Peter Dunsby *November 12, 1966*

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Summary

Peter Dunsby is currently full professor of gravitation and cosmology at the University of Cape Town (UCT). He has published extensively in theoretical cosmology, teaches undergraduate and postgraduate courses in Applied Mathematics and Theoretical Physics and works closely with his graduate students and postdocs. He is regularly invited to lecture at local and international meetings and has a proven track record in fund raising and in the management of large research grants. In 2003 he secured a bid to host the National Astrophysics and Space Science Programme (NASSP) at the University of Cape Town and served as director of this programme until July 2013 . Over the past eighteen years NASSP has made a major contribution to human resource development in Astronomy and the Space Science in Southern Africa. In 2006 he was awarded the British Association (silver) medal from South African Association for the Advancement of Science and in 2016, the National Science and Technology Forum (NSTF) award for Human Capacity Development. In 2017 he was elected to the College of Fellows of the University of Cape Town

Scientific Career

- Professor of Cosmology 2007-
- Professor and Head of the Department of Mathematics and Applied Mathematics 2017-.2019
- Professor in the Department of Mathematics and Applied Mathematics 2007-2016.
- Co-Director of the Astrophysics, Cosmology and Gravity Centre 2007-2015.
- Programme Director of the National Astrophysics and Space Science Programme 2003-2013.
- Associate Professor in Applied Mathematics, University of Cape Town 2003-2006.
- Senior Lecturer in Applied Mathematics, University of Cape Town 2001-2002.
- Lecturer in Applied Mathematics, University of Cape Town 1998-2000.
- Temporary Lecturer in Applied Mathematics, University of Cape Town 1997.
- Postdoctoral Fellow at Dalhousie University, Halifax, Canada 1996.
- Postdoctoral Fellow at the University of Cape Town 1993-1995.

Honours and Awards

- Awarded S2A3 British Association Medal (Silver) in 2006.
- Awarded the National Science and Technology Forum (NSTF) award for Human Capacity Development in 2016.
- Honorary Research Fellow at the *South African Astronomical Observatory*.
- Honorary Academic Member in the Department of Astronomy, University of Cape Town.
- President of the South African Gravity Society (2014).
- B2 rating from the National Research Foundation (SA).
- Fellow of the University of Cape Town (2017-)

Undergraduate teaching

I have taught the following courses since my appointment in January 1998:

- MAM1003W: Calculus for Engineers (1998 - 1999).
- MAM2000W: Advanced Calculus (1998 - 1999, 2015, 2021).
- MAM3040W: General Relativity (1998 - 2005, 2012 - 2013), 2021-.
- MAM4000W: Differential Geometry (1999).
- MAM4001W: Cosmology (1998).
- MAM1044H: Dynamics (2000 - 2009, 2016-2018).
- MAM3040W: Differential Geometry (2000 - 2001).
- PHY5002F: Hot Topics in Cosmology (2003-2011, 2013-2015).
- MAM4001W: Advanced General Relativity (2006, 2010-2011, 2013-2018).
- MAM1012S: Calculus for Commerce Students (2014).

I have also acted as course coordinator for the following courses

- MAM1003W: Calculus for Engineers (1998 - 1999).
- MAM3040W: Applied Mathematics III (2000 - 2001, 2005).
- MAM1044H: Dynamics (2000 - 2009, 2016-2018).
- AST4003W: National Astrophysics and Space Science Programme: Honours.
- AST5002F: National Astrophysics and Space Science Programme: Masters coursework component.
- AST5002W: National Astrophysics and Space Science Programme: Masters thesis component.
- 58 third year integrated assessment projects since 2003.

Teaching forms an important and challenging part of my activities and I enjoy interacting with students at all levels. My first and second year classes have provided me with an opportunity to experiment with the use of technology in the classroom. The web as a delivery tool for course-work material has been particularly useful both as a way of enhancing understanding and providing me with an efficient way of monitoring students progress. For example in my second year advanced calculus course, students are continually assessed via a series of on-line multiple choice problem sheets which give me instant feedback on how the students are coping with a particular topic. I regularly use computer algebra systems, and numerical simulations in classroom demonstrations to give a different perspectives on mathematical problems, providing a much needed link to situations of importance in everyday life. My on - line course on general relativity has had considerable international recognition, has received more than 2000 web citations (c.f. google.com with "Tensors and Relativity by Peter Dunsby"), is used widely as reference material in many general relativity courses around the world: see for example

- http://www.staff.science.uu.nl/ hooft101/theorist.html
- http://preposterousuniverse.com/spacetimeandgeometry/resources.html

The site has also has received several WWW awards (most recently from *StudySphere*.

> "Tensors and Relativity, by Peter Dunsby (Mathematics, University of Cape Town). This is a fabulous site featuring a complete course available for free over the web as html documents. (Registered students can also download postscript and dvi versions.) At the level of Schutz, A First Course in General Relativity, i.e. more challenging than the previous site. Topics covered include vectors and tensors in flat spacetime, the conceptual basis of general relativity, curved spacetime, the field equation, and the Schwarzschild solution. Highly recommended!"

Course evaluations for the past 10 years give me an average score of 90% for effectiveness with more than half of students rating me as one of the best lecturers they have had at UCT. Below are some typical comments from student evaluations:

> "Prof. Dunsby is one of, if not the best lecturer I've had this year. The material is interesting and he teaches it in a stimulating manner."

"Peter Dunsby is a brilliant lecturer, who obviously knows this section of applied maths and teaches excellently."

"Prof. Dunsby made the 2nd semester incredibly interesting. The content was great, really fun stuff. It is also great to have a lecturer who obviously understands the course material in depth. The second semester of this course has made me want to major in applied maths. I think Prof. Dunsby is a great lecturer! The course and "mission to Mars" was really entertaining."

"This lecturer is wonderfully organised and effective in explanation."

Finally in 2001 and 2003 I was nominated for a *Distinguished Teacher Award*.

Postgraduate supervision

The following students have completed their studies under my direct or joint supervision:

- Peter McEwan (Honours, 2000),
- Tobias Brandt (Honours, 2000),
- Tim Gebbie[1] (PhD, 2000),
- Bonita de Swardt (Honours, 2001),
- Alexander Kahle (Honours, 2001),
- Stacey Hobbs (MSc with distinction, 2001),
- Teresa Lu (Honours, 2003),
- Alexander Kahle (MSc with distinction, 2003),
- Deon Solomons (PhD, 2003),
- Bonita de Swardt (MSc with distinction, 2004),
- Antony Millner (MSc with distinction, 2005) Awarded the S2A3 South African Association for the Advancement of Science bronze medal for best masters thesis in pure science (2006),
- Naureen Goheer (PhD, 2005),
- Gerold Betschart (PhD, 2005),
- Caroline Zunckel (MSc with distinction, 2005).
- Bob Osano (PhD, 2008),
- Jannie Leach (PhD, 2008),
- Mohamed Elshzli Sirelakhtim (MSc with distinction, 2008).
- Amare Abebe Gidelew (MSc, 2009),
- Anne Marie Nzoki (MSc with distinction, 2009),
- Maye Elmardi (MSc, 2010),
- Hassan Bourhrous (MSc, 2012),
- Pieter Conradie (MSc, 2012),
- Mohamed Elshzli Sirelakhtim (PhD, 2013),
- Anne Marie Nzoki (PhD, 2013),
- Amare Abebe Gidelew (PhD, 2013),
- Sulona Kandhai (MSc, 2013).
- Tjaart de Wit (MSc, 2013)
- Bishop Mongwane (PhD, 2014)

- Shreef Nasser (MSc, 2014).
- Tim Oreta (MSc, 2015).
- Sulona Kandhai (PhD, 2019).
- Mariam Campbell (MSc, 2019).
- Muzikayise Sikhonde (PhD, 2019).

