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Into the darkness : forging a stable path through the gravitational landscape

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Bibliography

- [1] S. Perlmutter et al. “Measurements of Omega and Lambda from 42 high redshift supernovae”. In: *Astrophys. J.* 517 (1999), pp. 565–586. DOI: 10.1086/307221. arXiv: astro-ph/9812133 [astro-ph].
- [2] Adam G. Riess et al. “Observational evidence from supernovae for an accelerating universe and a cosmological constant”. In: *Astron. J.* 116 (1998), pp. 1009–1038. DOI: 10.1086/300499. arXiv: astro-ph/9805201 [astro-ph].
- [3] Gianfranco Bertone, Dan Hooper, and Joseph Silk. “Particle dark matter: Evidence, candidates and constraints”. In: *Phys. Rept.* 405 (2005), pp. 279–390. DOI: 10.1016/j.physrep.2004.08.031. arXiv: hep-ph/0404175 [hep-ph].
- [4] J. P. Ostriker and Paul J. Steinhardt. “Cosmic concordance”. In: (1995). arXiv: astro-ph/9505066 [astro-ph].
- [5] Neta A. Bahcall et al. “The Cosmic triangle: Assessing the state of the universe”. In: *Science* 284 (1999), pp. 1481–1488. DOI: 10.1126/science.284.5419.1481. arXiv: astro-ph/9906463 [astro-ph].
- [6] Bharat Ratra and P. J. E. Peebles. “Cosmological Consequences of a Rolling Homogeneous Scalar Field”. In: *Phys. Rev. D* 37 (1988), p. 3406. DOI: 10.1103/PhysRevD.37.3406.
- [7] Edmund J. Copeland, M. Sami, and Shinji Tsujikawa. “Dynamics of dark energy”. In: *Int. J. Mod. Phys. D* 15 (2006), pp. 1753–1936. DOI: 10.1142/S021827180600942X. arXiv: hep-th/0603057 [hep-th].
- [8] T. Barreiro, Edmund J. Copeland, and N. J. Nunes. “Quintessence arising from exponential potentials”. In: *Phys. Rev. D* 61 (2000), p. 127301. DOI: 10.1103/PhysRevD.61.127301. arXiv: astro-ph/9910214 [astro-ph].
- [9] Eric V. Linder. “The Dynamics of Quintessence, The Quintessence of Dynamics”. In: *Gen. Rel. Grav.* 40 (2008), pp. 329–356. DOI: 10.1007/s10714-007-0550-z. arXiv: 0704.2064 [astro-ph].

Bibliography

- [10] Thomas P. Sotiriou and Valerio Faraoni. “f(R) Theories Of Gravity”. In: *Rev. Mod. Phys.* 82 (2010), pp. 451–497. DOI: 10.1103/RevModPhys.82.451. arXiv: 0805.1726 [gr-qc].
- [11] Antonio De Felice and Shinji Tsujikawa. “f(R) theories”. In: *Living Rev. Rel.* 13 (2010), p. 3. DOI: 10.12942/lrr-2010-3. arXiv: 1002.4928 [gr-qc].
- [12] Levon Pogosian and Alessandra Silvestri. “The pattern of growth in viable f(R) cosmologies”. In: *Phys. Rev. D* 77 (2008). [Erratum: *Phys. Rev. D* 81,049901(2010)], p. 023503. DOI: 10.1103/PhysRevD.77.023503, 10.1103/PhysRevD.81.049901. arXiv: 0709.0296 [astro-ph].
- [13] Austin Joyce, Lucas Lombriser, and Fabian Schmidt. “Dark Energy Versus Modified Gravity”. In: *Ann. Rev. Nucl. Part. Sci.* 66 (2016), pp. 95–122. DOI: 10.1146/annurev-nucl-102115-044553. arXiv: 1601.06133 [astro-ph.CO].
- [14] Giulia Gubitosi, Federico Piazza, and Filippo Vernizzi. “The Effective Field Theory of Dark Energy”. In: *JCAP* 1302 (2013). [JCAP1302,032(2013)], p. 032. DOI: 10.1088/1475-7516/2013/02/032. arXiv: 1210.0201 [hep-th].
- [15] Jolyon K. Bloomfield et al. “Dark energy or modified gravity? An effective field theory approach”. In: *JCAP* 1308 (2013), p. 010. DOI: 10.1088/1475-7516/2013/08/010. arXiv: 1211.7054 [astro-ph.CO].
- [16] Jerome Gleyzes et al. “Essential Building Blocks of Dark Energy”. In: *JCAP* 1308 (2013), p. 025. DOI: 10.1088/1475-7516/2013/08/025. arXiv: 1304.4840 [hep-th].
- [17] Clifford Cheung et al. “The Effective Field Theory of Inflation”. In: *JHEP* 03 (2008), p. 014. DOI: 10.1088/1126-6708/2008/03/014. arXiv: 0709.0293 [hep-th].
- [18] Paolo Creminelli et al. “The Effective Theory of Quintessence: the $w_j = -1$ Side Unveiled”. In: *JCAP* 0902 (2009), p. 018. DOI: 10.1088/1475-7516/2009/02/018. arXiv: 0811.0827 [astro-ph].
- [19] Eric Gourgoulhon. “3+1 formalism and bases of numerical relativity”. In: (2007). arXiv: gr-qc/0703035 [GR-QC].
- [20] Antony Lewis, Anthony Challinor, and Anthony Lasenby. “Efficient Computation of CMB anisotropies in closed FRW models”. In: *Astrophys. J.* 538 (2000), pp. 473–476. eprint: astro-ph/9911177.
- [21] “www.CAMB.info”. In: ().

