Curriculum Vitæ

Georgios KOFINAS

- **Date and place of birth** 28th of December 1970 in Athens-Greece
- **Title** Dr
- **Nationality** Greek
- **Marital Status** Single
- **Professional address** University of the Aegean
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  Communication Systems Engineering
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  (updated list of publications and citations can be found)

Studies :

- **1996 - May 1999** Ph.D. degree at the University of Athens, Physics Department, Athens, Greece. Thesis title: "Relativistic Classical and Quantum Cosmology". Supervisor Ass. Prof. T. Christodoulakis.
  Honourable mention with congratulations from the jury.
- **1993 - 1995** M.Sc. degree in Theoretical Physics at the University of Alberta, Physics Department, Edmonton, Canada. Thesis title: "Bianchi-IX Universe in Euclidean Quantum Cosmology". Supervisor Professor D.N. Page.
- **1988 - 1992** Diploma in Physics at the University of Athens, Greece.
  Class of qualification 8.9/10 (Honours).
- **1988** High School graduation (19.5/20.0). Entry examination to the University of Athens, Physics Department.

Professional/Employment Career :

- **06/19 -** Associate Professor, University of the Aegean, Department of Information and Communication Systems Engineering.
- **06/15 - 06/19** Assistant Professor, University of the Aegean, Department of Information and Communication Systems Engineering.
- **12/13 - 06/15** Lecturer, University of the Aegean, Department of Information and Communication Systems Engineering.
- **09/12 - 12/12** Visiting Professor (Lecturer), University of Cyprus, Department of Physics, Nicosia, courses taught: Statistical Physics, Physics for chemists, Quantum Field Theory II.
- **10/11 - 12/13** Visiting Professor, University of the Aegean, Department of Information and Communication Systems Engineering, courses taught: Calculus, Linear Algebra, Physics I (mechanics), Physics II (electromagnetism), Physics (mechanics & electromagnetism), Cosmology (graduate), Differential Equations (ordinary), Probability-Statistics, Numerical Analysis.
- **10/10** Elected Lecturer (to be appointed by Ministry), University of the Aegean, Department of Information and Communication Systems Engineering.
- **09/06 - 09/11** Visiting Professor (non-permanent Associate Professor), University of Crete, Physics Department, Heraklion, Greece, courses taught: Cosmology, General Relativity, Classical Mechanics (graduate), Partial Differential Equations, Linear Algebra.
- **06/04 - 06/06** Postdoctoral research at the Universitat de Barcelona, Departament de Física Fonamental, Barcelona, Spain
- **10/02 - 01/04** Postdoctoral research at the Centro de Estudios Cientificos (CECS), Valdivia, Chile.
- **01/02 - 09/02** Postdoctoral research and teaching of the Cosmology course at the University of Crete, Physics Department, Heraklion, Greece.
- **01/01 - 12/01** Postdoctoral research at the University of Athens, Physics Department, Athens, Greece.
- **05/99 - 11/00** Compulsory Military service in the Greek army (18 months).
- **1993 - 1995** Teaching Assistantship at the University of Alberta, Physics Department, Edmonton, Canada.
- Private lessons to students of secondary education during the undergraduate and graduate studies.

Fellowships - Distinctions :

- Marie Curie Intra-European Fellowship for postdoctoral research.
- Fellowship from the Hellenic Research Foundation during Ph.D. studies (first prize in national exams for graduate studies).
- Fellowship from the Lilian Voudouri Foundation during the M.Sc. studies.
- University of Athens Fellowships during undergraduate studies.
- Prizes of excellence during all the years of High School.

Additional Pieces of Information :

- Languages : Greek (native), English (fluent), French, Spanish (elementary).

Research Interests :

- Theoretical/Mathematical Physics.
- Classical gravity, Alternative gravity theories, Gravity of higher dimensions, Black holes, Gravitational radiation, Teleparallel theories of gravity, Torsion and non-metricity in gravity.
- Cosmology, Braneworld cosmology, String cosmology.
- Canonical approach of quantum gravity and quantum cosmology, Asymptotic safety in cosmology.
- Biological Physics.

Publications :

1. T. Christodoulakis, G. Kofinas, E. Korfiatis and A. Paschos, *Wave functions for the general Type II Cosmology*, Phys. Lett. **390B** (1997) 55.

2. T. Christodoulakis, G. Kofinas, E. Korfiatis and A. Paschos, *Normalizable wave functions for the general Type V Cosmology*, Phys. Lett. **419B** (1998) 30.

3. T. Christodoulakis, G. Kofinas and V. Zarikas, *The untilted diffuse matter Bianchi V Universe*, Phys. Lett. **275A** (2000) 180 [gr-qc/9907104].

4. T. Christodoulakis, G. Kofinas, E. Korfiatis, G.O. Papadopoulos and A. Paschos, *Time-dependent Automorphism Inducing Diffeomorphisms in vacuum Bianchi Cosmologies and the complete closed form solutions for Type II and V*, J. Math. Phys. **42** (2001) 3580 [gr-qc/0008050].

5. T. Christodoulakis, G. Kofinas and G.O. Papadopoulos, *Conditional symmetries and phase space reduction towards G.C.T. invariant wave functions for the Class A Bianchi Type VI and VII vacuum Cosmologies*, Phys. Lett. **B514** (2001) 149 [gr-qc/0101103].

6. G. Kofinas, *New perspectives on moving domain walls in* $(A)dS_5$ *space*, Nucl. Phys. **B622** (2002) 347 [hep-th/0103045].

7. G. Kofinas, *General brane Cosmology with* ${}^{(4)}R$ *term in* $(A)dS_5$ *or Minkowski bulk*, JHEP **0108** (2001) 034 [hep-th/0108013].

8. G. Kofinas, E. Papantonopoulos and I. Pappa, *Spherically symmetric braneworld solutions with* ${}^{(4)}R$ *term in the bulk*, Phys. Rev. **D66** (2002) 104014 [hep-th/0112019].

9. E. Kiritsis, G. Kofinas, N. Tetradis, T.N. Tomaras and V. Zarikas, *Cosmological evolution with brane-bulk energy exchange*, JHEP **0302** (2003) 035 [hep-th/0207060].

10. G. Kofinas, E. Papantonopoulos and V. Zamarias, *Black hole solutions in braneworlds with induced gravity*, Phys. Rev. **D66** (2002) 104028 [hep-th/0208207].

11. G. Kofinas, E. Papantonopoulos and V. Zamarias, *Black holes on the brane with induced gravity*, Astrophys. Space Sci. **283** (2003) 685, talk presented at the JENAM 2002 workshop on varying fundamental constants, Porto, September 2002 [hep-th/0210006].

12. G. Kofinas, R. Maartens and E. Papantonopoulos, *Brane cosmology with curvature corrections*, JHEP **10** (2003) 066 [hep-th/0307138].

13. G. Kofinas and E. Papantonopoulos, *Gravitational collapse in braneworld models with curvature corrections*, JCAP **0412** (2004) 011 [gr-qc/0401047].

14. A. Kehagias and G. Kofinas, *Cosmology with exponential potentials*, Class. Quant. Grav. **21** (2004) 3871 [gr-qc/0402059].

15. G. Kofinas, *Conservation equation on braneworld in six dimensions*, Class. Quant. Grav. **22** (2005) L47 [hep-th/0412299].

16. G. Kofinas, *On braneworld cosmologies from six dimensions, and absence thereof*, Phys. Lett. **B633** (2006) 141 [hep-th/0506035].

17. G. Kofinas, G. Panotopoulos and T.N. Tomaras, *Brane-bulk energy exchange: a model with the present universe as a global attractor*, JHEP **0601** (2006) 107 [hep-th/0510207].

18. G. Kofinas and R. Olea, *Vacuum energy in Einstein-Gauss-Bonnet AdS gravity*, Phys. Rev. **D74** (2006) 084035 [hep-th/0606253].

19. G. Kofinas and T.N. Tomaras, *Gravitating defects of codimension-two*, Class. Quantum Grav. **24** (2007) 5861 [hep-th/0702010].

20. G. Kofinas and R. Olea, *Universal regularization prescription for Lovelock AdS gravity*, JHEP **11** (2007) 069 [hep-th/0708.0782].

21. G. Kofinas, R. Olea, *Universal Kounterterms in Lovelock AdS gravity*, Fortsch. Phys. **56** (2008) 957 [hep-th/0806.1197].

22. D.V. Gal'tsov, G. Kofinas, P. Spirin and T.N. Tomaras, *Classical ultra-relativistic scattering in ADD*, JHEP **05** (2009) 074 [hep-ph/0903.3019].

23. E. Kiritsis, G. Kofinas, *Hořava-Lifshitz Cosmology*, Nucl. Phys. **B821** (2009) 467 [hep-th/0904.1334].

24. C. Charmousis, G. Kofinas and A. Papazoglou, *The consistency of codimension-2 braneworlds and their cosmology*, JCAP **1001** (2010) 022 [hep-th/0907.1640].

25. D.V. Gal'tsov, G. Kofinas, P. Spirin and T.N. Tomaras, *Transplanckian bremsstra hlung and black hole production*, Phys. Lett. **B683** (2010) 331 [hep-ph/0908.0675].

26. E. Kiritsis, G. Kofinas, *On Hořava-Lifshitz "Black holes"*, JHEP **01** (2010) 122 [hep-th/0910.5487].

27. D.V. Gal'tsov, G. Kofinas, P. Spirin and T.N. Tomaras, *Scalar ultrarelativistic bremsstrahlung in extra dimensions*, JHEP **05** (2010) 055 [hep-th/1003.2982].

28. G. Kofinas, V. Zarikas, *A solution of the coincidence problem based on the recent galactic core black hole energy density increase*, The European Physical Journal C **73** (2013) 2379 [hep-th/1107.2602].

29. G. Kofinas, M. Irakleidou, *Self-gravitating branes again*, Phys. Rev. **D89** (2014) 065015 [hep-th/1309.0674].

30. G. Kofinas, V. Zarikas, *5-dimensional braneworld with gravitating Nambu-Goto matching conditions*, Annals Phys. **351** (2014) 504-530 [gr-qc/1312.4292].

31. G. Kofinas, E. Saridakis and J.-Q. Xia, *Cosmological solutions and observational constraints on 5-dimensional braneworld cosmology with gravitating Nambu-Goto matching conditions*, Phys. Rev. **D90** (2014) 8, 084049 [astro-ph/1403.7510].

32. D.P. Jatkar, G. Kofinas, O. Miskovic and R. Olea, *Conformal Mass in AdS gravity*, Phys. Rev. **D89** (2014) 12, 124010 [hep-th/1404.1411].

33. G. Kofinas and E.N. Saridakis, *Teleparallel equivalent of Gauss-Bonnet gravity and its modifications*, Phys. Rev. **D90** (2014) 084044 [hep-th/1404.2249].