I currently have three graduate students

- Mariam Campbell (PhD)
- Ira Georg (PhD)
- Avishek Dusoye (PhD)

Postgraduate supervision and training is a key component of my academic life. Over the last few years I have successfully developed an integrated research programme involving, graduate students, postdocs and international collaborators, many of whom are involved in research projects linked to bilateral agreements between South Africa, Sweden, Italy and the UK. This has provided a vibrant research atmosphere for my students who regularly interact with colleagues here and abroad. In particular, my collaboration with Mattias Marklund has been particularly productive, leading, among other things to a joint PhD programme between our two research groupings.

Since 1998 the majority of my MSc students have been awarded their degrees with distinction and all of my research students (MSc and PhD) regularly publish papers in leading international journals and present our work at international conferences.

The partnerships I have developed through these bilateral agreements have provided a springboard for my PhD students to set up their own independent research linkages. For example Naureen Goheer was invited by Leonhard Susskind to visited the Institute of Advanced Study in Korea and this resulted in two papers published in the Journal of High Energy Physics. Another PhD student (Gerold Betschart) also benefited greatly from my joint PhD programme with Mattias Marklund. During his year at Chalmers University of Technology, he presented work at conferences in Sweden and Hungary and completed a Licentiate degree in "Plasma Physics on Curved Spacetimes".

A number of my students (Hobbs, de Swardt, Kahle, Millner, Zunckel) received either “prestigious” or “scarce skills” free standing bursaries and were holders of UCT Research associateships (Goheer, Millner, Betschart, Leach, Nzoki).

On finishing their degrees many of of students have obtaining prestigious PhD and postdoctoral scholarships, for example Kahle obtained a Fulbright scholarship to study at the University of Texas, Austin, de Swardt obtained an MSc in Astronomy at Rutgers while holding a Salt - Stobie Scholarship, Milner obtained a distinction in Part III at Cambridge university, Zunckel received a full scholarship to study for a PhD at Oxford university, Goheer obtained a Claude - Leon postdoctoral fellowship to work at UCT under George Ellis and myself and Betschart has obtained a postdoctoral fellowship to work under Jacob Beckenstein at the Hebrew University of Jerusalem. Milner was awarded the S2A3 South African Association for the Advancement of Science bronze medal for best masters thesis in pure science.

Four of my former graduate students now have permanent positions. Caroline Zunckel was a lecturer at the University of Kwazulu Natal, Bob Osano is an Associate Professor at the University of Cape Town, Amare Abebe Gidelew is an Associate Professor at the University of the North West and Bishop Mongwane has just took up a lectureship at the University of Cape Town in January 2016.

I have also supervised a number of postdoctoral researchers that have spent or are spending time with the UCT Cosmology Research Group:

- Mattias Marklund (2000).
- Chris Clarkson (2001 - 2002).
- Christos Tsagas (2001 - 2002).
- Sante Carloni (2004 - 2009).
- Naureen Goheer (2006 - ; with George Ellis).
- Rituparno Goswami (2008 - 2012).
- Julien Larena (2008 - 2011).

- Kishore Ananda (2007 - 2010).
- Alvaro de la Cruz Dombriz (2010-2014).
- Diego Saiz Gomez (2013-2015) .
- Vinicius Busto (2013-2015).
- Lorenzo Reverberi (2015-2018).
- Orlando Luongo (2015-2017).
- Jack Morrice (2018-2019).
- Abbas Sherif (2020-)
- Nolene Ferarri Naidu (2020-)

Seven of my recent postdoctoral fellows now have permanent positions: Mattias Marklund is a full professor at Umea University, Christopher Clarkson is a Reader at the University of London, Julian Larena is a Senior Lecturer at the University of Cape Town, Christos Tsagas is an Assistant Professor. Section of Astrophysics, Astronomy & Mechanics. Department of Physics Aristotle University of Thessaloniki, Greece, Rituparno Goswami is a Professor at the University of Kwazulu Natal, Sante Carloni is a Lecturer at the University of Genoa and Alvaro de la Cruz Dombriz is a Senior Lecturer at the University of Cape Town.

Research: Current NRF Rating - B2

The common thread that links all my research activities over the past decade is its focus on what is arguably the most important problem in contemporary cosmology - the nature of dark energy. In particular I have concentrated my efforts on two of the most promising alternatives to the standard concordance model of cosmology: the cosmology and astrophysics of extended theories of gravity, and studies of cosmology on backgrounds other than the standard Friedmann-Lemaitre-Robertson-Walker (FLRW) metric. During this period I have published 35 papers in leading international peer-reviewed journals, eight papers in conference proceedings and have presented my work as a plenary speaker at ten major international conferences and workshops.

A large part of my work has concentrated on developing a detailed understanding of one of the most important classes of Modified Gravity (MG) Ð the so called f(R) theories of gravity. The work I have completed in this area can be broadly divided into three focus areas: Cosmological Dynamics, Inhomogeneity and Spherical Symmetry. Other work focused on perturbations of inhomogeneous and anisotropic cosmological models, with a particular emphasis on highlighting difficulties that exist when trying to distinguish between competing dark energy models.

Cosmological Dynamics: Building on my seminal work on the cosmological dynamics of f(R) gravity Ð Ref [71], a general framework for compactifying the phase- space of general f(R) cosmologies was developed in Refs [31,53,54]. This work demonstrated for the first time that these theories are able to admit a cosmic history which begins with a power-law inflationary epoch, followed by a curvature fluid dominated phase which mimics standard radiation, then passing through a cold dark era and ultimately evolving asymptotically towards a de-Sitter-like late-time accelerated phase. The inclusion of shear was then introduced in Refs [60] to determine under what situations an isotropic singularity occurs and whether there is late-time isotropisation in these models. In Refs [49,51], the condition for which an Einstein-Static universe is a solution of f(R) gravity was determined, together with stability criteria under generic inhomogeneous and anisotropic perturbations. These papers have received considerable recognition (total of 388 citations) and provide, among other things, important tools for identifying viable cosmic histories, which can be used as background models for the study of the growth of large-scale structure in these models.

Another useful technique for studying background models in f(R) gravity is the so-called reconstruction method. Here one assumes that the expansion history of the universe is known exactly and, by inverting the field equations deduce what f(R) theories give rise to a given FLRW model. The existence of such solutions is particularly relevant because in FLRW backgrounds they typically represent asymptotic or intermediate states in the full phase-space of all possible cosmological evolutions. An important result was found in Ref [36] (69 citations), where it was shown that the only theory whose Lagrangian is a simple function of the Ricci scalar R, that admits an exact LCDM expansion history, is standard general relativity with a positive cosmological constant and the only way to obtain this behaviour of the scale factor for more general functions of R is to add additional degrees of freedom to the matter sector.

Inhomogeneity: The above techniques provided the background models needed for detailed studies of the growth of inhomogeneity and evolution of gravitational waves in MG. Unlike other work in the literature, where the Quasi-Static (QS) approximation is widely used, my work focused on using exact (analytic and numerical) solutions of both the background and perturbation equations to determine potential signatures (or smoking guns) of MG. Two key results were found Ð Refs [48,50] (133 citations). Firstly, for the simplest extensions to

general relativity, it was found that there is always a growing mode for the density contrast, even if the universe undergoes an accelerated expansion. Such a behaviour does not occur in standard General Relativity, where as soon as Dark Energy dominates, the density contrast experiences an unrelenting decay. Secondly, the structure of the general fourth order perturbation equations lead to a signature of fourth order gravity in the matter power spectrum not seen before. This could provide a crucial test for these theories on cosmological scales, not yet probed by observations. These effects were missed is studies where the QS approximation was used. My attention then turned to the problem of confronting these theoretical results with several Sloan Digital Sky Survey data sets Ð Ref [21]. Determining the statistical significance in relation to observational data highlighted the importance of studying the first order perturbed equations using the correct background evolution and the relevance of initial conditions. In Ref [55] tensor (gravitational wave) perturbations in f(R) gravity were also considered providing the background for ongoing work on determining the imprint of gravitational waves on the Cosmic Microwave Background Radiation.

