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# Classical and Quantum Gravity

Adam Day
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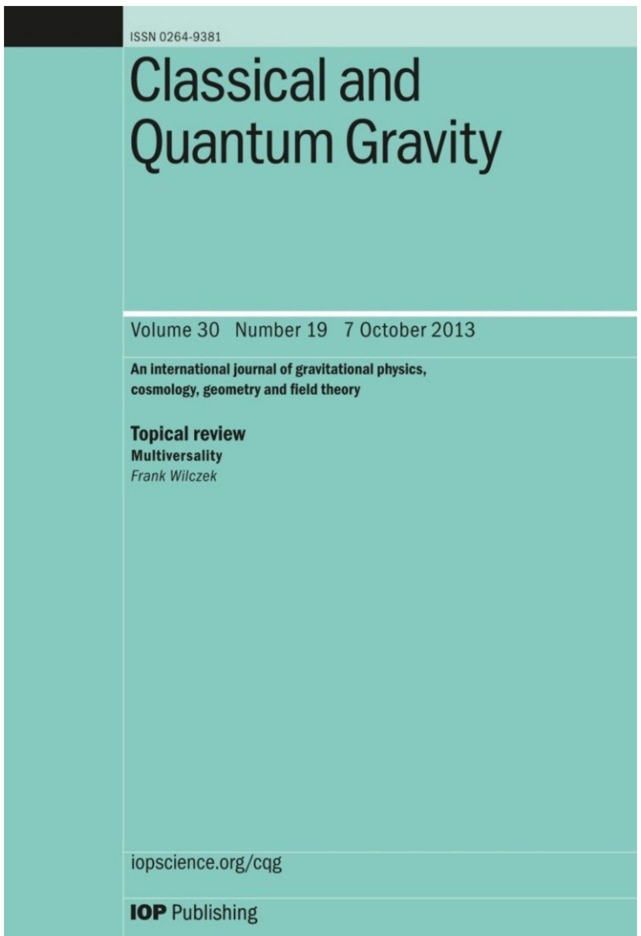
# Introduction



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# Introduction

# Introduction

## Introduction

- About CQG
- The life cycle of a CQG paper
- Open access and CQG

# About CQG

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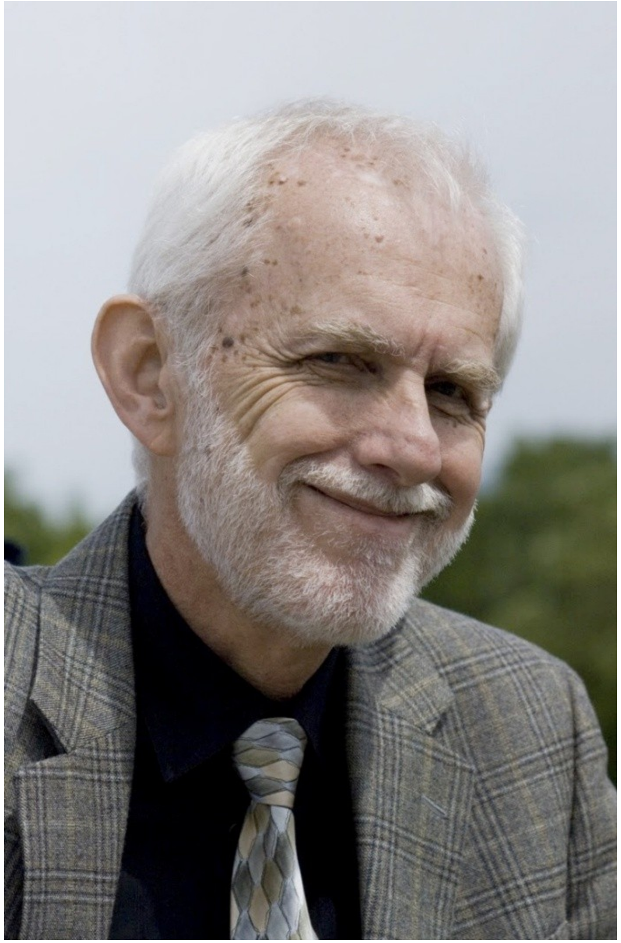
# About CQG



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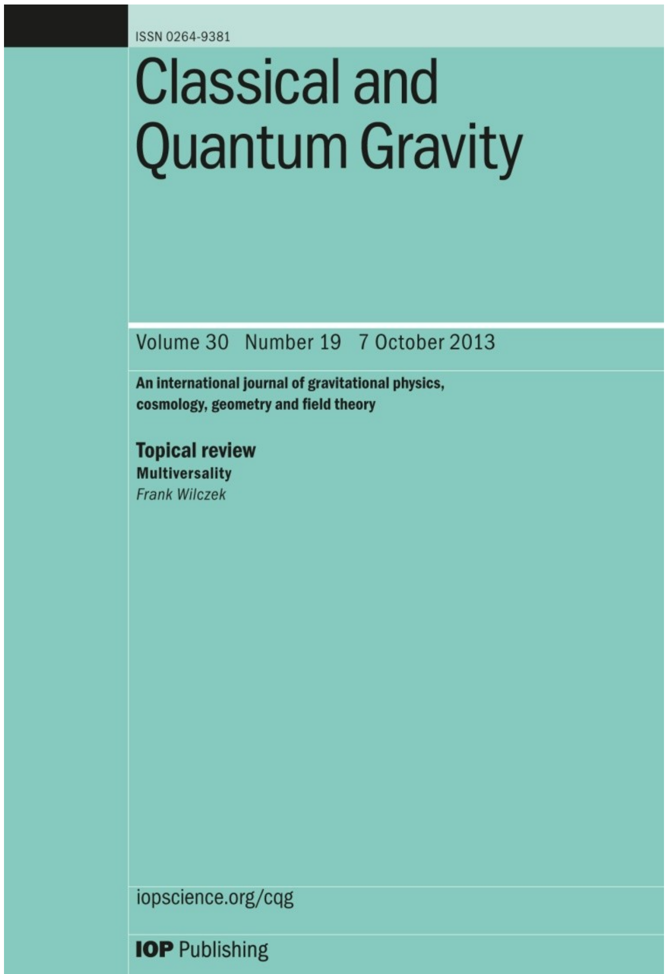
# About CQG




What is CQG known for?

