

Cover Page



Universiteit Leiden



The handle <http://hdl.handle.net/1887/67091> holds various files of this Leiden University dissertation.

Author: Welling, Y.M.

Title: Spectroscopy of two-field Inflation

Issue Date: 2018-11-27

Bibliografie

- [1] J.-P. Luminet, “Lemaitre’s Big Bang,” *PoS*, vol. FFP14, p. 214, 2016, 1503.08304.
- [2] J. Einasto, “Dark Matter,” *ArXiv e-prints*, Jan. 2009, 0901.0632.
- [3] A. D. Linde, “Particle physics and inflationary cosmology,” *Contemp. Concepts Phys.*, vol. 5, pp. 1–362, 1990, hep-th/0503203.
- [4] V. Mukhanov, *Physical Foundations of Cosmology*. Oxford: Cambridge University Press, 2005.
- [5] D. Baumann, “Inflation,” in *Physics of the large and the small, TASI 09, proceedings of the Theoretical Advanced Study Institute in Elementary Particle Physics, Boulder, Colorado, USA, 1-26 June 2009*, pp. 523–686, 2011, 0907.5424.
- [6] S. Weinberg, *Cosmology*. 2008.
- [7] A. Einstein, “The Foundation of the General Theory of Relativity,” *Annalen Phys.*, vol. 49, no. 7, pp. 769–822, 1916. [65(1916)].
- [8] A. Einstein, “Cosmological Considerations in the General Theory of Relativity,” *Sitzungsber. Preuss. Akad. Wiss. Berlin (Math. Phys.)*, vol. 1917, pp. 142–152, 1917.
- [9] A. S. Eddington, “On the Instability of Einstein’s Spherical World,” *Mon. Not. Roy. Astron. Soc.*, vol. 90, pp. 668–678, 1930.
- [10] W. de Sitter, “Einstein’s theory of gravitation and its astronomical consequences,” *Mon. Not. Roy. Astron. Soc.*, vol. 78, pp. 3–28, 1917.
- [11] V. M. Slipher, “Nebulae,” *Proceedings of the American Philosophical Society*, vol. 56, pp. 403–409, 1917.

- [12] A. Friedmann, "On the curvature of space," *Z. Phys.*, vol. 10, p. 377–386, 1922. [Gen. Rel. Grav.31,1991 (1999)].
- [13] A. Friedmann, "On the Possibility of a world with constant negative curvature of space," *Z. Phys.*, vol. 21, pp. 326–332, 1924. [Gen. Rel. Grav.31,2001(1999)].
- [14] G. Lemaitre, "A Homogeneous Universe of Constant Mass and Growing Radius Accounting for the Radial Velocity of Extragalactic Nebulae," *Annales Soc. Sci. Bruxelles A*, vol. 47, pp. 49–59, 1927. [Gen. Rel. Grav.45,no.8,1635(2013)].
- [15] H. P. Robertson, "Kinematics and World-Structure," *Astrophys. J.*, vol. 82, pp. 284–301, 1935.
- [16] A. G. Walker, "On Milne's theory of world-structure," *Proceedings of the London Mathematical Society*, vol. 42, p. 90–127, 1937.
- [17] E. P. Hubble, "Extragalactic nebulae," *Astrophys. J.*, vol. 64, pp. 321–369, 1926.
- [18] A. S. Eddington, *The Mathematical Theory of Relativity*. 1924.
- [19] G. Lemaitre, "Note on de sitter's universe," *Journal of mathematics and physics*, vol. 4, no. 1-4, pp. 188–192, 1925.
- [20] E. Hubble, "A relation between distance and radial velocity among extragalactic nebulae," *Proc. Nat. Acad. Sci.*, vol. 15, pp. 168–173, 1929.
- [21] G. Lemaitre, "The expanding universe," *Gen. Rel. Grav.*, vol. 29, pp. 641–680, 1997. [Annales Soc. Sci. Bruxelles A53,51(1933)].
- [22] R. A. Alpher, H. Bethe, and G. Gamow, "The origin of chemical elements," *Phys. Rev.*, vol. 73, pp. 803–804, 1948.
- [23] R. H. Cyburt, B. D. Fields, and K. A. Olive, "Primordial nucleosynthesis in light of WMAP," *Phys.Lett.*, vol. B567, pp. 227–234, 2003, astro-ph/0302431.
- [24] A. Coc, J.-P. Uzan, and E. Vangioni, "Standard Big-Bang Nucleosynthesis after Planck," 2013, 1307.6955.
- [25] A. Coc, P. Petitjean, J.-P. Uzan, E. Vangioni, P. Descouvemont, C. Iliadis, and R. Longland, "New reaction rates for improved primordial D/H calculation and the cosmic evolution of deuterium," *Phys. Rev.*, vol. D92, no. 12, p. 123526, 2015, 1511.03843.

-
- [26] R. A. Alpher and H. Herman, “Evolution of the Universe,” *Nature*, vol. 162, pp. 774–775, 1948.
- [27] A. A. Penzias and R. W. Wilson, “A Measurement of excess antenna temperature at 4080-Mc/s,” *Astrophys. J.*, vol. 142, pp. 419–421, 1965.
- [28] J. C. Mather *et al.*, “Measurement of the Cosmic Microwave Background spectrum by the COBE FIRAS instrument,” *Astrophys. J.*, vol. 420, pp. 439–444, 1994.
- [29] G. F. Smoot, C. Bennett, A. Kogut, E. Wright, J. Aymon, *et al.*, “Structure in the COBE differential microwave radiometer first year maps,” *Astrophys. J.*, vol. 396, pp. L1–L5, 1992.
- [30] R. Adam *et al.*, “Planck 2015 results. I. Overview of products and scientific results,” *Astron. Astrophys.*, vol. 594, p. A1, 2016, 1502.01582.
- [31] H. W. Babcock, “The rotation of the Andromeda Nebula,” *Lick Observatory Bulletin*, vol. 19, pp. 41–51, 1939.
- [32] J. H. Oort, “Some Problems Concerning the Structure and Dynamics of the Galactic System and the Elliptical Nebulae NGC 3115 and 4494.,” *ApJ*, vol. 91, p. 273, Apr. 1940.
- [33] P. J. E. Peebles, *Physical cosmology*. 1971.
- [34] Y. Parijskij, “Search for Primordial Perturbations of the Universe: Observations with Ratan-600 Radio Telescope,” *The Large Scale Structure of the Universe. International Astronomical Union*, vol. 79, 1978.
- [35] J. Kapteyn, “First Attempt at a Theory of the Arrangement and Motion of the Sidereal System,” *ApJ*, vol. 55, p. 302, May 1922.
- [36] J. H. Jeans, “The Motions of Stars in a Kapteyn Universe,” *MNRAS*, vol. 82, pp. 122–132, Jan. 1922.
- [37] F. Zwicky, “Die Rotverschiebung von extragalaktischen Nebeln,” *Helvetica Physica Acta*, vol. 6, pp. 110–127, 1933.
- [38] V. C. Rubin, W. K. Ford, Jr., and N. Thonnard, “Rotational properties of 21 SC galaxies with a large range of luminosities and radii, from NGC 4605 / $R = 4\text{kpc}/$ to UGC 2885 / $R = 122\text{ kpc}/$,” *ApJ*, vol. 238, pp. 471–487, June 1980.
- [39] G. R. Blumenthal, H. Pagels, and J. R. Primack, “Galaxy formation by dissipationless particles heavier than neutrinos,” *Nature*, vol. 299, p. 37, Sept. 1982.