Recent work on the role of inhomogeneity in MG has focused on cosmological modeling in f(R) theories of gravity, using both top-down and bottom-up constructions. The top-down models are FLRW geometries, while the bottom-up constructions are built by patching together sub-horizon-sized regions of perturbed Minkowski space. My results with Clifton Ref [75,82] suggest that these theories do not provide a theoretically attractive alternative to the standard general relativistic cosmology. We found that the only f(R) theories that can admit an observationally viable weak-field limit have large-scale expansions that are observationally indistinguishable from the standard model. Such theories do not alleviate any of the difficulties associated with a cosmological constant, and cannot produce any new behaviour in the cosmological expansion without simultaneously destroying the Newtonian approximation to gravity on small scales.

Spherical Symmetry: In Ref [41] a new framework for treating spherically symmetric spacetimes in f(R) gravity was developed. General equations for a static and spherically symmetric metric were obtained and used to determine the conditions for which the Schwarzschild metric is the only vacuum solution with vanishing Ricci scalar. Our general framework also provided a clear way of showing that the Schwarzschild solution is not the unique static spherically symmetric solution in these theories, providing some insight on how the classical form of the Jebsen-Birkhoff theorem breaks down. This work then led to a generalisation of this theorem in f(R) in order to find the necessary conditions required for the existence of the Schwarzschild solution and demonstrated that the stability of such solutions of f(R) gravity is valid even in the perturbed scenario - Ref [17]. This formalism was also used for studies of gravitational lensing in spherically symmetric spacetimes within the context of f(R) gravity Ð Ref [41]. Equations for the propagation of null geodesics, together with an expression for the bending angle were found for any f(R) theory. We found that for this case more bending is expected for f(R) gravity theories in comparison to general relativity.

The problem of matching different regions of spacetime in order to construct inhomogeneous cosmological models was investigated in the context of f(R) theories of gravity Ð Ref [26]. It was found that it is impossible to satisfy the required junction conditions without the large-scale behaviour reducing to that expected from Einsteins equations with a cosmological constant. For theories with analytic f(R) this suggests that the usual treatment of weak-field systems as perturbations about Minkowski space may not be compatible with late-time acceleration driven by anything other than a constant term of the form f(0), which acts like a cosmological constant. In the absence of Minkowski space as a suitable background for weak-field systems, one must then choose and justify some other solution to perform perturbative analyses around. It was also found that no known spherically symmetric vacuum solutions can be matched to an expanding FLRW background in f(R) gravity. This includes the absence of any Einstein-Straus-like embeddings of the Schwarzschild exterior solution in FLRW spacetimes.

This work was also extended to Teleparallel gravity theories Ð Ref [16], where it was found that in the absence of shells/branes, the general junction conditions on the matching hypersurfaces depend both on the underlying theory and a new condition on the induced tetrads in order to avoid delta-like distributions in the field equations. Like f(R) gravity, this result imposes strict consequences on the viability of standard solutions such as the Einstein-Straus model.

Inhomogeneous and anisotropic cosmological models: Another possible explanation of dark energy is that it does not exist at all but has been inferred as a result of matching the incorrect background model to cosmological observations. In particular, my efforts have focused on the Lematre-Tolman-Bondi (LTB) models, with the aim of reproducing the late time dynamics of the Universe without introducing a cosmological constant or dark energy. Work was done in Ref [38] to investigate the possibility of distinguishing such models from the standard model using background and large-scale structure data. It emphasised the necessity of testing the Copernican principle before confronting tests of general relativity with the large-scale structure. More recently Ref [13], the relation between the dynamics of LTB dust models (with and without a cosmological constant) and the dynamics of dust perturbations in two of the main mathematical frameworks used in cosmology: the metric-based cosmological perturbation theory (CPT) and the covariant gauge invariant (CGI) approach was addressed. For this purpose, the evolution of LTB models was expressed in terms of a CGI formalism of local and non-local exact fluctuations on a FLRW background defined by suitable averages of covariant scalars. The properties of these

fluctuations were examined and it was found that the non-local density fluctuation provides a covariant and precise definition for the notion of the density contrast. It particular it was found that in their linear regime these LTB exact fluctuations (local and non-local) are fully equivalent to the conventional cosmological perturbations in the synchronous-comoving gauge of CPT and to CGI perturbations. This work is important in that it may provide important theoretical connections between the exact and perturbative (linear or non-linear) approach to the dynamics of dust sources in general relativity.

Publications

- Author of more than 100 papers and conference proceedings in leading international journals, h index of 40 (26 in past 5 years). More than 4000 citations.

1. **"Disformal couplings in a ΛCDM background cosmology"**
   A. Dusoye, A. de la Cruz-Dombriz, P. Dunsby and N. J. Nunes,
   JCAP **03** (2021), 002
   DOI:10.1088/1475-7516/2021/03/002
   arXiv:2006.16962 [gr-qc].

2. **"Fundamental physics with the Square Kilometre Array"**
   A. Weltman, P. Bull, S. Camera, K. Kelley, H. Padmanabhan, J. Pritchard, A. Raccanelli, S. Riemer-Sørensen, L. Shao and S. Andrianomena, *et al.*
   Astron. Soc. Austral. **37** (2020), e002
   DOI:10.1017/pasa.2019.42
   arXiv:1810.02680 [astro-ph.CO].

3. **"Analysis of branon dark matter and extra-dimensional models with AMS-02"**
   J. A. R. Cembranos, A. de la Cruz-Dombriz, P. K. S. Dunsby and M. Mendez-Isla.
   arXiv:1709.09819 [hep-ph]
   DOI:10.1016/j.physletb.2019.01.011
   Phys. Lett. B **790**, 345 (2019)

4. **"Reviving The Shear-Free Perfect Fluid Conjecture In General Relativity"**
   M. E. Sikhonde and P. K. S. Dunsby.
   arXiv:1708.02462 [gr-qc]
   DOI:10.1088/1361-6382/aa95ad
   Class. Quant. Grav. **34**, no. 24, 245007 (2017)

5. **"Covariant perturbations of Schwarzschild black holes in f(R) gravity"**
   A. M. Nzioki, R. Goswami and P. K. S. Dunsby.
   DOI:10.1142/S0218271817500481
   Int. J. Mod. Phys. D **26**, no. 06, 1750048 (2016).

6. **"Integrability conditions of quasi-Newtonian cosmologies in modified gravity"**
   A. Abebe, P. K. S. Dunsby and D. Solomons.
   arXiv:1611.07586 [gr-qc]
   DOI:10.1142/S0218271817500547
   Int. J. Mod. Phys. D **26**, no. 06, 1750054 (2016)

7. **"Scattering of Ricci scalar perturbations from Schwarzschild black holes in modified gravity"**
   D. B. Sibandze, R. Goswami, S. D. Maharaj, A. M. Nzioki and P. K. S. Dunsby.
   arXiv:1611.06043 [gr-qc]
   DOI:10.1140/epjc/s10052-017-4936-0
   Eur. Phys. J. C **77**, no. 6, 364 (2017)

8. **"Model-independent limits and constraints on extended theories of gravity from cosmic reconstruction techniques"**
   ç. de la Cruz-Dombriz, P. K. S. Dunsby, O. Luongo and L. Reverberi.
   arXiv:1608.03746 [gr-qc]
   DOI:10.1088/1475-7516/2016/12/042
   JCAP **1612**, no. 12, 042 (2016)