- Peer review
- Promotional work
- High quality output

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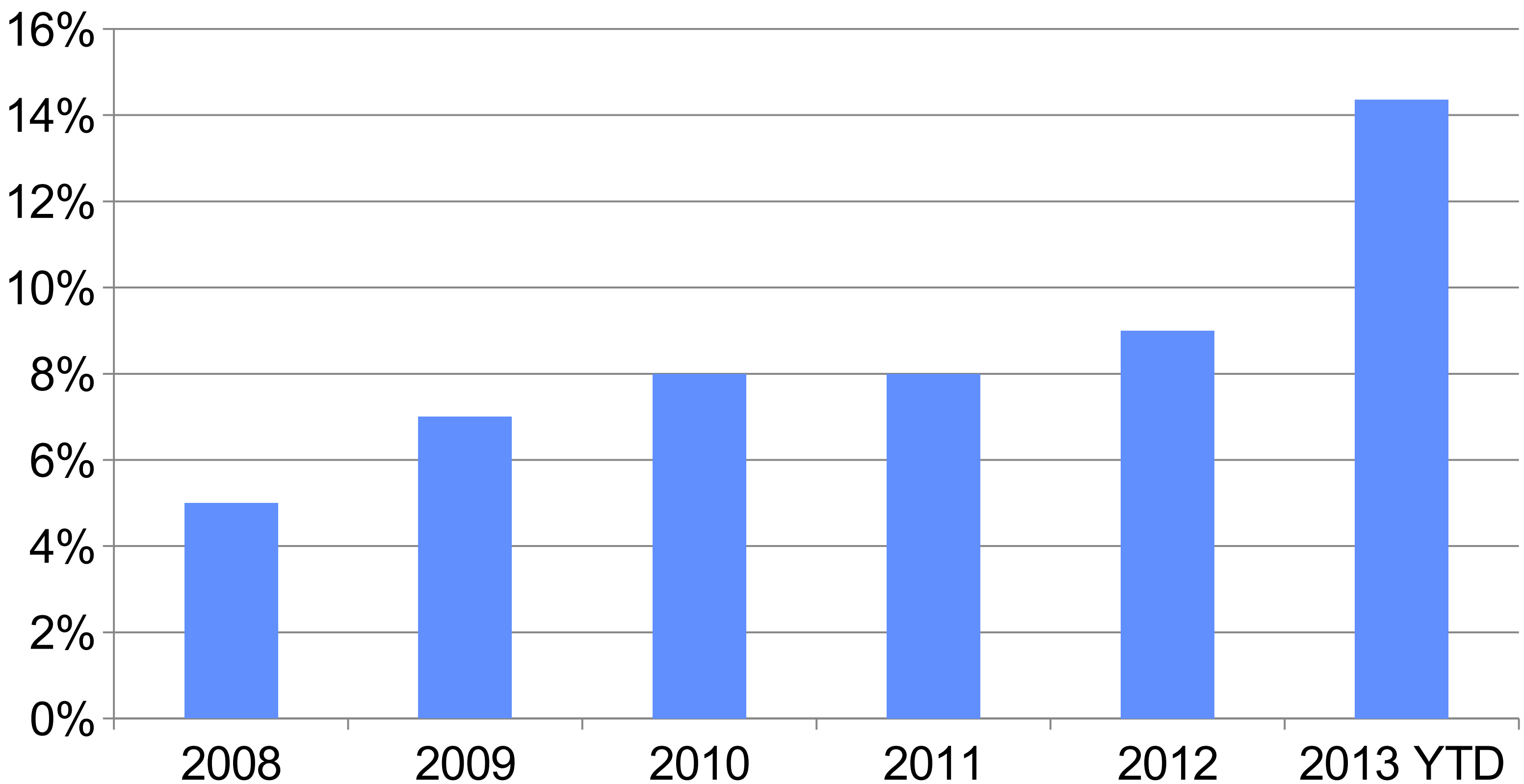
# High quality rated content in CQG



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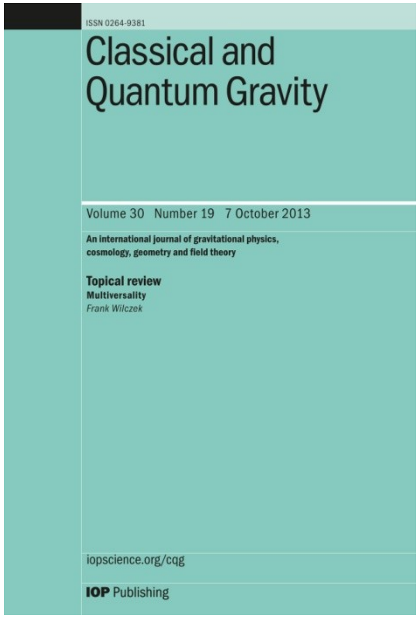


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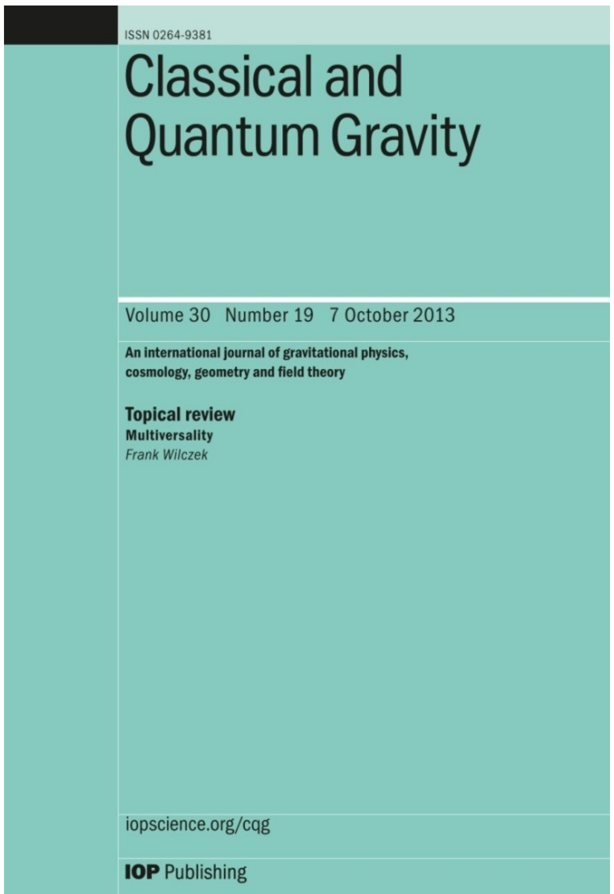
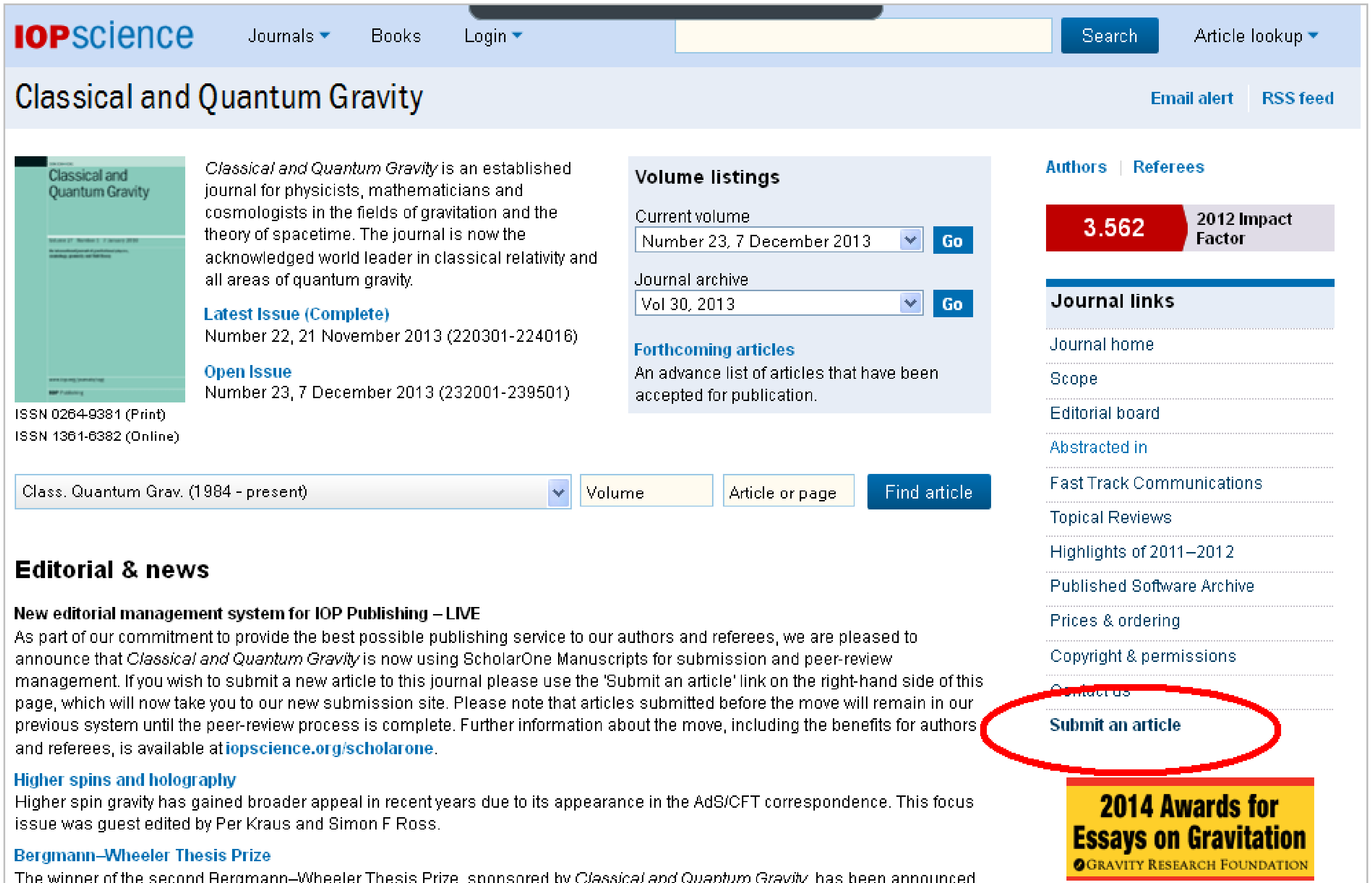