- [40] J. R. Bond, A. S. Szalay, and M. S. Turner, "Formation of Galaxies in a Gravitino Dominated Universe," *Phys. Rev. Lett.*, vol. 48, p. 1636, 1982.
- [41] H. Pagels and J. R. Primack, "Supersymmetry, cosmology, and new physics at teraelectronvolt energies," *Physical Review Letters*, vol. 48, pp. 223–226, Jan. 1982.
- [42] P. J. E. Peebles, "Primeval adiabatic perturbations - Effect of massive neutrinos," *ApJ*, vol. 258, pp. 415–424, July 1982.
- [43] J. R. Bond and A. S. Szalay, "The collisionless damping of density fluctuations in an expanding universe," *ApJ*, vol. 274, pp. 443–468, Nov. 1983.
- [44] J. E. Gunn and B. M. Tinsley, "An accelerating Universe," *Nature*, vol. 257, pp. 454–457, Oct. 1975.
- [45] M. S. Turner, G. Steigman, and L. M. Krauss, "Flatness of the universe - Reconciling theoretical prejudices with observational data," *Physical Review Letters*, vol. 52, pp. 2090–2093, June 1984.
- [46] L. A. Kofman and A. A. Starobinskii, "Effect of the Cosmological Constant on Largescale Anisotropies in the Microwave Background," *Soviet Astronomy Letters*, vol. 11, pp. 271–274, Sept. 1985.
- [47] A. G. Riess *et al.*, "Observational evidence from supernovae for an accelerating universe and a cosmological constant," *Astron. J.*, vol. 116, pp. 1009–1038, 1998, astro-ph/9805201.
- [48] S. Perlmutter *et al.*, "Measurements of Omega and Lambda from 42 high redshift supernovae," *Astrophys. J.*, vol. 517, pp. 565–586, 1999, astro-ph/9812133.
- [49] D. N. Spergel *et al.*, "First year Wilkinson Microwave Anisotropy Probe (WMAP) observations: Determination of cosmological parameters," *Astrophys. J. Suppl.*, vol. 148, pp. 175–194, 2003, astro-ph/0302209.
- [50] A. R. Liddle, "An Introduction to cosmological inflation," in *Proceedings, Summer School in High-energy physics and cosmology: Trieste, Italy, June 29-July 17, 1998*, pp. 260–295, 1999, astro-ph/9901124.
- [51] A. H. Guth, "The Inflationary Universe: A Possible Solution to the Horizon and Flatness Problems," *Phys. Rev.*, vol. D23, pp. 347–356, 1981.

-
- [52] S. W. Hawking, I. G. Moss, and J. M. Stewart, “Bubble collisions in the very early universe,” *Phys. Rev. D*, vol. 26, pp. 2681–2693, Nov. 1982.
- [53] A. H. Guth and E. J. Weinberg, “Could the Universe Have Recovered from a Slow First Order Phase Transition?,” *Nucl. Phys.*, vol. B212, pp. 321–364, 1983.
- [54] A. D. Linde, “A New Inflationary Universe Scenario: A Possible Solution of the Horizon, Flatness, Homogeneity, Isotropy and Primordial Monopole Problems,” *Phys. Lett.*, vol. 108B, pp. 389–393, 1982.
- [55] A. Albrecht and P. J. Steinhardt, “Cosmology for Grand Unified Theories with Radiatively Induced Symmetry Breaking,” *Phys. Rev. Lett.*, vol. 48, pp. 1220–1223, 1982.
- [56] V. F. Mukhanov and G. V. Chibisov, “Quantum Fluctuation and Non-singular Universe. (In Russian),” *JETP Lett.*, vol. 33, pp. 532–535, 1981.
- [57] A. A. Starobinsky, “Spectrum of relict gravitational radiation and the early state of the universe,” *JETP Lett.*, vol. 30, pp. 682–685, 1979.
- [58] S. Hawking, “The Development of Irregularities in a Single Bubble Inflationary Universe,” *Phys.Lett.*, vol. B115, p. 295, 1982.
- [59] A. A. Starobinsky, “Dynamics of Phase Transition in the New Inflationary Universe Scenario and Generation of Perturbations,” *Phys.Lett.*, vol. B117, pp. 175–178, 1982.
- [60] A. H. Guth and S. Pi, “Fluctuations in the New Inflationary Universe,” *Phys.Rev.Lett.*, vol. 49, pp. 1110–1113, 1982.
- [61] J. M. Bardeen, P. J. Steinhardt, and M. S. Turner, “Spontaneous Creation of Almost Scale - Free Density Perturbations in an Inflationary Universe,” *Phys. Rev.*, vol. D28, p. 679, 1983.
- [62] A. D. Linde, “Chaotic Inflation,” *Phys. Lett.*, vol. 129B, pp. 177–181, 1983.
- [63] P. A. R. Ade *et al.*, “Planck 2015 results. XIII. Cosmological parameters,” *Astron. Astrophys.*, vol. 594, p. A13, 2016, 1502.01589.
- [64] A. G. Riess *et al.*, “A 2.4% Determination of the Local Value of the Hubble Constant,” *Astrophys. J.*, vol. 826, no. 1, p. 56, 2016, 1604.01424.
- [65] T. M. C. Abbott *et al.*, “Dark Energy Survey Year 1 Results: Cosmological Constraints from Galaxy Clustering and Weak Lensing,” 2017, 1708.01530.

- [66] H. Hildebrandt *et al.*, “KiDS-450: Cosmological parameter constraints from tomographic weak gravitational lensing,” *Mon. Not. Roy. Astron. Soc.*, vol. 465, p. 1454, 2017, 1606.05338.
- [67] K. N. Abazajian *et al.*, “CMB-S4 Science Book, First Edition,” 2016, 1610.02743.
- [68] LSST Science Collaboration, P. A. Abell, J. Allison, S. F. Anderson, J. R. Andrew, J. R. P. Angel, L. Armus, D. Arnett, S. J. Asztalos, T. S. Axelrod, and *et al.*, “LSST Science Book, Version 2.0,” *ArXiv e-prints*, Dec. 2009, 0912.0201.
- [69] R. Laureijs, J. Amiaux, S. Arduini, J. . Auguères, J. Brinchmann, R. Cole, M. Cropper, C. Dabin, L. Duvet, A. Ealet, and *et al.*, “Euclid Definition Study Report,” *ArXiv e-prints*, Oct. 2011, 1110.3193.
- [70] D. Baumann, “Cosmology,” <http://www.damtp.cam.ac.uk/user/db275/Cosmology/Le>
- [71] W. E. East, M. Kleban, A. Linde, and L. Senatore, “Beginning inflation in an inhomogeneous universe,” *JCAP*, vol. 1609, no. 09, p. 010, 2016, 1511.05143.
- [72] K. Clough, E. A. Lim, B. S. DiNunno, W. Fischler, R. Flauger, and S. Paban, “Robustness of Inflation to Inhomogeneous Initial Conditions,” *JCAP*, vol. 1709, no. 09, p. 025, 2017, 1608.04408.
- [73] R. Brandenberger, “Initial conditions for inflation — A short review,” *Int. J. Mod. Phys.*, vol. D26, no. 01, p. 1740002, 2016, 1601.01918.
- [74] D. S. Salopek and J. R. Bond, “Nonlinear evolution of long wavelength metric fluctuations in inflationary models,” *Phys. Rev.*, vol. D42, pp. 3936–3962, 1990.
- [75] E. J. Copeland, E. W. Kolb, A. R. Liddle, and J. E. Lidsey, “Reconstructing the inflation potential, in principle and in practice,” *Phys. Rev.*, vol. D48, pp. 2529–2547, 1993, hep-ph/9303288.
- [76] A. R. Liddle, P. Parsons, and J. D. Barrow, “Formalizing the slow roll approximation in inflation,” *Phys. Rev.*, vol. D50, pp. 7222–7232, 1994, astro-ph/9408015.
- [77] A. G. Muslimov, “On the Scalar Field Dynamics in a Spatially Flat Friedman Universe,” *Class. Quant. Grav.*, vol. 7, pp. 231–237, 1990.
- [78] J. E. Lidsey, “The Scalar field as dynamical variable in inflation,” *Phys. Lett.*, vol. B273, pp. 42–46, 1991.