9. **"Reheating and preheating in the simplest extension of Starobinsky inflation"**
   C. van de Bruck, P. Dunsby and L. E. Paduraru.
   arXiv:1606.04346 [gr-qc]
   DOI:10.1142/S0218271817501528
   Int. J. Mod. Phys. D **26**, no. 13, 1750152 (2017)

10. **"Dark Energy and Dark Matter from an additional adiabatic fluid"**
P. K. S. Dunsby, O. Luongo and L. Reverberi.
arXiv:1604.06908 [gr-qc]
DOI:10.1103/PhysRevD.94.083525
Phys. Rev. D **94**, no. 8, 083525 (2016)

11. **"On the theory and applications of modern cosmography"**
P. K. S. Dunsby and O. Luongo.
arXiv:1511.06532 [gr-qc]
DOI:10.1142/S0219887816300026
Int. J. Geom. Meth. Mod. Phys. **13**, no. 03, 1630002 (2016)

12. **"Theoretical and observational constraints of viable f(R) theories of gravity"**
de la Cruz-Dombriz, P. K. S. Dunsby, S. Kandhai and D. S Gomes.
arXiv:1511.00102 [gr-qc]
DOI:10.1103/PhysRevD.93.084016
Phys. Rev. D **93**, no. 8, 084016 (2016)

13. **"Gravitational, shear and matter waves in Kantowski-Sachs cosmologies"**
Z. Keresztes, M. Forsberg, M. Bradley, P. K. S. Dunsby and L. Gergely.
arXiv:1507.08300 [gr-qc]
DOI:10.1088/1475-7516/2015/11/042
JCAP **1511**, no. 11, 042 (2015)

14. **"Is cosmography a useful tool for testing cosmology?"**
V. C. Busti, ç. de la Cruz-Dombriz, P. K. S. Dunsby and D. S-Gomez.
arXiv:1505.05503 [astro-ph.CO]
DOI:10.1103/PhysRevD.92.123512
Phys. Rev. D **92**, no. 12, 123512 (2015)

15. **"On the Emergence of Accelerating Cosmic Expansion in f(R) Theories of Gravity"**
T. Clifton and P. K. S. Dunsby.
arXiv:1501.04004 [gr-qc]
DOI:10.1103/PhysRevD.91.103528
Phys. Rev. D **91**, no. 10, 103528 (2015)

16. **"Spherical dust fluctuations: The exact versus the perturbative approach"**
R. A. Sussman, J. C. Hidalgo, P. K. S. Dunsby and G. German.
arXiv:1412.8404 [gr-qc]
DOI:10.1103/PhysRevD.91.063512
Phys. Rev. D **91**, no. 6, 063512 (2015)

17. **"Junction conditions in extended Teleparallel gravities"**
ç. de la Cruz-Dombriz, P. K. S. Dunsby and D. Saez-Gomez.
arXiv:1406.2334 [gr-qc]
DOI:10.1088/1475-7516/2014/12/048
JCAP **1412**, 048 (2014)

18. **"Jebsen-Birkhoff theorem and its stability in f(R) gravity"**
A. M. Nzioki, R. Goswami and P. K. S. Dunsby.
arXiv:1312.6790 [gr-qc]
DOI:10.1103/PhysRevD.89.064050
Phys. Rev. D **89**, no. 6, 064050 (2014)

19. **"Backreaction mechanism in multifluid and extended cosmologies"**
J. Beltran Jimenez, ç. de la Cruz-Dombriz, P. K. S. Dunsby and D. Saez-Gomez.
arXiv:1312.5680 [astro-ph.CO]
DOI:10.1088/1475-7516/2014/05/031
JCAP **1405**, 031 (2014)

20. **"On tidal forces in f(R) theories of gravity"**
A. de la Cruz-Dombriz, P. K. S. Dunsby, V. C. Busti and S. Kandhai.
arXiv:1312.2022 [gr-qc]
DOI:10.1103/PhysRevD.89.064029
Phys. Rev. D **89**, no. 6, 064029 (2014)

21. **"The 1+1+2 formalism for Scalar-Tensor gravity"**
S. Carloni and P. K. S. Dunsby.
arXiv:1306.2473 [gr-qc]
DOI:10.1007/s10714-016-2131-5
Gen. Rel. Grav. **48**, no. 10, 136 (2016)

22. **"Large Scale Structure Constraints for a Class of f(R) Theories of Gravity"**
A. Abebe, A. de la Cruz-Dombriz and P. K. S. Dunsby.
arXiv:1304.3462 [astro-ph.CO]
DOI:10.1103/PhysRevD.88.044050
Phys. Rev. D **88**, 044050 (2013)

23. **"On the absence of the usual weak-field limit, and the impossibility of embedding some known solutions for isolated masses in cosmologies with f(R) dark energy"**
T. Clifton, P. Dunsby, R. Goswami and A. M. Nzioki.
arXiv:1210.0730 [gr-qc]
DOI:10.1103/PhysRevD.87.063517
Phys. Rev. D **87**, no. 6, 063517 (2013)

24. **"Cosmic Electromagnetic Fields due to Perturbations in the Gravitational Field"**
B. Mongwane, P. K. S. Dunsby and B. Osano.
arXiv:1203.6032 [gr-qc]
DOI:10.1103/PhysRevD.86.083533
Phys. Rev. D **86**, 083533 (2012)

25. **"Cosmological dynamics of fourth order gravity: A compact view"**
M. Abdelwahab, R. Goswami and P. K. S. Dunsby.
arXiv:1111.0171 [gr-qc]
DOI:10.1103/PhysRevD.85.083511
Phys. Rev. D **85**, 083511 (2012)

26. **"Covariant gauge-invariant perturbations in multifluid f(R) gravity"**
A. Abebe, M. Abdelwahab, A. de la Cruz-Dombriz and P. K. S. Dunsby.
arXiv:1110.1191 [gr-qc]
DOI:10.1088/0264-9381/29/13/135011
Class. Quant. Grav. **29**, 135011 (2012)

27. **"On Shear-free perturbations of f(R) gravity"**
A. Abebe, R. Goswami and P. K. S. Dunsby.
arXiv:1108.2900 [gr-qc]
DOI:10.1103/PhysRevD.84.124027
Phys. Rev. D **84**, 124027 (2011)

28. **"On Shear-Free perturbations of FLRW Universes"**
A. M. Nzioki, R. Goswami, P. K. S. Dunsby and G. F. R. Ellis.
arXiv:1107.5410 [gr-qc]
DOI:10.1103/PhysRevD.84.124028
Phys. Rev. D **84**, 124028 (2011)

29. **"Density growth in Kantowski-Sachs cosmologies with cosmological constant"**
M. Bradley, P. K. S. Dunsby, M. Forsberg and Z. Keresztes.
arXiv:1106.4932 [gr-qc]
DOI:10.1088/0264-9381/29/9/095023
Class. Quant. Grav. **29**, 095023 (2012)

30. **"On the LCDM Universe in f(R) gravity"**
P. K. S. Dunsby, E. Elizalde, R. Goswami, S. Odintsov and D. S. Gomez.
arXiv:1005.2205 [gr-qc]
DOI:10.1103/PhysRevD.82.023519
Phys. Rev. D **82**, 023519 (2010)

31. **"A new approach to reconstruction methods in $f(R)$ gravity"**
S. Carloni, R. Goswami and P. K. S. Dunsby.
arXiv:1005.1840 [gr-qc]
DOI:10.1088/0264-9381/29/13/135012
Class. Quant. Grav. **29**, 135012 (2012)

32. **"How close can an Inhomogeneous Universe mimic the Concordance Model?"**
P. Dunsby, N. Goheer, B. Osano and J. P. Uzan.
arXiv:1002.2397 [astro-ph.CO]
DOI:10.1088/1475-7516/2010/06/017
JCAP **1006**, 017 (2010)

