



Universiteit
Leiden
The Netherlands

Sweeping vacuum gravitational waves under the rug

Negro, A.

Citation

Negro, A. (2024, October 1). *Sweeping vacuum gravitational waves under the rug*. Retrieved from <https://hdl.handle.net/1887/4093391>

Version: Publisher's Version

License: [Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden](#)

Downloaded from: <https://hdl.handle.net/1887/4093391>

Note: To cite this publication please use the final published version (if applicable).

Bibliography

- [1] L. F. Abbott. Introduction to the Background Field Method. *Acta Phys. Polon. B*, 13:33, 1982.
- [2] R. Abbott et al. GW190521: A Binary Black Hole Merger with a Total Mass of $150M_{\odot}$. *Phys. Rev. Lett.*, 125(10):101102, 2020.
- [3] R. Abbott et al. Properties and Astrophysical Implications of the $150 M_{\odot}$ Binary Black Hole Merger GW190521. *Astrophys. J. Lett.*, 900(1):L13, 2020.
- [4] R. Abbott et al. GWTC-3: Compact Binary Coalescences Observed by LIGO and Virgo during the Second Part of the Third Observing Run. *Phys. Rev. X*, 13(4):041039, 2023.
- [5] A. Achúcarro, V. Atal, and Y. Welling. On the viability of $m^2\phi^2$ and natural inflation. *JCAP*, 07:008, 2015.
- [6] V. Acquaviva, N. Bartolo, S. Matarrese, and A. Riotto. Second order cosmological perturbations from inflation. *Nucl. Phys. B*, 667:119–148, 2003.
- [7] P. A. R. Ade et al. Planck 2013 results. XVI. Cosmological parameters. *Astron. Astrophys.*, 571:A16, 2014.
- [8] P. A. R. Ade et al. Planck 2015 results. XIII. Cosmological parameters. *Astron. Astrophys.*, 594:A13, 2016.
- [9] P. A. R. Ade et al. BICEP2 / Keck Array x: Constraints on Primordial Gravitational Waves using Planck, WMAP, and New BICEP2/Keck Observations through the 2015 Season. *Phys. Rev. Lett.*, 121:221301, 2018.
- [10] P. A. R. Ade et al. Improved Constraints on Primordial Gravitational Waves using Planck, WMAP, and BICEP/Keck Observations through the 2018 Observing Season. *Phys. Rev. Lett.*, 127(15):151301, 2021.
- [11] S. L. Adler. Axial vector vertex in spinor electrodynamics. *Phys. Rev.*, 177:2426–2438, 1969.
- [12] S. L. Adler, J. C. Collins, and A. Duncan. Energy-Momentum-Tensor Trace Anomaly in Spin 1/2 Quantum Electrodynamics. *Phys. Rev. D*, 15:1712, 1977.

BIBLIOGRAPHY

- [13] S. L. Adler and J. Lieberman. Trace Anomaly of the Stress - Energy Tensor for Massless Vector Particles Propagating in a General Background Metric. *Annals Phys.*, 113:294, 1978.
- [14] S. L. Adler, J. Lieberman, and Y. J. Ng. Regularization of the Stress Energy Tensor for Vector and Scalar Particles Propagating in a General Background Metric. *Annals Phys.*, 106:279, 1977.
- [15] E. T. Akhmedov. Physical meaning and consequences of the loop infrared divergences in global de Sitter space. *Phys. Rev. D*, 87:044049, 2013.
- [16] E. T. Akhmedov, F. K. Popov, and V. M. Slepukhin. Infrared dynamics of the massive ϕ^4 theory on de Sitter space. *Phys. Rev. D*, 88:024021, 2013.
- [17] B. Allen. The Stochastic gravity wave background: Sources and detection. In *Les Houches School of Physics: Astrophysical Sources of Gravitational Radiation*, pages 373–417, 4 1996.
- [18] B. Allen, A. Folacci, and A. C. Ottewill. The Renormalized Graviton Stress - Energy Tensor in Curved Vacuum Space-times. *Phys. Rev. D*, 38:1069, 1988.
- [19] L. Amendola and S. Tsujikawa. *Dark Energy: Theory and Observations*. Cambridge University Press, 1 2015.
- [20] P. R. Anderson, C. Molina-Paris, and E. Mottola. Cosmological Horizon Modes and Linear Response in de Sitter Spacetime. *Phys. Rev. D*, 80:084005, 2009.
- [21] P. R. Anderson and E. Mottola. Instability of global de Sitter space to particle creation. *Phys. Rev. D*, 89:104038, 2014.
- [22] P. R. Anderson and L. Parker. Adiabatic Regularization in Closed Robertson-walker Universes. *Phys. Rev. D*, 36:2963, 1987.
- [23] K. Ando and V. Vennin. Power spectrum in stochastic inflation. *JCAP*, 04:057, 2021.
- [24] C. Animali, P. Conzino, and G. Marozzi. On adiabatic renormalization with a physically motivated infrared cut-off. *JCAP*, 05(05):026, 2022.
- [25] I. Antoniadis and E. Mottola. Graviton Fluctuations in De Sitter Space. *J. Math. Phys.*, 32:1037–1044, 1991.
- [26] T. Appelquist and J. Carazzone. Infrared Singularities and Massive Fields. *Phys. Rev. D*, 11:2856, 1975.
- [27] I. Y. Arefeva, L. D. Faddeev, and A. A. Slavnov. Generating Functional for the s Matrix in Gauge Theories. *Teor. Mat. Fiz.*, 21:311–321, 1974.
- [28] C. Armendariz-Picon, V. F. Mukhanov, and P. J. Steinhardt. Essentials of k essence. *Phys. Rev. D*, 63:103510, 2001.