34. G. Kofinas, G. Leon and E.N. Saridakis, *Dynamical behavior in $f(T, T_G)$ cosmology*, Class. Quant. Grav. **31** (2014) 175011 [gr-qc/1404.7100].

35. G. Aliferis, G. Kofinas and V. Zarikas, *Efficient electroweak baryogenesis by black holes*, Phys. Rev. **D91** (2015) 4, 045002 [hep-ph/1406.6215].

36. G. Kofinas, and E.N. Saridakis, *Cosmological applications of $F(T, T_G)$ gravity*, Phys. Rev. **D90** (2014) 084045 [gr-qc/1408.0107].

37. G. Kofinas, E. Papantonopoulos and E.N. Saridakis, *Self-gravitating spherically symmetric solutions in scalar-torsion theories*, Phys. Rev. **D91** (2015) 10, 104034 [gr-qc/1501.00365].

38. D. Jatkar, G. Kofinas, O. Miskovic and R. Olea, *Conformal Mass in Einstein-Gauss-Bonnet AdS gravity*, Phys. Rev. **D91** (2015) 10, 105030 [gr-qc/1501.06861].

39. G. Kofinas, V. Zarikas, *Avoidance of singularities in asymptotically safe Quantum Einstein Gravity*, JCAP **1510** (2015) 10, 069 [gr-qc/1506.02965].

40. G. Kofinas, *Hyperscaling violating black holes in scalar-torsion theories*, Phys. Rev. **D92** (2015) 8, 084022 [hep-th/1507.07434].

41. G. Kofinas, *The complete Brans-Dicke theories*, Annals Phys. **376** (2017) 425 [gr-qc/1510.06845].

42. G. Kofinas, M. Tsoukalas, *On the action of the complete Brans-Dicke theory*, Eur. Phys. J. **C76** (2016) 12, 686 [gr-qc/1512.04786].

43. G. Kofinas, E. Papantonopoulos and E.N. Saridakis, *Modified Brans-Dicke cosmology with matter-scalar field interaction*, Class. Quant. Grav. **33** (2016) 15, 155004 [gr-qc/1602.02687].

44. G. Kofinas, V. Zarikas, *Asymptotic Safe gravity and non-singular inflationary Big Bang with vacuum birth*, Phys. Rev. **D94** (2016) 10, 103514 [gr-qc/1605.02241].

45. G. Kofinas, N. Lima, *Dynamics of cosmological perturbations in modified Brans-Dicke cosmology with matter-scalar field interaction*, Phys. Rev. **D96** (2017) 8, 084016 [gr-qc/1704.08925].

46. G. Kofinas, V. Zarikas, *Solution of the dark energy and its coincidence problem based on local antigravity sources without fine-tuning or new scales*, Phys. Rev. **D97** (2018) 12, 123542 [gr-qc/1706.08779].

47. G. Kofinas, *Is the use of Christoffel connection in gravity theories conceptually correct?*, Journal of Modern Physics **11** (2020) 1013 [physics.gen-ph/1712.02215].

48. F.K. Anagnostopoulos, S. Basilakos, G. Kofinas, V. Zarikas, *Constraining the Asymptotically Safe Cosmology: cosmic acceleration without dark energy*, JCAP **02** (2019) 053 [astro-ph/1806.10580].

49. V. Zarikas, G. Kofinas, *Singularities and Phenomenological aspects of Asymptotic Safe Gravity*, J. Phys. Conf. Ser. **1051** (2018) 1, 012028 [doi:10.1088/1742-6596/1051/1/012028].

50. F.K. Anagnostopoulos, G. Kofinas, V. Zarikas, *IR quantum gravity solves naturally cosmic acceleration and its coincidence problem*, Int. J. Mod. Phys. **D28** (2019) 14, 1944013 [doi:10.1142/S0218271819440139].

51. A. Bonanno, G. Kofinas, V. Zarikas, *Effective field equations and scale-dependent couplings in gravity*, Phys. Rev. **D103** (2021), 104025 [gr-qc/2012.05338].

Selected Talks and Seminars :

- **March 2023:** Speaker at the *Spring School of Gravity and Cosmology*, National Observatory of Athens, Athens, Greece. Title of the talk: *Black holes*.
- **September 2018:** Speaker at the 18th Conference on *Recent Developments in Gravity and Relativity*, Hellenic Society on Relativity, Gravitation & Cosmology, Rhodes, Greece. Title of the talk: *On the affine-connection of the universe*.

- **September 2017:** Speaker at the *9nd Aegean Summer School on Cosmology*, Sifnos, Greece. Title of the talk: *A modified Brans-Dicke theory with matter-scalar interaction.*

- **September 2016:** Speaker at the 17th Conference on *Recent Developments in Gravity*, Hellenic Society on Relativity, Gravitation & Cosmology, Mykonos, Greece. Title of the talk: *A generalization of Brans-Dicke gravity through matter-scalar interaction.*

- **July 2015:** Speaker at the *8nd Aegean Summer School on Cosmology*, Rethymno, Greece. Title of the talk: *Teleparallel gravity and modifications.*

- **February 2015:** Speaker at the conference *Progress in Fluid/Gravity Correspondence*, Thessaloniki, Greece. Title of the talk: *Teleparallel equivalent of Gauss-Bonnet gravity and other gravities.*

- **December 2014:** Seminar given at the National Technical University of Athens, Department of Applied Mathematics and Physical Sciences, Athens, Greece. Title of the seminar: *Teleparallel equivalent of Gauss-Bonnet gravity and modified gravities.*

- **October 2014:** Seminar given at the University of Crete, Physics Department, Heraklion, Greece. Title of the seminar: *Teleparallel equivalent of Gauss-Bonnet gravity and its modifications.*

- **September 2014:** Speaker at the 16th Conference on *Recent Developments in Gravity*, Hellenic Society on Relativity, Gravitation & Cosmology, Mykonos, Greece. Title of the talk: *Teleparallel equivalent of Gauss-Bonnet gravity.*

- **May 2014:** Seminar given at the National Technical University of Athens, Department of Applied Mathematics and Physical Sciences, Athens, Greece. Title of the seminar: *Gravitating Nambu-Goto matching conditions for gravitating defects.*

- **March 2014:** Seminar given at the University Andres Bello, Physics Department, Santiago, Chile. Title of the seminar: *Gravitating Nambu-Goto matching conditions for gravitating defects.*

- **March 2014:** Speaker at the conference *Meeting on the Horizon*, Valparaiso, Chile. Title of the talk: *Gravitating Nambu-Goto matching conditions for gravitating defects.*

- **September 2013:** Speaker at the *7nd Aegean Summer School on Cosmology*, Paros, Greece. Title of the talk: *Alternative matching conditions for gravitating defects.*

- **November 2010:** Seminar given at the University of the Aegean, Department of Information and Communication Systems Engineering, Samos, Greece. Title of the seminar: *Ultrarelativistic gravitational bremsstrahlung in ADD.*

- **October 2010:** Seminar given at the AstroParticle and Cosmology (APC) Laboratory, University of Paris 7, Paris, France. Title of the seminar: *Gravitational bremsstrahlung in transplanckian collisions.*

- **September 2010:** Speaker at the *Crete Conference on Gauge Theories and the Structure of Spacetime*, Kolymbari, Orthodox Academy of Crete. Title of the talk: *Gravitational bremsstrahlung in transplanckian scattering.*

- **June 2010:** Seminar given at the Ben-Gurion University, Department of Physics, Beer-Sheva, Israel. Title of the seminar: *Ultrarelativistic gravitational bremsstrahlung in ADD.*

- **June 2010:** Speaker at the 14th Conference on *Recent Developments in Gravity*, University of Ioannina, Physics Department, Ioannina, Greece. Title of the talk: *Ultrarelativistic gravitational bremsstrahlung in ADD.*

- **November 2009:** Seminar given at the University of Patras, Physics Department, Patra, Greece. Title of the seminar: *Gravitational radiation in relativistic collisions and black hole production.*

- **June-July 2009:** Speaker at the *Fifth Crete Regional Meeting in String Theory*, Kolymbari, Orthodox Academy of Crete. Title of the talk: *Black-holes in non-relativistic gravity.*

- **January 2006:** Seminar given at the University of Barcelona, Barcelona, Spain. Title of the seminar: *Higher codimensional braneworlds.*

- **September 2005:** Speaker at the *3rd Aegean Summer School on Cosmology*, Chios, Greece. Title of the talk: *On braneworld cosmologies from six dimensions.*

- **September 2003:** Speaker at the *2nd Aegean Summer School on Cosmology*, Syros, Greece. Title of the talk: *Brane cosmology with curvature corrections.*

- **November 2002:** Lectures given at the Centro de Estudios Cientificos, Valdivia, Chile. Title: *Introduction to the Braneworlds.*

- **June 2002:** Speaker at the 10th Conference on *Recent Developments in Gravity*, University of Thessaloniki, Physics Department, Chalkidiki, Greece. Title of the talk: *Braneworlds with induced gravity.*

- **May 2002:** Seminars given at the University of Crete, Physics Department. Title of the seminars: *The induced gravity scenario on the braneworld.*

- **December 2001:** Seminar given at the School of Applied Mathematics and Physical Sciences, National Technical University of Athens. Title of the seminar: *Dark Matter.*

- **August 2000:** Speaker at the 9th Conference on *Recent Developments in Gravity*, University of Ioannina, Physics Department, Ioannina, Greece. Title of the talk: *Temperature anisotropy in Bianchi type V cosmology.*

- **October 1996:** Speaker at the 7th Conference on *Recent Developments in Gravity*, University of Athens, Physics Department, Athens, Greece. Title of the talk: *Bianchi-IX universe in Euclidean quantum cosmology.*

Participation to Conferences :

- **September 2023:** 20th Conference on *Recent Developments in Relativity*, Hellenic Society on Relativity, Gravitation & Cosmology, Eugenides Foundation, Athens, Greece.
- **September 2023:** Workshop on *Compact Objects in Modified Theories of Gravity*, National Technical University of Athens, Athens, Greece.
- **September 2021:** 19th Conference on *Recent Developments in Relativity*, Hellenic Society on Relativity, Gravitation & Cosmology, Online.
- **December 2019:** *Lectures on Theoretical Physics 2019*, National Technical University of Athens, Athens, Greece.
- **September 2019:** *10th Aegean Summer School: Recent developments in theory and observations in gravity and cosmology*, Syros, Greece.
- **June 2019:** *3rd FLAG meeting: the Quantum and Gravity* (INFN), Catania, Sicily, Italy.
- **June 2019:** *Gravity and other fields under the volcano* (INFN, INAF), Catania, Sicily, Italy.
- **January 2019:** *Tests of Gravity Workshop: Gravitational waves, black holes and fundamental Physics*, Gravity Data Group initiation of the EU COST, Athens, Greece.
- **December 2018:** *Lectures on Theoretical Physics 2018*, National Technical University of Athens, Athens, Greece.
- **March-April 2018:** *HEP 2018-Conference on Recent Developments in High Energy Physics and Cosmology*, Hellenic Society for the Study of High Energy Physics, Athens, Greece.
- **March 2018:** Workshop on *Gravitational waves in modified gravity theories*, National Technical University of Athens, Athens, Greece.
- **December 2017:** *Xmas Theoretical Physics Workshop 2017*, University of Athens, Physics Department, Athens, Greece.
- **December 2017:** *Lectures on Theoretical Physics 2017*, National Technical University of Athens, Athens, Greece.
- **December 2016:** *Xmas Theoretical Physics Workshop 2016*, University of Athens, Physics Department, Athens, Greece.
- **September 2016:** Workshop on *Gravitational waves in modified gravity theories*, National Technical University of Athens, Athens, Greece.
- **December 2015:** *Xmas Theoretical Physics Workshop 2015*, University of Athens, Physics Department, Athens, Greece.
- **April 2015:** *HEP 2015-Conference on Recent Developments in High Energy Physics and Cosmology*, Hellenic Society for the Study of High Energy Physics, Athens, Greece.