- [22] Bin Hu et al. “Effective Field Theory of Cosmic Acceleration: an implementation in CAMB”. In: *Phys. Rev. D* 89.10 (2014), p. 103530. DOI: 10.1103/PhysRevD.89.103530. arXiv: 1312.5742 [astro-ph.CO].
- [23] Marco Raveri et al. “Effective Field Theory of Cosmic Acceleration: constraining dark energy with CMB data”. In: *Phys. Rev. D* 90.4 (2014), p. 043513. DOI: 10.1103/PhysRevD.90.043513. arXiv: 1405.1022 [astro-ph.CO].
- [24] “<http://wwwhome.lorentz.leidenuniv.nl/hu/codes/>”. In: ().
- [25] M. Ostrogradsky. “Mémoires sur les équations différentielles, relatives au problème des isopérimètres”. In: *Mem. Acad. St. Petersburg* 6.4 (1850), pp. 385–517.
- [26] David Langlois et al. “Effective Description of Higher-Order Scalar-Tensor Theories”. In: *JCAP* 1705.05 (2017), p. 033. DOI: 10.1088/1475-7516/2017/05/033. arXiv: 1703.03797 [hep-th].
- [27] Marco Crisostomi, Kazuya Koyama, and Gianmassimo Tasinato. “Extended Scalar-Tensor Theories of Gravity”. In: *JCAP* 1604.04 (2016), p. 044. DOI: 10.1088/1475-7516/2016/04/044. arXiv: 1602.03119 [hep-th].
- [28] David Langlois and Karim Noui. “Degenerate higher derivative theories beyond Horndeski: evading the Ostrogradski instability”. In: *JCAP* 1602.02 (2016), p. 034. DOI: 10.1088/1475-7516/2016/02/034. arXiv: 1510.06930 [gr-qc].
- [29] Sean M. Carroll, Mark Hoffman, and Mark Trodden. “Can the dark energy equation - of - state parameter w be less than -1?” In: *Phys. Rev. D* 68 (2003), p. 023509. DOI: 10.1103/PhysRevD.68.023509. arXiv: astro-ph/0301273 [astro-ph].
- [30] James M. Cline, Sangyong Jeon, and Guy D. Moore. “The Phantom menaced: Constraints on low-energy effective ghosts”. In: *Phys. Rev. D* 70 (2004), p. 043543. DOI: 10.1103/PhysRevD.70.043543. arXiv: hep-ph/0311312 [hep-ph].
- [31] Noemi Frusciante, Georgios Papadomanolakis, and Alessandra Silvestri. “An Extended action for the effective field theory of dark energy: a stability analysis and a complete guide to the mapping at the basis of EFTCAMB”. In: (2016). arXiv: 1601.04064 [gr-qc].
- [32] Antonio De Felice, Noemi Frusciante, and Georgios Papadomanolakis. “On the stability conditions for theories of modified gravity in the presence of matter fields”. In: *JCAP* 1703.03 (2017), p. 027. DOI: 10.1088/1475-7516/2017/03/027. arXiv: 1609.03599 [gr-qc].

Bibliography

- [33] Antonio De Felice, Noemi Frusciante, and Georgios Papadomanolakis. “de Sitter limit analysis for dark energy and modified gravity models”. In: *Phys. Rev. D* 96.2 (2017), p. 024060. DOI: 10.1103/PhysRevD.96.024060. arXiv: 1705.01960 [gr-qc].
- [34] Noemi Frusciante et al. “The role of the tachyonic instability in Horndeski gravity”. In: *JCAP* 2019.02 (2019), p. 029. DOI: 10.1088/1475-7516/2019/02/029. arXiv: 1810.03461 [gr-qc].
- [35] Petr Horava. “Membranes at Quantum Criticality”. In: *JHEP* 03 (2009), p. 020. DOI: 10.1088/1126-6708/2009/03/020. arXiv: 0812.4287 [hep-th].
- [36] Petr Horava. “Quantum Gravity at a Lifshitz Point”. In: *Phys. Rev. D* 79 (2009), p. 084008. DOI: 10.1103/PhysRevD.79.084008. arXiv: 0901.3775 [hep-th].
- [37] Ryotaro Kase and Shinji Tsujikawa. “Effective field theory approach to modified gravity including Horndeski theory and Ho?ava?Lifshitz gravity”. In: *Int. J. Mod. Phys. D* 23.13 (2015), p. 1443008. DOI: 10.1142/S0218271814430081. arXiv: 1409.1984 [hep-th].
- [38] Xian Gao. “Unifying framework for scalar-tensor theories of gravity”. In: *Phys. Rev. D* 90 (2014), p. 081501. DOI: 10.1103/PhysRevD.90.081501. arXiv: 1406.0822 [gr-qc].
- [39] Noemi Frusciante et al. “Horava Gravity in the Effective Field Theory formalism: From cosmology to observational constraints”. In: *Phys. Dark Univ.* 13 (2016), pp. 7–24. DOI: 10.1016/j.dark.2016.03.002. arXiv: 1508.01787 [astro-ph.CO].
- [40] Gianluca Calcagni. “Cosmology of the Lifshitz universe”. In: *JHEP* 09 (2009), p. 112. DOI: 10.1088/1126-6708/2009/09/112. arXiv: 0904.0829 [hep-th].
- [41] Elias Kiritsis and Georgios Kofinas. “Horava-Lifshitz Cosmology”. In: *Nucl. Phys. B* 821 (2009), pp. 467–480. DOI: 10.1016/j.nuclphysb.2009.05.005. arXiv: 0904.1334 [hep-th].
- [42] Robert Brandenberger. “Matter Bounce in Horava-Lifshitz Cosmology”. In: *Phys. Rev. D* 80 (2009), p. 043516. DOI: 10.1103/PhysRevD.80.043516. arXiv: 0904.2835 [hep-th].
- [43] Shinji Mukohyama. “Scale-invariant cosmological perturbations from Horava-Lifshitz gravity without inflation”. In: *JCAP* 0906 (2009), p. 001. DOI: 10.1088/1475-7516/2009/06/001. arXiv: 0904.2190 [hep-th].