- [29] H. Assadullahi, H. Firouzjahi, M. Noorbala, V. Vennin, and D. Wands. Multiple Fields in Stochastic Inflation. *JCAP*, 06:043, 2016.
- [30] V. Balakumar and E. Winstanley. Hadamard renormalization for a charged scalar field. *Class. Quant. Grav.*, 37(6):065004, 2020.
- [31] G. Ballesteros, J. Rey, M. Taoso, and A. Urbano. Stochastic inflationary dynamics beyond slow-roll and consequences for primordial black hole formation. *JCAP*, 08:043, 2020.
- [32] J. M. Bardeen. Gauge Invariant Cosmological Perturbations. *Phys. Rev. D*, 22:1882–1905, 1980.
- [33] J. M. Bardeen and G. J. Bublik. Quantum Fluctuations and Inflation. *Class. Quant. Grav.*, 4:573, 1987.
- [34] N. H. Barth and S. M. Christensen. Quantizing Fourth Order Gravity Theories. 1. The Functional Integral. *Phys. Rev. D*, 28:1876, 1983.
- [35] N. Bartolo, S. Matarrese, M. Pietroni, A. Riotto, and D. Seery. On the Physical Significance of Infra-red Corrections to Inflationary Observables. *JCAP*, 01:015, 2008.
- [36] A. O. Barvinsky and G. A. Vilkovisky. Beyond the Schwinger-Dewitt Technique: Converting Loops Into Trees and In-In Currents. *Nucl. Phys. B*, 282:163–188, 1987.
- [37] A. O. Barvinsky and G. A. Vilkovisky. Covariant perturbation theory. 2: Second order in the curvature. General algorithms. *Nucl. Phys. B*, 333:471–511, 1990.
- [38] A. O. Barvinsky and G. A. Vilkovisky. Covariant perturbation theory. 3: Spectral representations of the third order form-factors. *Nucl. Phys. B*, 333:512–524, 1990.
- [39] D. Baumann. Inflation. In *Theoretical Advanced Study Institute in Elementary Particle Physics: Physics of the Large and the Small*, pages 523–686, 2011.
- [40] M. Baumgart, J. J. Heckman, and L. Thomas. CFTs blueshift tensor fluctuations universally. *JCAP*, 07(07):034, 2022.
- [41] M. Baumgart and R. Sundrum. De Sitter Diagrammar and the Resummation of Time. *JHEP*, 07:119, 2020.
- [42] A. Belokogne and A. Folacci. Stueckelberg massive electromagnetism in curved spacetime: Hadamard renormalization of the stress-energy tensor and the Casimir effect. *Phys. Rev. D*, 93(4):044063, 2016.
- [43] M. Benetti, L. L. Graef, and S. Vagnozzi. Primordial gravitational waves from NANOGrav: A broken power-law approach. *Phys. Rev. D*, 105(4):043520, 2022.