- **December 2014:** *Xmas Theoretical Physics Workshop 2014*, University of Athens, Physics Department, Athens, Greece.
- **October 2014:** FloratosFest2014 *New Horizons in Particles, Strings and Membranes*, University of Athens, Physics Department, Athens, Greece.
- **September 2012:** Kounnas-Fest *Tales on Supergravity, Strings and QCD*, University of Cyprus, Physics Department, Nicosia, Cyprus.
- **March-April 2010:** *Workshop on Cosmology*, Physics Department, University of Crete, Heraklion, Greece.
- **May 2009:** *Workshop on applications of AdS/CFT to condensed matter problems*, Foundation for Research and Technology, Heraklion, Greece.
- **September 2008:** *4th Young Researchers Workshop of the European Superstring Theory Network*, Agia Napa, Cyprus.
- **July 2007:** *Workshop on Cosmology and Strings*, ICTP, Miramare-Trieste, Italy.
- **June 2006:** 12th Conference on *Recent Developments in Relativity*, University of Athens, Physics Department, Nafplio, Greece.
- **September 2005:** XXVIII Spanish Relativity Meeting 2005, *A Century of Relativity Physics*, Oviedo, Asturias, Spain.
- **July 2005:** Albert Einstein Century International Conference, Palais de l' Unesco, Paris, France.
- **April 2005:** String Cosmology Conference, Department of Theoretical Physics, Uppsala Universitet, Uppsala, Sweden.
- **March 2005:** Winter School on Modern Trends in Supersymmetric Mechanics, INFN-Laboratori Nazionali di Frascati, Frascati, Italy.
- **September 2004:** XXVII Spanish Relativity Meeting 2004, *Beyond General Relativity*, La Cristalera, Miraflores de la Sierra, Madrid, Spain.
- **October 2002:** Mini-workshop organized by the Universidad de Santiago de Chile on *Integrable Systems*, Santiago, Chile.
- **April 2002:** *HEP 2002*, University of Patras, Physics Department, Patras, Greece.
- **September 2001:** *1st Aegean Summer School on Cosmology*, Samos, Greece.
- **June 2001:** *Crete Regional Meeting on String Theory*, Orthodox Academy of Crete, Kolymbari, Greece.
- **April 2001:** *HEP 2001*, University of Crete, Physics Department, Heraklion, Greece.

- **April 2001:** *2nd Hellenic Cosmology Workshop*, National Observatory of Athens, Penteli, Athens, Greece.
- **September 2000:** *Particle Physics and Gravitation*, Euroconference on Quantum Fields and Strings, Kolymbari, Crete, Greece.
- **September 1998:** 2nd Samos Meeting on *Cosmology, Geometry and Relativity*, Pythagoreon, Samos, Greece.
- **August 1998:** 8th Hellenic Conference on *Recent Developments in Relativity*, University of the Aegean, Department of Mathematics, Karlovassi, Greece.

Other Scientific Activities :

- Member of the Organizing Committee of the 7th Hellenic Conference on *Recent Developments in Relativity*, October 1996, Athens, Greece.
- Member of the Organizing Committee of the *Fifth Crete Regional Meeting in String Theory*, June 2009, Kolymbari, Orthodox Academy of Crete.
- Member of the Organizing Committee of the *Crete Workshop on the Frontiers of Cosmology*, April 2010, Crete Center of Theoretical Physics, Heraklion.
- Member of the Organizing Committee of the *Crete Conference on Gauge Theories and the Structure of Spacetime*, September 2010, Kolymbari, Orthodox Academy of Crete.
- Member of the Organizing Committee of the Conference NEB-19 *Recent Developments in Gravity*, Hellenic Society on Relativity, Gravitation & Cosmology, September 2021, Online.
- Member of the Organizing Committee of the Conference NEB-20 *Recent Developments in Gravity*, Hellenic Society on Relativity, Gravitation & Cosmology, September 2023, Athens, Greece.
- Permanent Referee for *Physical Review D, JCAP, European Journal of Physics, Classical and Quantum Gravity, Nuclear Physics B, Int. Jour. Mod. Phys., Ann. of Phys., General Relativity and Gravitation, Progress of Theoretical and Experimental Physics, Foundations of Physics.*
- Visitor at the Institute of Cosmology & Gravitation, University of Postsmouth, Postsmouth, UK (November 2004).
- Visitor at the Laboratoire de Physique Théorique, Ecole Polytechnique, Paris, France (June 2005).
- Visitor at the Physics Department, University of Crete, Heraklion, Crete (October 2005).
- Visitor at the Laboratoire de Physique Théorique d' Orsay, Université Paris-Sud 11, Paris, France (June 2005, December 2007).

- Visitor at the Center for Astrophysics and Gravitation, Universidade Técnica de Lisboa, Lisbon, Portugal (April 2006).
- Visitor at Cern, Theory Division, Geneva, Switzerland (January 2016, January 2017, February 2018).
- Honorable Mention in the Gravity Essay Competition 2019, with the Essay published in a Special issue of IJMPD.
- Participant in the research Project SOE2019010 *Quantum Gravity at astrophysical distances* (responsible V. Zarikas), 2019, funded by the School of Engineering, Nazarbayev University, Kazakhstan.
- Member of various administrative Committees in the Department of Information and Communication Systems Engineering, University of the Aegean (2014-today).
- Member of the Governing Board of the Hellenic Society on Relativity, Gravitation and Cosmology, HSRGC (2020-2024).
- Educator and supervisor/co-supervisor of PhD students within the Doctorate Programme of Theoretical Cosmology of the Laboratory of Geometry, Dynamical Systems and Cosmology of the University of the Aegean.
- Supervisor of the master's thesis of M. Heraklidou, Physics Department, University of Crete, Title: A study of codimension-2 gravitational defects with Gauss-Bonnet action. Master degree 2010.
- Member of the examining committee of the PhD candidate Y. Konstantinou, Physics Department, University of Crete, Title: Radiation in Ultraplanckian particle collisions. PhD degree 2014.
- Member of the examining committee of the PhD candidate G. Kittou, Department of Information and Communication Systems Engineering, University of the Aegean, Title: Cosmological singularities in multi-fluid universes. PhD degree 2015.
- Member of the advisory committee of the PhD candidate G. Kolionis, Department of Information and Communication Systems Engineering, University of the Aegean, Title: Cosmological asymptotics in higher-order gravity theories. PhD degree 2016.
- Member of the examining committee of the PhD candidate K. Tzanni, Department of Marine Sciences, University of the Aegean, Title: Dynamical systems approach in scalar field cosmologies. PhD degree 2016.
- Member of the advisory committee of the PhD candidate D. Trachilis, Department of Information and Communication Systems Engineering, University of the Aegean, Title: The generic expansion in analytic modified gravity. PhD degree 2016.

- Member of the examining committee of the PhD candidate D. Iosifidis, Physics Department, Aristotle University of Thessaloniki, Title: Metric-affine gravity and cosmology/aspects of torsion and non-metricity in gravity theories. PhD degree 2019.
- Member of the examining committee of the PhD candidate A. Karagiorgos, Physics Department, National and Kapodistrian University of Athens, Title: Symmetries in quantum cosmology-gravity and the problem of time. PhD degree 2019.
- Member of the examining committee of the PhD candidate T. Pailas, Physics Department, National and Kapodistrian University of Athens, Title: Classical and quantum aspects of spatially homogeneous spacetimes of dimension D =3,4,5. PhD degree 2020.
- Member of the advisory committee of the PhD candidate C. Vlachos, School of Applied Mathematics and Physical Sciences, National Technical University of Athens, Title: Solutions and stability of compact objects in scalar-tensor theories. PhD degree 2023.
- Supervisor of the doctoral thesis of the PhD candidate D. Kokkinos, Department of Information and Communication Systems Engineering, University of the Aegean, Title: The study of the Jordan canonical forms of Killing tensor in the frame of General theory of Relativity. PhD degree 2024.
- Member of the advisory committee of the PhD candidate A. Karakostas, Department of Information and Communication Systems Engineering, University of the Aegean, Title: Development of methods and tools for teaching basic concepts of data structures and databases to elementary students.
- Supervisor of the doctoral thesis of the PhD candidate N. Nomikos, Department of Information and Communication Systems Engineering, University of the Aegean, Title: Modified theories of gravity and cosmology.

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Outline of research activity :

The research I have been carrying out up to date refers to the areas of quantum cosmology, classical cosmology, to cosmological models and black hole solutions coming from higher dimensions according to the braneworld or string-like paradigm, to topics of gravity in asymptotically Anti-de Sitter spaces connected to the AdS/CFT correspondence of high energy physics, with the problem of gravitational radiation from the scattering of particles in the presence of extra dimensions and the non-relativistic Horăva-Lifshitz gravity. The total number of citations that my published work has taken is more than 1000.

As a M.Sc. student, I dealt, under the instruction of my supervisor, with the path-integral

approximation of quantum-cosmology, applied to a particular homogeneous and anisotropic model (Bianchi type-IX). Approximate instanton solutions close to the boundaries (NUT-Bolt) were derived for vacuum or including scalar fields, and they were used for numerical integration of the system and for drawing sketches of peak-shaped wave functions of the universe according to the Hartle-Hawking proposal.