What do I want?

- Peer review
- Promotional work
- High quality output

# Lifecycle of a CQG paper

# Peer review



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## Classical and Quantum Gravity

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*Classical and Quantum Gravity* is an established journal for physicists, mathematicians and cosmologists in the fields of gravitation and the theory of spacetime. The journal is now the acknowledged world leader in classical relativity and all areas of quantum gravity.

**Latest Issue (Complete)**
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**Open Issue**
Number 23, 7 December 2013 (232001-239501)

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### Editorial & news

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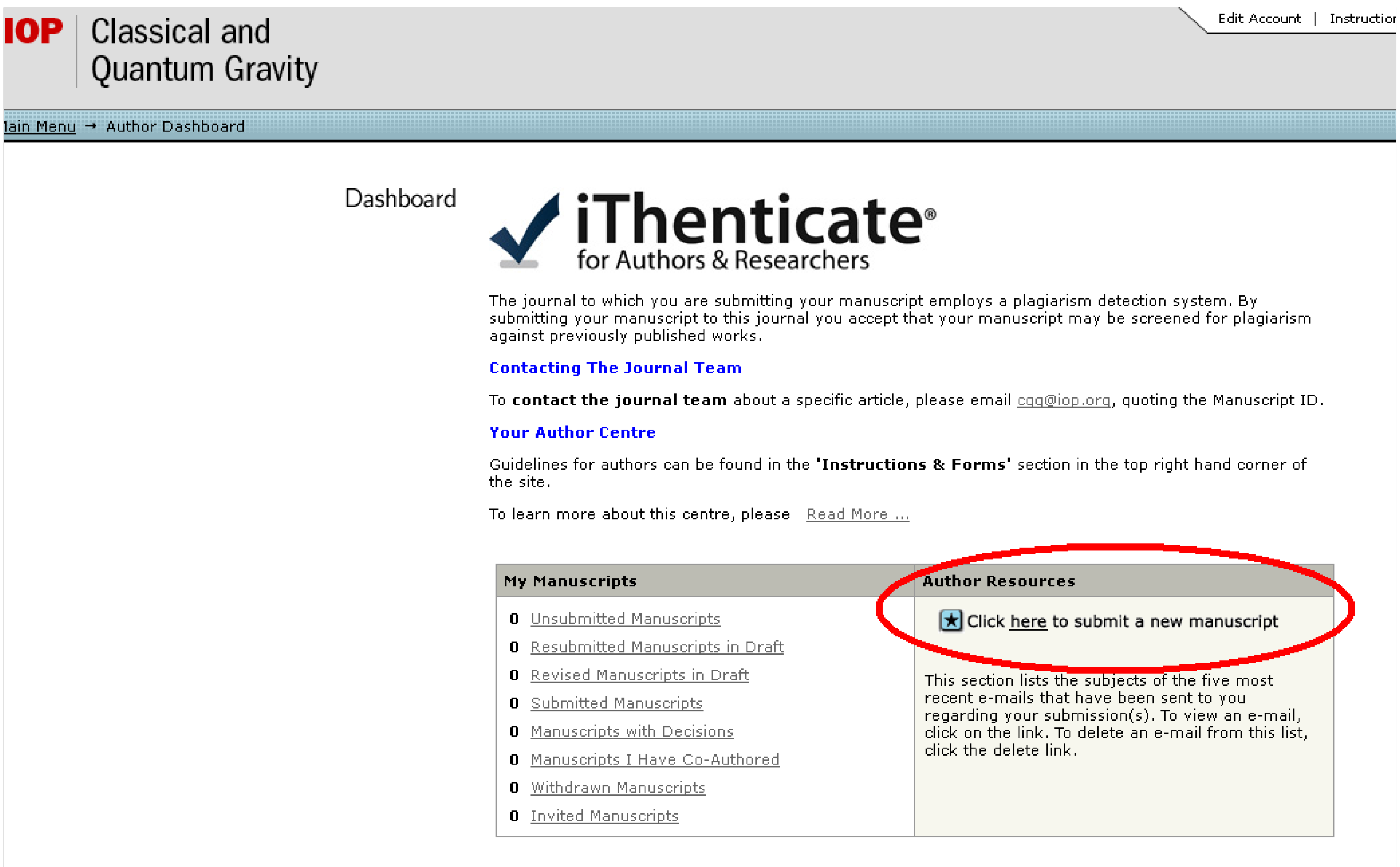
As part of our commitment to provide the best possible publishing service to our authors and referees, we are pleased to announce that *Classical and Quantum Gravity* is now using ScholarOne Manuscripts for submission and peer-review management. If you wish to submit a new article to this journal please use the 'Submit an article' link on the right-hand side of this page, which will now take you to our new submission site. Please note that articles submitted before the move will remain in our previous system until the peer-review process is complete. Further information about the move, including the benefits for authors and referees, is available at iopscience.org/scholarone.

**Higher spins and holography**
Higher spin gravity has gained broader appeal in recent years due to its appearance in the AdS/CFT correspondence. This focus issue was guest edited by Per Kraus and Simon F Ross.

**Bergmann–Wheeler Thesis Prize**
The winner of the second Bergmann–Wheeler Thesis Prize, sponsored by *Classical and Quantum Gravity*, has been announced.

# Peer review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# Peer review

Options include:

- Recommend referees
- Recommend referees to avoid

## Peer review

How are referees selected?