BIBLIOGRAPHY

- [44] M. Berbig and A. Ghoshal. Impact of high-scale Seesaw and Leptogenesis on inflationary tensor perturbations as detectable gravitational waves. *JHEP*, 05:172, 2023.
- [45] J. Berges. Introduction to nonequilibrium quantum field theory. *AIP Conf. Proc.*, 739(1):3–62, 2004.
- [46] E. Bertschinger. Cosmological dynamics: Course 1. In *Les Houches Summer School on Cosmology and Large Scale Structure (Session 60)*, pages 273–348, 8 1993.
- [47] H. J. Bhabha. The scattering of positrons by electrons with exchange on Dirac’s theory of the positron. *Proc. Roy. Soc. Lond. A*, 154:195–206, 1936.
- [48] N. D. Birrell and P. C. W. Davies. *Quantum Fields in Curved Space*. Cambridge Monographs on Mathematical Physics. Cambridge Univ. Press, Cambridge, UK, 2 1984.
- [49] F. Bloch and A. Nordsieck. Note on the Radiation Field of the electron. *Phys. Rev.*, 52:54–59, 1937.
- [50] L. Boubekur, P. Creminelli, J. Norena, and F. Vernizzi. Action approach to cosmological perturbations: the 2nd order metric in matter dominance. *JCAP*, 08:028, 2008.
- [51] D. G. Boulware. Gauge Dependence of the Effective Action. *Phys. Rev. D*, 23:389, 1981.
- [52] D. Boyanovsky and H. J. de Vega. Dynamical renormalization group approach to relaxation in quantum field theory. *Annals Phys.*, 307:335–371, 2003.
- [53] L. A. Boyle and P. J. Steinhardt. Probing the early universe with inflationary gravitational waves. *Phys. Rev. D*, 77:063504, 2008.
- [54] D. R. Brill and J. B. Hartle. Method of the Self-Consistent Field in General Relativity and its Application to the Gravitational Geon. *Phys. Rev.*, 135:B271–B278, 1964.
- [55] M. R. Brown and A. C. Ottewill. Photon Propagators and the Definition and Approximation of Renormalized Stress Tensors in Curved Space-time. *Phys. Rev. D*, 34:1776–1786, 1986.
- [56] T. S. Bunch. Adiabatic Regularization for Scalar Fields with Arbitrary Coupling to the Scalar Curvature. *J. Phys. A*, 13:1297–1310, 1980.
- [57] T. S. Bunch, S. M. Christensen, and S. A. Fulling. Massive Quantum Field Theory in Two-Dimensional Robertson-Walker Space-Time. *Phys. Rev. D*, 18:4435–4459, 1978.
- [58] T. S. Bunch and P. C. W. Davies. Nonconformal Renormalized Stress Tensors in Robertson-Walker Space-Times. *J. Phys. A*, 11:1315–1328, 1978.

- [59] C. Burgess, A. del Rio, and S. S. Patil.
- [60] C. P. Burgess. Quantum gravity in everyday life: General relativity as an effective field theory. *Living Rev. Rel.*, 7:5–56, 2004.
- [61] C. P. Burgess. *Introduction to Effective Field Theory*. Cambridge University Press, 12 2020.
- [62] C. P. Burgess, R. Holman, L. Leblond, and S. Shandera. Breakdown of Semi-classical Methods in de Sitter Space. *JCAP*, 10:017, 2010.
- [63] C. P. Burgess, R. Holman, and G. Tasinato. Open EFTs, IR effects & late-time resummations: systematic corrections in stochastic inflation. *JHEP*, 01:153, 2016.
- [64] C. P. Burgess, L. Leblond, R. Holman, and S. Shandera. Super-Hubble de Sitter Fluctuations and the Dynamical RG. *JCAP*, 03:033, 2010.
- [65] G. Cabass, L. Pagano, L. Salvati, M. Gerbino, E. Giusarma, and A. Melchiorri. Updated Constraints and Forecasts on Primordial Tensor Modes. *Phys. Rev. D*, 93(6):063508, 2016.
- [66] E. A. Calzetta and B.-L. B. Hu. *Nonequilibrium Quantum Field Theory*. Oxford University Press, 2009.
- [67] P. Campeti and E. Komatsu. New Constraint on the Tensor-to-scalar Ratio from the Planck and BICEP/Keck Array Data Using the Profile Likelihood. *Astrophys. J.*, 941(2):110, 2022.
- [68] C. Caprini and D. G. Figueroa. Cosmological Backgrounds of Gravitational Waves. *Class. Quant. Grav.*, 35(16):163001, 2018.
- [69] H. B. G. Casimir and D. Polder. The Influence of retardation on the London-van der Waals forces. *Phys. Rev.*, 73:360–372, 1948.
- [70] J. Chluba, J. Hamann, and S. P. Patil. Features and New Physical Scales in Primordial Observables: Theory and Observation. *Int. J. Mod. Phys. D*, 24(10):1530023, 2015.
- [71] S. M. Christensen. Vacuum Expectation Value of the Stress Tensor in an Arbitrary Curved Background: The Covariant Point Separation Method. *Phys. Rev. D*, 14:2490–2501, 1976.
- [72] S. M. Christensen. Regularization, Renormalization, and Covariant Geodesic Point Separation. *Phys. Rev. D*, 17:946–963, 1978.
- [73] S. M. Christensen and M. J. Duff. Quantizing Gravity with a Cosmological Constant. *Nucl. Phys. B*, 170:480–506, 1980.
- [74] J. C. Collins. *Renormalization*, volume 26 of *Cambridge Monographs on Mathematical Physics*. Cambridge University Press, Cambridge, 7 2023.