-
- [79] J. D. Barrow, “New types of inflationary universe,” *Phys. Rev.*, vol. D48, pp. 1585–1590, 1993.
- [80] J. D. Barrow, “Exact inflationary universes with potential minima,” *Phys. Rev.*, vol. D49, pp. 3055–3058, 1994.
- [81] J. M. Maldacena, “Non-Gaussian features of primordial fluctuations in single field inflationary models,” *JHEP*, vol. 05, p. 013, 2003, astro-ph/0210603.
- [82] W. H. Kinney, “Horizon crossing and inflation with large eta,” *Phys. Rev.*, vol. D72, p. 023515, 2005, gr-qc/0503017.
- [83] R. L. Arnowitt, S. Deser, and C. W. Misner, “The Dynamics of general relativity,” *Gen. Rel. Grav.*, vol. 40, pp. 1997–2027, 2008, gr-qc/0405109.
- [84] M. Sasaki, “Large Scale Quantum Fluctuations in the Inflationary Universe,” *Prog. Theor. Phys.*, vol. 76, p. 1036, 1986.
- [85] V. F. Mukhanov, “Quantum Theory of Gauge Invariant Cosmological Perturbations,” *Sov. Phys. JETP*, vol. 67, pp. 1297–1302, 1988. [Zh. Eksp. Teor. Fiz.94N7,1(1988)].
- [86] 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.*, vol. 215, pp. 203–333, 1992.
- [87] N. D. Birrell and P. C. W. Davies, *Quantum Fields in Curved Space*. Cambridge Monographs on Mathematical Physics, Cambridge, UK: Cambridge Univ. Press, 1984.
- [88] E. D. Stewart and D. H. Lyth, “A More accurate analytic calculation of the spectrum of cosmological perturbations produced during inflation,” *Phys. Lett.*, vol. B302, pp. 171–175, 1993, gr-qc/9302019.
- [89] D. H. Lyth, “What would we learn by detecting a gravitational wave signal in the cosmic microwave background anisotropy?,” *Phys. Rev. Lett.*, vol. 78, pp. 1861–1863, 1997, hep-ph/9606387.
- [90] C. Armendariz-Picon, T. Damour, and V. F. Mukhanov, “k - inflation,” *Phys. Lett.*, vol. B458, pp. 209–218, 1999, hep-th/9904075.
- [91] V. Acquaviva, N. Bartolo, S. Matarrese, and A. Riotto, “Second order cosmological perturbations from inflation,” *Nucl. Phys.*, vol. B667, pp. 119–148, 2003, astro-ph/0209156.

-
- [92] N. Bartolo, E. Komatsu, S. Matarrese, and A. Riotto, “Non-Gaussianity from inflation: Theory and observations,” *Phys. Rept.*, vol. 402, pp. 103–266, 2004, astro-ph/0406398.
- [93] X. Chen, “Primordial Non-Gaussianities from Inflation Models,” *Adv. Astron.*, vol. 2010, p. 638979, 2010, 1002.1416.
- [94] E. Komatsu and D. N. Spergel, “Acoustic signatures in the primary microwave background bispectrum,” *Phys. Rev.*, vol. D63, p. 063002, 2001, astro-ph/0005036.
- [95] N. Bartolo, S. Matarrese, and A. Riotto, “Nongaussianity from inflation,” *Phys. Rev.*, vol. D65, p. 103505, 2002, hep-ph/0112261.
- [96] D. Wands, “Local non-Gaussianity from inflation,” *Class. Quant. Grav.*, vol. 27, p. 124002, 2010, 1004.0818.
- [97] P. Creminelli, “On non-Gaussianities in single-field inflation,” *JCAP*, vol. 0310, p. 003, 2003, astro-ph/0306122.
- [98] X. Chen, M.-x. Huang, S. Kachru, and G. Shiu, “Observational signatures and non-Gaussianities of general single field inflation,” *JCAP*, vol. 0701, p. 002, 2007, hep-th/0605045.
- [99] C. Cheung, P. Creminelli, A. L. Fitzpatrick, J. Kaplan, and L. Senatore, “The Effective Field Theory of Inflation,” *JHEP*, vol. 03, p. 014, 2008, 0709.0293.
- [100] X. Chen and Y. Wang, “Quasi-Single Field Inflation and Non-Gaussianities,” *JCAP*, vol. 1004, p. 027, 2010, 0911.3380.
- [101] X. Chen and Y. Wang, “Large non-Gaussianities with Intermediate Shapes from Quasi-Single Field Inflation,” *Phys. Rev.*, vol. D81, p. 063511, 2010, 0909.0496.
- [102] R. Gwyn, G. A. Palma, M. Sakellariadou, and S. Sypsas, “Effective field theory of weakly coupled inflationary models,” *JCAP*, vol. 1304, p. 004, 2013, 1210.3020.
- [103] M. Alvarez *et al.*, “Testing Inflation with Large Scale Structure: Connecting Hopes with Reality,” 2014, 1412.4671.
- [104] D. Baumann, D. Green, and R. A. Porto, “B-modes and the Nature of Inflation,” *JCAP*, vol. 1501, no. 01, p. 016, 2015, 1407.2621.

-
- [105] P. Creminelli and M. Zaldarriaga, “Single field consistency relation for the 3-point function,” *JCAP*, vol. 0410, p. 006, 2004, astro-ph/0407059.
- [106] C. Cheung, A. L. Fitzpatrick, J. Kaplan, and L. Senatore, “On the consistency relation of the 3-point function in single field inflation,” *JCAP*, vol. 0802, p. 021, 2008, 0709.0295.
- [107] Y. Tada and V. Vennin, “Squeezed bispectrum in the δN formalism: local observer effect in field space,” *JCAP*, vol. 1702, no. 02, p. 021, 2017, 1609.08876.
- [108] T. Tanaka and Y. Urakawa, “Dominance of gauge artifact in the consistency relation for the primordial bispectrum,” *JCAP*, vol. 1105, p. 014, 2011, 1103.1251.
- [109] E. Pajer, F. Schmidt, and M. Zaldarriaga, “The Observed Squeezed Limit of Cosmological Three-Point Functions,” *Phys. Rev.*, vol. D88, no. 8, p. 083502, 2013, 1305.0824.
- [110] G. Cabass, E. Pajer, and F. Schmidt, “How Gaussian can our Universe be?,” *JCAP*, vol. 1701, no. 01, p. 003, 2017, 1612.00033.
- [111] S. Weinberg, “Adiabatic modes in cosmology,” *Phys. Rev.*, vol. D67, p. 123504, 2003, astro-ph/0302326.
- [112] S. Dodelson, “Coherent phase argument for inflation,” *AIP Conf. Proc.*, vol. 689, pp. 184–196, 2003, hep-ph/0309057. [,184(2003)].
- [113] W. Hu and S. Dodelson, “Cosmic microwave background anisotropies,” *Ann.Rev.Astron.Astrophys.*, vol. 40, pp. 171–216, 2002, astro-ph/0110414.
- [114] S. Dodelson, *Modern Cosmology*. Amsterdam: Academic Press, 2003.
- [115] P. A. R. Ade *et al.*, “Planck 2015 results. XX. Constraints on inflation,” *Astron. Astrophys.*, vol. 594, p. A20, 2016, 1502.02114.
- [116] A. R. Liddle and S. M. Leach, “How long before the end of inflation were observable perturbations produced?,” *Phys. Rev.*, vol. D68, p. 103503, 2003, astro-ph/0305263.
- [117] S. Weinberg, “Must cosmological perturbations remain non-adiabatic after multi-field inflation?,” *Phys. Rev.*, vol. D70, p. 083522, 2004, astro-ph/0405397.