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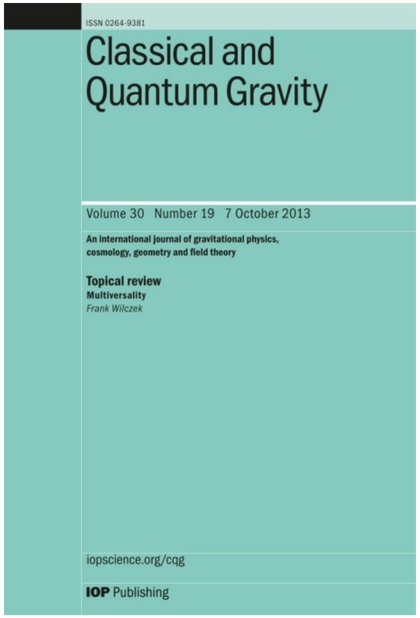
- History of refereeing and publication
- Geography
- Politics

# Peer review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Volume 30 Number 19 7 October 2013
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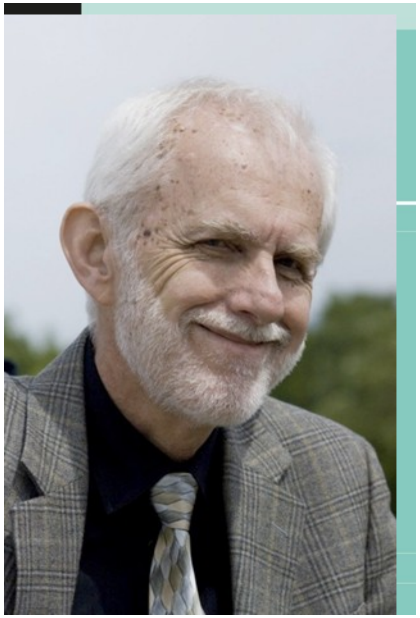

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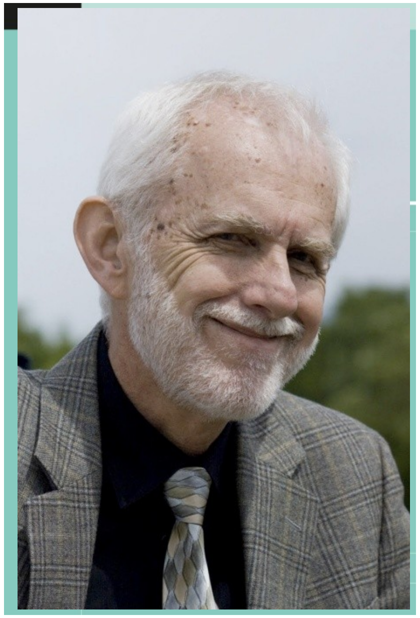

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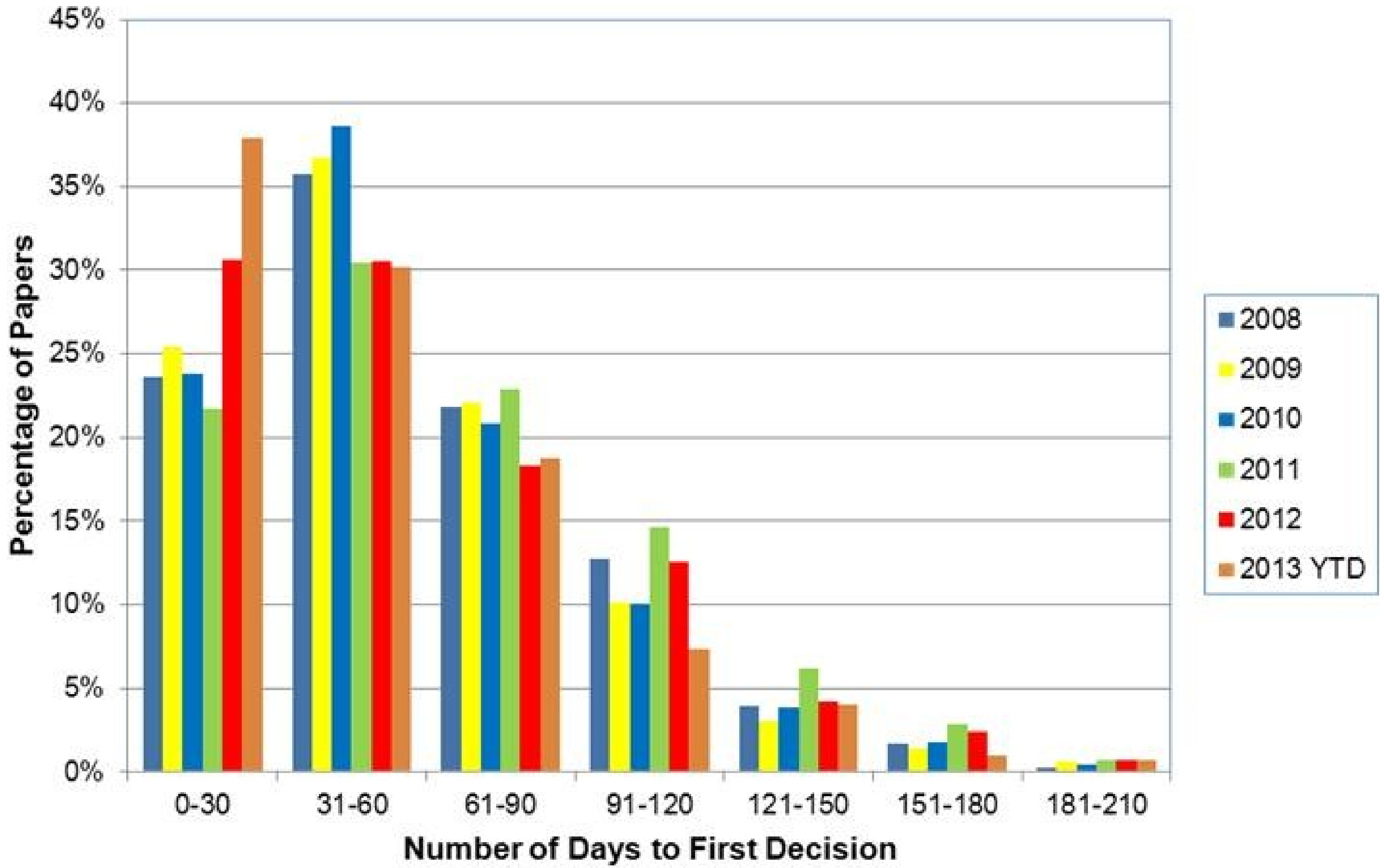

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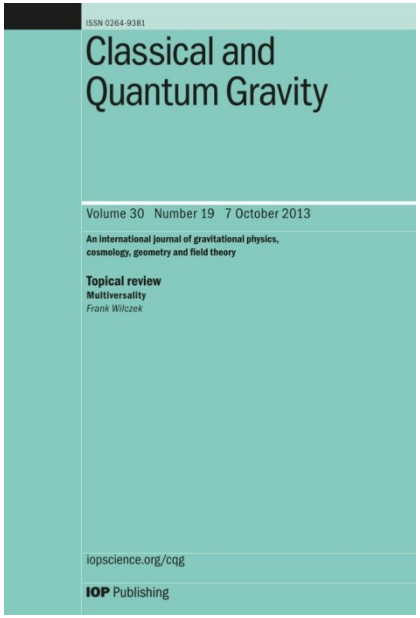