- [44] Rong-Gen Cai, Bin Hu, and Hong-Bo Zhang. “Dynamical Scalar Degree of Freedom in Horava-Lifshitz Gravity”. In: *Phys. Rev. D* 80 (2009), p. 041501. DOI: 10.1103/PhysRevD.80.041501. arXiv: 0905.0255 [hep-th].
- [45] Bin Chen, Shi Pi, and Jin-Zhang Tang. “Scale Invariant Power Spectrum in Horava-Lifshitz Cosmology without Matter”. In: *JCAP* 0908 (2009), p. 007. DOI: 10.1088/1475-7516/2009/08/007. arXiv: 0905.2300 [hep-th].
- [46] Rong-Gen Cai, Bin Hu, and Hong-Bo Zhang. “Scalar graviton in the healthy extension of Hořava-Lifshitz theory”. In: *Phys. Rev. D* 83 (2011), p. 084009. DOI: 10.1103/PhysRevD.83.084009. arXiv: 1008.5048 [hep-th].
- [47] Sean M. Carroll and Eugene A. Lim. “Lorentz-violating vector fields slow the universe down”. In: *Phys. Rev. D* 70 (2004), p. 123525. DOI: 10.1103/PhysRevD.70.123525. arXiv: hep-th/0407149 [hep-th].
- [48] Joseph A. Zuntz, P. G. Ferreira, and T. G. Zlosnik. “Constraining Lorentz violation with cosmology”. In: *Phys. Rev. Lett.* 101 (2008), p. 261102. DOI: 10.1103/PhysRevLett.101.261102. arXiv: 0808.1824 [gr-qc].
- [49] Xian Gao et al. “Cosmological Perturbations in Horava-Lifshitz Gravity”. In: *Phys. Rev. D* 81 (2010), p. 083508. DOI: 10.1103/PhysRevD.81.083508. arXiv: 0905.3821 [hep-th].
- [50] Anzhong Wang and Roy Maartens. “Linear perturbations of cosmological models in the Horava-Lifshitz theory of gravity without detailed balance”. In: *Phys. Rev. D* 81 (2010), p. 024009. DOI: 10.1103/PhysRevD.81.024009. arXiv: 0907.1748 [hep-th].
- [51] Tsutomu Kobayashi, Yuko Urakawa, and Masahide Yamaguchi. “Large scale evolution of the curvature perturbation in Horava-Lifshitz cosmology”. In: *JCAP* 0911 (2009), p. 015. DOI: 10.1088/1475-7516/2009/11/015. arXiv: 0908.1005 [astro-ph.CO].
- [52] Sourish Dutta and Emmanuel N. Saridakis. “Observational constraints on Horava-Lifshitz cosmology”. In: *JCAP* 1001 (2010), p. 013. DOI: 10.1088/1475-7516/2010/01/013. arXiv: 0911.1435 [hep-th].
- [53] Tsutomu Kobayashi, Yuko Urakawa, and Masahide Yamaguchi. “Cosmological perturbations in a healthy extension of Horava gravity”. In: *JCAP* 1004 (2010), p. 025. DOI: 10.1088/1475-7516/2010/04/025. arXiv: 1002.3101 [hep-th].

Bibliography

- [54] Sourish Dutta and Emmanuel N. Saridakis. “Overall observational constraints on the running parameter λ of Horava-Lifshitz gravity”. In: *JCAP* 1005 (2010), p. 013. DOI: 10.1088/1475-7516/2010/05/013. arXiv: 1002.3373 [hep-th].
- [55] Shinji Mukohyama. “Horava-Lifshitz Cosmology: A Review”. In: *Class. Quant. Grav.* 27 (2010), p. 223101. DOI: 10.1088/0264-9381/27/22/223101. arXiv: 1007.5199 [hep-th].
- [56] Diego Blas, Mikhail M. Ivanov, and Sergey Sibiryakov. “Testing Lorentz invariance of dark matter”. In: *JCAP* 1210 (2012), p. 057. DOI: 10.1088/1475-7516/2012/10/057. arXiv: 1209.0464 [astro-ph.CO].
- [57] B. Audren et al. “Cosmological constraints on Lorentz violating dark energy”. In: *JCAP* 1308 (2013), p. 039. DOI: 10.1088/1475-7516/2013/08/039. arXiv: 1305.0009 [astro-ph.CO].
- [58] B. Audren et al. “Cosmological constraints on deviations from Lorentz invariance in gravity and dark matter”. In: *JCAP* 1503.03 (2015), p. 016. DOI: 10.1088/1475-7516/2015/03/016. arXiv: 1410.6514 [astro-ph.CO].
- [59] Thomas P. Sotiriou. “Horava-Lifshitz gravity: a status report”. In: *J. Phys. Conf. Ser.* 283 (2011), p. 012034. DOI: 10.1088/1742-6596/283/1/012034. arXiv: 1010.3218 [hep-th].
- [60] Matt Visser. “Status of Horava gravity: A personal perspective”. In: *J. Phys. Conf. Ser.* 314 (2011), p. 012002. DOI: 10.1088/1742-6596/314/1/012002. arXiv: 1103.5587 [hep-th].
- [61] Andrei O. Barvinsky et al. “Renormalization of Hořava gravity”. In: *Phys. Rev.* D93.6 (2016), p. 064022. DOI: 10.1103/PhysRevD.93.064022. arXiv: 1512.02250 [hep-th].
- [62] Matt Visser. “Lorentz symmetry breaking as a quantum field theory regulator”. In: *Phys. Rev.* D80 (2009), p. 025011. DOI: 10.1103/PhysRevD.80.025011. arXiv: 0902.0590 [hep-th].
- [63] Matt Visser. “Power-counting renormalizability of generalized Horava gravity”. In: (2009). arXiv: 0912.4757 [hep-th].
- [64] D. Blas, O. Pujolas, and S. Sibiryakov. “Consistent Extension of Horava Gravity”. In: *Phys. Rev. Lett.* 104 (2010), p. 181302. DOI: 10.1103/PhysRevLett.104.181302. arXiv: 0909.3525 [hep-th].
- [65] Jerome Gleyzes et al. “Essential Building Blocks of Dark Energy”. In: *JCAP* 1308 (2013), p. 025. DOI: 10.1088/1475-7516/2013/08/025. arXiv: 1304.4840 [hep-th].