In the group of papers [1, 2, 4, 5], we have adopted a way of canonically quantizing the most general anisotropic cosmological models, without any restrictions on the form of the metric, or any gauge choice, by exploiting the information carried by the linear constraints. Furthermore, the role played by the automorphism group at the classical level in simplifying the Einstein equations, and at the quantum in reducing the Wheeler-De Witt equation to its true degrees of freedom, was investigated. In [3], we investigated the relationship of the CMB anisotropy to a possible primordial global anisotropy for the general Bianchi V universe. The computations of the CMB spectrum have the value that can be contracted with the accurate and recent CMB data and allow for testing the available theories of the early universe. In [6], I found in the braneworld context a 5-dimensional bulk metric solution, depending on both the time and the extra coordinate, and is dynamically interacting with a moving domain wall. After the general formulation was established, the 3-universe cosmological evolution was obtained and found to possess non-singular characteristics, although the corresponding 5-dimensional characteristics appear singular. In [7], the generic dynamics which is induced on the braneworld in the induced gravity scenario was found. Although the intrinsic curvature term is geometrical in nature, and thus, induces additional geometrical terms on the brane equations beyond the Einstein one, it was shown that the induced braneworld dynamics resembles the Einstein dynamics with a well-defined modified energy-momentum tensor. This way, the methods of standard General Relativity can be used for deriving new braneworld solutions. Indeed, four-dimensional black hole solutions were obtained in [8, 10] which are generalizations of the four-dimensional Schwarzschild-$(A)dS$ spacetime. Some of these solutions are interesting from the astrophysical data viewpoint, as they give long-distance (galactic scale) modifications of gravity. In [9], we explored a novel mechanism of energy exchange (outflow/influx) between brane and bulk, due to particle physics processes, which supplies a variety of cosmological perspectives. The most significant is the possibility of associating an accelerating era of the universe to this mechanism; this could be relevant to the old inflationary regime, as well as to the today small acceleration era. In [12], the cosmology of the Randall-Sundrum braneworld was studied when two curvature correction terms are added in the action: the five-dimensional Gauss-Bonnet curvature term, and the the four-dimensional scalar curvature from induced gravity on the brane. As a result, the infinite-density big bang singularity is removed, while the curvature can still diverge for some parameter values. Additionally, a radiation brane can undergo accelerated expansion near the minimal scale factor, without an inflaton field or negative pressures. In [13], the collapse of a homogenous braneworld dust cloud was studied in the context of the various braneworld scenarios, namely, the induced-gravity, the Gauss-Bonnet, and the combined induced-gravity and Gauss-Bonnet. It was found that in accordance to the Randall-Sundrum model, and contrary to four-dimensional general relativity, the exterior spacetime on the brane is always non-static. In [14], the dynamics of a spatially flat Robertson-Walker universe filled with a classical minimally coupled scalar field of exponential potential plus pressureless baryonic matter was studied in the context of general relativity. This system was reduced to a first-order ordinary differential equation, providing in general direct evidence of the passage into acceleration during the evolution, and

setting bounds on the parameter of the exponent of the potential. Additionally, for the almost cosmological constant case, as well as for late times, general solutions were found. In the group of papers [15, 16], (thin) braneworlds with conical singularities were considered in six-dimensional Einstein-Gauss-Bonnet gravity, as it is known that in such dimensions the Gauss-Bonnet term is necessary for including non-trivial matter on the brane. The energy-momentum of the brane was shown to be always conserved, independently of any regular bulk energy-momentum tensor, contrary to the situation of the five-dimensional case. Furthermore, for a bulk cosmological constant, it was shown that the model for axially symmetric bulks does not possess isotropic braneworld cosmological solutions. In [17], the role of brane-bulk energy exchange and of an induced gravity term on a braneworld of negative tension and vanishing effective cosmological constant was studied. It was shown that a unique global attractor which can realize our present universe exists for a wide range of the parameters of the model. Moreover, during the evolution, the parameter of the equation of state for the dark energy crosses the cosmological constant value -1 to smaller values.

Beyond the relevant success against current observational data of the 5-dimensional cosmological scenarios as alternatives to the standard model, the difficulty has now accumulated at the nonlocal character of the gravitational brane-bulk interaction as seen from the brane viewpoint. Therefore, a significant open problem for astrophysics and cosmology would be to find the simplest realistic solution (or approximation to it) of an astrophysical black hole on the brane, and settle the questions about its staticity, Hawking radiation and horizon; moreover, it is a key open question to investigate the distinguishing signals of the cosmological perturbations on all scales and computing the anisotropies and large-scale structures at the level beyond the commonly used maximal symmetry. Generalizing such models to various directions, e.g. by adding brane/bulk scalars, curvature corrections, supersymmetry, is necessary to make them more realistic and explore aspects of higher-dimensions not probed by simpler models. E.g., the difficulty of stability of Horava-Witten spacetimes with two branes of opposite tension has been recently resolved assuming the unbroken supersymmetry of the theory; the study of such stability with supersymmetry unbroken in the bulk, but softly broken on the brane would be interesting. Finding four-dimensional braneworld solutions which are generalizations of the Schwarzschild solution arising from some higher curvature corrected 5-dimensional gravity and study its thermodynamics is also interesting and necessary from the phenomenological point of view and has not been done. Another interesting line of activity could be the study, through explicit solutions, of the mechanism of energy influx/outflow between brane and bulk due to scalar fields in the bulk and on the brane. Under the prism of the AdS/CFT correspondence, the treatment of scalar fields becomes more significant, and the study of the holographic dual will provide a more controllable picture of such exchange mechanisms. It seems that one of the hottest topics today in cosmology is how far it is possible the parameter of the equation of state for the dark energy can mimic a value which is smaller than -1. I plan to investigate further models which offer such a possibility, and in particular, models which arise from an interaction between brane and bulk (these could in principle solve also the coincidence problem in cosmology by realizing the present universe as being close to a late-time fixed point of the evolution).

A new perspective arises from a recent proposal for understanding the smallness of the vacuum energy within the framework of 6-dimensional gravity or supergravity: a codimension-two object induces a conical singularity, and a cancelation occurring between the brane tension and the bulk gravitational degrees of freedom gives rise to a vanishing effective cosmological constant. However,

it is known that six-dimensional Einstein gravity cannot support a thin gravitating braneworld with a non-trivial matter different than a brane tension. One might try to modify the gravitational part of the action expecting to obtain consistent configurations, e.g. some consistent four-dimensional braneworld cosmology. One such proposal by including the six-dimensional Gauss-Bonnet term has been partially investigated, and bulks which are axially symmetric around the defect do not seem to support deviations from maximal symmetry on the brane. I would be interested in further investigation (formal development) of such sort of models, as well as investigating alternative matching conditions or more general bulk symmetry ansatzen lacking axial symmetry, or also study the linearization and stability around the maximally symmetric solutions. Maybe the inclusion of a bulk scalar (or dilatonic) will not only add degrees of freedom to the problem, but contributes to making the situation meaningful. In case a meaningful cosmology is found, the standard cornerstones in the area of physical cosmology have to be addressed, namely, the inflation, the primordial nucleosynthesis, the CMB, and the cosmological perturbations.

Another line of research I would be interested is working in the context of the string cosmological models (D-brane inflation, S-brane scenarios, cyclic, KKLT), in the investigation of the rich structure of the vacua solutions in moduli space revealed recently, the inclusion of realistic cosmological matter, and how a viable cosmological picture could be obtained.
I would also like to think how previous ideas found in the area of quantum cosmology could provide some new realizations in the context of string theory.

Abstracts of papers

1. T. Christodoulakis, G. Kofinas, E. Korfiatis and A. Paschos, *Wave functions for the general Type II Cosmology*, Phys. Lett. **390B** (1997) 55.
The quantization of the most general Type II geometry (having all six scale factors as well as the shift vector) is considered. The information carried by the linear constraints is used to reduce the initial Wheeler-De Witt equation (in six variables) to a final PDE in four variables. The full space of solutions to this equation is exhibited.

2. T. Christodoulakis, G. Kofinas, E. Korfiatis and . Paschos, *Isolation of the true degree of freeedom and normalizable wave functions for the general type V cosmology*, Phys. Lett. **419B** (1998) 30.
The quantization of the most general Type V geometry (with all six scale factors as well as the shift vector present) is considered. The information carried by the linear constraints is used to reduce the Wheeler-DeWitt equation (arising from a valid Hamiltonian found earlier), which initially included six variables, to a final PDE in three variables, getting rid of three redundant variables (gauge degrees of freedom). The full space of solutions to this equation is presented. In trying to interpret these wave functions, we are led through further consideration of the action of the automorphism group on the configuration space, to a final reduction to the one and only true degree of freedom, i.e. the only independent curvature invariant of the slice t=constant. Thus, a normalizable wave function in terms of the true degree of freedom is obtained.

3. T. Christodoulakis, G. Kofinas and V. Zarikas, *The general untilted diffuse matter Bianchi V universe*, Phys. Lett. **275A** (2000) 180 [gr-qc/9907104].
A diffuse matter filled Type V Universe is studied. The anisotropic behaviour, the distortion caused to the CMBR and the parameter region allowed by present cosmological bounds are examined. It is shown how the overall sky pattern of temperature anisotropies changes under a non-infinitesimal spatial coordinate transformation that preserves the Type V manifest homogeneity.

4. T. Christodoulakis, G. Kofinas, E. Korfiatis, G.O. Papadopoulos and A. Paschos, *Time dependent automorphism inducing diffeomorphisms and the complete closed form solutions of Bianchi types II and V vacuum cosmologies*, J. Math. Phys. **42** (2001) 3580 [gr-qc/0008050].
We investigate the set of spacetime general coordinate transformations (G.C.T.) which leave the line element of a generic Bianchi Type Geometry, quasi-form invariant; i.e. preserve manifest spatial Homogeneity. We find that these G.C.T.'s, induce special time-dependent automorphic changes, on the spatial scale factor matrix $\gamma_{\alpha\beta}(t)$ -along with corresponding changes on the lapse function $N(t)$ and the shift vector $N^{\alpha}(t)$. These changes, which are Bianchi Type dependent, form a group and are, in general, different from those induced by the group SAut(G) -advocated in earlier investigations as the relevant symmetry group-, they are used to simplify the form of the line element -and thus simplify Einstein's equations as well-, without losing generality. As far as this simplification procedure is concerned, the transformations found, are proved to be essentialy unique. For the case of Bianchi Types II

and V, where the most general solutions are known -Taub's and Joseph's, respectively-, it is explicitly verified that our transformations and only those, suffice to reduce the generic line element, to the previously known forms. It becomes thus possible, -for these Types- to give in closed form, the most general solution, containing all the necessary "gauge" freedom.

5. T. Christodoulakis, G. Kofinas and G.O. Papadopoulos, *Conditional symmetries and phase space reduction towards G.C.T. invariant wave functions for the Class A Bianchi Type VI and VII vacuum Cosmologies*, Phys. Lett. **B514** (2001) 149 [gr-qc/0101103].
The quantization of Class A Bianchi Type VI and VII geometries -with all six scale factors, as well as the lapse function and the shift vector present- is considered. A first reduction of the initial 6-dimensional configuration space is achieved by the usage of the information furnished by the quantum form of the linear constraints. Further reduction of the space in which the wave function -obeying the Wheeler-DeWitt equation- lives, is accomplished by revealing a classical integral of motion, tantamount to an extra symmetry of the corresponding classical Hamiltonian. This symmetry generator -member of a larger group- is linear in momenta and corresponds to G.C.T.s through the action of the automorphism group -especially through the action of the outer automorphism subgroup. Thus, a G.C.T. invariant wave function is found, which depends on one combination of the two curvature invariants –which uniquely and irreducibly characterizes the hypersurfaces t=const.