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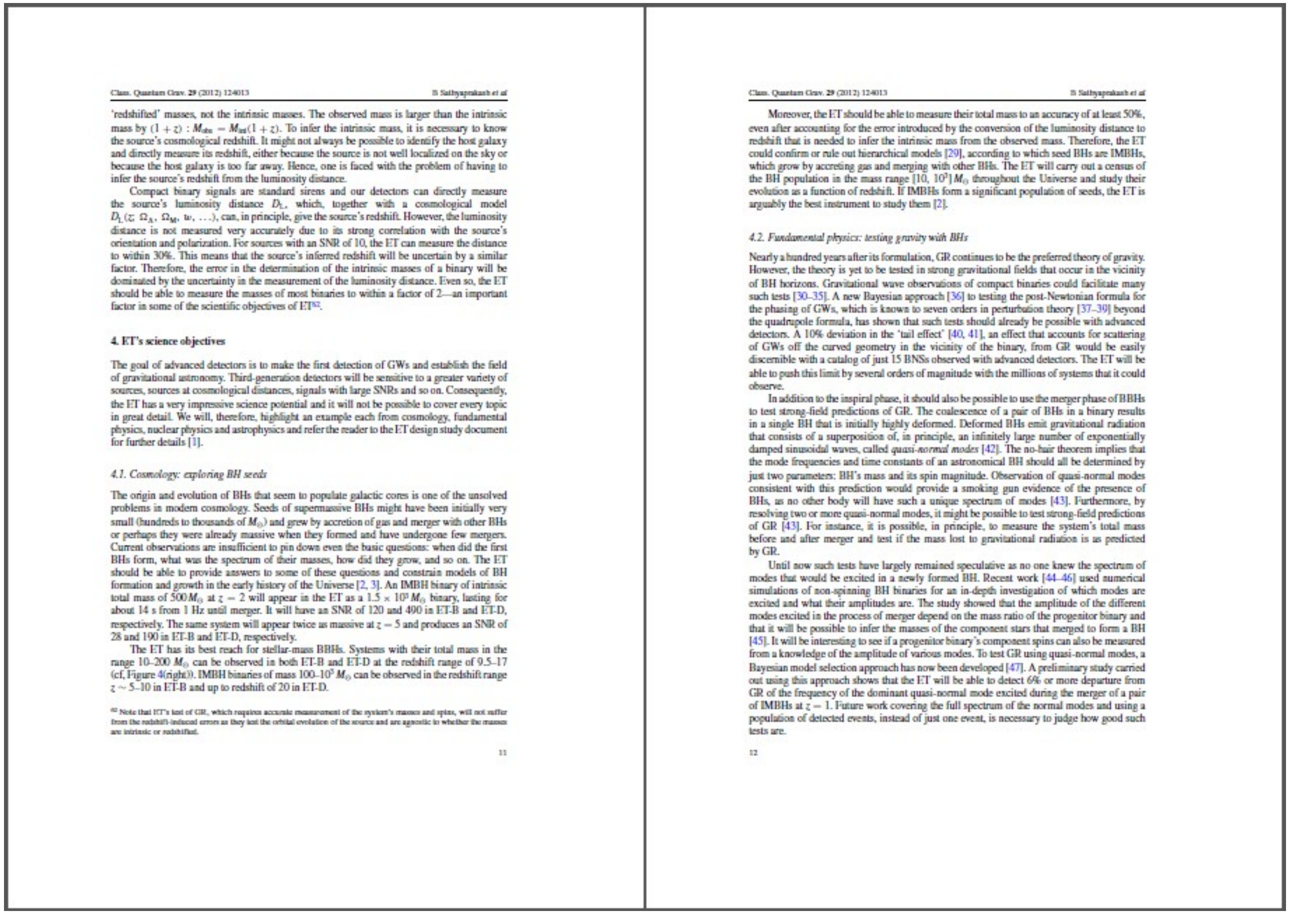

Class. Quantum Grav. **29** (2012) 124013 B Sathyaprakash *et al*

'redshifted' masses, not the intrinsic masses. The observed mass is larger than the intrinsic mass by $(1 + z) : M_{obs} = M_{int}(1 + z)$. To infer the intrinsic mass, it is necessary to know the source's cosmological redshift. It might not always be possible to identify the host galaxy and directly measure its redshift, either because the source is not well localized on the sky or because the host galaxy is too far away. Hence, one is faced with the problem of having to infer the source's redshift from the luminosity distance.

Compact binary signals are standard sirens and our detectors can directly measure the source's luminosity distance $D_L$, which, together with a cosmological model $D_L(z; \Omega_\Lambda, \Omega_M, w, \ldots)$, can, in principle, give the source's redshift. However, the luminosity distance is not measured very accurately due to its strong correlation with the source's orientation and polarization. For sources with an SNR of 10, the ET can measure the distance to within 30%. This means that the source's inferred redshift will be uncertain by a similar factor. Therefore, the error in the determination of the intrinsic masses of a binary will be dominated by the uncertainty in the measurement of the luminosity distance. Even so, the ET should be able to measure the masses of most binaries to within a factor of 2—an important factor in some of the scientific objectives of ET[62].

**4. ET's science objectives**

The goal of advanced detectors is to make the first detection of GWs and establish the field of gravitational astronomy. Third-generation detectors will be sensitive to a greater variety of sources, sources at cosmological distances, signals with large SNRs and so on. Consequently, the ET has a very impressive science potential and it will not be possible to cover every topic in great detail. We will, therefore, highlight an example each from cosmology, fundamental physics, nuclear physics and astrophysics and refer the reader to the ET design study document for further details [1].

*4.1. Cosmology: exploring BH seeds*

The origin and evolution of BHs that seem to populate galactic cores is one of the unsolved problems in modern cosmology. Seeds of supermassive BHs might have been initially very small (hundreds to thousands of $M_\odot$) and grew by accretion of gas and merger with other BHs or perhaps they were already massive when they formed and have undergone few mergers. Current observations are insufficient to pin down even the basic questions: when did the first BHs form, what was the spectrum of their masses, how did they grow, and so on. The ET should be able to provide answers to some of these questions and constrain models of BH formation and growth in the early history of the Universe [2, 3]. An IMBH binary of intrinsic total mass of $500 M_\odot$ at $z = 2$ will appear in the ET as a $1.5 \times 10^3 M_\odot$ binary, lasting for about 14 s from 1 Hz until merger. It will have an SNR of 120 and 490 in ET-B and ET-D, respectively. The same system will appear twice as massive at $z = 5$ and produces an SNR of 28 and 190 in ET-B and ET-D, respectively.

The ET has its best reach for stellar-mass BBHs. Systems with their total mass in the range 10–200 $M_\odot$ can be observed in both ET-B and ET-D at the redshift range of 9.5–17 (cf, Figure 4(right)). IMBH binaries of mass 100–$10^3 M_\odot$ can be observed in the redshift range $z \sim 5$–10 in ET-B and up to redshift of 20 in ET-D.

[62] Note that ET's test of GR, which requires accurate measurement of the system's masses and spins, will not suffer from the redshift-induced errors as they test the orbital evolution of the source and are agnostic to whether the masses are intrinsic or redshifted.