- [118] P. A. R. Ade *et al.*, “Planck 2015 results. XVII. Constraints on primordial non-Gaussianity,” *Astron. Astrophys.*, vol. 594, p. A17, 2016, 1502.01592.
- [119] W. Hu and M. J. White, “A CMB polarization primer,” *New Astron.*, vol. 2, p. 323, 1997, astro-ph/9706147.
- [120] U. Seljak, “Measuring polarization in cosmic microwave background,” *Astrophys. J.*, vol. 482, p. 6, 1997, astro-ph/9608131.
- [121] M. Zaldarriaga and U. Seljak, “An all sky analysis of polarization in the microwave background,” *Phys.Rev.*, vol. D55, pp. 1830–1840, 1997, astro-ph/9609170.
- [122] M. Kamionkowski, A. Kosowsky, and A. Stebbins, “Statistics of cosmic microwave background polarization,” *Phys.Rev.*, vol. D55, pp. 7368–7388, 1997, astro-ph/9611125.
- [123] D. Baumann *et al.*, “CMBPol Mission Concept Study: Probing Inflation with CMB Polarization,” *AIP Conf. Proc.*, vol. 1141, pp. 10–120, 2009, 0811.3919.
- [124] E. Pajer and M. Zaldarriaga, “A New Window on Primordial non-Gaussianity,” *Phys. Rev. Lett.*, vol. 109, p. 021302, 2012, 1201.5375.
- [125] R. Emami, E. Dimastrogiovanni, J. Chluba, and M. Kamionkowski, “Probing the scale dependence of non-Gaussianity with spectral distortions of the cosmic microwave background,” *Phys. Rev.*, vol. D91, no. 12, p. 123531, 2015, 1504.00675.
- [126] W. Hu, D. Scott, and J. Silk, “Power spectrum constraints from spectral distortions in the cosmic microwave background,” *Astrophys. J.*, vol. 430, pp. L5–L8, 1994, astro-ph/9402045.
- [127] J. Chluba, R. Khatri, and R. A. Sunyaev, “CMB at 2x2 order: The dissipation of primordial acoustic waves and the observable part of the associated energy release,” *Mon. Not. Roy. Astron. Soc.*, vol. 425, pp. 1129–1169, 2012, 1202.0057.
- [128] G. Cabass, E. Pajer, and D. van der Woude, “Spectral distortion anisotropies from single-field inflation,” 2018, 1805.08775.
- [129] N. Dalal, O. Dore, D. Huterer, and A. Shirokov, “The imprints of primordial non-gaussianities on large-scale structure: scale dependent bias and abundance of virialized objects,” *Phys. Rev.*, vol. D77, p. 123514, 2008, 0710.4560.

-
- [130] O. Doré *et al.*, “Cosmology with the SPHEREX All-Sky Spectral Survey,” 2014, 1412.4872.
- [131] P. E. Dewdney, P. J. Hall, R. T. Schilizzi, and T. J. L. W. Lazio, “The Square Kilometre Array,” *IEEE Proceedings*, vol. 97, pp. 1482–1496, Aug. 2009.
- [132] Y.-C. Li and Y.-Z. Ma, “Constraints on Primordial non-Gaussianity from Future HI Intensity Mapping Experiments,” *Phys. Rev.*, vol. D96, no. 6, p. 063525, 2017, 1701.00221.
- [133] B. P. Abbott *et al.*, “Observation of Gravitational Waves from a Binary Black Hole Merger,” *Phys. Rev. Lett.*, vol. 116, no. 6, p. 061102, 2016, 1602.03837.
- [134] P. D. Lasky *et al.*, “Gravitational-wave cosmology across 29 decades in frequency,” *Phys. Rev.*, vol. X6, no. 1, p. 011035, 2016, 1511.05994.
- [135] M. C. Guzzetti, N. Bartolo, M. Liguori, and S. Matarrese, “Gravitational waves from inflation,” *Riv. Nuovo Cim.*, vol. 39, no. 9, pp. 399–495, 2016, 1605.01615.
- [136] B. Carr, F. Kuhnel, and M. Sandstad, “Primordial Black Holes as Dark Matter,” *Phys. Rev.*, vol. D94, no. 8, p. 083504, 2016, 1607.06077.
- [137] D. Baumann and L. McAllister, *Inflation and String Theory*. Cambridge Monographs on Mathematical Physics, Cambridge University Press, 2015, 1404.2601.
- [138] A. Achúcarro, V. Atal, C. Germani, and G. A. Palma, “Cumulative effects in inflation with ultra-light entropy modes,” *JCAP*, vol. 1702, no. 02, p. 013, 2017, 1607.08609.
- [139] A. Achúcarro, R. Kallosh, A. Linde, D.-G. Wang, and Y. Welling, “Universality of multi-field α -attractors,” *JCAP*, vol. 1804, no. 04, p. 028, 2018, 1711.09478.
- [140] A. Achúcarro, V. Atal, and Y. Welling, “On the viability of $m^2\phi^2$ and natural inflation,” *JCAP*, vol. 1507, p. 008, 2015, 1503.07486.
- [141] Y. Welling, D. van der Woude, and E. Pajer, “Lifting Primordial Non-Gaussianity Above the Noise,” *JCAP*, vol. 1608, no. 08, p. 044, 2016, 1605.06426.
- [142] Y. B. Zel’dovich, “Gravitational instability: An approximate theory for large density perturbations,” *A & A*, vol. 5, pp. 84–89, Mar. 1970.

- [143] P. J. E. Peebles and J. T. Yu, “Primeval Adiabatic Perturbation in an Expanding Universe,” *ApJ*, vol. 162, p. 815, Dec. 1970.
- [144] G. R. Blumenthal, S. M. Faber, J. R. Primack, and M. J. Rees, “Formation of galaxies and large-scale structure with cold dark matter,” *Nature*, vol. 311, pp. 517–525, Oct. 1984.
- [145] N. Kaiser, “Clustering in real space and in redshift space,” *Mon. Not. Roy. Astron. Soc.*, vol. 227, pp. 1–27, 1987.
- [146] T. Matsubara, “The Correlation function in redshift space: General formula with wide angle effects and cosmological distortions,” *Astrophys. J.*, vol. 535, p. 1, 2000, astro-ph/9908056.
- [147] V. Desjacques, D. Jeong, and F. Schmidt, “Large-Scale Galaxy Bias,” *Phys. Rept.*, vol. 733, pp. 1–193, 2018, 1611.09787.
- [148] D. J. Eisenstein *et al.*, “Detection of the Baryon Acoustic Peak in the Large-Scale Correlation Function of SDSS Luminous Red Galaxies,” *Astrophys. J.*, vol. 633, pp. 560–574, 2005, astro-ph/0501171.
- [149] F. Bernardeau, S. Colombi, E. Gaztanaga, and R. Scoccimarro, “Large scale structure of the universe and cosmological perturbation theory,” *Phys. Rept.*, vol. 367, pp. 1–248, 2002, astro-ph/0112551.
- [150] R. Laureijs *et al.*, “Euclid Definition Study Report,” 2011, 1110.3193.
- [151] M. Levi *et al.*, “The DESI Experiment, a whitepaper for Snowmass 2013,” 2013, 1308.0847.
- [152] K. S. Dawson *et al.*, “The SDSS-IV extended Baryon Oscillation Spectroscopic Survey: Overview and Early Data,” *Astron. J.*, vol. 151, p. 44, 2016, 1508.04473.
- [153] M. Crocce and R. Scoccimarro, “Renormalized cosmological perturbation theory,” *Phys. Rev.*, vol. D73, p. 063519, 2006, astro-ph/0509418.
- [154] P. McDonald, “Dark matter clustering: a simple renormalization group approach,” *Phys. Rev.*, vol. D75, p. 043514, 2007, astro-ph/0606028.
- [155] S. Matarrese and M. Pietroni, “Resumming Cosmic Perturbations,” *JCAP*, vol. 0706, p. 026, 2007, astro-ph/0703563.
- [156] T. Matsubara, “Nonlinear perturbation theory with halo bias and redshift-space distortions via the Lagrangian picture,” *Phys. Rev.*, vol. D78, p. 083519, 2008, 0807.1733. [Erratum: *Phys. Rev.*D78,109901(2008)].