BIBLIOGRAPHY

- [75] E. J. Copeland, M. Sami, and S. Tsujikawa. Dynamics of dark energy. *Int. J. Mod. Phys. D*, 15:1753–1936, 2006.
- [76] P. Creminelli, S. Dubovsky, A. Nicolis, L. Senatore, and M. Zaldarriaga. The Phase Transition to Slow-roll Eternal Inflation. *JHEP*, 09:036, 2008.
- [77] D. Cruces. Review on Stochastic Approach to Inflation. *Universe*, 8(6):334, 2022.
- [78] R. H. Cyburt, B. D. Fields, K. A. Olive, and T.-H. Yeh. Big Bang Nucleosynthesis: 2015. *Rev. Mod. Phys.*, 88:015004, 2016.
- [79] B. N. D. The Application of Adiabatic Regularization to Calculations of Cosmological Interest. *Proc R Soc (London) A.*, 361:513–526, 1978.
- [80] P. C. W. Davies, S. A. Fulling, S. M. Christensen, and T. S. Bunch. Energy Momentum Tensor of a Massless Scalar Quantum Field in a Robertson-Walker Universe. *Annals Phys.*, 109:108–142, 1977.
- [81] B. De Witt. Dynamical theory of groups and fields. *Conf. Proc. C*, 630701:585–820, 1964.
- [82] C. De Witt and B. De Witt. Relativité, Groupes et Topologie: Proceedings, Ecole d’été de Physique Théorique. *Session XIII, Les Houches*, France, Jul 1 - Aug 24, 1963.
- [83] Y. Decanini and A. Folacci. Off-diagonal coefficients of the Dewitt-Schwinger and Hadamard representations of the Feynman propagator. *Phys. Rev. D*, 73:044027, 2006.
- [84] A. del Rio, R. Durrer, and S. P. Patil. Tensor Bounds on the Hidden Universe. *JHEP*, 12:094, 2018.
- [85] S. Deser, J. H. Kay, and K. S. Stelle. Renormalizability Properties of Supergravity. *Phys. Rev. Lett.*, 38:527, 1977.
- [86] B. S. DeWitt. A Gauge Invariant Effective Action. In *Oxford Conference on Quantum Gravity*, 7 1980.
- [87] B. S. DeWitt and R. W. Brehme. Radiation damping in a gravitational field. *Annals Phys.*, 9:220–259, 1960.
- [88] S. Dodelson. *Modern Cosmology*. Academic Press, Amsterdam, 2003.
- [89] A. D. Dolgov, M. B. Einhorn, and V. I. Zakharov. The Vacuum of de Sitter space. *Acta Phys. Polon. B*, 26:65–90, 1995.
- [90] J. F. Donoghue. General relativity as an effective field theory: The leading quantum corrections. *Phys. Rev. D*, 50:3874–3888, 1994.

- [91] J. F. Donoghue. Introduction to the effective field theory description of gravity. In *Advanced School on Effective Theories*, 6 1995.
- [92] J. F. Donoghue. The effective field theory treatment of quantum gravity. *AIP Conf. Proc.*, 1483(1):73–94, 2012.
- [93] J. S. Dowker and R. Critchley. Effective Lagrangian and Energy Momentum Tensor in de Sitter Space. *Phys. Rev. D*, 13:3224, 1976.
- [94] G. Ecker and J. Honerkamp. Application of invariant renormalization to the nonlinear chiral invariant pion lagrangian in the one-loop approximation. *Nucl. Phys. B*, 35:481–492, 1971.
- [95] K. Enqvist, S. Nurmi, D. Podolsky, and G. I. Rigopoulos. On the divergences of inflationary superhorizon perturbations. *JCAP*, 04:025, 2008.
- [96] J. M. Ezquiaga, J. García-Bellido, and V. Vennin. The exponential tail of inflationary fluctuations: consequences for primordial black holes. *JCAP*, 03:029, 2020.
- [97] L. D. Faddeev and V. N. Popov. Feynman Diagrams for the Yang-Mills Field. *Phys. Lett. B*, 25:29–30, 1967.
- [98] A. Ferreira and F. Torrenti. Ultraviolet-regularized power spectrum without infrared distortions in cosmological spacetimes. *Phys. Lett. B*, 840:137868, 2023.
- [99] F. Finelli, G. Marozzi, A. A. Starobinsky, G. P. Vacca, and G. Venturi. Generation of fluctuations during inflation: Comparison of stochastic and field-theoretic approaches. *Phys. Rev. D*, 79:044007, 2009.
- [100] F. Finelli, G. Marozzi, A. A. Starobinsky, G. P. Vacca, and G. Venturi. Stochastic growth of quantum fluctuations during slow-roll inflation. *Phys. Rev. D*, 82:064020, 2010.
- [101] L. H. Ford. Quantum Instability of De Sitter Space-time. *Phys. Rev. D*, 31:710, 1985.
- [102] A. Friedman. On the Curvature of Space . *General Relativity and Gravitation*, 31:1991–2000, 1999.
- [103] A. Friedmann. On the Possibility of a world with constant negative curvature of space. *Z. Phys.*, 21:326–332, 1924.
- [104] S. A. Fulling, L. Parker, and B. L. Hu. Conformal energy-momentum tensor in curved spacetime: Adiabatic regularization and renormalization. *Phys. Rev. D*, 10:3905–3924, 1974.
- [105] J. Garcia-Bellido and E. Ruiz Morales. Primordial black holes from single field models of inflation. *Phys. Dark Univ.*, 18:47–54, 2017.