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Class. Quantum Grav. **29** (2012) 124013 B Sathyaprakash *et al*

Moreover, the ET should be able to measure their total mass to an accuracy of at least 50%, even after accounting for the error introduced by the conversion of the luminosity distance to redshift that is needed to infer the intrinsic mass from the observed mass. Therefore, the ET could confirm or rule out hierarchical models [29], according to which seed BHs are IMBHs, which grow by accreting gas and merging with other BHs. The ET will carry out a census of the BH population in the mass range $[10, 10^3] M_\odot$ throughout the Universe and study their evolution as a function of redshift. If IMBHs form a significant population of seeds, the ET is arguably the best instrument to study them [2].

*4.2. Fundamental physics: testing gravity with BHs*

Nearly a hundred years after its formulation, GR continues to be the preferred theory of gravity. However, the theory is yet to be tested in strong gravitational fields that occur in the vicinity of BH horizons. Gravitational wave observations of compact binaries could facilitate many such tests [30–35]. A new Bayesian approach [36] to testing the post-Newtonian formula for the phasing of GWs, which is known to seven orders in perturbation theory [37–39] beyond the quadrupole formula, has shown that such tests should already be possible with advanced detectors. A 10% deviation in the 'tail effect' [40, 41], an effect that accounts for scattering of GWs off the curved geometry in the vicinity of the binary, from GR would be easily discernible with a catalog of just 15 BNSs observed with advanced detectors. The ET will be able to push this limit by several orders of magnitude with the millions of systems that it could observe.

In addition to the inspiral phase, it should also be possible to use the merger phase of BBHs to test strong-field predictions of GR. The coalescence of a pair of BHs in a binary results in a single BH that is initially highly deformed. Deformed BHs emit gravitational radiation that consists of a superposition of, in principle, an infinitely large number of exponentially damped sinusoidal waves, called *quasi-normal modes* [42]. The no-hair theorem implies that the mode frequencies and time constants of an astronomical BH should all be determined by just two parameters: BH's mass and its spin magnitude. Observation of quasi-normal modes consistent with this prediction would provide a smoking gun evidence of the presence of BHs, as no other body will have such a unique spectrum of modes [43]. Furthermore, by resolving two or more quasi-normal modes, it might be possible to test strong-field predictions of GR [43]. For instance, it is possible, in principle, to measure the system's total mass before and after merger and test if the mass lost to gravitational radiation is as predicted by GR.

Until now such tests have largely remained speculative as no one knew the spectrum of modes that would be excited in a newly formed BH. Recent work [44–46] used numerical simulations of non-spinning BH binaries for an in-depth investigation of which modes are excited and what their amplitudes are. The study showed that the amplitude of the different modes excited in the process of merger depend on the mass ratio of the progenitor binary and that it will be possible to infer the masses of the component stars that merged to form a BH [45]. It will be interesting to see if a progenitor binary's component spins can also be measured from a knowledge of the amplitude of various modes. To test GR using quasi-normal modes, a Bayesian model selection approach has now been developed [47]. A preliminary study carried out using this approach shows that the ET will be able to detect 6% or more departure from GR of the frequency of the dominant quasi-normal mode excited during the merger of a pair of IMBHs at $z = 1$. Future work covering the full spectrum of the normal modes and using a population of detected events, instead of just one event, is necessary to judge how good such tests are.

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Class. Quantum Grav. **29** (2012) 124013 (16pp) doi:10.1088/0264-9381/29/12/124013

## Scientific objectives of Einstein Telescope

**B Sathyaprakash[1], M Abernathy[2], F Acernese[3,4], P Ajith[5], B Allen[6], P Amaro-Seoane[7,8], N Andersson[9], S Aoudia[7], K Arun[10], P Astone[11,12], B Krishnan[6], L Barack[9], F Barone[3,4], B Barr[2], M Barsuglia[13], M Bassan[14,15], R Bassiri[2], M Beker[16], N Beveridge[2], M Bizouard[17], C Bond[18], S Bose[19], L Bosi[20], S Braccini[21], C Bradaschia[21,22], M Britzger[6], F Brueckner[23], T Bulik[24], H J Bulten[25], O Burmeister[6], E Calloni[3,26], P Campsie[2], L Carbone[18], G Cella[21], E Chalkley[18], E Chassande-Mottin[13], S Chelkowski[18], A Chincarini[27], A Di Cintio[11], J Clark[1], E Coccia[14,15], C N Colacino[21], J Colas[22], A Colla[11,12], A Corsi[5], A Cumming[2], L Cunningham[2], E Cuoco[22], S Danilishin[28], K Danzmann[6], E Daw[29], R De Salvo[30], W Del Pozzo[16], T Dent[1], R De Rosa[3,26], L Di Fiore[3], M Di Paolo Emilio[14], A Di Virgilio[21], A Dietz[31], M Doets[16], J Dueck[6], M Edwards[1], V Fafone[14,15],**

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Classical and Quantum Gravity > Volume 29 > Number 12

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## Scientific objectives of Einstein Telescope

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### Abstract

The advanced interferometer network will herald a new era in observational astronomy. There is a very strong science case to go beyond the advanced detector network and build detectors that operate in a frequency range from 1 Hz to 10 kHz, with sensitivity a factor 10 better in amplitude. Such detectors will be able to probe a range of topics in nuclear physics, astronomy, cosmology and fundamental physics, providing insights into many unsolved problems in these areas.

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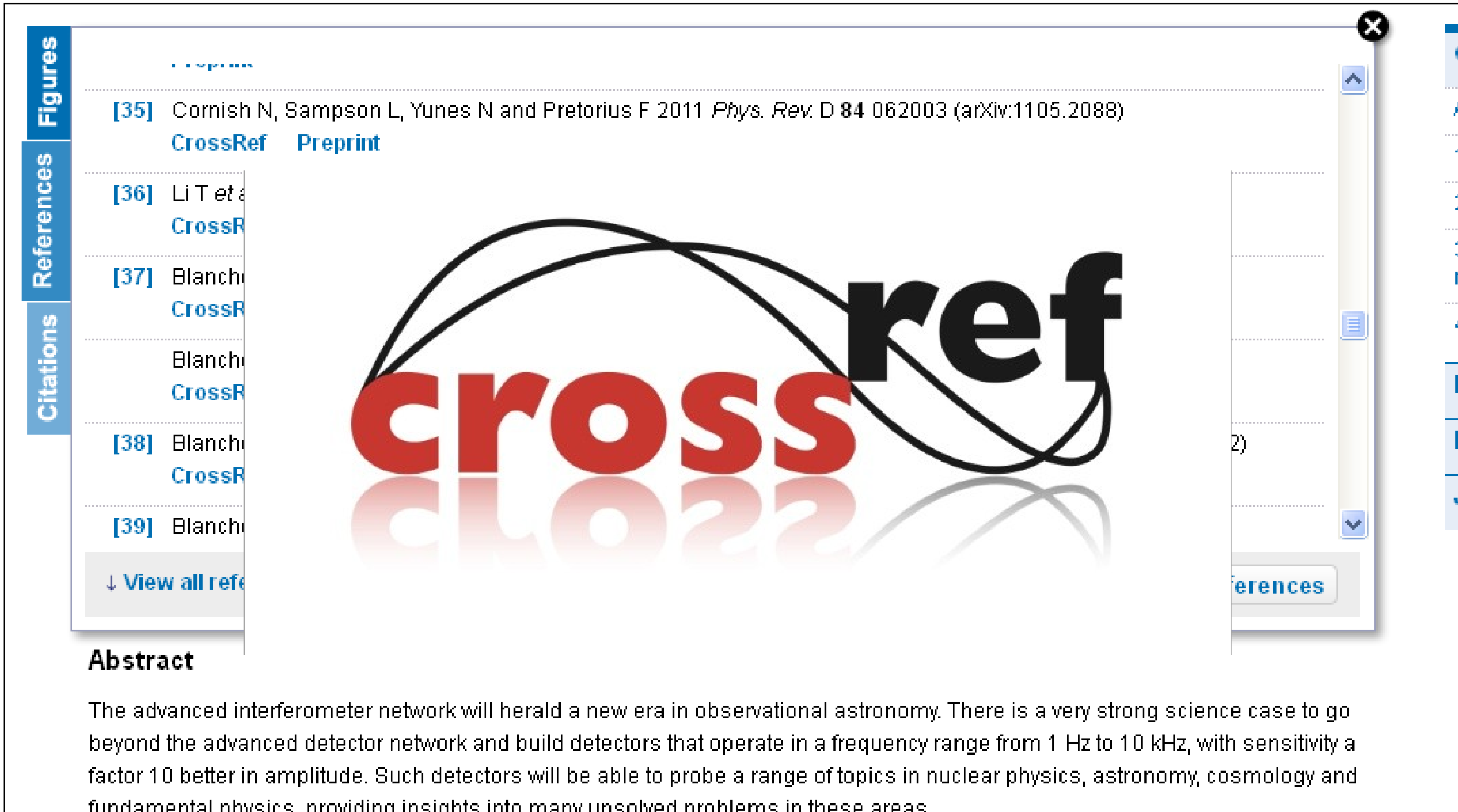