- [66] Jérôme Gleyzes et al. “Healthy theories beyond Horndeski”. In: *Phys. Rev. Lett.* 114.21 (2015), p. 211101. DOI: 10.1103/PhysRevLett.114.211101. arXiv: 1404.6495 [hep-th].
- [67] Jerome Gleyzes et al. “Exploring gravitational theories beyond Horndeski”. In: *JCAP* 1502 (2015), p. 018. DOI: 10.1088/1475-7516/2015/02/018. arXiv: 1408.1952 [astro-ph.CO].
- [68] Federico Piazza, Heinrich Steigerwald, and Christian Marinoni. “Phenomenology of dark energy: exploring the space of theories with future redshift surveys”. In: *JCAP* 1405 (2014), p. 043. DOI: 10.1088/1475-7516/2014/05/043. arXiv: 1312.6111 [astro-ph.CO].
- [69] Emilio Bellini and Ignacy Sawicki. “Maximal freedom at minimum cost: linear large-scale structure in general modifications of gravity”. In: *JCAP* 1407 (2014), p. 050. DOI: 10.1088/1475-7516/2014/07/050. arXiv: 1404.3713 [astro-ph.CO].
- [70] Timothy Clifton et al. “Modified Gravity and Cosmology”. In: *Phys. Rept.* 513 (2012), pp. 1–189. DOI: 10.1016/j.physrep.2012.01.001. arXiv: 1106.2476 [astro-ph.CO].
- [71] Shinji Tsujikawa. “Quintessence: A Review”. In: *Class. Quant. Grav.* 30 (2013), p. 214003. DOI: 10.1088/0264-9381/30/21/214003. arXiv: 1304.1961 [gr-qc].
- [72] Cédric Deffayet and Danièle A. Steer. “A formal introduction to Horndeski and Galileon theories and their generalizations”. In: *Class. Quant. Grav.* 30 (2013), p. 214006. DOI: 10.1088/0264-9381/30/21/214006. arXiv: 1307.2450 [hep-th].
- [73] Kazuya Koyama. “Cosmological Tests of Modified Gravity”. In: *Rept. Prog. Phys.* 79.4 (2016), p. 046902. DOI: 10.1088/0034-4885/79/4/046902. arXiv: 1504.04623 [astro-ph.CO].
- [74] Jolyon Bloomfield. “A Simplified Approach to General Scalar-Tensor Theories”. In: *JCAP* 1312 (2013), p. 044. DOI: 10.1088/1475-7516/2013/12/044. arXiv: 1304.6712 [astro-ph.CO].
- [75] Jérôme Gleyzes, David Langlois, and Filippo Vernizzi. “A unifying description of dark energy”. In: *Int. J. Mod. Phys. D* 23.13 (2015), p. 1443010. DOI: 10.1142/S021827181443010X. arXiv: 1411.3712 [hep-th].
- [76] Federico Piazza and Filippo Vernizzi. “Effective Field Theory of Cosmological Perturbations”. In: *Class. Quant. Grav.* 30 (2013), p. 214007. DOI: 10.1088/0264-9381/30/21/214007. arXiv: 1307.4350 [hep-th].

