School, Groton CT, December 2000.

2001

1. "Is the universe accelerating?", University of Connecticut Physics Club, Storrs CT, September 2001.
2. "Science and the Bible", Emmanuel Synagogue Adult Education Program, West Hartford CT, October 2001.

2002

1. "Is the universe accelerating?", Center for Learning In Retirement, Storrs CT, May 2002.

2003

1. "The accelerating universe", Greater Hartford Learning Corridor, Hartford CT, January 2003.
2. "The accelerating universe", StarConn, Annual Meeting of Connecticut Astronomy Society, at Wesleyan University, Middletown CT, April 2003.
3. "The accelerating universe", University of Connecticut Physics Club, Storrs CT, April 2003.
4. "The accelerating universe", Skyscrapers, amateur astronomical society, Rhode Island, July 2003.
5. "String Theory", University of Connecticut Physics club, Storrs CT, October 2003.
6. "Astronomy and the Jewish calendar", Emmanuel Synagogue, West Hartford CT, November, 2003.

2005

1. "The accelerating universe", E. O. Smith High School, Storrs CT, January, 2005.

2006

1. "The accelerating universe and the anthropic principle", Center for Learning in Retirement, Storrs CT, January 2006.
2. "Science and our place in the cosmos", Merseyside Council of Christians and Jews, Liverpool, England, February 2006.

2007

1. "The accelerating universe", Connecticut Valley Independent School Science Teacher Association, Suffield CT, April 2007.
2. "The accelerating universe", Greater Hartford Academy of Arts and Sciences, Hartford CT, May 2007.
3. "The accelerating universe", Bolton High School, Bolton CT, October 2007.
4. "The accelerating universe", Windsor High School, Windsor CT, October 2007.

2008

1. "The accelerating universe", Amity High School, New Haven, CT, December 2008.

2009

1. "Spacetime curvature and quantum gravity", University of Connecticut Physics Club, Storrs CT, March 2009.

2010

1. "The accelerating universe", Hyde High School, Woodstock CT, January 2010.
2. "The accelerating universe", Osher Lifelong Learning Institute at the University of Connecticut, Waterbury CT, August 2010.
3. "The end of the universe", The Colin McEnroe Show, WNPR public radio station, Hartford CT, September 2010.
4. "The accelerating universe", University of Connecticut Physics Club, Storrs CT, October 2010.

2011

1. "Have we reached an end to big ideas?", The Colin McEnroe Show, WNPR public radio station, Hartford CT, August 2011.
2. "Particle physics research at the University of Connecticut", University of Connecticut Physics Club, Storrs CT, October 2011.
3. "The work of Gerard 't Hooft", University of Connecticut Physics Club, Storrs CT, November 2011.

2012

1. "The sky at night", Emanuel Synagogue Youth Education Program, West Hartford CT, October 2012.
2. "How do we understand 'now'?", The Colin McEnroe Show, WNPR public radio station, Hartford CT, November 2012.
3. "Quantum mechanics with non-Hermitian Hamiltonians", University of Connecticut Physics Club, Storrs CT, December 2012.

2013

1. "The Higgs boson and cosmology", University of Connecticut Physics Club, Storrs CT, April 2013.
2. "Living without dark matter", University of Connecticut Physics Graduate Students Association, September 2013.
3. "The life of a star", University of Connecticut Physics Club, Storrs CT, October 2013.
4. "The large and the small of the universe", The Graduate Institute, Bethany CT, November 2013.

2014

1. "The 2013 Nobel Prize for the Higgs Boson", University of Connecticut Physics Club, Storrs CT, March 2014.
2. "The Higgs Boson", The Colin McEnroe Show, WNPR public radio station, Hartford CT, April 2014.
3. Participant in discussion following the opening night showing of the movie "Particle Fever", Real Art Ways Cinema, Hartford CT, April 2014.
4. "The crisis in fundamental physics", University of Connecticut Physics Club, Storrs CT, October 2014.

2015

1. "The Big Bang and the Accelerating Universe", Hebrew High School of New England, West Hartford CT, March 2015.
2. "Neutrino Oscillations", University of Connecticut Physics Club, Storrs CT, October 2015.

2016

1. "Gravity Waves", interview on University of Connecticut radio station WHUS, April 2016.
2. "Dark Matter", University of Connecticut Physics Club, Storrs CT, October 2016.

2017

1. "Dark Matter, Fact or Fantasy?", Westport Astronomical Society, Westport, CT, May 2017.
2. "Neutrino Oscillations", University of Connecticut Physics Club, Storrs CT, September, 2017.

2018

1. "The Crisis in Fundamental Physics", University of Connecticut Mathematics Department, Research Experience for Undergraduates Program, Storrs CT, June 29, 2018.
2. "The Crisis in Fundamental Physics", Chapman University public lecture, August 31, 2018.

2019

1. "Is dark matter fact or fantasy? – clues from the data", Video Presentation to SuspiciousObservers lay astronomy group: <https://www.youtube.com/watch?v=z5j92Zzojts>

Philip David Mannheim – Statement of Research Interests

Philip Mannheim is an elementary particle theorist who pursues research in grandunification and in dynamical models of mass generation, and who has recently become involved in the explosively growing interface between particle physics and astrophysics. He is active in elementary particle theory, many body theory, astrophysics, cosmology, and general relativity. In all of his work, the notion first of maximum symmetry and then second that of symmetry breaking has been an abiding focus. Given this interest in local symmetry, it was thus natural to extend it to gravity as well, and to consider the possibility that just like the other fundamental strong, electromagnetic and weak interactions, gravity might also be a theory with dimensionless coupling constants and purely dynamical mass scales, i.e. that it might be locally conformal invariant. Given this motivation, conformal gravity theory was then explored in detail, and it was found to solve the dark matter, flatness, horizon, cosmological constant, universe age, and cosmic acceleration problems, all naturally, and all without fine tuning. More recently, the same conformal gravity theory has been shown to be consistent at the quantum level; and with it thus being both renormalizable and unitary, it is advanced as a candidate theory of quantum gravity which can serve as an alternative to string theory.