33. **"A Geometrical Approach to Strong Gravitational Lensing in f(R) Gravity"**
A. M. Nzioki, P. K. S. Dunsby, R. Goswami and S. Carloni.
arXiv:1002.2056 [gr-qc]
DOI:10.1103/PhysRevD.83.024030
Phys. Rev. D **83**, 024030 (2011)

34. **"A New framework for studying spherically symmetric static solutions in f(R) gravity"**
A. M. Nzioki, S. Carloni, R. Goswami and P. K. S. Dunsby.
arXiv:0908.3333 [gr-qc]
DOI:10.1103/PhysRevD.81.084028
Phys. Rev. D **81**, 084028 (2010)

35. **"Power-law cosmic expansion in f(R) gravity models"**
N. Goheer, J. Larena and P. K. S. Dunsby.
arXiv:0906.3860 [gr-qc]
DOI:10.1103/PhysRevD.80.061301
Phys. Rev. D **80**, 061301 (2009)

36. **"On the co-existence of matter dominated and accelerating solutions in f(G)-gravity"**
N. Goheer, R. Goswami, P. K. S. Dunsby and K. Ananda.
arXiv:0904.2559 [gr-qc]
DOI:10.1103/PhysRevD.79.121301
Phys. Rev. D **79**, 121301 (2009)

37. **"Dynamics of f(R)-cosmologies containing Einstein static models"**
N. Goheer, R. Goswami and P. K. S. Dunsby.
arXiv:0809.5247 [gr-qc]
DOI:10.1088/0264-9381/26/10/105003
Class. Quant. Grav. **26**, 105003 (2009)

38. **"A detailed analysis of structure growth in $f(R)$ theories of gravity"**
K. Ananda, S. Carloni and P. K. S. Dunsby.
arXiv:0809.3673 [astro-ph]
DOI:10.1088/0264-9381/26/23/235018
Class. Quant. Grav. **26**, 235018 (2009)

39. **"The Existence of Einstein Static Universes and their Stability in Fourth order Theories of Gravity"**
R. Goswami, N. Goheer and P. K. S. Dunsby.
arXiv:0804.3528 [gr-qc]
DOI:10.1103/PhysRevD.78.044011
Phys. Rev. D **78**, 044011 (2008)

40. **"Compactifying the state space for alternative theories of gravity"**
N. Goheer, J. A. Leach and P. K. S. Dunsby.
arXiv:0710.0819 [gr-qc]
DOI:10.1088/0264-9381/25/3/035013
Class. Quant. Grav. **25**, 035013 (2008)

41. **"Dynamical systems analysis of anisotropic cosmologies in R**n-gravity"**
N. Goheer, J. A. Leach and P. K. S. Dunsby.
arXiv:0710.0814 [gr-qc]
DOI:10.1088/0264-9381/24/22/026
Class. Quant. Grav. **24**, 5689 (2007)

42. **"The Evolution of cosmological gravitational waves in f(R) gravity"**
K. N. Ananda, S. Carloni and P. K. S. Dunsby.
arXiv:0708.2258 [gr-qc]
DOI:10.1103/PhysRevD.77.024033
Phys. Rev. D **77**, 024033 (2008)

43. **"The Evolution of density perturbations in f(R) gravity"**
S. Carloni, P. K. S. Dunsby and A. Troisi.
arXiv:0707.0106 [gr-qc]
DOI:10.1103/PhysRevD.77.024024
Phys. Rev. D **77**, 024024 (2008)

44. **"Constraining scalar-tensor quintessence by cosmic clocks"**
S. Capozziello, P. K. S. Dunsby, E. Piedipalumbo and C. Rubano.
arXiv:0706.2615 [astro-ph]
DOI:10.1051/0004-6361:20077827
Astron. Astrophys. **472**, 51 (2007)

45. **"Cosmological dynamics of exponential gravity"**
M. Abdelwahab, S. Carloni and P. K. S. Dunsby.
arXiv:0706.1375 [gr-qc]
DOI:10.1088/0264-9381/25/13/135002
Class. Quant. Grav. **25**, 135002 (2008)

46. **"Some remarks on the dynamical systems approach to fourth order gravity"**
S. Carloni, A. Troisi and P. K. S. Dunsby.
arXiv:0706.0452 [gr-qc]
DOI:10.1007/s10714-008-0747-9
Gen. Rel. Grav. **41**, 1757 (2009)

47. **"Response to "Comment on 'Primordial magnetic seed field amplification by gravitational waves' ""**
G. Betschart, C. Zunckel, P. K. S. Dunsby and M. Marklund.
gr-qc/0702104 [GR-QC]
DOI:10.1103/PhysRevD.75.087902
Phys. Rev. D **75**, 087902 (2007)

48. **"Cosmological dynamics of scalar-tensor gravity"**
S. Carloni, S. Capozziello, J. A. Leach and P. K. S. Dunsby.
gr-qc/0701009
DOI:10.1088/0264-9381/25/3/035008
Class. Quant. Grav. **25**, 035008 (2008)

49. **"The Evolution of tensor perturbations in scalar-tensor theories of gravity"**
S. Carloni and P. K. S. Dunsby.
gr-qc/0612133
DOI:10.1103/PhysRevD.75.064012
Phys. Rev. D **75**, 064012 (2007)

50. **"Gravitational waves generated by second order effects during inflation"**
B. Osano, C. Pitrou, P. Dunsby, J. P. Uzan and C. Clarkson.
gr-qc/0612108
DOI:10.1088/1475-7516/2007/04/003
JCAP **0704**, 003 (2007)

51. **"Gauge invariant perturbations of Scalar-Tensor Cosmologies: The Vacuum case"**
S. Carloni, P. K. S. Dunsby and C. Rubano.
gr-qc/0611113
DOI:10.1103/PhysRevD.74.123513
Phys. Rev. D **74**, 123513 (2006)

52. **"Shear dynamics in Bianchi I cosmologies with R**n-gravity"**
J. A. Leach, S. Carloni and P. K. S. Dunsby.
gr-qc/0603012
DOI:10.1088/0264-9381/23/15/011
Class. Quant. Grav. **23**, 4915 (2006)

53. **"On inhomogeneous magnetic seed fields and gravitational waves within the MHD limit"**
C. Zunckel, G. Betschart, P. K. S. Dunsby and M. Marklund.
gr-qc/0602036
DOI:10.1103/PhysRevD.73.103509
Phys. Rev. D **73**, 103509 (2006)

54. **"Bounce conditions in f(R) cosmologies"**
S. Carloni, P. K. S. Dunsby and D. M. Solomons.
gr-qc/0510130
DOI:10.1088/0264-9381/23/6/006
Class. Quant. Grav. **23**, 1913 (2006)

55. **"Primordial magnetic seed field amplification by gravitational waves"**
G. Betschart, C. Zunckel, P. Dunsby and M. Marklund.
gr-qc/0503006
DOI:10.1103/PhysRevD.72.123514
Phys. Rev. D **72**, 123514 (2005)

56. **"Cosmological dynamics of R**n gravity"**
S. Carloni, P. K. S. Dunsby, S. Capozziello and A. Troisi.
gr-qc/0410046
DOI:10.1088/0264-9381/22/22/011
Class. Quant. Grav. **22**, 4839 (2005)

57. **"Large-scale perturbations on the brane and the isotropy of the cosmological singularity"**
N. Goheer, P. K. S. Dunsby, A. Coley and M. Bruni.
hep-th/0408092
DOI:10.1103/PhysRevD.70.123517
Phys. Rev. D **70**, 123517 (2004)

58. **"Are braneworlds born isotropic?"**
P. Dunsby, N. Goheer, M. Bruni and A. Coley.
hep-th/0312174
DOI:10.1103/PhysRevD.69.101303
Phys. Rev. D **69**, 101303 (2004)