BIBLIOGRAPHY

- [106] M. Gasperini and G. Veneziano. String Theory and Pre-big bang Cosmology. *Nuovo Cim. C*, 38(5):160, 2016.
- [107] W. Giarè, M. Forconi, E. Di Valentino, and A. Melchiorri. Towards a reliable calculation of relic radiation from primordial gravitational waves. *Mon. Not. Roy. Astron. Soc.*, 520:2, 2023.
- [108] S. B. Giddings and M. S. Sloth. Semiclassical relations and IR effects in de Sitter and slow-roll space-times. *JCAP*, 01:023, 2011.
- [109] D. Glavan, T. Prokopec, and T. Takahashi. Late-time quantum backreaction of a very light nonminimally coupled scalar. *Phys. Rev. D*, 94:084053, 2016.
- [110] A. S. Goncharov, A. D. Linde, and V. F. Mukhanov. The Global Structure of the Inflationary Universe. *Int. J. Mod. Phys. A*, 2:561–591, 1987.
- [111] E. P. Gordov and S. D. Tvorogov. Eigenfunctions of the Vector-Potential Operator of the Electromagnetic Field and Semiclassical Electrodynamics. *Phys. Rev. D*, 8:3286, 1973.
- [112] M. H. Goroff and A. Sagnotti. The Ultraviolet Behavior of Einstein Gravity. *Nucl. Phys. B*, 266:709–736, 1986.
- [113] A. M. Green and A. R. Liddle. Constraints on the density perturbation spectrum from primordial black holes. *Phys. Rev. D*, 56:6166–6174, 1997.
- [114] D. Green and A. Premkumar. Dynamical RG and Critical Phenomena in de Sitter Space. *JHEP*, 04:064, 2020.
- [115] L. P. Grishchuk. Amplification of gravitational waves in an isotropic universe. *Zh. Eksp. Teor. Fiz.*, 67:825–838, 1974.
- [116] G. Grunberg. Renormalization Group Improved Perturbative QCD. *Phys. Lett. B*, 95:70, 1980. [Erratum: Phys.Lett.B 110, 501 (1982)].
- [117] G. Grunberg. Renormalization Scheme Independent QCD and QED: The Method of Effective Charges. *Phys. Rev. D*, 29:2315–2338, 1984.
- [118] A. H. Guth. The Inflationary Universe: A Possible Solution to the Horizon and Flatness Problems. *Phys. Rev. D*, 23:347–356, 1981.
- [119] M. C. Guzzetti, N. Bartolo, M. Liguori, and S. Matarrese. Gravitational waves from inflation. *Riv. Nuovo Cim.*, 39(9):399–495, 2016.
- [120] J. Hadamard. Le problème de Cauchy et les équations aux dérivées partielles linéaires hyperboliques.
- [121] S. Henrot-Versille et al. Improved constraint on the primordial gravitational-wave density using recent cosmological data and its impact on cosmic string models. *Class. Quant. Grav.*, 32(4):045003, 2015.

- [122] A. Higuchi. Decay of the free-theory vacuum of scalar field theory in de Sitter spacetime in the interaction picture. *Class. Quant. Grav.*, 26:072001, 2009.
- [123] R. A. Isaacson. Gravitational Radiation in the Limit of High Frequency. II. Nonlinear Terms and the Effective Stress Tensor. *Phys. Rev.*, 166:1272–1279, 1968.
- [124] R. A. Isaacson. Gravitational Radiation in the Limit of High Frequency. II. Nonlinear Terms and the Effective Stress Tensor. *Phys. Rev.*, 166:1272–1279, 1968.
- [125] C. Itzykson and J. B. Zuber. *Quantum Field Theory*. International Series In Pure and Applied Physics. McGraw-Hill, New York, 1980.
- [126] E. O. Kahya and V. K. Onemli. Quantum Stability of a $w < -1$ Phase of Cosmic Acceleration. *Phys. Rev. D*, 76:043512, 2007.
- [127] N. Kaiser. Theoretical implications of deviations from Hubble flow. *Mon. Not. Roy. Astron. Soc.*, 231:149, 1989.
- [128] M. Kamionkowski, A. Kosowsky, and A. Stebbins. Statistics of cosmic microwave background polarization. *Phys. Rev. D*, 55:7368–7388, 1997.
- [129] S. Y. Khlebnikov and I. I. Tkachev. Classical decay of inflaton. *Phys. Rev. Lett.*, 77:219–222, 1996.
- [130] H. Kleinert and V. Schulte-Frohlinde. *Critical properties of ϕ^4 -theories*. 2001.
- [131] H. Kluberg-Stern and J. B. Zuber. Renormalization of Nonabelian Gauge Theories in a Background Field Gauge. 1. Green Functions. *Phys. Rev. D*, 12:482–488, 1975.
- [132] H. Kodama and M. Sasaki. Cosmological Perturbation Theory. *Prog. Theor. Phys. Suppl.*, 78:1–166, 1984.
- [133] J. F. Koksmma and T. Prokopec. The Cosmological Constant and Lorentz Invariance of the Vacuum State. 5 2011.
- [134] E. W. Kolb and M. S. Turner. *The Early Universe*, volume 69. 1990.
- [135] E. W. Kolb and S. Wolfram. Baryon Number Generation in the Early Universe. *Nucl. Phys. B*, 172:224, 1980. [Erratum: Nucl.Phys.B 195, 542 (1982)].
- [136] Z. Kunszt. From scattering amplitudes to cross-sections in QCD. In *Theoretical Advanced Study Institute in Elementary Particle Physics (TASI 95): QCD and Beyond*, pages 515–538, 3 1996.
- [137] S. K. Lamoreaux. Demonstration of the Casimir force in the 0.6 to 6 micrometers range. *Phys. Rev. Lett.*, 78:5–8, 1997. [Erratum: Phys.Rev.Lett. 81, 5475–5476 (1998)].