-
- [157] A. Taruya, F. Bernardeau, T. Nishimichi, and S. Codis, “RegPT: Direct and fast calculation of regularized cosmological power spectrum at two-loop order,” *Phys. Rev.*, vol. D86, p. 103528, 2012, 1208.1191.
- [158] J. Carlson, M. White, and N. Padmanabhan, “A critical look at cosmological perturbation theory techniques,” *Phys. Rev.*, vol. D80, p. 043531, 2009, 0905.0479.
- [159] D. Baumann, A. Nicolis, L. Senatore, and M. Zaldarriaga, “Cosmological Non-Linearities as an Effective Fluid,” *JCAP*, vol. 1207, p. 051, 2012, 1004.2488.
- [160] X. Wang, M. Neyrinck, I. Szapudi, A. Szalay, X. Chen, J. Lesgourgues, A. Riotto, and M. Sloth, “Perturbation Theory of the Cosmological Log-Density Field,” *Astrophys. J.*, vol. 735, p. 32, 2011, 1103.2166.
- [161] F. Bernardeau, N. van de Rijt, and F. Vernizzi, “Resummed propagators in multicomponent cosmic fluids with the eikonal approximation,” *PrD*, vol. 85, p. 063509, Mar. 2012, 1109.3400.
- [162] J. J. M. Carrasco, M. P. Hertzberg, and L. Senatore, “The Effective Field Theory of Cosmological Large Scale Structures,” *JHEP*, vol. 09, p. 082, 2012, 1206.2926.
- [163] M. Crocce, R. Scoccimarro, and F. Bernardeau, “MPTbreeze: A fast renormalized perturbative scheme,” *Mon. Not. Roy. Astron. Soc.*, vol. 427, p. 2537, 2012, 1207.1465.
- [164] D. Blas, S. Floerchinger, M. Garny, N. Tetradis, and U. A. Wiedemann, “Large scale structure from viscous dark matter,” *JCAP*, vol. 1511, p. 049, 2015, 1507.06665.
- [165] D. Blas, M. Garny, M. M. Ivanov, and S. Sibiryakov, “Time-Sliced Perturbation Theory for Large Scale Structure I: General Formalism,” *JCAP*, vol. 1607, no. 07, p. 052, 2016, 1512.05807.
- [166] S. Pueblas and R. Scoccimarro, “Generation of Vorticity and Velocity Dispersion by Orbit Crossing,” *Phys. Rev.*, vol. D80, p. 043504, 2009, 0809.4606.
- [167] P. Valageas, “Impact of shell crossing and scope of perturbative approaches, in real and redshift space,” *Astron. Astrophys.*, vol. 526, p. A67, Feb. 2011, 1009.0106.

- [168] M. Pietroni, G. Mangano, N. Saviano, and M. Viel, “Coarse-Grained Cosmological Perturbation Theory,” *JCAP*, vol. 1201, p. 019, 2012, 1108.5203.
- [169] J. M. Bardeen, “Gauge Invariant Cosmological Perturbations,” *Phys. Rev.*, vol. D22, pp. 1882–1905, 1980.
- [170] J. M. Bardeen, J. R. Bond, N. Kaiser, and A. S. Szalay, “The statistics of peaks of Gaussian random fields,” *ApJ*, vol. 304, pp. 15–61, May 1986.
- [171] D. J. Eisenstein and W. Hu, “Baryonic features in the matter transfer function,” *Astrophys. J.*, vol. 496, p. 605, 1998, astro-ph/9709112.
- [172] U. Seljak and M. Zaldarriaga, “A line of sight approach to cosmic microwave background anisotropies,” *Astrophys. J.*, vol. 469, pp. 437–444, 1996, astro-ph/9603033.
- [173] A. Lewis and S. Bridle, “Cosmological parameters from CMB and other data: A Monte Carlo approach,” *Phys. Rev.*, vol. D66, p. 103511, 2002, astro-ph/0205436.
- [174] P. J. E. Peebles, *The large-scale structure of the universe*. 1980.
- [175] E. Bertschinger, “Cosmological dynamics: Course 1,” in *Proceedings, Les Houches Summer School on Cosmology and Large Scale Structure (Session 60): Les Houches, France, August 1-28, 1993*, pp. 273–348, 1993, astro-ph/9503125.
- [176] C.-P. Ma and E. Bertschinger, “Cosmological perturbation theory in the synchronous and conformal Newtonian gauges,” *Astrophys. J.*, vol. 455, pp. 7–25, 1995, astro-ph/9506072.
- [177] M. P. Hertzberg, “Effective field theory of dark matter and structure formation: Semianalytical results,” *Phys. Rev.*, vol. D89, no. 4, p. 043521, 2014, 1208.0839.
- [178] L. Mercolli and E. Pajer, “On the velocity in the Effective Field Theory of Large Scale Structures,” *JCAP*, vol. 1403, p. 006, 2014, 1307.3220.
- [179] M. Mirbabayi, F. Schmidt, and M. Zaldarriaga, “Biased Tracers and Time Evolution,” *JCAP*, vol. 1507, no. 07, p. 030, 2015, 1412.5169.
- [180] J. J. M. Carrasco, S. Foreman, D. Green, and L. Senatore, “The 2-loop matter power spectrum and the IR-safe integrand,” *JCAP*, vol. 1407, p. 056, 2014, 1304.4946.

-
- [181] T. Baldauf, L. Mercolli, M. Mirbabayi, and E. Pajer, “The Bispectrum in the Effective Field Theory of Large Scale Structure,” *JCAP*, vol. 1505, no. 05, p. 007, 2015, 1406.4135.
- [182] R. E. Angulo, S. Foreman, M. Schmittfull, and L. Senatore, “The One-Loop Matter Bispectrum in the Effective Field Theory of Large Scale Structures,” *JCAP*, vol. 1510, no. 10, p. 039, 2015, 1406.4143.
- [183] V. Assassi, D. Baumann, E. Pajer, Y. Welling, and D. van der Woude, “Effective theory of large-scale structure with primordial non-Gaussianity,” *JCAP*, vol. 1511, p. 024, 2015, 1505.06668.
- [184] E. Pajer and M. Zaldarriaga, “On the Renormalization of the Effective Field Theory of Large Scale Structures,” *JCAP*, vol. 1308, p. 037, 2013, 1301.7182.
- [185] A. A. Abolhasani, M. Mirbabayi, and E. Pajer, “Systematic Renormalization of the Effective Theory of Large Scale Structure,” *JCAP*, vol. 1605, no. 05, p. 063, 2016, 1509.07886.
- [186] D. J. Heath, “The growth of density perturbations in zero pressure Friedmann-Lemaitre universes,” *MNRAS*, vol. 179, pp. 351–358, May 1977.
- [187] O. Lahav, P. B. Lilje, J. R. Primack, and M. J. Rees, “Dynamical effects of the cosmological constant,” *MNRAS*, vol. 251, pp. 128–136, July 1991.
- [188] S. M. Carroll, W. H. Press, and E. L. Turner, “The cosmological constant,” *Annual review of astronomy and astrophysics*, vol. 30, pp. 499–542, 1992.
- [189] M. H. Goroff, B. Grinstein, S.-J. Rey, and M. B. Wise, “Coupling of modes of cosmological mass density fluctuations,” *ApJ*, vol. 311, pp. 6–14, Dec. 1986.
- [190] R. Scoccimarro, S. Colombi, J. N. Fry, J. A. Frieman, E. Hivon, and A. Melott, “Nonlinear evolution of the bispectrum of cosmological perturbations,” *Astrophys. J.*, vol. 496, p. 586, 1998, astro-ph/9704075.
- [191] E. Sefusatti, “1-loop Perturbative Corrections to the Matter and Galaxy Bispectrum with non-Gaussian Initial Conditions,” *Phys. Rev.*, vol. D80, p. 123002, 2009, 0905.0717.
- [192] L. Senatore and M. Zaldarriaga, “The Effective Field Theory of Multi-field Inflation,” *JHEP*, vol. 04, p. 024, 2012, 1009.2093.