59. **"Cosmic magnetic fields from velocity perturbations in the early universe"**
G. Betschart, P. K. S. Dunsby and M. Marklund.
gr-qc/0310085
DOI:10.1088/0264-9381/21/8/014
Class. Quant. Grav. **21**, 2115 (2004)

60. **"The electromagnetic signature of black hole ringdown"**
C. A. Clarkson, M. Marklund, G. Betschart and P. K. S. Dunsby.
astro-ph/0310323
DOI:10.1086/422497
Astrophys. J. **613**, 492 (2004)

61. **"Charged multifluids in general relativity"**
M. Marklund, P. K. S. Dunsby, M. Servin, G. Betschart and C. Tsagas.
gr-qc/0211067
DOI:10.1088/0264-9381/20/9/315
Class. Quant. Grav. **20**, 1823 (2003)

62. **"Exponential potentials on the brane"**
N. Goheer and P. K. S. Dunsby.
gr-qc/0211020
DOI:10.1103/PhysRevD.67.103513
Phys. Rev. D **67**, 103513 (2003)

63. **"Singularities on the brane aren't isotropic"**
M. Bruni and P. K. S. Dunsby.
hep-th/0207189
DOI:10.1103/PhysRevD.66.101301
Phys. Rev. D **66**, 101301 (2002)

64. **"Brane world dynamics of inflationary cosmologies with exponential potentials"**
N. Goheer and P. Dunsby.
gr-qc/0204059
DOI:10.1103/PhysRevD.66.043527
Phys. Rev. D **66**, 043527 (2002)

65. **"Gravitational wave amplification of seed magnetic fields"**
C. G. Tsagas, P. K. S. Dunsby and M. Marklund.
astro-ph/0112560
DOI:10.1016/S0370-2693(03)00415-5
Phys. Lett. B **561**, 17 (2003)

66. **"(1+3) covariant dynamics of scalar perturbations in brane worlds"**
B. Leong, P. Dunsby, A. Challinor and A. Lasenby.
gr-qc/0111033
DOI:10.1103/PhysRevD.65.104012
Phys. Rev. D **65**, 104012 (2002)

67. **"Causality in inflationary universes with positive spatial curvature"**
G. F. R. Ellis, P. McEwan, W. R. Stoeger, S.J. and P. Dunsby.
gr-qc/0109024
DOI:10.1023/A:1020039120851
Gen. Rel. Grav. **34**, 1461 (2002)

68. **"Dynamics of inflationary universes with positive spatial curvature"**
G. F. R. Ellis, W. R. Stoeger, S.J., P. McEwan and P. Dunsby.
gr-qc/0109023
DOI:10.1023/A:1020087004012
Gen. Rel. Grav. **34**, 1445 (2002)

69. **"Plane fronted parallel waves in a warm two component plasma"**
G. Brodin, M. Marklund and P. Dunsby.
gr-qc/0108039
DOI:10.1088/0264-9381/18/23/318
Class. Quant. Grav. **18**, 5249 (2001)

70. **"Bounce behaviour in Kantowski-Sachs and Bianchi cosmologies"**
D. M. Solomons, P. Dunsby and G. Ellis.
gr-qc/0103087
DOI:10.1088/0264-9381/23/23/001
Class. Quant. Grav. **23**, 6585 (2006)
UCT-COSMOLOGY-01-04

71. **"Solution to the graceful exit problem in pre - big bang cosmology"**
G. F. R. Ellis, D. C. Roberts, D. M. Solomons and P. K. S. Dunsby.
DOI:10.1103/PhysRevD.62.084004
Phys. Rev. D **62**, 084004 (2000).

72. **"Cosmological electromagnetic fields due to gravitational wave perturbations"**
M. Marklund, P. K. S. Dunsby and G. Brodin.
gr-qc/0007035
DOI:10.1103/PhysRevD.62.101501
Phys. Rev. D **62**, 101501 (2000)
UCT-COSMOLOGY-00-07

73. **"Dynamical systems approach to magnetized cosmological perturbations"**
S. Hobbs and P. K. S. Dunsby.
gr-qc/0007010
DOI:10.1103/PhysRevD.62.124007
Phys. Rev. D **62**, 124007 (2000)
UCT-COSMOLOGY-00-05

74. **"Nonlinear gravitational wave interactions with plasmas"**
G. Brodin, M. Marklund and P. K. S. Dunsby.
gr-qc/0006030
DOI:10.1103/PhysRevD.62.104008
Phys. Rev. D **62**, 104008 (2000)

75. **"Radio wave emissions due to gravitational radiation"**
M. Marklund, G. Brodin and P. K. S. Dunsby.
astro-ph/9907350

DOI:10.1086/308957
Astrophys. J. **536**, 875 (2000)
UCT-COSMOLOGY-99-01

76. **"(1+3) covariant cosmic microwave background anisotropies. 2. The Almost Friedmann Lemaitre model"**
T. Gebbie, P. Dunsby and G. F. R. Ellis.
astro-ph/9904408
DOI:10.1006/aphy.2000.6034
Annals Phys. **282**, 321 (2000)

77. **"Lensing and caustic effects on cosmological distances"**
G. F. R. Ellis, B. A. Bassett and P. K. S. Dunsby.
gr-qc/9801092
DOI:10.1088/0264-9381/15/8/015
Class. Quant. Grav. **15**, 2345 (1998)

78. **"Covariant analysis of gravitational waves in a cosmological context"**
P. K. S. Dunsby, B. A. C. C. Bassett and G. F. R. Ellis.
gr-qc/9811092
DOI:10.1088/0264-9381/14/5/023
Class. Quant. Grav. **14**, 1215 (1997)

79. **"A Fully covariant description of CMB anisotropies"**
P. K. S. Dunsby.
gr-qc/9707022
DOI:10.1088/0264-9381/14/12/021
Class. Quant. Grav. **14**, 3391 (1997)

80. **"Irrotational dust with div H = 0"**
W. M. Lesame, G. F. R. Ellis and P. K. S. Dunsby.
gr-qc/9508049
DOI:10.1103/PhysRevD.53.738
Phys. Rev. D **53**, 738 (1996)

81. **"Integrability conditions for irrotational dust with a purely electric Weyl tensor: A Tetrad analysis"**
W. M. Lesame, P. K. S. Dunsby and G. F. R. Ellis.
astro-ph/9410005
DOI:10.1103/PhysRevD.52.3406
Phys. Rev. D **52**, 3406 (1995)

82. **"Newtonian evolution of the Weyl tensor"**
G. F. R. Ellis and P. K. S. Dunsby.
astro-ph/9410001
DOI:10.1086/303839
Astrophys. J. **479**, 97 (1997)

83. **"Constraints on inflationary solutions in the presence of shear and bulk viscosity"**
H. van Elst, P. Dunsby and R. K. Tavakol.
gr-qc/9405009
DOI:10.1007/BF02107957
Gen. Rel. Grav. **27**, 171 (1995)

84. **"A Covariant and Gauge Invariant Formulation of the Sachs-Wolfe Effect"**
H. Russ, M. Soffel, C. Xu and P. K. S. Dunsby.
DOI:10.1103/PhysRevD.48.4552
Phys. Rev. D **48**, 4552 (1993).

85. **"Conserved quantities in perturbed inflationary universes"**
P. K. S. Dunsby and M. Bruni.
gr-qc/9405008
DOI:10.1142/S0218271894000629
Int. J. Mod. Phys. D **3**, 443 (1994)
SISSA-163-93-A, UCT-94-5

86. **"Gauge invariant perturbations of anisotropic cosmological models"**
P. K. S. Dunsby.
DOI:10.1103/PhysRevD.48.3562
Phys. Rev. D **48**, 3562 (1993).

87. **"Cosmological perturbations and the physical meaning of gauge invariant variables"**
M. Bruni, P. K. S. Dunsby and G. F. R. Ellis.
DOI:10.1086/171629
Astrophys. J. **395**, 34 (1992).