6. G. Kofinas, *New perspectives on moving domain walls in* $(A)dS_5$ *space*, Nucl. Phys. **B622** (2002) 347 [hep-th/0103045].
A new moving domain wall solution is obtained for a flat 3-universe. This consists of a bulk metric depending on both time and the extra coordinate, plus a dynamically interacting domain wall, admitted by the metric and inhabited by the three-universe. The matter contents are cosmological constants on the domain wall and the bulk. The bulk space is shown to be $(A)dS_5$. A remarkable fact concerning the three-universe is that its scale factor never vanishes, even though the corresponding scale factor of the bulk metric vanishes. The inclusion of a bulk scalar field is discussed, neglecting back-reaction. Its normalizability and the existence of a positive frequency or adiabatic bulk vacuum are shown.

7. G. Kofinas, *General brane Cosmology with* ${}^{(4)}R$ *term in* $(A)dS_5$ *or Minkowski bulk*, JHEP **0108** (2001) 034 [hep-th/0108013].
A general analysis of the induced brane dynamics is performed when the intrinsic curvature term is included in the action. Such a term is known to cause dramatic changes and is generically induced by quantum corrections coming from the bulk gravity and its coupling with matter living on the brane. The induced brane dynamics is shown to be the usual Einstein dynamics coupled to a well defined modified energy-momentum tensor. In cosmology, conventional general relativity revives for an initial era whose duration depends on the value of the five-dimensional Planck mass. Violations of energy conditions may be possible, as well as matter inhomogeneities on the brane in $(A)dS_5$ or Minkowski backgrounds. A new anisotropic cosmological solution is given in the above context. This solution, for a fine-tuned five-dimensional cosmological constant, exhibits an intermediate accelerating phase which is followed by an era corresponding to a 4D perfect fluid solution with no future horizons.

8. G. Kofinas, E. Papantonopoulos and I. Pappa, *Spherically symmetric braneworld*

solutions with ${}^{(4)}R$ *term in the bulk*, Phys. Rev. **D66** (2002) 104014 [hep-th/0112019].
An analysis of a spherically symmetric braneworld configuration is performed when the intrinsic curvature scalar is included in the bulk action; the vanishing of the electric part of the Weyl tensor is used as the boundary condition for the embedding of the brane in the bulk. All the solutions outside a static localized matter distribution are found; some of them are of the Schwarzschild-$(A)dS_4$ form. Two modified Oppenheimer-Volkoff interior solutions are also found; one is matched to a Schwarzschild-$(A)dS_4$ exterior, while the other does not. A non-universal gravitational constant arises, depending on the density of the considered object; however, the conventional limits of the Newton's constant are recovered. An upper bound of the order of TeV for the energy string scale is extracted from the known solar system measurements (experiments). On the contrary, in usual brane dynamics, this string scale is calculated to be larger than TeV.

9. E. Kiritsis, G. Kofinas, N. Tetradis, T.N. Tomaras and V. Zarikas, *Cosmological evolution with brane-bulk energy exchange*, JHEP **0302** (2003) 035 [hep-th/0207060].
The consequences on the brane cosmological evolution of energy exchange between the brane and the bulk are analysed in detail, in the context of a non-factorizable background geometry with vanishing effective cosmological constant on the brane. A rich variety of brane cosmologies is obtained, depending on the precise mechanism of energy transfer, on the equation of state of brane-matter and on the spatial topology. An accelerating era is generically a feature of our solutions. In the case of low-density flat universe more dark matter than in the conventional FRW picture is predicted. Spatially compact solutions were found to delay their recollapse.

10. G. Kofinas, E. Papantonopoulos and V. Zamarias, *Black hole solutions in braneworlds with induced gravity*, Phys. Rev. **D66** (2002) 104028 [hep-th/0208207].
We extent our previous study on spherically symmetric braneworld solutions with induced gravity, including non-local bulk effects. We find the most general static four-dimensional black hole solutions with $g_{tt} = -g_{rr}^{-1}$. They satisfy a closed system of equations on the brane and represent the strong-gravity corrections to the Schwarzschild-$(A)dS_4$ spacetime. These new solutions have extra terms which give extra attraction relative to the Newtonian-$(A)dS_4$ force; however, the conventional limits are easily obtained. These terms, when defined asymptotically, behave like AdS_4 in this regime, while when defined at infinitely short distances predict either an additional attractive Newtonian potential or an attractive potential which scales approximately as $\sqrt{r}$. One of the solutions found gives extra deflection of light compared to Newtonian deflection.

11. G. Kofinas, E. Papantonopoulos and V. Zamarias, *Black holes on the brane with induced gravity*, Astrophys. Space Sci. **283** (2003) 685, talk presented at the JENAM 2002 workshop on varying fundamental constants, Porto, September 2002 [hep-th/0210006].
An analysis of a spherically symmetric braneworld configuration is performed when the intrinsic curvature scalar is included in the bulk action. In the case when the electric part of the Weyl tensor is zero, all the exterior solutions are found; one of them is of the Schwarzschild-(A)dS(4) form, which is matched to a modified Oppenheimer-Volkoff interior solution. In the case when the electric part of the Weyl tensor is non zero, the exterior Schwarzschild-

(A)dS(4) black hole solution is modified receiving corrections from the non-local bulk effects. A non-universal gravitational constant arises, depending on the density of the considered object and the Newton's law is modified for small and large distances; however, the conventional limits are easily obtained.

12. G. Kofinas, R. Maartens and E. Papantonopoulos, *Brane cosmology with curvature corrections*, JHEP **10** (2003) 066 [hep-th/0307138].
We study the cosmology of the Randall-Sundrum brane-world where the Einstein-Hilbert action is modified by curvature correction terms: a four-dimensional scalar curvature from induced gravity on the brane, and a five-dimensional Gauss-Bonnet curvature term. The combined effect of these curvature corrections to the action removes the infinite-density big bang singularity, although the curvature can still diverge for some parameter values. A radiation brane undergoes accelerated expansion near the minimal scale factor, for a range of parameters. This acceleration is driven by the geometric effects, without an inflaton field or negative pressures. At late times, conventional cosmology is recovered.

13. G. Kofinas and E. Papantonopoulos, *Gravitational collapse in braneworld models with curvature corrections*, JCAP **0412** (2004) 011 [gr-qc/0401047].
We study the collapse of a homogeneous braneworld dust cloud in the context of the various curvature correction scenarios, namely, the induced-gravity, the Gauss-Bonnet, and the combined induced-gravity and Gauss-Bonnet. In accordance to the Randall-Sundrum model, and contrary to four-dimensional general relativity, we show in all cases that the exterior spacetime on the brane is non-static.

14. A. Kehagias and G. Kofinas, *Cosmology with exponential potentials*, Class. Quant. Grav. **21** (2004) 3871 [gr-qc/0402059].
We examine in the context of general relativity the dynamics of a spatially flat Robertson-Walker universe filled with a classical minimally coupled scalar field ϕ of exponential potential $V(\phi) \sim exp(-\mu\phi)$ plus pressureless baryonic matter. This system is reduced to a first-order ordinary differential equation for $\Omega_\phi(w_\phi)$ or $q(w_\phi)$, providing direct evidence on the acceleration/deceleration properties of the system. As a consequence, for positive potentials, passage into acceleration not at late times is generically a feature of the system for any value of μ, even when the late-times attractors are decelerating. Furthermore, the structure formation bound, together with the constraints $\Omega_{m0} \approx 0.25 - 0.3$, $-1 \leq w_{\phi 0} \leq -0.6$ provide, independently of initial conditions and other parameters, the necessary condition $0 < \mu < 1.6\sqrt{8\pi G_N}$, while the less conservative constraint $-1 \leq w_\phi \leq -0.93$ gives $0 < \mu < 0.7\sqrt{8\pi G_N}$. Special solutions are found to possess intervals of acceleration. For the almost cosmological constant case $w_\phi \approx -1$, the general relation $\Omega_\phi(w_\phi)$ is obtained. The generic (non-linearized) late-times solution of the system in the plane (w_ϕ, Ω_ϕ) or (w_ϕ, q) is also derived.

15. G. Kofinas, *Conservation equation on braneworld in six dimensions*, Class. Quant. Grav. **22** (2005) L47 [hep-th/0412299].
We study braneworlds in six-dimensional Einstein-Gauss-Bonnet gravity. The Gauss-Bonnet term is crucial for the equations to be well-posed in six dimensions when non-trivial matter on the brane is included (the also involved induced gravity term is not significant for

their structure), and the matching conditions of the braneworld are known. We show that the energy-momentum of the brane is always conserved, independently of any regular bulk energy-momentum tensor, contrary to the situation of the five-dimensional case.

16. G. Kofinas, *On braneworld cosmologies from six dimensions, and absence thereof*, Class. Quant. Grav. **21** (2004) 3871 [gr-qc/0402059].
We consider (thin) braneworlds with conical singularities in six-dimensional Einstein-Gauss-Bonnet gravity with a bulk cosmological constant. The Gauss-Bonnet term is necessary in six dimensions for including non-trivial brane matter. We show that this model for axially symmetric bulks does not possess isotropic braneworld cosmological solutions.

17. G. Kofinas, G. Panotopoulos and T.N. Tomaras, *Brane-bulk energy exchange: a model with the present universe as a global attractor*, JHEP **0601** (2006) 107 [hep-th/0510207].
The role of brane-bulk energy exchange and of an induced gravity term on a single braneworld of negative tension and vanishing effective cosmological constant is studied. It is shown that for the physically interesting cases of dust and radiation a unique global attractor which can realize our present universe (accelerating and $0 < \Omega_{m0} < 1$) exists for a wide range of the parameters of the model. For $\Omega_{m0} = 0.3$, independently of the other parameters, the model predicts that the equation of state for the dark energy today is $w_{DE,0} = -1.4$, while $\Omega_{m0} = 0.03$ leads to $w_{DE,0} = -1.03$. In addition, during its evolution, w_{DE} crosses the $w_{DE} = -1$ line to smaller values.