- [193] M. Alishahiha, E. Silverstein, and D. Tong, “DBI in the sky,” *Phys. Rev.*, vol. D70, p. 123505, 2004, hep-th/0404084.
- [194] N. Arkani-Hamed and J. Maldacena, “Cosmological Collider Physics,” 2015, 1503.08043.
- [195] H. Lee, D. Baumann, and G. L. Pimentel, “Non-Gaussianity as a Particle Detector,” *JHEP*, vol. 12, p. 040, 2016, 1607.03735.
- [196] A. Nicolis and F. Piazza, “Spontaneous Symmetry Probing,” *JHEP*, vol. 06, p. 025, 2012, 1112.5174.
- [197] I.-S. Yang, “The Strong Multifield Slowroll Condition and Spiral Inflation,” *Phys. Rev.*, vol. D85, p. 123532, 2012, 1202.3388.
- [198] S. Groot Nibbelink and B. J. W. van Tent, “Density perturbations arising from multiple field slow roll inflation,” 2000, hep-ph/0011325.
- [199] S. Groot Nibbelink and B. J. W. van Tent, “Scalar perturbations during multiple field slow-roll inflation,” *Class. Quant. Grav.*, vol. 19, pp. 613–640, 2002, hep-ph/0107272.
- [200] A. Achúcarro, J.-O. Gong, S. Hardeman, G. A. Palma, and S. P. Patil, “Mass hierarchies and non-decoupling in multi-scalar field dynamics,” *Phys. Rev.*, vol. D84, p. 043502, 2011, 1005.3848.
- [201] A. Achúcarro, J.-O. Gong, S. Hardeman, G. A. Palma, and S. P. Patil, “Features of heavy physics in the CMB power spectrum,” *JCAP*, vol. 1101, p. 030, 2011, 1010.3693.
- [202] C. Gordon, D. Wands, B. A. Bassett, and R. Maartens, “Adiabatic and entropy perturbations from inflation,” *Phys. Rev.*, vol. D63, p. 023506, 2001, astro-ph/0009131.
- [203] Z. Lalak, D. Langlois, S. Pokorski, and K. Turzyski, “Curvature and isocurvature perturbations in two-field inflation,” *JCAP*, vol. 0707, p. 014, 2007, 0704.0212.
- [204] C. M. Peterson and M. Tegmark, “Testing multifield inflation: A geometric approach,” *Phys. Rev.*, vol. D87, no. 10, p. 103507, 2013, 1111.0927.
- [205] Y. Welling, “Multiple Field Inflation and Signatures of Heavy Physics in the CMB,” Master’s thesis, Utrecht U., 2015, 1502.04369.
- [206] S. Cespedes and G. A. Palma, “Cosmic inflation in a landscape of heavy-fields,” *JCAP*, vol. 1310, p. 051, 2013, 1303.4703.

-
- [207] D. Seery and J. E. Lidsey, “Primordial non-Gaussianities from multiple-field inflation,” *JCAP*, vol. 0509, p. 011, 2005, astro-ph/0506056.
- [208] D. Langlois and F. Vernizzi, “A geometrical approach to nonlinear perturbations in relativistic cosmology,” *Class. Quant. Grav.*, vol. 27, p. 124007, 2010, 1003.3270.
- [209] J.-O. Gong and T. Tanaka, “A covariant approach to general field space metric in multi-field inflation,” *JCAP*, vol. 1103, p. 015, 2011, 1101.4809. [Erratum: *JCAP*1202,E01(2012)].
- [210] J. Elliston, D. Seery, and R. Tavakol, “The inflationary bispectrum with curved field-space,” *JCAP*, vol. 1211, p. 060, 2012, 1208.6011.
- [211] S. Cespedes, V. Atal, and G. A. Palma, “On the importance of heavy fields during inflation,” *JCAP*, vol. 1205, p. 008, 2012, 1201.4848.
- [212] A. Achucarro, J.-O. Gong, S. Hardeman, G. A. Palma, and S. P. Patil, “Effective theories of single field inflation when heavy fields matter,” *JHEP*, vol. 05, p. 066, 2012, 1201.6342.
- [213] A. Achucarro, V. Atal, S. Cespedes, J.-O. Gong, G. A. Palma, and S. P. Patil, “Heavy fields, reduced speeds of sound and decoupling during inflation,” *Phys. Rev.*, vol. D86, p. 121301, 2012, 1205.0710.
- [214] A. J. Tolley and M. Wyman, “The Gelaton Scenario: Equilateral non-Gaussianity from multi-field dynamics,” *Phys. Rev.*, vol. D81, p. 043502, 2010, 0910.1853.
- [215] S. Cremonini, Z. Lalak, and K. Turzynski, “Strongly Coupled Perturbations in Two-Field Inflationary Models,” *JCAP*, vol. 1103, p. 016, 2011, 1010.3021.
- [216] M. Dias, J. Frazer, D. J. Mulryne, and D. Seery, “Numerical evaluation of the bispectrum in multiple field inflation—the transport approach with code,” *JCAP*, vol. 1612, no. 12, p. 033, 2016, 1609.00379.
- [217] D. Seery, “CppTransport: a platform to automate calculation of inflationary correlation functions,” 2016, 1609.00380.
- [218] D. J. Mulryne and J. W. Ronayne, “PyTransport: A Python package for the calculation of inflationary correlation functions,” 2016, 1609.00381.
- [219] J. W. Ronayne and D. J. Mulryne, “Numerically evaluating the bispectrum in curved field-space— with PyTransport 2.0,” *JCAP*, vol. 1801, no. 01, p. 023, 2018, 1708.07130.

- [220] A. A. Starobinsky, “Multicomponent de Sitter (Inflationary) Stages and the Generation of Perturbations,” *JETP Lett.*, vol. 42, pp. 152–155, 1985. [Pisma Zh. Eksp. Teor. Fiz.42,124(1985)].
- [221] M. Sasaki and E. D. Stewart, “A General analytic formula for the spectral index of the density perturbations produced during inflation,” *Prog. Theor. Phys.*, vol. 95, pp. 71–78, 1996, astro-ph/9507001.
- [222] M. Sasaki and T. Tanaka, “Superhorizon scale dynamics of multiscalar inflation,” *Prog. Theor. Phys.*, vol. 99, pp. 763–782, 1998, gr-qc/9801017.
- [223] H.-C. Lee, M. Sasaki, E. D. Stewart, T. Tanaka, and S. Yokoyama, “A New delta N formalism for multi-component inflation,” *JCAP*, vol. 0510, p. 004, 2005, astro-ph/0506262.
- [224] A. Achúcarro, V. Vardanyan, D.-G. Wang, and Y. Welling, “In Preparation,” 2018, 18xx.xxxxx.
- [225] R. Kallosh and A. Linde, “Universality Class in Conformal Inflation,” *JCAP*, vol. 1307, p. 002, 2013, 1306.5220.
- [226] S. Ferrara, R. Kallosh, A. Linde, and M. Porrati, “Minimal Supergravity Models of Inflation,” *Phys. Rev.*, vol. D88, no. 8, p. 085038, 2013, 1307.7696.
- [227] R. Kallosh, A. Linde, and D. Roest, “Superconformal Inflationary α -Attractors,” *JHEP*, vol. 11, p. 198, 2013, 1311.0472.
- [228] S. Cecotti and R. Kallosh, “Cosmological Attractor Models and Higher Curvature Supergravity,” *JHEP*, vol. 05, p. 114, 2014, 1403.2932.
- [229] M. Galante, R. Kallosh, A. Linde, and D. Roest, “Unity of Cosmological Inflation Attractors,” *Phys. Rev. Lett.*, vol. 114, no. 14, p. 141302, 2015, 1412.3797.
- [230] R. Kallosh and A. Linde, “Escher in the Sky,” *Comptes Rendus Physique*, vol. 16, pp. 914–927, 2015, 1503.06785.
- [231] S. Ferrara and R. Kallosh, “Seven-Disk Manifold, α -attractors and B-modes,” 2016, 1610.04163.
- [232] R. Kallosh, A. Linde, T. Wrase, and Y. Yamada, “Maximal Supersymmetry and B-Mode Targets,” *JHEP*, vol. 04, p. 144, 2017, 1704.04829.
- [233] R. Kallosh, A. Linde, D. Roest, and Y. Yamada, “ $\overline{D3}$ induced geometric inflation,” *JHEP*, vol. 07, p. 057, 2017, 1705.09247.