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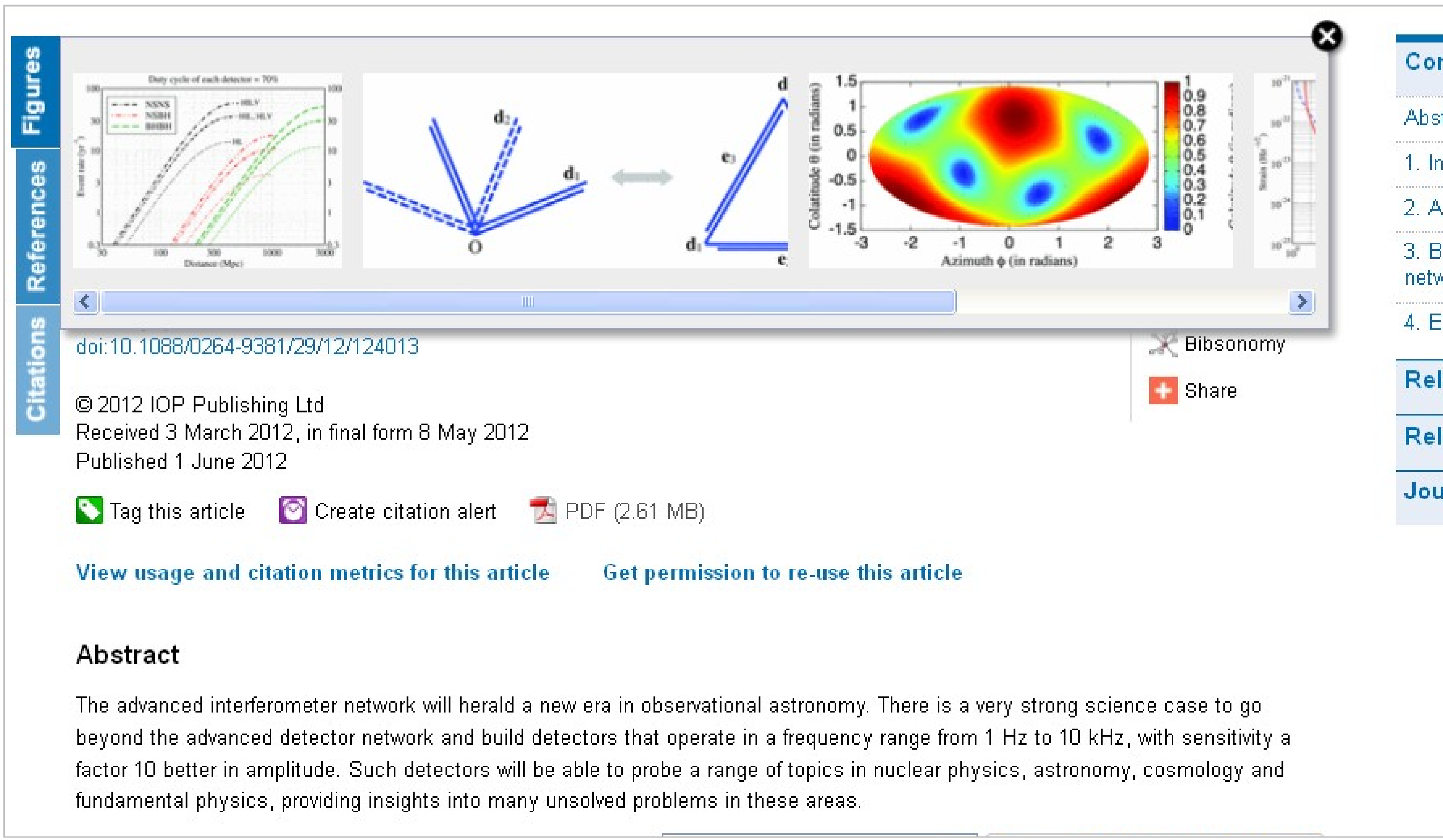