18. G. Kofinas and R. Olea, *Vacuum energy in Einstein-Gauss-Bonnet AdS gravity*, Phys. Rev. **D74** (2006) 084035 [hep-th/0606253].
A finite action principle for Einstein-Gauss-Bonnet anti−de Sitter gravity is achieved supplementing the bulk Lagrangian by a suitable boundary term, whose form substantially differs in odd and even dimensions. For even dimensions, this term is given by the boundary contribution in the Euler theorem with a coupling constant fixed demanding the spacetime to have constant (negative) curvature in the asymptotic region. For odd dimensions, the action is stationary under a boundary condition on the variation of the extrinsic curvature. A well-posed variational principle leads to an appropriate definition of energy and other conserved quantities using the Noether theorem, and to a correct description of black hole thermodynamics. In particular, this procedure assigns a nonzero energy to anti-de Sitter spacetime in all odd dimensions.

19. G. Kofinas and T.N. Tomaras, *Gravitating defects of codimension-two*, Class. Quantum Grav. **24** (2007) 5861 [hep-th/0702010].
Thin gravitating defects with conical singularities in higher codimensions and with generalized Israel matching conditions are known to be inconsistent for generic energy-momentum. A way to remove this inconsistency is proposed and is realized for an axially symmetric gravitating codimension-two defect in six dimensional Einstein gravity. By varying with respect to the brane embedding fields, alternative matching conditions are derived, which are generalizations of the Nambu-Goto equations of motion of the defect, consistent with bulk gravity. For a maximally symmetric defect the standard picture is recovered. The four-dimensional perfect fluid cosmology coincides with conventional FRW in the case of radiation, but for

dust it has $\rho^{4/3}$ instead of ρ. A four-dimensional black hole solution is presented having the Schwarzschild form with a short-distance correction r^{-2}.

20. G. Kofinas and R. Olea, *Universal regularization prescription for Lovelock AdS gravity*, JHEP **11** (2007) 069 [hep-th/0708.0782].
A definite form for the boundary term that produces the finiteness of both the conserved quantities and Euclidean action for any Lovelock gravity with AdS asymptotics is presented. This prescription merely tells even from odd bulk dimensions, regardless the particular theory considered, what is valid even for Einstein-Hilbert and Einstein-Gauss-Bonnet AdS gravity. The boundary term is a given polynomial of the boundary extrinsic and intrinsic curvatures (also referred to as Kounterterms series). Only the coupling constant of the boundary term changes accordingly, such that it always preserves a well-posed variational principle for boundary conditions suitable for asymptotically AdS spaces. The background-independent conserved charges associated to asymptotic symmetries are found. In odd bulk dimensions, this regularization produces a generalized formula for the vacuum energy in Lovelock AdS gravity. The standard entropy for asymptotically AdS black holes is recovered directly from the regularization of the Euclidean action, and not only from the first law of thermodynamics associated to the conserved quantities.

21. G. Kofinas, R. Olea, *Universal Kounterterms in Lovelock AdS gravity*, Fortsch. Phys. **56** (2008) 957 [hep-th/0806.1197].
We show the universal form of the boundary term (Kounterterm series) which regularizes the Euclidean action and background-independent definition of conserved quantities for any Lovelock gravity theory with AdS asymptotics (including Einstein-Hilbert and Einstein-Gauss-Bonnet). We discuss on the connection of this procedure to the existence of topological invariants and Chern-Simons forms in the corresponding dimensions.

22. D. Gal'tsov, G. Kofinas, P. Spirin and T. Tomaras, *Classical ultra-relativistic scattering in ADD*, JHEP **0905** (2009) 074 [hep-ph/0903.3019].
The classical differential cross-section is calculated for high-energy small-angle gravitational scattering in the factorizable model with toroidal extra dimensions. The three main features of the classical computation are: (a) It involves summation over the infinite Kaluza-Klein towers but, contrary to the Born amplitude, it is finite with no need of an ultraviolet cutoff. (b) It is shown to correspond to the non-perturbative saddle-point approximation of the eikonal amplitude, obtained by the summation of an infinite number of ladder graphs of the quantum theory. (c) In the absence of extra dimensions it reproduces all previously known results.

23. E. Kiritsis and G. Kofinas, *Horava-Lifshitz Cosmology*, Nucl. Phys. **B821** (2009) 467 [hep-th/0904.1334]
The cosmological equations suggested by the non-relativistic renormalizable gravitational theory proposed by Hořava are considered. It is pointed out that the early universe cosmology has features that may give an alternative to inflation and the theory may be able to escape singularities.

24. C. Charmousis, G. Kofinas and A. Papazoglou, *The consistency of codimension-2*

braneworlds and their cosmology, JCAP **1001** (2010) 022 [hep-th/0907.1640].
We study axially symmetric codimension-2 cosmology for a distributional braneworld fueled by a localised four-dimensional perfect fluid, in a six-dimensional Lovelock theory. We argue that only the matching conditions (dubbed topological) where the extrinsic curvature on the brane has no jump describe a pure codimension-2 brane. If there is discontinuity in the extrinsic curvature on the brane, this induces inevitably codimension-1 distributional terms. We study these topological matching conditions, together with constraints from the bulk equations evaluated at the brane position, for two cases of regularisation of the codimension-2 defect. First, for an arbitrary smooth regularisation of the defect and second for a ring regularisation which has a cusp in the angular part of the metric. For a cosmological ansatz, we see that in the first case the coupled system is not closed and requires input from the bulk equations away from the brane. The relevant bulk function, which is a time-dependent angular deficit, describes the energy exchange between the brane and the six-dimensional bulk spacetime. On the other hand, for the ring regularisation case, the system is closed and there is no leakage of energy in the bulk. We demonstrate that the full set of matching conditions and field equations evaluated at the brane position are consistent, correcting some previous claim in the literature which used rather restrictive assumptions for the form of geometrical quantities close to the codimension-2 brane. We analyse the modified Friedmann equation and we see that there are certain corrections coming from the non-zero extrinsic curvature on the brane. We establish the presence of geometric self-acceleration and a possible curvature domination wedged in between the period of matter and self-acceleration eras as signatures of codimension-2 cosmology.

25. D. Gal'tsov, G. Kofinas, P. Spirin and T. Tomaras, *Transplanckian bremsstrahlung and black hole production*, Phys. Lett. **B683** (2010) 331 [hep-ph/0908.0675].
Classical gravitational bremsstrahlung in particle collisions at transplanckian energies is studied in $\mathcal{M}_4 \times \mathcal{T}^d$. The radiation efficiency $\epsilon \equiv E_{\rm rad}/E_{\rm initial}$ is computed in terms of the Schwarzschild radius $r_S(\sqrt{s})$, the impact parameter b and the Lorentz factor $\gamma_{\rm cm}$ and found to be $\epsilon = C_d (r_S/b)^{3d+3} \gamma_{\rm cm}^{2d+1}$, larger than previous *estimates* by many powers of $\gamma_{\rm cm} \gg 1$. The cubic graviton vertex is consistently taken into account and the approximation is reliable for impact parameters in the range $r_S < b < b_c$, with b_c marking (for $d \neq 0$) the loss of the notion of classical trajectories. It follows that gravitational bremsstrahlung leads to extreme damping in transplanckian collisions and radiation reaction should be included in the analysis of black hole production. Furthermore, even if a black hole forms, its thermal Hawking radiation will be hardly distinguishable from the non-thermal radiation due to collisions with impact parameters larger than r_S.

26. E. Kiritsis and G. Kofinas, *On Hořava-Lifshitz 'Black Holes'*, JHEP **01** (2010) 122 [hep-th/0910.5487].
The most general spherically symmetric solution with zero shift is found in the non-projectable Hořava-Lifshitz class of theories with general coupling constants. It contains as special cases, spherically symmetric solutions found by other authors earlier. It is found that the generic solution has conventional (AdS, dS or flat) asymptotics with a universal 1/r tail. There are several special cases where the asymptotics differ, including the detailed balance choice of couplings. The conventional thermodynamics of this general class of solutions is established

by calculating the energy, temperature and entropy. Although several of the solutions have conventional horizons, for particles with ultra-luminal dispersion relations such solutions appear to be horizonless.

27. D. Gal'tsov, G. Kofinas, P. Spirin and T. Tomaras, *Scalar ultrarelativistic bremsstrah- lung in extra dimensions*, JHEP **05** (2010) 055 [hep-th/1003.2982].
The emitted energy and the cross-section of classical scalar bremsstrahlung in massive particle collisions in $D = 4 + d-$dimensional Minkowski space $\mathcal{M}_D$ as well as in the brane world $\mathcal{M}_4 \times \mathcal{T}^d$ is computed to leading ultra-relativistic order. The particles are taken to interact in the first case via the exchange of a bulk massless scalar field Φ and in the second with an additional massless scalar ϕ, confined together with the particles on the brane. Energy is emitted as Φ radiation in the bulk or ϕ radiation on the brane. In contrast to the quantum Born approximation, the classical result is unambiguous and valid in a kinematical region which is also specified. For $D = 4$ the results are in agreement with similar expressions in classical electrodynamics.

28. G. Kofinas and V. Zarikas, *A solution of the coincidence problem based on the recent galactic core black hole energy density increase*, The European Physical Journal C **73** (2013) 2379 [hep-th/1107.2602].
A mechanism capable to provide a natural solution to two major cosmological problems, i.e. the cosmic acceleration and the coincidence problem, is proposed. A specific brane-bulk energy exchange mechanism produces a total dark pressure, arising when adding all normal to the brane negative pressures in the interior of galactic core black holes. This astrophysically produced negative dark pressure explains cosmic acceleration and why the dark energy today is of the same order to the matter density for a wide range of the involved parameters. An exciting result of the analysis is that the recent rise of the galactic core black hole mass density causes the recent passage from cosmic deceleration to acceleration. Finally, it is worth mentioning that this work corrects a wide spread fallacy among brane cosmologists, i.e. that escaping gravitons result to positive dark pressure.

29. G. Kofinas and M. Heraklidou, *Self-gravitating branes again*, Phys. Rev. **D89** (2014) 065015 [hep-th/1309.0674].
We raise on theoretical grounds the question of the physical relevance of Israel matching conditions and their generalizations to higher codimensions, the standard cornerstone of the braneworld and other membrane scenarios. Our reasoning is twofold: First, the incapability of the conventional matching conditions to accept the Nambu-Goto probe limit (even the geodesic limit of the Israel matching conditions is not acceptable since being the geodesic equation a kinematical fact it should be preserved for all gravitational theories or defects, which is not the case for these conditions). Second, in our D-dimensional spacetime (maybe D=4), classical defects of any possible codimension should be compatible. These matching conditions fail to accept codimension-2 and 3 defects for D=4 (which represents effectively the spacetime at certain length and energy scales) and most probably fail to accept high enough codimensional defects for any D since there is no high enough Lovelock density to support them. Here, we propose alternative matching conditions which seem to satisfy the previous criteria. Instead of varying the brane-bulk action with respect to the bulk metric at the

brane position, we vary with respect to the brane embedding fields so that the gravitational back-reaction is included. For a codimension-2 brane in 6-dim EGB gravity we prove its consistency for an axially symmetric cosmological configuration. The cosmologies found have the LFRW behaviour and extra correction terms. For a radiation brane one solution avoids a cosmological singularity and undergoes accelerated expansion near the minimum scale factor. In the presence of an induced gravity term, there naturally appears in the theory the effective cosmological constant scale $\lambda/(M_6^4 r_c^2)$, which for a brane tension $\lambda \sim M_6^4$ (e.g. TeV^4) and $r_c \sim H_0^{-1}$ gives the observed value of the cosmological constant.