BIBLIOGRAPHY

- [138] A. Landete, J. Navarro-Salas, and F. Torrenti. Adiabatic regularization and particle creation for spin one-half fields. *Phys. Rev. D*, 89:044030, 2014.
- [139] G. Lemaitre. A Homogeneous Universe of Constant Mass and Increasing Radius accounting for the Radial Velocity of Extra-galactic Nebulae. *Mon. Not. Roy. Astron. Soc.*, 91(5):483–490, 1931.
- [140] J. Li, Z.-C. Chen, and Q.-G. Huang. Measuring the tilt of primordial gravitational-wave power spectrum from observations. *Sci. China Phys. Mech. Astron.*, 62(11):110421, 2019. [Erratum: *Sci.China Phys.Mech.Astron.* 64, 250451 (2021)].
- [141] A. R. Liddle. *An introduction to modern cosmology*. 1998.
- [142] A. R. Liddle and A. M. Green. Cosmological constraints from primordial black holes. *Phys. Rept.*, 307:125–131, 1998.
- [143] E. Lifshitz. Republication of: On the gravitational stability of the expanding universe. *J. Phys. (USSR)*, 10(2):116, 1946.
- [144] A. D. Linde. A New Inflationary Universe Scenario: A Possible Solution of the Horizon, Flatness, Homogeneity, Isotropy and Primordial Monopole Problems. *Phys. Lett. B*, 108:389–393, 1982.
- [145] A. D. Linde, D. A. Linde, and A. Mezhlumian. From the Big Bang theory to the theory of a stationary universe. *Phys. Rev. D*, 49:1783–1826, 1994.
- [146] X.-J. Liu, W. Zhao, Y. Zhang, and Z.-H. Zhu. Detecting Relic Gravitational Waves by Pulsar Timing Arrays: Effects of Cosmic Phase Transitions and Relativistic Free-Streaming Gases. *Phys. Rev. D*, 93(2):024031, 2016.
- [147] J. Lizarraga, I. Sendra, and J. Urrestilla. Correlations between cosmic strings and extra relativistic species. *Phys. Rev. D*, 86:123014, 2012.
- [148] G. Luisoni and S. Marzani. QCD resummation for hadronic final states. *J. Phys. G*, 42(10):103101, 2015.
- [149] M. A. H. Maccallum and A. H. Taub. The averaged lagrangian and high-frequency gravitational waves. *Commun. Math. Phys.*, 30:153–169, 1973.
- [150] M. Maggiore. Stochastic backgrounds of gravitational waves. *ICTP Lect. Notes Ser.*, 3:397–414, 2001.
- [151] M. Maggiore. *Gravitational Waves. Vol. 1: Theory and Experiments*. Oxford University Press, 2007.
- [152] M. Maggiore. *Gravitational Waves. Vol. 1: Theory and Experiments*. Oxford University Press, 2007.
- [153] K. A. Malik and D. Wands. Cosmological perturbations. *Phys. Rept.*, 475:1–51, 2009.