88. **"Covariant Perturbations in a multifluid cosmological medium"**
P. K. S. Dunsby, M. Bruni and G. F. R. Ellis.
DOI:10.1086/171630
Astrophys. J. **395**, 54 (1992).
SISSA-139-91-A

89. **"Gauge invariant perturbations in a scalar field dominated universe"**
M. Bruni, G. F. R. Ellis and P. K. S. Dunsby.
DOI:10.1088/0264-9381/9/4/010
Class. Quant. Grav. **9**, 921 (1992).
SISSA-77-91-A

90. **"Gauge invariant perturbations in multicomponent fluid cosmologies"**
P. K. S. Dunsby.
DOI:10.1088/0264-9381/8/10/006
Class. Quant. Grav. **8**, 1785 (1991).

Invited Keynote Lectures

- Invited to give on - line presentation at the *9th International Congress on Mathematical Education*, Tokyo, 31 July - 6th August 2000,
- Invited to the Federal University of Rio de Janeiro from 18th November to the 4th December 1999 to give a series of lectures on *Cosmological Perturbation Theory and Structure Formation*,
- Invited key note speaker at the Hsinchu summer school in Astrophysics, Taiwan, August 2001,
- Invited to give a series of lectures on the Cosmic Microwave Background at Chalmers University of Technology, Göteborg, Sweden, October 2001,
- Invited key note speaker at the Seventh Constantine School in Astroparticle Physics, Constantine, Algeria, 3rd-8th April 2004,
- Invited key note speaker at MacCallum-Fest, Queen Mary University, London, July 17th 2004,
- Invited speaker at the 17th International Conference on General Relativity and Gravitation, Dublin, 18th - 24th July 2004 in workshop A6,
- Invited speaker at the 17th International Conference on General Relativity and Gravitation, Dublin, 18th - 24th July 2004 in workshop B1,
- Invited speaker at the 17th International Conference on General Relativity and Gravitation, Dublin, 18th - 24th July 2004 in workshop B2(i),
- Invited lecturer in Cosmology at the University Monte S. Angelo, Napoli, Italy, 19th-26th October 2005,
- Invited keynote speaker at the "First African Conference for Physics Students", 15th-18th November, 2005,
- Invited keynote speaker at the 2nd International summer school on Astroparticle physics, Nijmegen, The Netherlands, August 29th-8th September, 2006,
- Invited keynote speaker at the Dark Side of the Universe, Cairo, June 2008,
- Invited keynote speaker at the International School on Coarse-Graned Cosmology, Florence, February, 2009,
- Invited keynote speaker at South African Gravity Society, Durban, April 2009,
- Invited keynote speaker at the Dark Side of the Universe, Melbourne, 1-5 June 2009,

- Invited keynote speaker at the workshop to celebrate the 60th birthday of Emilio Elizalde, ICE/CSIC, Universitat AutÂnoma de Barcelona, 8-10 March 2010,
- Invited keynote speaker at ERE2011 (Spanish Relativity Meeting), Madrid, 28th August-2nd September 2011,
- Invited keynote speaker at ERE2012 (Spanish Relativity Meeting), Guimaraes, 3-7 September 2012.
- Invited keynote speaker at the Dark Side of the Universe meeting (DSU 2013), SISSA, Trieste, 14-18 October 2013.
- Invited keynote speaker at the X Iberian Cosmology meeting, Aranjuez, March 30-2 April, 2015.

Key Invited Research Visits and International Conferences

- Invited speaker at the Relativistic Cosmology Symposium in Honour of Professor George Ellis, University of Cape Town, February 1999,
- Invited participant at the International School of Astrophysics "de Chalonge" *7th Course in Astrofundamental Physics* in Erice - Sicily, December 1999. Joint work with G. F. R. Ellis was presented at this school,
- Visitor at the School of Mathematical Sciences, Queen Mary and Westfield College, University of London, December 1999,
- Invited participant at the the International School of Astrophysics "de Chalonge" *7th Course in Astrofundamental Physics* in Erice - Sicily, December 2000. Joint work with G. F. R. Ellis was presented at this school.
- Invited researcher at Cavendish Laboratory, Cambridge University, UK, May 17 - June 21st, 2001,
- Invited paper at the 16th International Conference on General Relativity and Gravitation, July 2001,
- Invited researcher at the department of electrodynamics, Chalmers University of Technology, Göteborg, Sweden, 17th-31st October, 2001,
- Invited researcher at Chalmers University of Technology, Göteborg, Sweden, 17th-31st May, 2002,
- Invited researcher at Cavendish laboratory, Cambridge University, 1st-15th June, 2002,
- Visiting researcher at the Institute of Cosmology, Portsmouth University, 15th-20th June, 2002,
- Contributed paper at BRITGRAV 2003, Portsmouth, September 2003,
- Gave an invited lecture as part of the Southampton General Relativity Group seminar series, September 2003,
- Invited researcher at the department of physics, Umea University, Sweden May 30th - 5th June, 2005,
- Invited researcher at the department of physics, University Monte S. Angelo, Napoli, Italy, 6th-10th June 2005,
- Invited researcher at the department of physics, University Monte S. Angelo, Napoli, Italy, 19th-26th October 2005. University Monte S. Angelo,
- Invited researcher at the department of physics, University Monte S. Angelo, Napoli, Italy, 17th-27th July 2006,
- CNRS funded researcher at Institut d'Astrophysique de Paris, Paris, France, 1st-5th October 2006,
- Royal Society Fellow at the Institute of Gravitation and Cosmology, Portsmouth, UK, 20th-29th November, 2006.
- Contributed a paper at the Spanish Relativity Meeting at the Puerto de La Cruz Conference Centre, Tenerife, Spain, 10-14 September, 2007,
- Gave an invited lecture as part of the Columbia Theory Seminars, University of Columbia, 18th January 2008,
- Contributed a paper at COSMO 08, University of Wisconson, USA, 25-29 August 2008,
- Contributed a paper at the 12th Marcel Grossmann Meeting, July 12-18, 2009,

- Gave an invited lecture at the Department of Physics and Astronomy, University of Calgary, 15 October 2010,
- Gave an invited seminar at the School of Mathematical Sciences, Queen Mary University, 20th October 2010,
- Gave an invited lecture as part of the University of Nottingham Cosmology Seminar Series, 22nd October 2010,
- Gave an invited lecture as part of the University College Dublin Physics Seminar Series, 5th April 2012,
- Gave an invited lecture as part of the University of Nottingham Cosmology Seminar Series, 22 November 2012,
- Invited researcher at the School of Mathematical Sciences, Queen Mary University, 25-28 March 2013.
- Invited researcher at the Department of Physics, Sheffield University, 15-18 September 2013.

Conferences organisation

- Chaired the workshop on the Present Observational and Theoretical State of Cosmology at the Relativistic Cosmology Symposium in Honour of G. F. R. Ellis, University of Cape Town, February 1999. The talks presented at this meeting have been published in a special issue of *General Relativity and Gravitation* (see [9] in research output).
- Chaired the workshop on Mathematical Cosmology at the 16th International Conference on General Relativity and Gravitation, July 2001. I also served on the National Organising Committee.
- I co-chaired the Local Organising Committee for a three day workshop on the *Early Universe: A Critical Review*. The talks presented at this meeting have been published in a special issue of *Classical and Quantum Gravity* (see [15] in research output).
- Member of the organising committee for NASSP/AIMS Student Workshop on SALT Science, 7th to 11th November 2005.
- Member of the organising committee for the Chris Engelbrecht Summer School for Theoretical Physics (2006).
- Organised the "Beyond the Concordance Model" workshop, STIAS, Stellenbosch, 23-27 August 2010.
- Organised the "Dark Side of the Universe" meeting, Cape Town, 17-21 November, 2014.
- Organised the "Beyond the Concordance Model II" workshop, Cape Town, 28th November-2nd December, 2016.