30. G. Kofinas and V. Zarikas, *5-dimensional braneworld with gravitating Nambu-Goto matching conditions*, Annals Phys. **351** (2014) 504-530 [gr-qc/1312.4292].
We continue the investigation of a recent proposal on alternative matching conditions for self-gravitating defects which generalize the standard matching conditions. The reasoning for this study is the need for consistency of the various codimension defects and the existence of a meaningful equation of motion at the probe limit, things that seem to lack from the standard approach. These matching conditions arise by varying the brane-bulk action with respect to the brane embedding fields (and not with respect to the bulk metric at the brane position) in a way that takes into account the gravitational back-reaction of the brane to the bulk. They always possess a Nambu-Goto probe limit and any codimension defect is seemingly consistent for any second order bulk gravity theory. Here, we consider in detail the case of a codimension-1 brane in five-dimensional Einstein gravity, derive the generic alternative junction conditions and find the Z_2-symmetric braneworld cosmology, as well as its bulk extension. Compared to the standard braneworld cosmology, the new one has an extra integration constant which accounts for the today matter and dark energy contents, therefore, there is more freedom for accommodating the observed cosmic features. One branch of the solution possesses the asymptotic linearized LFRW regime. We have constrained the parameters so that to have a recent passage from a long deceleration era to a small today acceleration epoch and we have computed the age of the universe, consistent with current data, and the time-varying dark energy equation of state. For a range of the parameters it is possible for the presented cosmology to provide a large acceleration in the high energy regime.

31. G. Kofinas, E.N. Saridakis and J.-Q. Xia, *Cosmological solutions and observational constraints on 5-dimensional braneworld cosmology with gravitating Nambu-Goto matching conditions*, Phys. Rev. **D90** (2014)8, 084049 [astro-ph/1403.7510].
We investigate the cosmological implications of the recently constructed 5-dimensional braneworld cosmology with gravitating Nambu-Goto matching conditions. Inserting both matter and radiation sectors, we first extract the analytical cosmological solutions. Additionally, we use observational data from Type Ia Supernovae (SNIa) and Baryon Acoustic Oscillations (BAO), along with requirements of Big Bang Nucleosynthesis (BBN), in order to impose constraints on the parameters of the model. We find that the scenario at hand is in very good agreement with observations, and thus a small departure from the standard Randall-Sundrum scenario is allowed.

32. D.P. Jatkar, G. Kofinas, O. Miskovic and R. Olea, *Conformal Mass in AdS*

gravity, Phys. Rev. **D89** (2014) 124010 [hep-th/1404.1411].
We show that the Ashtekar-Magnon-Das (AMD) mass and other conserved quantities are equivalent to the Kounterterm charges in the asymptotically AdS spacetimes that satisfy the Einstein equations, if we assume the same asymptotic fall-off behavior of the Weyl tensor as considered by AMD. This therefore implies that, in all dimensions, the conformal mass can be directly derived from the bulk action and the boundary terms, which are written in terms of the extrinsic curvature.

33. G. Kofinas and E.N. Saridakis, *Teleparallel equivalent of Gauss-Bonnet gravity and its modifications*, Phys. Rev. D **D90** (2014) 084044 [hep-th/1404.2249].
Inspired by the teleparallel formulation of General Relativity, whose Lagrangian is the torsion invariant T, we have constructed the teleparallel equivalent of Gauss-Bonnet gravity in arbitrary dimensions. Without imposing the Weitzenbock connection, we have extracted the torsion invariant T_G, equivalent (up to boundary terms) to the Gauss-Bonnet term G. T_G is constructed by the vielbein and the connection, it contains quartic powers of the torsion tensor, it is diffeomorphism and Lorentz invariant, and in four dimensions it reduces to a topological invariant as expected. Imposing the Weitzenbock connection, T_G depends only on the vielbein, and this allows us to consider a novel class of modified gravity theories based on $F(T, T_G)$, which is not spanned by the class of $F(T)$ theories, nor by the $F(R, G)$ class of curvature modified gravity. Finally, varying the action we extract the equations of motion for $F(T, TG)$ gravity.

34. G. Kofinas, G. Leon and E.N. Saridakis, *Dynamical behavior in $f(T, T_G)$ cosmology*, Class. Quant. Grav. **31** (2014) 175011 [gr-qc/1404.7100].
The $f(T, T_G)$ class of gravitational modification, based on the quadratic torsion scalar T, as well as on the new quartic torsion scalar T_G which is the teleparallel equivalent of the Gauss-Bonnet term, is a novel theory, different from both $f(T)$ and $f(R, G)$ ones. We perform a detailed dynamical analysis of a spatially flat universe governed by the simplest non-trivial model of $f(T, T_G)$ gravity. We find that the universe can result in dark-energy dominated, quintessence-like, cosmological-constant-like or phantom-like solutions, according to the parameter choices. Additionally, it may result to a dark energy - dark matter scaling solution, and thus it can alleviate the coincidence problem. Finally, the analysis "at infinity" reveals that the universe may result in future, past, or intermediate singularities depending on the parameters.

35. G. Aliferis, G. Kofinas and V. Zarikas, *Efficient electroweak baryogenesis by black holes*, Phys. Rev. **D91** (2015) 4, 045002 [hep-ph/1406.6215].
A novel cosmological scenario, capable to generate the observed baryon number at the electroweak scale for very small CP violating angles, is presented. The proposed mechanism can be applied in conventional FRW cosmology, but becomes extremely efficient due to accretion in the context of early cosmic expansion with high energy modifications. Assuming that our universe is a Randall-Sundrum brane, baryon asymmetry can easily be produced by Hawking radiation of very small primordial black holes. The Hawking radiation reheats a spherical region around every black hole to a high temperature and the electroweak symmetry is restored there. A domain wall is formed separating the region with the symmetric vacuum from the

asymmetric region where electroweak baryogenesis takes place. First order phase transition is not needed. The black holes's lifetime is prolonged due to accretion, resulting to strong efficiency of the baryon producing mechanism. The allowed by the mechanism black hole mass range includes masses that are energetically favoured to be produced from interactions around the higher dimensional Planck scale.

36. G. Kofinas and E.N. Saridakis, *Cosmological applications of $F(T, T_G)$ gravity*, Phys. Rev. **D90** (2014) 084045 [gr-qc/1408.0107].
We investigate the cosmological applications of $F(T, T_G)$ gravity, which is a novel modified gravitational theory based on the torsion invariant T and the teleparallel equivalent of the Gauss-Bonnet term T_G. $F(T, T_G)$ gravity differs from both $F(T)$ theories as well as from $F(R, G)$ class of curvature modified gravity, and thus its corresponding cosmology proves to be very interesting. In particular, it provides a unified description of the cosmological history from early-times inflation to late-times self-acceleration, without the inclusion of a cosmological constant. Moreover, the dark energy equation-of-state parameter can be quintessence or phantom-like, or experience the phantom-divide crossing, depending on the parameters of the model.

37. G. Kofinas, E. Papantonopoulos and E.N. Saridakis, *Self-gravitating spherically symmetric solutions in scalar-torsion theories*, Phys. Rev. **D91** (2015) 10, 104034 [gr-qc/1501.00365].
We studied spherically symmetric solutions in scalar-torsion gravity theories in which a scalar field is coupled to torsion with a derivative coupling. We obtained the general field equations from which we extracted a decoupled master equation, the solution of which leads to the specification of all other unknown functions. We first obtained an exact solution which represents a new wormhole-like solution dressed with a regular scalar field. Then, we found large distance linearized spherically symmetric solutions in which the space asymptotically is AdS.

38. D. Jatkar, G. Kofinas, O. Miskovic and R. Olea, *Conformal Mass in Einstein-Gauss-Bonnet AdS gravity*, Phys. Rev. **D91** (2015) 10, 105030 [gr-qc/1501.06861].
In this paper, we show that the physical information given by conserved charges for asymptotically AdS spacetimes in Einstein-Gauss-Bonnet AdS gravity is encoded in the electric part of the Weyl tensor. This result generalizes the conformal mass definition by Ashtekar-Magnon-Das (AMD) to a gravity theory with a Gauss-Bonnet term. This proof makes use of the Noether charges obtained from an action renormalized by the addition of counterterms which depend on the extrinsic curvature (Kounterterms). If the asymptotic fall-off behaviour of the Weyl tensor is same as the one considered in the AMD method, then the Kounterterm charges and the AMD charges agree in any dimension.

39. G. Kofinas, V. Zarikas, *Avoidance of singularities in asymptotically safe Quantum Einstein Gravity*, JCAP **1510** (2015) 10, 069 [gr-qc/1506.02965].
New general spherically symmetric solutions have been derived with a cosmological "constant" Λ as a source. This Λ field is not constant but it satisfies the properties of the asymptotically safe gravity at the ultraviolet fixed point. The importance of these solutions

comes from the fact that they describe the near to the centre region of black hole spacetimes as this is modified by the Renormalization Group scaling behaviour of the fields. The consistent set of field equations which respect the Bianchi identities is derived and solved. One of the solutions (with conventional sign of temporal-radial metric components) is timelike geodesically complete, and although there is still a curvature divergent origin, this is never approachable by an infalling massive particle which is reflected at a finite distance due to the repulsive origin. Another family of solutions (of both signatures) range from a finite radius outwards, they cannot be extended to the centre of spherical symmetry, and the curvature invariants are finite at the minimum radius.

40. G. Kofinas, *Hyperscaling violating black holes in scalar-torsion theories*, Phys. Rev. **D92** (2015) 8, 084022 [hep-th/1507.07434].
We study a gravity theory where a scalar field with potential, beyond its minimal coupling, is also coupled through a non-minimal derivative coupling with the torsion scalar which is the teleparallel equivalent of Einstein gravity. This theory provides second order equations of motion and we find large-distance non-perturbative static spherically symmetric four-dimensional solutions. Among them a general class of black hole solutions is found for some range of the parameters/integration constants with asymptotics of the form of hyperscaling violating Lifshitz spacetime with spherical horizon topology. Although the scalar field diverges at the horizon, its energy density and pressures are finite there. From the astrophysical point of view, this solution provides extra deflection of light compared to the Newtonian deflection.