- [154] A. V. Manohar. The HQET / NRQCD Lagrangian to order alpha / m-3. *Phys. Rev. D*, 56:230–237, 1997.
- [155] A. V. Manohar. Introduction to Effective Field Theories. 4 2018.
- [156] F. J. Marañón González and J. Navarro-Salas. Adiabatic regularization for spin-1 fields. *Phys. Rev. D*, 108(12):125001, 2023.
- [157] S. Matarrese. On the Classical and Quantum Irrotational Motions of a Relativistic Perfect Fluid. 1. Classical Theory. *Proc. Roy. Soc. Lond. A*, 401:53–66, 1985.
- [158] P. D. Meerburg, R. Hložek, B. Hadzhiyska, and J. Meyers. Multiwavelength constraints on the inflationary consistency relation. *Phys. Rev. D*, 91(10):103505, 2015.
- [159] D. Melikhov and B. Stech. On the $\gamma^*\gamma \rightarrow \pi(\eta, \eta')$ transition form factors. *Phys. Rev. D*, 85:051901, 2012.
- [160] C. W. Misner, K. S. Thorne, and J. A. Wheeler. *Gravitation*. W. H. Freeman, San Francisco, 1973.
- [161] S. Mollerach, S. Matarrese, A. Ortolan, and F. Lucchin. Stochastic inflation in a simple two field model. *Phys. Rev. D*, 44:1670–1679, 1991.
- [162] E. Mottola. Thermodynamic Instability of de Sitter Space. *Phys. Rev. D*, 33:1616–1621, 1986.
- [163] V. Mukhanov. *Physical Foundations of Cosmology*. Cambridge University Press, Oxford, 2005.
- [164] V. Mukhanov and S. Winitzki. *Introduction to quantum effects in gravity*. Cambridge University Press, 6 2007.
- [165] V. F. Mukhanov, H. A. Feldman, and R. H. Brandenberger. Theory of cosmological perturbations. Part 1. Classical perturbations. Part 2. Quantum theory of perturbations. Part 3. Extensions. *Phys. Rept.*, 215:203–333, 1992.
- [166] K.-i. Nakao, Y. Nambu, and M. Sasaki. Stochastic Dynamics of New Inflation. *Prog. Theor. Phys.*, 80:1041, 1988.
- [167] Y. Nambu. Stochastic Dynamics of an Inflationary Model and Initial Distribution of Universes. *Prog. Theor. Phys.*, 81:1037, 1989.
- [168] Y. Nambu and M. Sasaki. Stochastic approach to chaotic inflation and the distribution of universes. *Phys. Lett. B*, 219:240–246, 1989.
- [169] A. Negro and S. P. Patil. An Étude on the Regularization and Renormalization of Divergences in Primordial Observables. 2 2024.

BIBLIOGRAPHY

- [170] A. Negro and S. P. Patil. Hadamard Regularization of the Graviton Stress Tensor. 3 2024.
- [171] A. Negro and S. S. Patil. .
- [172] C. Newton, P. Osland, and T. T. Wu. Point splitting regularization for gauge theories: Quantum electrodynamics. *Z. Phys. C*, 61:441–448, 1994.
- [173] K. A. Olive, G. Steigman, and T. P. Walker. Primordial nucleosynthesis: Theory and observations. *Phys. Rept.*, 333:389–407, 2000.
- [174] V. K. Onemli and R. P. Woodard. Quantum effects can render $w < -1$ on cosmological scales. *Phys. Rev. D*, 70:107301, 2004.
- [175] T. Padmanabhan. Cosmological constant: The Weight of the vacuum. *Phys. Rept.*, 380:235–320, 2003.
- [176] L. Pagano, L. Salvati, and A. Melchiorri. New constraints on primordial gravitational waves from Planck 2015. *Phys. Lett. B*, 760:823–825, 2016.
- [177] S. N. Pandey. Conformally Invariant Gravitational Waves in a Modified Gravitational Theory. *Int. J. Theor. Phys.*, 22:209–217, 1983.
- [178] L. E. Parker and D. Toms. *Quantum Field Theory in Curved Spacetime: Quantized Field and Gravity*. Cambridge Monographs on Mathematical Physics. Cambridge University Press, 8 2009.
- [179] P. J. Peebles. *The Large-Scale Structure of the Universe*. Princeton University Press, 11 1980.
- [180] P. J. E. Peebles and B. Ratra. The Cosmological Constant and Dark Energy. *Rev. Mod. Phys.*, 75:559–606, 2003.
- [181] A. A. Penzias and R. W. Wilson. A Measurement of excess antenna temperature at 4080-Mc/s. *Astrophys. J.*, 142:419–421, 1965.
- [182] L. Perreault Levasseur. Lagrangian formulation of stochastic inflation: Langevin equations, one-loop corrections and a proposed recursive approach. *Phys. Rev. D*, 88(8):083537, 2013.
- [183] A. M. Polyakov. Infrared instability of the de Sitter space. 9 2012.
- [184] P. Ramond. *Field theory: a modern primer*, volume 51. 1981.
- [185] S.-J. Rey. Dynamics of Inflationary Phase Transition. *Nucl. Phys. B*, 284:706–728, 1987.
- [186] A. Riotto. *Inflation and the Theory of Cosmological Perturbations*. 2018.
- [187] H. P. Robertson. Kinematics and World-Structure. *Astrophys. J.*, 82:284–301, 1935.