Bibliography

- [77] Louis Perenon et al. “Phenomenology of dark energy: general features of large-scale perturbations”. In: *JCAP* 1511.11 (2015), p. 029. DOI: 10.1088/1475-7516/2015/11/029. arXiv: 1506.03047 [astro-ph.CO].
- [78] Gregory Walter Horndeski. “Second-order scalar-tensor field equations in a four-dimensional space”. In: *Int. J. Theor. Phys.* 10 (1974), pp. 363–384. DOI: 10.1007/BF01807638.
- [79] C. Deffayet, S. Deser, and G. Esposito-Farese. “Generalized Galileons: All scalar models whose curved background extensions maintain second-order field equations and stress-tensors”. In: *Phys. Rev. D* 80 (2009), p. 064015. DOI: 10.1103/PhysRevD.80.064015. arXiv: 0906.1967 [gr-qc].
- [80] Bin Hu et al. “EFTCAMB/EFTCosmoMC: Numerical Notes v3.0”. In: (2014). arXiv: 1405.3590 [astro-ph.IM].
- [81] Yong-Seon Song, Wayne Hu, and Ignacy Sawicki. “The Large Scale Structure of f(R) Gravity”. In: *Phys. Rev. D* 75 (2007), p. 044004. DOI: 10.1103/PhysRevD.75.044004. arXiv: astro-ph/0610532 [astro-ph].
- [82] Bin Hu et al. “Testing Hu-Sawicki f(R) gravity with the effective field theory approach”. In: *Mon. Not. Roy. Astron. Soc.* 459.4 (2016), pp. 3880–3889. DOI: 10.1093/mnras/stw775. arXiv: 1601.07536 [astro-ph.CO].
- [83] Alberto Nicolis, Riccardo Rattazzi, and Enrico Trincherini. “The Galileon as a local modification of gravity”. In: *Phys. Rev. D* 79 (2009), p. 064036. DOI: 10.1103/PhysRevD.79.064036. arXiv: 0811.2197 [hep-th].
- [84] G. R. Dvali, Gregory Gabadadze, and Massimo Porrati. “4-D gravity on a brane in 5-D Minkowski space”. In: *Phys. Lett. B* 485 (2000), pp. 208–214. DOI: 10.1016/S0370-2693(00)00669-9. arXiv: hep-th/0005016 [hep-th].
- [85] Austin Joyce et al. “Beyond the Cosmological Standard Model”. In: *Phys. Rept.* 568 (2015), pp. 1–98. DOI: 10.1016/j.physrep.2014.12.002. arXiv: 1407.0059 [astro-ph.CO].
- [86] C. Deffayet, Gilles Esposito-Farese, and A. Vikman. “Covariant Galileon”. In: *Phys. Rev. D* 79 (2009), p. 084003. DOI: 10.1103/PhysRevD.79.084003. arXiv: 0901.1314 [hep-th].
- [87] Paolo Creminelli, Alberto Nicolis, and Enrico Trincherini. “Galilean Genesis: An Alternative to inflation”. In: *JCAP* 1011 (2010), p. 021. DOI: 10.1088/1475-7516/2010/11/021. arXiv: 1007.0027 [hep-th].

- [88] Tsutomu Kobayashi, Masahide Yamaguchi, and Jun'ichi Yokoyama. "G-inflation: Inflation driven by the Galileon field". In: *Phys. Rev. Lett.* 105 (2010), p. 231302. DOI: 10.1103/PhysRevLett.105.231302. arXiv: 1008.0603 [hep-th].
- [89] Clare Burrage et al. "Galileon inflation". In: *JCAP* 1101 (2011), p. 014. DOI: 10.1088/1475-7516/2011/01/014. arXiv: 1009.2497 [hep-th].
- [90] Kohei Kamada et al. "Higgs G-inflation". In: *Phys. Rev. D* 83 (2011), p. 083515. DOI: 10.1103/PhysRevD.83.083515. arXiv: 1012.4238 [astro-ph.CO].
- [91] Paolo Creminelli et al. "Galilean symmetry in the effective theory of inflation: new shapes of non-Gaussianity". In: *JCAP* 1102 (2011), p. 006. DOI: 10.1088/1475-7516/2011/02/006. arXiv: 1011.3004 [hep-th].
- [92] Tsutomu Kobayashi, Masahide Yamaguchi, and Jun'ichi Yokoyama. "Generalized G-inflation: Inflation with the most general second-order field equations". In: *Prog. Theor. Phys.* 126 (2011), pp. 511–529. DOI: 10.1143/PTP.126.511. arXiv: 1105.5723 [hep-th].
- [93] Xian Gao and Daniele A. Steer. "Inflation and primordial non-Gaussianities of 'generalized Galileons'". In: *JCAP* 1112 (2011), p. 019. DOI: 10.1088/1475-7516/2011/12/019. arXiv: 1107.2642 [astro-ph.CO].
- [94] Antonio De Felice and Shinji Tsujikawa. "Shapes of primordial non-Gaussianities in the Horndeski's most general scalar-tensor theories". In: *JCAP* 1303 (2013), p. 030. DOI: 10.1088/1475-7516/2013/03/030. arXiv: 1301.5721 [hep-th].
- [95] Yu-ichi Takamizu and Tsutomu Kobayashi. "Nonlinear superhorizon curvature perturbation in generic single-field inflation". In: *PTEP* 2013.6 (2013), 063E03. DOI: 10.1093/ptep/ptt033. arXiv: 1301.2370 [gr-qc].
- [96] Noemi Frusciante, Shuang-Yong Zhou, and Thomas P. Sotiriou. "Gradient expansion of superhorizon perturbations in G-inflation". In: *JCAP* 1307 (2013), p. 020. DOI: 10.1088/1475-7516/2013/07/020. arXiv: 1303.6628 [astro-ph.CO].
- [97] Nathan Chow and Justin Khoury. "Galileon Cosmology". In: *Phys. Rev. D* 80 (2009), p. 024037. DOI: 10.1103/PhysRevD.80.024037. arXiv: 0905.1325 [hep-th].
- [98] Fabio P Silva and Kazuya Koyama. "Self-Accelerating Universe in Galileon Cosmology". In: *Phys. Rev. D* 80 (2009), p. 121301. DOI: 10.1103/PhysRevD.80.121301. arXiv: 0909.4538 [astro-ph.CO].