41. G. Kofinas, *The complete Brans-Dicke theories*, Annals Phys. **376** (2017) 425 [gr-qc/1510.06845].
Given that the simple wave equation of BransDicke theory for the scalar field is preserved, we have investigated, through exhaustively analyzing the Bianchi identities, the consistent theories which violate the exact energy conservation equation. It is found that only three theories exist which are unambiguously determined from consistency, without imposing arbitrary functions by hand. Each of these theories possesses a specific interaction term which controls the energy exchange between the scalar field and ordinary matter. The theories contain new parameters (integration constants from the integration procedure) and when these are switched-off, BransDicke theory emerges. As usually, the vacuum theories can be defined from the complete BransDicke theories when the matter energymomentum tensor vanishes.

42. G. Kofinas, M. Tsoukalas, *On the action of the complete Brans-Dicke theory*, Eur. Phys. J. **C76** (2016) 12, 686 [gr-qc/1512.04786].
Recently the most general completion of BransDicke theory has appeared with energy exchanged between the scalar field and ordinary matter, given that the equation of motion for the scalar field keeps the simple wave form of BransDicke. This class of theories contain undetermined functions, but there exist only three theories which are unambiguously determined from consistency. Here, for the first such theory, the action of the vacuum theory is found, which arises as the limit of the full matter theory. A symmetry transformation of this vacuum action in the Jordan frame is found which consists of a conformal transformation of

the metric together with a redefinition of the scalar field. Since the general family of vacuum theories is parametrized by an arbitrary function of the scalar field, the action of this family is also found. As for the full theory with matter the action of the system is only found when the matter Lagrangian vanishes on-shell, as for example for pressureless dust. Due to the interaction, the matter Lagrangian is non-minimally coupled either in the Jordan or the Einstein frame.

43. G. Kofinas, E. Papantonopoulos and E.N. Saridakis, *Modified Brans-Dicke cosmology with matter-scalar field interaction*, Class. Quant. Grav. **33** (2016) 15, 155004 [gr-qc/1602.02687].
We discuss the cosmological implications of an extended Brans-Dicke theory presented recently, in which there is an energy exchange between the scalar field and ordinary matter, determined by the theory. A new mass scale is generated in the theory which modifies the Friedmann equations with field-dependent corrected kinetic terms. In a radiation universe the general solutions are found and there are branches with complete removal of the initial singularity, while at the same time a transient accelerating period can occur within deceleration. Entropy production is also possible in the early universe. In the dust era, late-times acceleration has been found numerically in agreement with the correct behaviour of the density parameters and the dark energy equation of state, while the gravitational constant has only a slight variation over a large redshift interval in agreement with observational bounds.

44. G. Kofinas, V. Zarikas, *Asymptotic Safe gravity and non-singular inflationary Big Bang with vacuum birth*, Phys. Rev. **D94** (2016) 10, 103514 [gr-qc/1605.02241].
General non-singular accelerating cosmological solutions for an initial cosmic period of pure vacuum birth era are derived. This vacuum era is described by a varying cosmological "constant" suggested by the Renormalisation Group flow of Asymptotic Safety scenario near the ultraviolet fixed point. In this scenario, natural exit from inflation to the standard decelerating cosmology occurs when the energy scale lowers and the cosmological "constant" becomes insignificant. In the following period where matter is also present, cosmological solutions with characteristics similar to the vacuum case are generated. Remarkably the set of equations allow for particle production and entropy generation. Alternatively, in the case of non-zero bulk viscosity, entropy production and reheating is found. As for the equations of motion, they modify Einstein equations by adding covariant kinetic terms of the cosmological "constant" which respect the Bianchi identities. An advance of the proposed framework is that it ensures a consistent description of both a quantum vacuum birth of the universe and a subsequent cosmic era in the presence of matter.

45. G. Kofinas, N. Lima, *Dynamics of cosmological perturbations in modified Brans-Dicke cosmology with matter-scalar field interaction*, Phys. Rev. **D96** (2017) 8, 084016 [gr-qc/1704.08925].
In this work we focus on a novel completion of the well-known Brans-Dicke theory that introduces an interaction between the dark energy and dark matter sectors, known as complete Brans-Dicke (CBD) theory. We obtain viable cosmological accelerating solutions that fit Supernovae observations with great precision without any scalar potential $V(\phi)$. We use these solutions to explore the impact of the CBD theory on the large scale structure by studying

the dynamics of its linear perturbations. We observe a growing behavior of the lensing potential Φ_+ at late-times, while the growth rate is actually suppressed relatively to ΛCDM, which allows the CBD theory to provide a competitive fit to current RSD measurements of $f\sigma_8$. However, we also observe that the theory exhibits a pathological change of sign in the effective gravitational constant concerning the perturbations on sub-horizon scales that could pose a challenge to its validity.

46. G. Kofinas, V. Zarikas, *Solution of the dark energy and its coincidence problem based on local antigravity sources without fine-tuning or new scales*, Phys. Rev. **D97** (2018) 12, 123542 [gr-qc/1706.08779].
A novel idea is proposed for a natural solution of the dark energy and its cosmic coincidence problem. The existence of local antigravity sources, associated with astrophysical matter configurations distributed throughout the universe, can lead to a recent cosmic acceleration effect. Various physical theories can be compatible with this idea, but here, in order to test our proposal, we focus on quantum originated spherically symmetric metrics matched with the cosmological evolution through a Swiss cheese analysis. In the context of asymptotically safe gravity, we have explained the observed amount of dark energy using Newton's constant, the galaxy or cluster length scales, and dimensionless order one parameters predicted by the theory, without fine-tuning or extra unproven energy scales. The interior modified Schwarzschild-de Sitter metric allows us to approximately interpret this result as that the standard cosmological constant is a composite quantity made of the above parameters, instead of a fundamental one.

47. G. Kofinas, *Is the use of Christoffel connection in gravity theories conceptually correct?*, Journal of Modern Physics **11** (2020) 1013 [physics.gen-ph/1712.02215].
Christoffel connection did not enter gravity as an axiom of minimal length for the free fall of particles (where anyway length action is not defined for massless particles), nor out of economy, but from the weak equivalence principle (gravitational force is equivalent to acceleration according to Einstein) together with the identification of the local inertial frame with the local Lorentz one. This identification implies that the orbits of all particles are given by the geodesics of the Christoffel connection. Here, we show that in the presence of only massless particles (absence of massive particles) the above identification is inconsistent and does not lead to any connection. The proof is based on the existence of projectively equivalent connections and the absence of proper time for null particles. If a connection derived by some kinematical principles for the particles is to be applied in the world, it is better these principles to be valid in all relevant spacetime rather than different principles to give different connections in different spacetime regions. Therefore, our result stated above may imply a conceptual insufficiency of the use of the Christoffel connection in the early universe where only massless particles are expected to be present (whenever at least some notions, like orbits, are meaningful), and thus of the total use of this connection. If in the early universe the notion of a massive particle, which appears latter in time, cannot be used, in an analogous way in a causally disconnected high-energy region (maybe deep interior of astrophysical objects or black holes) the same conclusions could be extracted if only massless particles are present.

48. F.K. Anagnostopoulos, S. Basilakos, G. Kofinas, V. Zarikas, *Constraining the Asymptotically Safe Cosmology: cosmic acceleration without dark energy*, JCAP **02** (2019) 053 [astro-ph/1806.10580].
A recently proposed Asymptotically Safe cosmology provides an elegant mechanism towards understanding the nature of dark energy and its associated cosmic coincidence problem. The underlying idea is that the accelerated expansion of the universe can occur due to infrared quantum gravity modifications at intermediate astrophysical scales (galaxies or galaxy clusters) which produce local anti-gravity sources. In this cosmological model no extra unproven energy scales or fine-tuning are used. In this study the Asymptotically Safe model is confronted with the most recent observational data from low-redshift probes, namely measurements of the Hubble parameter, standard candles (Pantheon SnIa, Quasi-stellar objects) and high redshift probes (CMB shift parameters). Performing an overall likelihood analysis we constrain the free parameters of the model and we test its performance against the concordance model (flat ΛCDM) utilizing a variety of information criteria. We find that the Asymptotically Safe model is statistically equivalent with that of ΛCDM, hence it can be seen as a viable and very efficient cosmological alternative.

49. V. Zarikas, G. Kofinas, *Singularities and Phenomenological aspects of Asymptotic Safe Gravity*, J. Phys. Conf. Ser. **1051** (2018) 1, 012028
[doi:10.1088/1742-6596/1051/1/012028].
Asymptotic Safety (AS) Program for quantum gravity keeps the same fields and symmetries with General Relativity and studies the associated gravitational action as a fundamental part of the complete theory at the nonperturbative level with the help of functional renormalization group (RG) techniques. An important phenomenological task that can test the new point of view of AS approach is the discovery of RG improved cosmologies and black holes. In this work, we analyze the properties of recently found non-singular spherically symmetric and non-singular cosmological solutions. Furthermore, we derive a novel consistent set of modified Einstein field equations, in the spirit of AS, which respects the Bianchi identities. This new set of equations completes previously published modified Einstein equations which arise by adding appropriate covariant kinetic terms to the action.

50. F.K. Anagnostopoulos, G. Kofinas, V. Zarikas, *IR quantum gravity solves naturally cosmic acceleration and its coincidence problem*, Int. J. Mod. Phys. **D28** (2019) 14, 1944013 [doi:10.1142/S0218271819440139].
The novel idea is that the undergoing accelerated expansion of the universe happens due to infrared quantum gravity modifications at intermediate astrophysical scales of galaxies or galaxy clusters, within the framework of Asymptotically Safe gravity. The reason is that structures of matter are associated with a scale-dependent positive cosmological constant of quantum origin. In this context no extra unproven energy scales or fine-tuning are used. Furthermore, this model was confronted with the most recent observational data from a variety of probes, and with aid of Bayesian analysis, the most probable values of the free parameters were extracted. Finally, the model proved to be statistically equivalent with ΛCDM, and thus being able to resolve naturally the concept of dark energy and its associated cosmic coincidence problem.

51. A. Bonanno, G. Kofinas, V. Zarikas, *Effective field equations and scale-dependent couplings in gravity*, Phys. Rev. **D103** (2021), 104025 [gr-qc/2012.05338].
A new set of field equations for a space-time dependent Newton's constant $G(x)$ and cosmological constant $\Lambda(x)$ in the presence of matter is presented. We prove that it represents the most general mathematically consistent, physically plausible, set of evolution equations assuming at most second derivatives in the dynamical variables. In the new Einstein's equations, only Λ-kinetic terms arise, while in the modified conservation equation, derivative terms of G also appear. As an application, this formalism is applied in the context of the Asymptotic Safety scenario to the early universe, assuming a perfect fluid with a radiation equation of state. Cosmological solutions are obtained for all types of spatial curvature, displaying a variety of interesting cosmic evolutions. As an indication of such behaviours, bouncing solutions, recollapsing solutions or non-singular expanding solutions with a transient acceleration era are discussed in details.