- [188] V. A. Rubakov, M. V. Sazhin, and A. V. Veryaskin. Graviton Creation in the Inflationary Universe and the Grand Unification Scale. *Phys. Lett. B*, 115:189–192, 1982.
- [189] D. S. Salopek and J. R. Bond. Stochastic inflation and nonlinear gravity. *Phys. Rev. D*, 43:1005–1031, 1991.
- [190] S. Sarkar. Big bang nucleosynthesis and physics beyond the standard model. *Rept. Prog. Phys.*, 59:1493–1610, 1996.
- [191] S. Sarkar and H. Strubbe. Anomalous Dimensions in Background Field Gauges. *Nucl. Phys. B*, 90:45–51, 1975.
- [192] M. Sasaki. Large Scale Quantum Fluctuations in the Inflationary Universe. *Prog. Theor. Phys.*, 76:1036, 1986.
- [193] L. Schwartz. *Theorie des distributions*.
- [194] M. D. Schwartz. *Quantum Field Theory and the Standard Model*. Cambridge University Press, 3 2014.
- [195] D. J. Schwarz. Evolution of gravitational waves through cosmological transitions. *Mod. Phys. Lett. A*, 13:2771–2778, 1998.
- [196] J. S. Schwinger. On gauge invariance and vacuum polarization. *Phys. Rev.*, 82:664–679, 1951.
- [197] D. Seery. Infrared effects in inflationary correlation functions. *Class. Quant. Grav.*, 27:124005, 2010.
- [198] U. Seljak and M. Zaldarriaga. Signature of gravity waves in polarization of the microwave background. *Phys. Rev. Lett.*, 78:2054–2057, 1997.
- [199] L. Senatore and M. Zaldarriaga. On Loops in Inflation. *JHEP*, 12:008, 2010.
- [200] T. L. Smith, E. Pierpaoli, and M. Kamionkowski. A new cosmic microwave background constraint to primordial gravitational waves. *Phys. Rev. Lett.*, 97:021301, 2006.
- [201] A. A. Starobinsky. Spectrum of relict gravitational radiation and the early state of the universe. *JETP Lett.*, 30:682–685, 1979.
- [202] A. A. Starobinsky. Stochastic de Sitter (Inflationary) Stage in the Early Universe. *Lect. Notes Phys.*, 246:107–126, 1986.
- [203] A. A. Starobinsky and J. Yokoyama. Equilibrium state of a selfinteracting scalar field in the De Sitter background. *Phys. Rev. D*, 50:6357–6368, 1994.
- [204] L. C. Stein and N. Yunes. Effective Gravitational Wave Stress-energy Tensor in Alternative Theories of Gravity. *Phys. Rev. D*, 83:064038, 2011.

BIBLIOGRAPHY

- [205] K. Symanzik. Small distance behavior in field theory and power counting. *Commun. Math. Phys.*, 18:227–246, 1970.
- [206] G. 't Hooft. An algorithm for the poles at dimension four in the dimensional regularization procedure. *Nucl. Phys. B*, 62:444–460, 1973.
- [207] G. 't Hooft. The Background Field Method in Gauge Field Theories. In *12th Annual Winter School of Theoretical Physics*, 1975.
- [208] G. 't Hooft and M. J. G. Veltman. One loop divergencies in the theory of gravitation. *Ann. Inst. H. Poincaré Phys. Théor. A*, 20:69–94, 1974.
- [209] Y. Tada and V. Vennin. Statistics of coarse-grained cosmological fields in stochastic inflation. *JCAP*, 02(02):021, 2022.
- [210] D. V. Vassilevich. Heat kernel expansion: User's manual. *Phys. Rept.*, 388:279–360, 2003.
- [211] V. Vennin and A. A. Starobinsky. Correlation Functions in Stochastic Inflation. *Eur. Phys. J. C*, 75:413, 2015.
- [212] A. G. Walker. On Milne's Theory of World-Structure. *Proc. Lond. Math. Soc.*, 2-42(1):90–127, 1937.
- [213] T. P. Walker, G. Steigman, D. N. Schramm, K. A. Olive, and H.-S. Kang. Primordial nucleosynthesis redux. *Astrophys. J.*, 376:51–69, 1991.
- [214] S. Weinberg. Cosmological Production of Baryons. *Phys. Rev. Lett.*, 42:850–853, 1979.
- [215] S. Weinberg. *The Quantum theory of fields. Vol. 1: Foundations*. Cambridge University Press, 6 2005.
- [216] S. Weinberg. Effective Field Theory for Inflation. *Phys. Rev. D*, 77:123541, 2008.
- [217] A. Wightman. Hilbert's sixth problem: Mathematical treatment of the axioms of physics. *Amer. Math. Soc.*, 28:241–268, 1976.
- [218] A. Zee. *Quantum Field Theory in a Nutshell: Second Edition*. Princeton University Press, 2 2010.