Bibliography

- [99] Antonio De Felice and Shinji Tsujikawa. “Cosmology of a covariant Galileon field”. In: *Phys. Rev. Lett.* 105 (2010), p. 111301. DOI: 10.1103/PhysRevLett.105.111301. arXiv: 1007.2700 [astro-ph.CO].
- [100] Cedric Deffayet et al. “Imperfect Dark Energy from Kinetic Gravity Braiding”. In: *JCAP* 1010 (2010), p. 026. DOI: 10.1088/1475-7516/2010/10/026. arXiv: 1008.0048 [hep-th].
- [101] Oriol Pujolas, Ignacy Sawicki, and Alexander Vikman. “The Imperfect Fluid behind Kinetic Gravity Braiding”. In: *JHEP* 11 (2011), p. 156. DOI: 10.1007/JHEP11(2011)156. arXiv: 1103.5360 [hep-th].
- [102] A. I. Vainshtein. “To the problem of nonvanishing gravitation mass”. In: *Phys. Lett.* B39 (1972), pp. 393–394. DOI: 10.1016/0370-2693(72)90147-5.
- [103] Eugeny Babichev and Cédric Deffayet. “An introduction to the Vainshtein mechanism”. In: *Class. Quant. Grav.* 30 (2013), p. 184001. DOI: 10.1088/0264-9381/30/18/184001. arXiv: 1304.7240 [gr-qc].
- [104] Clare Burrage and David Seery. “Revisiting fifth forces in the Galileon model”. In: *JCAP* 1008 (2010), p. 011. DOI: 10.1088/1475-7516/2010/08/011. arXiv: 1005.1927 [astro-ph.CO].
- [105] Antonio De Felice, Ryotaro Kase, and Shinji Tsujikawa. “Vainshtein mechanism in second-order scalar-tensor theories”. In: *Phys. Rev.* D85 (2012), p. 044059. DOI: 10.1103/PhysRevD.85.044059. arXiv: 1111.5090 [gr-qc].
- [106] Philippe Brax, Clare Burrage, and Anne-Christine Davis. “Laboratory Tests of the Galileon”. In: *JCAP* 1109 (2011), p. 020. DOI: 10.1088/1475-7516/2011/09/020. arXiv: 1106.1573 [hep-ph].
- [107] Ryotaro Kase and Shinji Tsujikawa. “Screening the fifth force in the Horndeski’s most general scalar-tensor theories”. In: *JCAP* 1308 (2013), p. 054. DOI: 10.1088/1475-7516/2013/08/054. arXiv: 1306.6401 [gr-qc].
- [108] Jolyon K. Bloomfield, Clare Burrage, and Anne-Christine Davis. “Shape dependence of Vainshtein screening”. In: *Phys. Rev.* D91.8 (2015), p. 083510. DOI: 10.1103/PhysRevD.91.083510. arXiv: 1408.4759 [gr-qc].
- [109] Fulvio Sbisá. “Classical and quantum ghosts”. In: *Eur. J. Phys.* 36 (2015), p. 015009. DOI: 10.1088/0143-0807/36/1/015009. arXiv: 1406.4550 [hep-th].

- [110] Emilio Bellini et al. “Constraints on deviations from Λ CDM within Horndeski gravity”. In: *JCAP* 1602.02 (2016). [Erratum: *JCAP*1606,no.06,E01(2016)], p. 053. DOI: 10.1088/1475-7516/2016/06/E01, 10.1088/1475-7516/2016/02/053. arXiv: 1509.07816 [astro-ph.CO].
- [111] Antonio De Felice and Shinji Tsujikawa. “Conditions for the cosmological viability of the most general scalar-tensor theories and their applications to extended Galileon dark energy models”. In: *JCAP* 1202 (2012), p. 007. DOI: 10.1088/1475-7516/2012/02/007. arXiv: 1110.3878 [gr-qc].
- [112] Robert J. Scherrer. “Purely kinetic k-essence as unified dark matter”. In: *Phys. Rev. Lett.* 93 (2004), p. 011301. DOI: 10.1103/PhysRevLett.93.011301. arXiv: astro-ph/0402316 [astro-ph].
- [113] Daniele Bertacca, Sabino Matarrese, and Massimo Pietroni. “Unified Dark Matter in Scalar Field Cosmologies”. In: *Mod. Phys. Lett. A22* (2007), pp. 2893–2907. DOI: 10.1142/S0217732307025893. arXiv: astro-ph/0703259 [ASTRO-PH].
- [114] Daniele Bertacca and Nicola Bartolo. “ISW effect in Unified Dark Matter Scalar Field Cosmologies: An analytical approach”. In: *JCAP* 0711 (2007), p. 026. DOI: 10.1088/1475-7516/2007/11/026. arXiv: 0707.4247 [astro-ph].
- [115] Laszlo A. Gergely and Shinji Tsujikawa. “Effective field theory of modified gravity with two scalar fields: dark energy and dark matter”. In: *Phys. Rev. D* 89.6 (2014), p. 064059. DOI: 10.1103/PhysRevD.89.064059. arXiv: 1402.0553 [hep-th].
- [116] Gong-Bo Zhao et al. “Searching for modified growth patterns with tomographic surveys”. In: *Phys. Rev. D* 79 (2009), p. 083513. DOI: 10.1103/PhysRevD.79.083513. arXiv: 0809.3791 [astro-ph].
- [117] Miguel Zumalacarregui et al. “hiclass: Horndeski in the Cosmic Linear Anisotropy Solving System”. In: (2016). arXiv: 1605.06102 [astro-ph.CO].
- [118] Antony Lewis and Sarah Bridle. “Cosmological parameters from CMB and other data: a Monte-Carlo approach”. In: *Phys. Rev. D* 66 (2002), p. 103511. eprint: astro-ph/0205436.
- [119] Bin Hu et al. “Exploring massive neutrinos in dark cosmologies with *EFTCAMB*/*EFTCosmoMC*”. In: *Phys. Rev. D* 91.6 (2015), p. 063524. DOI: 10.1103/PhysRevD.91.063524. arXiv: 1410.5807 [astro-ph.CO].