-
- [234] N. Bartolo, S. Matarrese, and A. Riotto, “Adiabatic and isocurvature perturbations from inflation: Power spectra and consistency relations,” *Phys. Rev.*, vol. D64, p. 123504, 2001, astro-ph/0107502.
- [235] C. M. Peterson and M. Tegmark, “Testing Two-Field Inflation,” *Phys. Rev.*, vol. D83, p. 023522, 2011, 1005.4056.
- [236] Y. Welling, “Multiple Field Inflation and Signatures of Heavy Physics in the CMB,” 2015, 1502.04369.
- [237] T. Kobayashi and S. Mukohyama, “Effects of Light Fields During Inflation,” *Phys. Rev.*, vol. D81, p. 103504, 2010, 1003.0076.
- [238] S. Renaux-Petel and K. Turzyski, “On reaching the adiabatic limit in multi-field inflation,” *JCAP*, vol. 1506, no. 06, p. 010, 2015, 1405.6195.
- [239] S. Cremonini, Z. Lalak, and K. Turzyski, “On Non-Canonical Kinetic Terms and the Tilt of the Power Spectrum,” *Phys. Rev.*, vol. D82, p. 047301, 2010, 1005.4347.
- [240] C. van de Bruck and M. Robinson, “Power Spectra beyond the Slow Roll Approximation in Theories with Non-Canonical Kinetic Terms,” *JCAP*, vol. 1408, p. 024, 2014, 1404.7806.
- [241] R. Kallosh and A. Linde, “Multi-field Conformal Cosmological Attractors,” *JCAP*, vol. 1312, p. 006, 2013, 1309.2015.
- [242] A. A. Starobinsky, S. Tsujikawa, and J. Yokoyama, “Cosmological perturbations from multifield inflation in generalized Einstein theories,” *Nucl. Phys.*, vol. B610, pp. 383–410, 2001, astro-ph/0107555.
- [243] F. Di Marco, F. Finelli, and R. Brandenberger, “Adiabatic and isocurvature perturbations for multifield generalized Einstein models,” *Phys. Rev.*, vol. D67, p. 063512, 2003, astro-ph/0211276.
- [244] S. Renaux-Petel and K. Turzyski, “Geometrical Destabilization of Inflation,” *Phys. Rev. Lett.*, vol. 117, no. 14, p. 141301, 2016, 1510.01281.
- [245] J. Ellis, M. A. G. García, D. V. Nanopoulos, and K. A. Olive, “Two-Field Analysis of No-Scale Supergravity Inflation,” *JCAP*, vol. 1501, p. 010, 2015, 1409.8197.
- [246] A. R. Brown, “Hyperinflation,” 2017, 1705.03023.
- [247] S. Mizuno and S. Mukohyama, “Primordial perturbations from inflation with a hyperbolic field-space,” 2017, 1707.05125.

- [248] A. Achúcarro, O. Iarygina, G. A. Palma, D.-G. Wang, and Y. Welling, “In Preparation,” 2018, 18xx.xxxxx.
- [249] S. Ferrara, R. Kallosh, and A. Linde, “Cosmology with Nilpotent Superfields,” *JHEP*, vol. 10, p. 143, 2014, 1408.4096.
- [250] J. J. M. Carrasco, R. Kallosh, A. Linde, and D. Roest, “Hyperbolic geometry of cosmological attractors,” *Phys. Rev.*, vol. D92, no. 4, p. 041301, 2015, 1504.05557.
- [251] E. McDonough and M. Scalisi, “Inflation from Nilpotent Kähler Corrections,” *JCAP*, vol. 1611, no. 11, p. 028, 2016, 1609.00364.
- [252] A. Linde, D.-G. Wang, Y. Welling, Y. Yamada, and A. Achúcarro, “Hypernatural inflation,” 2018, 1803.09911.
- [253] M. Dias, J. Frazer, and D. Seery, “Computing observables in curved multifield models of inflation? A guide (with code) to the transport method,” *JCAP*, vol. 1512, no. 12, p. 030, 2015, 1502.03125.
- [254] Y. Yamada, “U(1) symmetric α -attractors,” 2018, 1802.04848.
- [255] K. Freese, J. A. Frieman, and A. V. Olinto, “Natural inflation with pseudo - Nambu-Goldstone bosons,” *Phys. Rev. Lett.*, vol. 65, pp. 3233–3236, 1990.
- [256] S. G. Rubin, “Effect of massive fields on inflation,” *JETP Lett.*, vol. 74, pp. 247–250, 2001, hep-ph/0110132. [Pisma Zh. Eksp. Teor. Fiz.74,275(2001)].
- [257] X. Dong, B. Horn, E. Silverstein, and A. Westphal, “Simple exercises to flatten your potential,” *Phys. Rev.*, vol. D84, p. 026011, 2011, 1011.4521.
- [258] S. Pi and M. Sasaki, “Curvature Perturbation Spectrum in Two-field Inflation with a Turning Trajectory,” *JCAP*, vol. 1210, p. 051, 2012, 1205.0161.
- [259] X. Chen and Y. Wang, “Quasi-Single Field Inflation with Large Mass,” *JCAP*, vol. 1209, p. 021, 2012, 1205.0160.
- [260] D. Baumann and D. Green, “Equilateral Non-Gaussianity and New Physics on the Horizon,” *JCAP*, vol. 1109, p. 014, 2011, 1102.5343.
- [261] G. Shiu and J. Xu, “Effective Field Theory and Decoupling in Multi-field Inflation: An Illustrative Case Study,” *Phys. Rev.*, vol. D84, p. 103509, 2011, 1108.0981.

-
- [262] A. Avgoustidis, S. Cremonini, A.-C. Davis, R. H. Ribeiro, K. Turzynski, and S. Watson, “Decoupling Survives Inflation: A Critical Look at Effective Field Theory Violations During Inflation,” *JCAP*, vol. 1206, p. 025, 2012, 1203.0016.
- [263] C. P. Burgess, M. W. Horbatsch, and S. Patil, “Inflating in a Trough: Single-Field Effective Theory from Multiple-Field Curved Valleys,” *JHEP*, vol. 01, p. 133, 2013, 1209.5701.
- [264] X. Gao, D. Langlois, and S. Mizuno, “Influence of heavy modes on perturbations in multiple field inflation,” *JCAP*, vol. 1210, p. 040, 2012, 1205.5275.
- [265] D. Baumann, D. Green, H. Lee, and R. A. Porto, “Signs of Analyticity in Single-Field Inflation,” *Phys. Rev.*, vol. D93, no. 2, p. 023523, 2016, 1502.07304.
- [266] J. McDonald, “Sub-Planckian Two-Field Inflation Consistent with the Lyth Bound,” *JCAP*, vol. 1409, no. 09, p. 027, 2014, 1404.4620.
- [267] G. Barenboim and W.-I. Park, “Spiral Inflation,” *Phys. Lett.*, vol. B741, pp. 252–255, 2015, 1412.2724.
- [268] T. Li, Z. Li, and D. V. Nanopoulos, “Helical Phase Inflation,” *Phys. Rev.*, vol. D91, no. 6, p. 061303, 2015, 1409.3267.
- [269] J. E. Kim, H. P. Nilles, and M. Peloso, “Completing natural inflation,” *JCAP*, vol. 0501, p. 005, 2005, hep-ph/0409138.
- [270] S. Dimopoulos, S. Kachru, J. McGreevy, and J. G. Wacker, “N-flation,” *JCAP*, vol. 0808, p. 003, 2008, hep-th/0507205.
- [271] R. Kappl, H. P. Nilles, and M. W. Winkler, “Natural Inflation and Low Energy Supersymmetry,” *Phys. Lett.*, vol. B746, pp. 15–21, 2015, 1503.01777.
- [272] T. Li, Z. Li, and D. V. Nanopoulos, “Symmetry Breaking Indication for Supergravity Inflation in Light of the Planck 2015,” *JCAP*, vol. 1509, no. 09, p. 006, 2015, 1502.05005.
- [273] C. Pallis, “Non-Minimally Gravity-Coupled Inflationary Models,” *Phys. Lett.*, vol. B692, pp. 287–296, 2010, 1002.4765.
- [274] R. Kallosh, A. Linde, and D. Roest, “Universal Attractor for Inflation at Strong Coupling,” *Phys. Rev. Lett.*, vol. 112, no. 1, p. 011303, 2014, 1310.3950.