Referee and editorial activities

- I currently referee for the following international journals and typically referee an average of 20 papers per year:
  - Classical and Quantum Gravity,
  - Physical Review D,
  - Astrophysical Journal,
  - Astronomy and Astrophysics,
  - General Relativity and Gravitation.
- Editor, International Journal of Modern Physics.
  See `http://www.worldscientific.com/page/ijmpd/editorial-board` for details
- I also regularly do reviews of local and international funding proposals and NRF rating applications.

Thesis examination

- MSc thesis examiner of Christos Venter (University of the Northwest, South Africa), 2004.
- MSc thesis examiner of Jannie Leach (University of South Africa), 2004.
- PhD thesis examiner of Woei Chet Lim (University of Waterloo), 2004.
- PhD thesis examiner of Yanjing He (Dalhousie university, Halifax), 2006.
- Aims Essay examiner of Mohamed Elshzli Sirelakhtim (African Institute of Mathematical Sciences), 2006.

Membership of National and International Bodies

- Co-Director of the Astrophysics, Cosmology and Gravity Centre, University of Cape Town.
- Council Member of the *South African Relativity Society*.
- Member of the *South African National Committee for the IAU*.
- Member of the *South African Institute of Physics*.
- Research Associate of the *National Institute for Theoretical Physics*.
- President of the *South African Gravity Society - 2014*.
- Member of the international committee of the *Dark Side of The Universe*.

Recent contributions to strategic proposals

- Pre-proposal to the Moore Foundation submitted with Professor Renee Kraan-Korteweg and Professor Mike Inggs for the establishment of a "Centre of Astrophysics at the University of Cape Town (2005).
- Contributor to the proposal fro the establishment of an Institute of Astronomy at the SAAO (Whitelock et. al) which was submitted to the Department of Science and Technology (South Africa, 2005).
- Contributor to the Astrophysics Frontier Programme document, submitted to the Department of Science and Technology (South Africa, 2005).
- Co-Leader with Professor Renee Kraan-Korteweg in successful application for Extragalactic Astronomy and Cosmology to be made an NRF Niche area (July 2006).

Contributions to the enhancement of science

- **National Astrophysics and Space Science Programme**

  Over the past eleven years I have been at the forefront of a significant new initiative to develop research capacity in Astrophysics and related fields. In 2002 I coordinated a successful bid to host the National Astrophysics and Space Science programme at the University of Cape Town (UCT) and from January 2003 until July 2013, served as the programme director. Capacity building in the sciences is of critical importance, not only to ensure that the users of national facilities such as the South African Large Telescope (SALT), and the future Square Kilometre Array do not have to be imported from the north, but also to provide graduates with the broad science skills demanded by the growing South African economy. The NASSP programme addresses directly a number of national strategic drivers, most particularly those associated with raising the research and postgraduate profile of South African institutions, and transformation in the physical sciences. Since its launch in February 2003, NASSP has graduated a total of 156 Honours students (note to non-South African reviewers: Honours corresponds to 1st year graduate studies) and by the end of 2012 it had graduated 98 Masters students. 82 percent of the graduated MSc embarked on local and international PhD programmes, with 30 PhD students have already graduated and a further 52 are at various stages of their research programmes. This represents a considerable growth in the number of research students active in Astrophysics and related areas in South Africa. Furthermore many of these students are black South Africans and students from the rest of Africa, making the NASSP a significant contributor to the transformation of the Space Sciences in South Africa and else where on the continent. For details see http://www.star.ac.za.

- **UCT Cosmology**

  Over the past decade the UCT cosmology group has become one of the leading research groups of its kind in the Southern Hemisphere, attracting considerable international recognition under the leadership of Professor George Ellis. Over the past ten years I have played a major role in the leadership of the cosmology research group and since the retirement of George Ellis in 2004. During this time the group has grown from three to eight permanent academic staff and by the end of 2013 the number of postdoc researchers in the group will have grown from 2 to more than 10. Student numbers are also on the rise. Very strong links have also developed with the department of astronomy and the South African Astronomical Observatory, leading to the formation of a University Accredited Research Centre - The Astrophysics, Cosmology and Gravity Research Centre (ACGC) in 2009, with a membership now of more than 80 researchers. In addition the number number of international collaborations have grown, many of them as a result of bilateral agreements signed with with other countries (these include Sweden, Italy, France, Switzerland, Poland, the UK, Germany, Egypt and Japan).

The long term vision of the group is to continue to boost the NASSP, develop further our strong ties with both the South African Physics and Astronomy communities and to make a major contribution to the national R&D programme, this providing UCT with clear leadership in what will become a crucial part of the future of fundamental science in South Africa.

- **Joint PhD Programme with M. Marklund**

  In 2000 Mattias Marklund spent eight months at the University of Cape Town, supported by the Royal Swedish Academy of Sciences. During his stay, a project was initiated with myself and Gert Brodin (Department of Plasma Physics, Umea University, Umea, Sweden), to investigate the non-linear interaction between gravitational and electromagnetic fields with applications to relativistic astrophysics and cosmology. This project was funded through a research grant under the South African-Swedish partnership programme and has been extremely successful with a significant number of high impact publications together with the development of a joint PhD programme between the Department of Electromagnetics, Chalmers University and the University of Cape Town. The first PhD student (Gerold Betschart) was recruited at the end of 2001 and spent 2003 at Chalmers hosted by Mattias Marklund. He returned to UCT at the beginning of 2004 and graduated in December 2005.

Source	Project	Duration	Amount
NRF	Relativistic Plasma Physics (GUN 2048578)	2001-2003	R 176,000
NRF	Relativistic Plasma Physics (GUN 2048578)	2001-2003	R 100,000
NRF	Alternate Theories of Gravitation and Cosmology (GUN 2068885)	2005-2007	R 288,000
NRF	Imprints of second order dynamics during inflation (GUN 2072650)	2006-2006	R 20,000
URC	Cosmology and Gravitation	2004-2006	R 80,000
Ford	NASSP (Patricia Whitelock et al)	2003-2004	R 1,400,000
UCT (Strategic)	NASSP	2003	R 440,000
Mellon	NASSP	2005-2006	R 1,800,000
NRF	NASSP (GUN 2053469)	2006-2010	R 822,000
NRF	Relativistic astrophysics and cosmology (FA2005022300001)	2006-2010	R 927,000
NRF	Generalised theories of Gravitation (FA2005021500014)	2006-2010	R 408,000
NRF	Generalized Theories of Gravitation (GUN 2068885)	2006-2007	R 250,000
Ford	NASSP	2006-2008	R 1,400,000
DST	NASSP	2006	R 2,000,000
DST	NASSP	2009-2011	R 17,567,825
NFR	Multi-wavelength astronomy	2007	R 445,000K
NRF	Spain	2009-2010	R 75,000
NRF	KISC	2008-2010	R 443,000
NFR	Sweden	2008-2010	R 408,000
SAAO	Publication award	2009	R 75,000
NRF	Incentive Grant	2010-2017	R 560,000
NRF	Competitive Grant for Rated Researchers	2010-2012	R 620,000
DST	NASSP	2012	R 5,780,000
DST	NASSP	2013	R 4,225,676
NRF	Egypt	2013-2014	R 300,000
NRF	Multi-wavelength astronomy	2014	R 435,000
NRF	Competitive Grant for Rated Researchers	2014-2016	R 650,000
First Rand Grant	For Human Capacity Development	2018-2021	R1,200,000
Total			R 42,895,501

Major grants and awards

Above is a table of grants obtained from the National Research Foundation (NRF) for my research programme and the National Astrophysics and Space Science Programme (NASSP).

Please refer to my Webpage for more details, detailed publication list and citations.