Bibliography

- [120] Bernard F. Schutz and Rafael Sorkin. “Variational aspects of relativistic field theories, with application to perfect fluids”. In: *Annals Phys.* 107 (1977), pp. 1–43. DOI: 10.1016/0003-4916(77)90200-7.
- [121] J. David Brown. “Action functionals for relativistic perfect fluids”. In: *Class. Quant. Grav.* 10 (1993), pp. 1579–1606. DOI: 10.1088/0264-9381/10/8/017. arXiv: gr-qc/9304026 [gr-qc].
- [122] Antonio De Felice and Shinji Mukohyama. “Phenomenology in minimal theory of massive gravity”. In: *JCAP* 1604.04 (2016), p. 028. DOI: 10.1088/1475-7516/2016/04/028. arXiv: 1512.04008 [hep-th].
- [123] Jérôme Gleyzes et al. “Effective Theory of Interacting Dark Energy”. In: *JCAP* 1508.08 (2015), p. 054. DOI: 10.1088/1475-7516/2015/08/054. arXiv: 1504.05481 [astro-ph.CO].
- [124] Guido D’Amico et al. “Weakening Gravity on Redshift-Survey Scales with Kinetic Matter Mixing”. In: *JCAP* 1702 (2017), p. 014. DOI: 10.1088/1475-7516/2017/02/014. arXiv: 1609.01272 [astro-ph.CO].
- [125] Valentina Salvatelli, Federico Piazza, and Christian Marinoni. “Constraints on modified gravity from Planck 2015: when the health of your theory makes the difference”. In: (2016). arXiv: 1602.08283 [astro-ph.CO].
- [126] A. Emir Gumrukcuoglu, Shinji Mukohyama, and Thomas P. Sotiriou. “Low energy ghosts and the Jeans? instability”. In: *Phys. Rev. D* 94.6 (2016), p. 064001. DOI: 10.1103/PhysRevD.94.064001. arXiv: 1606.00618 [hep-th].
- [127] J. L. Safko H. Goldstein C. P. Poole. *Classical Mechanics*. 3rd ed. Addison-wesley, 2001. ISBN: 0201316110.
- [128] P. A. R. Ade et al. “Planck 2015 results. XIII. Cosmological parameters”. In: *Astron. Astrophys.* 594 (2016), A13. DOI: 10.1051/0004-6361/201525830. arXiv: 1502.01589 [astro-ph.CO].
- [129] Michel Chevallier and David Polarski. “Accelerating universes with scaling dark matter”. In: *Int. J. Mod. Phys. D* 10 (2001), pp. 213–224. DOI: 10.1142/S0218271801000822. arXiv: gr-qc/0009008 [gr-qc].
- [130] Eric V. Linder. “Exploring the expansion history of the universe”. In: *Phys. Rev. Lett.* 90 (2003), p. 091301. DOI: 10.1103/PhysRevLett.90.091301. arXiv: astro-ph/0208512 [astro-ph].

- [131] Paolo Creminelli et al. “Starting the Universe: Stable Violation of the Null Energy Condition and Non-standard Cosmologies”. In: *JHEP* 12 (2006), p. 080. DOI: 10.1088/1126-6708/2006/12/080. arXiv: hep-th/0606090 [hep-th].
- [132] Savvas Nesseris, Antonio De Felice, and Shinji Tsujikawa. “Observational constraints on Galileon cosmology”. In: *Phys. Rev. D* 82 (2010), p. 124054. DOI: 10.1103/PhysRevD.82.124054. arXiv: 1010.0407 [astro-ph.CO].
- [133] Stephen Appleby and Eric V. Linder. “The Paths of Gravity in Galileon Cosmology”. In: *JCAP* 1203 (2012), p. 043. DOI: 10.1088/1475-7516/2012/03/043. arXiv: 1112.1981 [astro-ph.CO].
- [134] C. Armendariz-Picon, Viatcheslav F. Mukhanov, and Paul J. Steinhardt. “Essentials of k essence”. In: *Phys. Rev. D* 63 (2001), p. 103510. DOI: 10.1103/PhysRevD.63.103510. arXiv: astro-ph/0006373 [astro-ph].
- [135] Anzhong Wang. “Vector and tensor perturbations in Horava-Lifshitz cosmology”. In: *Phys. Rev. D* 82 (2010), p. 124063. DOI: 10.1103/PhysRevD.82.124063. arXiv: 1008.3637 [hep-th].
- [136] Eric V. Linder, Gizem Sengör, and Scott Watson. “Is the Effective Field Theory of Dark Energy Effective?” In: *JCAP* 1605.05 (2016), p. 053. DOI: 10.1088/1475-7516/2016/05/053. arXiv: 1512.06180 [astro-ph.CO].
- [137] Kent Yagi et al. “Constraints on Einstein-Æther theory and Hořava gravity from binary pulsar observations”. In: *Phys. Rev. D* 89.8 (2014). [Erratum: *Phys. Rev. D* 90,no.6,069901(2014)], p. 084067. DOI: 10.1103/PhysRevD.90.069902, 10.1103/PhysRevD.90.069901, 10.1103/PhysRevD.89.084067. arXiv: 1311.7144 [gr-qc].
- [138] Simone Peirone et al. “Impact of theoretical priors in cosmological analyses: the case of single field quintessence”. In: *Phys. Rev. D* 96.6 (2017), p. 063524. DOI: 10.1103/PhysRevD.96.063524. arXiv: 1702.06526 [astro-ph.CO].
- [139] C. Brans and R. H. Dicke. “Mach’s principle and a relativistic theory of gravitation”. In: *Phys. Rev.* 124 (1961). [142(1961)], pp. 925–935. DOI: 10.1103/PhysRev.124.925.
- [140] Marco Raveri et al. “Priors on the effective Dark Energy equation of state in scalar-tensor theories”. In: *Phys. Rev. D* 96.8 (2017), p. 083509. DOI: 10.1103/PhysRevD.96.083509. arXiv: 1703.05297 [astro-ph.CO].