- [275] A. Ashoorioon, K. Dimopoulos, M. M. Sheikh-Jabbari, and G. Shiu, “Reconciliation of High Energy Scale Models of Inflation with Planck,” *JCAP*, vol. 1402, p. 025, 2014, 1306.4914.
- [276] K. Kannike, G. Hütsi, L. Pizza, A. Racioppi, M. Raidal, A. Salvio, and A. Strumia, “Dynamically Induced Planck Scale and Inflation,” *JHEP*, vol. 05, p. 065, 2015, 1502.01334.
- [277] L. Boubekur, E. Giusarma, O. Mena, and H. Ramírez, “Does Current Data Prefer a Non-minimally Coupled Inflaton?,” *Phys. Rev.*, vol. D91, p. 103004, 2015, 1502.05193.
- [278] W. Buchmuller, E. Dudas, L. Heurtier, A. Westphal, C. Wieck, and M. W. Winkler, “Challenges for Large-Field Inflation and Moduli Stabilization,” *JHEP*, vol. 04, p. 058, 2015, 1501.05812.
- [279] L. McAllister, E. Silverstein, and A. Westphal, “Gravity Waves and Linear Inflation from Axion Monodromy,” *Phys. Rev.*, vol. D82, p. 046003, 2010, 0808.0706.
- [280] N. Kaloper and L. Sorbo, “A Natural Framework for Chaotic Inflation,” *Phys. Rev. Lett.*, vol. 102, p. 121301, 2009, 0811.1989.
- [281] N. Kaloper, A. Lawrence, and L. Sorbo, “An Ignoble Approach to Large Field Inflation,” *JCAP*, vol. 1103, p. 023, 2011, 1101.0026.
- [282] K. Harigaya and M. Ibe, “Simple realization of inflaton potential on a Riemann surface,” *Phys. Lett.*, vol. B738, pp. 301–304, 2014, 1404.3511.
- [283] G. A. Palma and A. Soto, “B-modes and the sound speed of primordial fluctuations,” *Phys. Rev.*, vol. D91, p. 063525, 2015, 1412.0033.
- [284] I. Zavala, “Effects of the speed of sound at large-N,” *Phys. Rev.*, vol. D91, no. 6, p. 063005, 2015, 1412.3732.
- [285] R. Gwyn, G. A. Palma, M. Sakellariadou, and S. Sypsas, “On degenerate models of cosmic inflation,” *JCAP*, vol. 1410, no. 10, p. 005, 2014, 1406.1947.
- [286] T. Banks, M. Dine, P. J. Fox, and E. Gorbatov, “On the possibility of large axion decay constants,” *JCAP*, vol. 0306, p. 001, 2003, hep-th/0303252.
- [287] M. Tellarini, A. J. Ross, G. Tasinato, and D. Wands, “Galaxy bispectrum, primordial non-Gaussianity and redshift space distortions,” *JCAP*, vol. 1606, no. 06, p. 014, 2016, 1603.06814.

-
- [288] R. Scoccimarro, E. Sefusatti, and M. Zaldarriaga, “Probing primordial non-Gaussianity with large - scale structure,” *Phys. Rev.*, vol. D69, p. 103513, 2004, astro-ph/0312286.
- [289] E. Sefusatti and E. Komatsu, “The bispectrum of galaxies from high-redshift galaxy surveys: Primordial non-Gaussianity and non-linear galaxy bias,” *Phys. Rev.*, vol. D76, p. 083004, 2007, 0705.0343.
- [290] T. Baldauf, U. Seljak, and L. Senatore, “Primordial non-Gaussianity in the Bispectrum of the Halo Density Field,” *JCAP*, vol. 1104, p. 006, 2011, 1011.1513.
- [291] D. Jeong and E. Komatsu, “Primordial non-Gaussianity, scale-dependent bias, and the bispectrum of galaxies,” *Astrophys. J.*, vol. 703, pp. 1230–1248, 2009, 0904.0497.
- [292] G. Tasinato, M. Tellarini, A. J. Ross, and D. Wands, “Primordial non-Gaussianity in the bispectra of large-scale structure,” *JCAP*, vol. 1403, p. 032, 2014, 1310.7482.
- [293] N. Roth and C. Porciani, “Can we really measure f_{NL} from the galaxy power spectrum?,” *Mon. Not. Roy. Astron. Soc.*, vol. 425, pp. L81–L85, 2012, 1205.3165.
- [294] T. Baldauf, M. Mirbabayi, M. Simonović, and M. Zaldarriaga, “LSS constraints with controlled theoretical uncertainties,” 2016, 1602.00674.
- [295] E. Sefusatti, M. Crocce, S. Pueblas, and R. Scoccimarro, “Cosmology and the Bispectrum,” *Phys. Rev.*, vol. D74, p. 023522, 2006, astro-ph/0604505.
- [296] T. Baldauf, L. Mercolli, and M. Zaldarriaga, “Effective field theory of large scale structure at two loops: The apparent scale dependence of the speed of sound,” *Phys. Rev.*, vol. D92, no. 12, p. 123007, 2015, 1507.02256.
- [297] S. Foreman, H. Perrier, and L. Senatore, “Precision Comparison of the Power Spectrum in the EFTofLSS with Simulations,” *JCAP*, vol. 1605, no. 05, p. 027, 2016, 1507.05326.
- [298] J. J. M. Carrasco, S. Foreman, D. Green, and L. Senatore, “The Effective Field Theory of Large Scale Structures at Two Loops,” *JCAP*, vol. 1407, p. 057, 2014, 1310.0464.
- [299] A. Heavens, “Statistical techniques in cosmology,” 2009, 0906.0664.

-
- [300] C. E. Powell, “Generating Realisations of Stationary Gaussian Random Fields by Circulant Embedding.” https://www.nag.co.uk/doc/techrep/pdf/tr1_14.pdf.
- [301] K. S. Dawson *et al.*, “The Baryon Oscillation Spectroscopic Survey of SDSS-III,” *Astron. J.*, vol. 145, p. 10, 2013, 1208.0022.
- [302] M. Garny, T. Konstandin, R. A. Porto, and L. Sagunski, “On the Soft Limit of the Large Scale Structure Power Spectrum: UV Dependence,” *JCAP*, vol. 1511, no. 11, p. 032, 2015, 1508.06306.
- [303] E. Sefusatti and R. Scoccimarro, “Galaxy bias and halo-occupation numbers from large-scale clustering,” *Phys. Rev.*, vol. D71, p. 063001, 2005, astro-ph/0412626.
- [304] U. Seljak, “Extracting primordial non-gaussianity without cosmic variance,” *Phys. Rev. Lett.*, vol. 102, p. 021302, 2009, 0807.1770.
- [305] L. Verde and A. F. Heavens, “On the trispectrum as a Gaussian test for cosmology,” *Astrophys. J.*, vol. 553, p. 14, 2001, astro-ph/0101143.
- [306] D. Bertolini, K. Schutz, M. P. Solon, and K. M. Zurek, “The Trispectrum in the Effective Field Theory of Large Scale Structure,” *JCAP*, vol. 1606, no. 06, p. 052, 2016, 1604.01770.
- [307] A. Cooray, “21-cm Background Anisotropies Can Discern Primordial Non-Gaussianity,” *Phys. Rev. Lett.*, vol. 97, p. 261301, 2006, astro-ph/0610257.
- [308] K. Heitmann, M. White, C. Wagner, S. Habib, and D. Higdon, “The Coyote Universe I: Precision Determination of the Nonlinear Matter Power Spectrum,” *Astrophys. J.*, vol. 715, pp. 104–121, 2010, 0812.1052.
- [309] A. Schneider, R. Teyssier, D. Potter, J. Stadel, J. Onions, D. S. Reed, R. E. Smith, V. Springel, F. R. Pearce, and R. Scoccimarro, “Matter power spectrum and the challenge of percent accuracy,” *JCAP*, vol. 1604, no. 04, p. 047, 2016, 1503.05920.

Publications

- *Hypersnatural inflation*, A. Linde, D.-G. Wang, Y. Welling, Y. Yamada, and A. Achúcarro, JCAP **1807** (2018) 07, 035, (arXiv:1803.09911 [hep-th]).
- *Universality of multi-field α -attractors*, A. Achúcarro, R. Kallosh, A. Linde, D.-G. Wang, and Y. Welling, JCAP **1804** (2018) 04, 028, (arXiv:1711.09478 [hep-th]).
- *Lifting Primordial Non-Gaussianity Above the Noise*, Y. Welling, D. van der Woude, and E. Pajer, JCAP **1608** (2016) 08, 044, (arXiv:1605.06426 [astro-ph.CO]).
- *Effective Theory of Large-Scale Structure with Primordial Non-Gaussianity*, V. Assassi, D. Baumann, E. Pajer, Y. Welling, and D. van der Woude, JCAP **1511** (2015) 11, 024, (arXiv:1505.06668 [astro-ph.CO]).
- *On the viability of $m^2\phi^2$ and natural inflation*, A. Achúcarro, V. Atal, and Y. Welling, JCAP **1507** (2015) 07, 008, (arXiv:1503.07486 [astro-ph.CO]).