Bibliography

- [141] Simone Peirone et al. “Large-scale structure phenomenology of viable Horndeski theories”. In: (2017). arXiv: 1712.00444 [astro-ph.CO].
- [142] B. P. Abbott et al. “GW170817: Observation of Gravitational Waves from a Binary Neutron Star Inspiral”. In: *Phys. Rev. Lett.* 119.16 (2017), p. 161101. DOI: 10.1103/PhysRevLett.119.161101. arXiv: 1710.05832 [gr-qc].
- [143] B. P. Abbott et al. “Gravitational Waves and Gamma-rays from a Binary Neutron Star Merger: GW170817 and GRB 170817A”. In: *Astrophys. J.* 848.2 (2017), p. L13. DOI: 10.3847/2041-8213/aa920c. arXiv: 1710.05834 [astro-ph.HE].
- [144] D. A. Coulter et al. “Swope Supernova Survey 2017a (SSS17a), the Optical Counterpart to a Gravitational Wave Source”. In: *Science* (2017). DOI: 10.1126/science.aap9811. arXiv: 1710.05452 [astro-ph.HE].
- [145] Luca Amendola et al. “Conditions for the cosmological viability of $f(R)$ dark energy models”. In: *Phys. Rev. D* 75 (2007), p. 083504. DOI: 10.1103/PhysRevD.75.083504. arXiv: gr-qc/0612180 [gr-qc].
- [146] Wayne Hu and Ignacy Sawicki. “Models of $f(R)$ Cosmic Acceleration that Evade Solar-System Tests”. In: *Phys. Rev. D* 76 (2007), p. 064004. DOI: 10.1103/PhysRevD.76.064004. arXiv: 0705.1158 [astro-ph].
- [147] Alexei A. Starobinsky. “Disappearing cosmological constant in $f(R)$ gravity”. In: *JETP Lett.* 86 (2007), pp. 157–163. DOI: 10.1134/S0021364007150027. arXiv: 0706.2041 [astro-ph].
- [148] Juan Espejo et al. “Phenomenology of Large Scale Structure in scalar-tensor theories: joint prior covariance of w_{DE} , Σ and μ in Horndeski”. In: (2018). arXiv: 1809.01121 [astro-ph.CO].
- [149] Rachel Bean and Matipon Tangmatitham. “Current constraints on the cosmic growth history”. In: *Phys. Rev. D* 81 (2010), p. 083534. DOI: 10.1103/PhysRevD.81.083534. arXiv: 1002.4197 [astro-ph.CO].
- [150] Yong-Seon Song et al. “Complementarity of Weak Lensing and Peculiar Velocity Measurements in Testing General Relativity”. In: *Phys. Rev. D* 84 (2011), p. 083523. DOI: 10.1103/PhysRevD.84.083523. arXiv: 1011.2106 [astro-ph.CO].
- [151] Fergus Simpson et al. “CFHTLenS: Testing the Laws of Gravity with Tomographic Weak Lensing and Redshift Space Distortions”. In: *Mon. Not. Roy. Astron. Soc.* 429 (2013), p. 2249. DOI: 10.1093/mnras/sts493. arXiv: 1212.3339 [astro-ph.CO].

- [152] Shinsuke Asaba et al. “Principal Component Analysis of Modified Gravity using Weak Lensing and Peculiar Velocity Measurements”. In: *JCAP* 1308 (2013), p. 029. DOI: 10.1088/1475-7516/2013/08/029. arXiv: 1306.2546 [astro-ph.CO].
- [153] R. Moessner, B. Jain, and J. V. Villumsen. “The effect of weak lensing on the angular correlation function of faint galaxies”. In: *Mon. Not. Roy. Astron. Soc.* 294 (1998), p. 291. DOI: 10.1046/j.1365-8711.1998.01225.x. arXiv: astro-ph/9708271 [astro-ph].
- [154] Alireza Hojjati et al. “Cosmological tests of General Relativity: a principal component analysis”. In: *Phys. Rev. D* 85 (2012), p. 043508. DOI: 10.1103/PhysRevD.85.043508. arXiv: 1111.3960 [astro-ph.CO].
- [155] Levon Pogosian and Alessandra Silvestri. “What can cosmology tell us about gravity? Constraining Horndeski gravity with Σ and μ ”. In: *Phys. Rev. D* 94.10 (2016), p. 104014. DOI: 10.1103/PhysRevD.94.104014. arXiv: 1606.05339 [astro-ph.CO].
- [156] N. Aghanim et al. “Planck 2018 results. VI. Cosmological parameters”. In: (2018). arXiv: 1807.06209 [astro-ph.CO].