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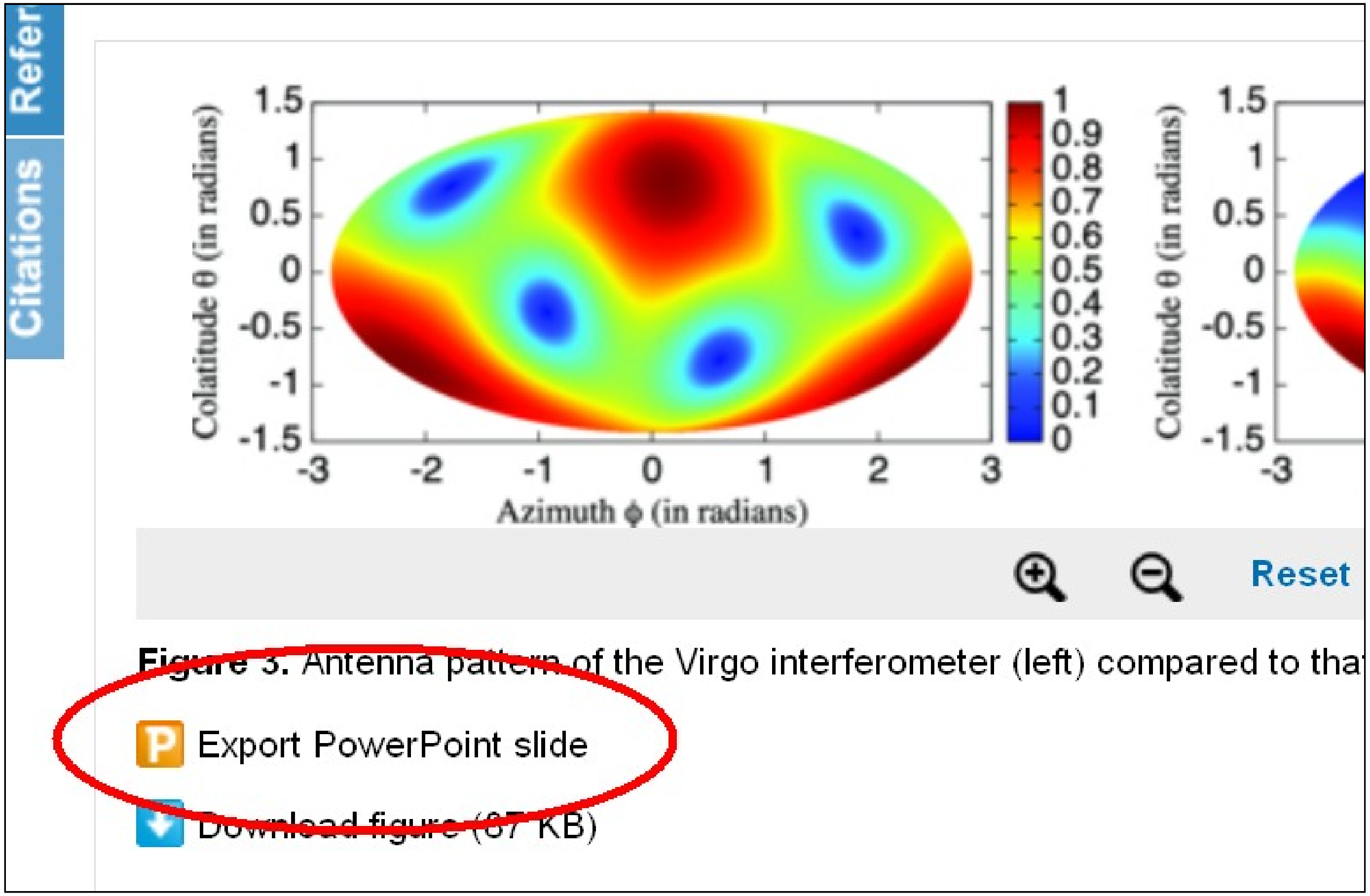

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*B Sathyaprakash et al*
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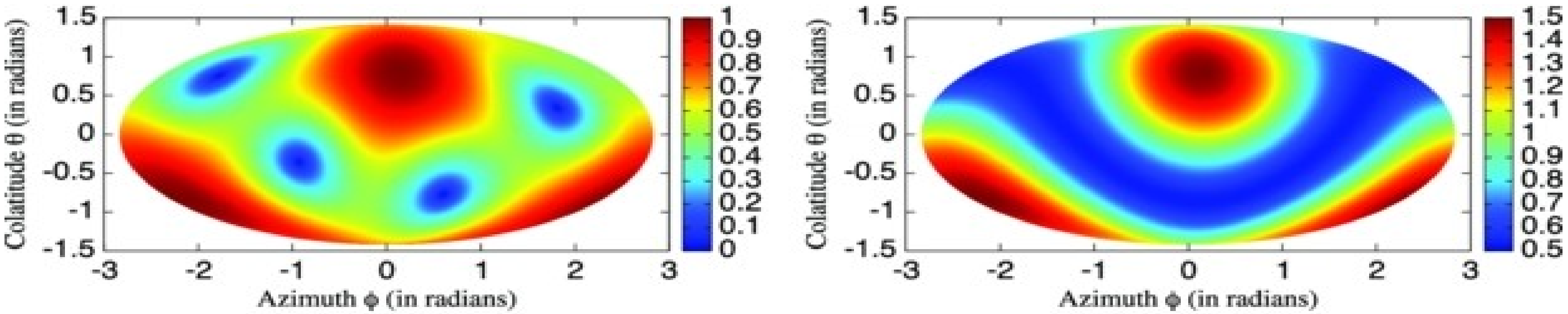

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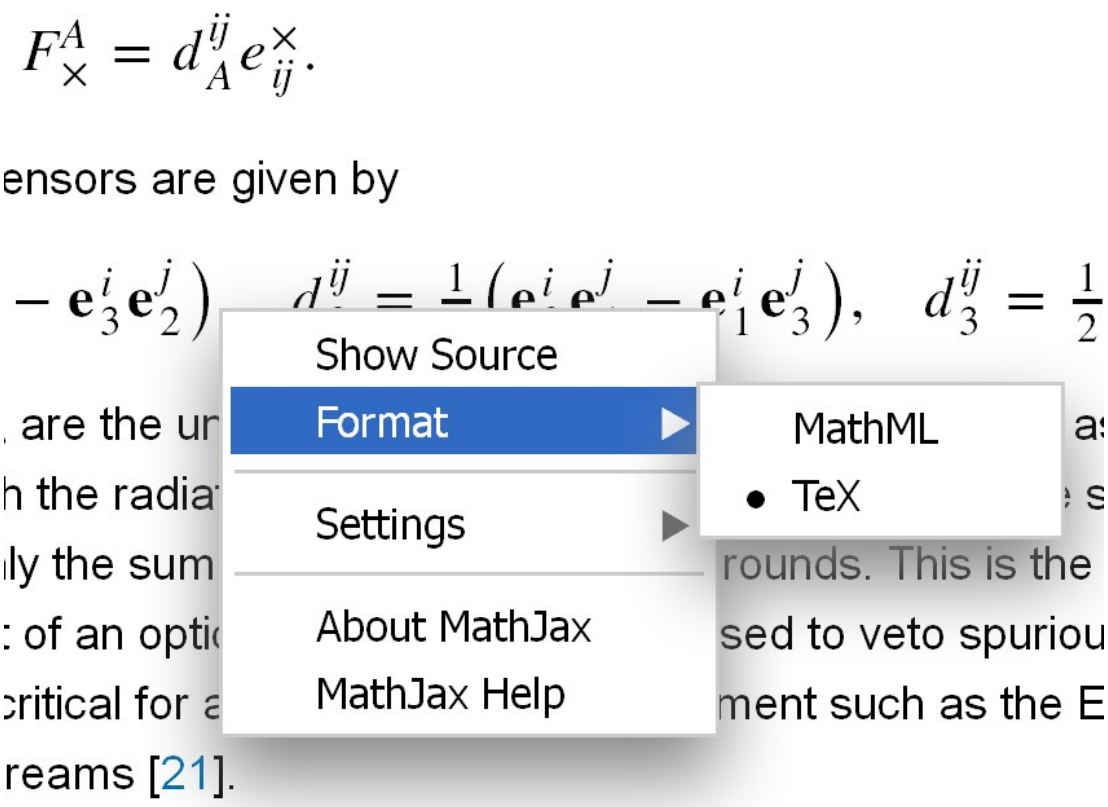

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**Journal links**

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**Contents** [+]

**Related Content** [−]

**Journal articles**

1. The Einstein Telescope: a third-generation gravitational wave observatory
2. The transient gravitational-wave sky
3. Astronomy and astrophysics with gravitational waves in the advanced detector era
4. Generic bounds on dipolar gravitational radiation from inspiralling compact binaries

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Various metrics also show:

- Citations
- Downloads
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inSPIRE HEP

ISI Web of KNOWLEDGE
Transforming Research

Scopus

IET The Institution of Engineering and Technology

# Post production

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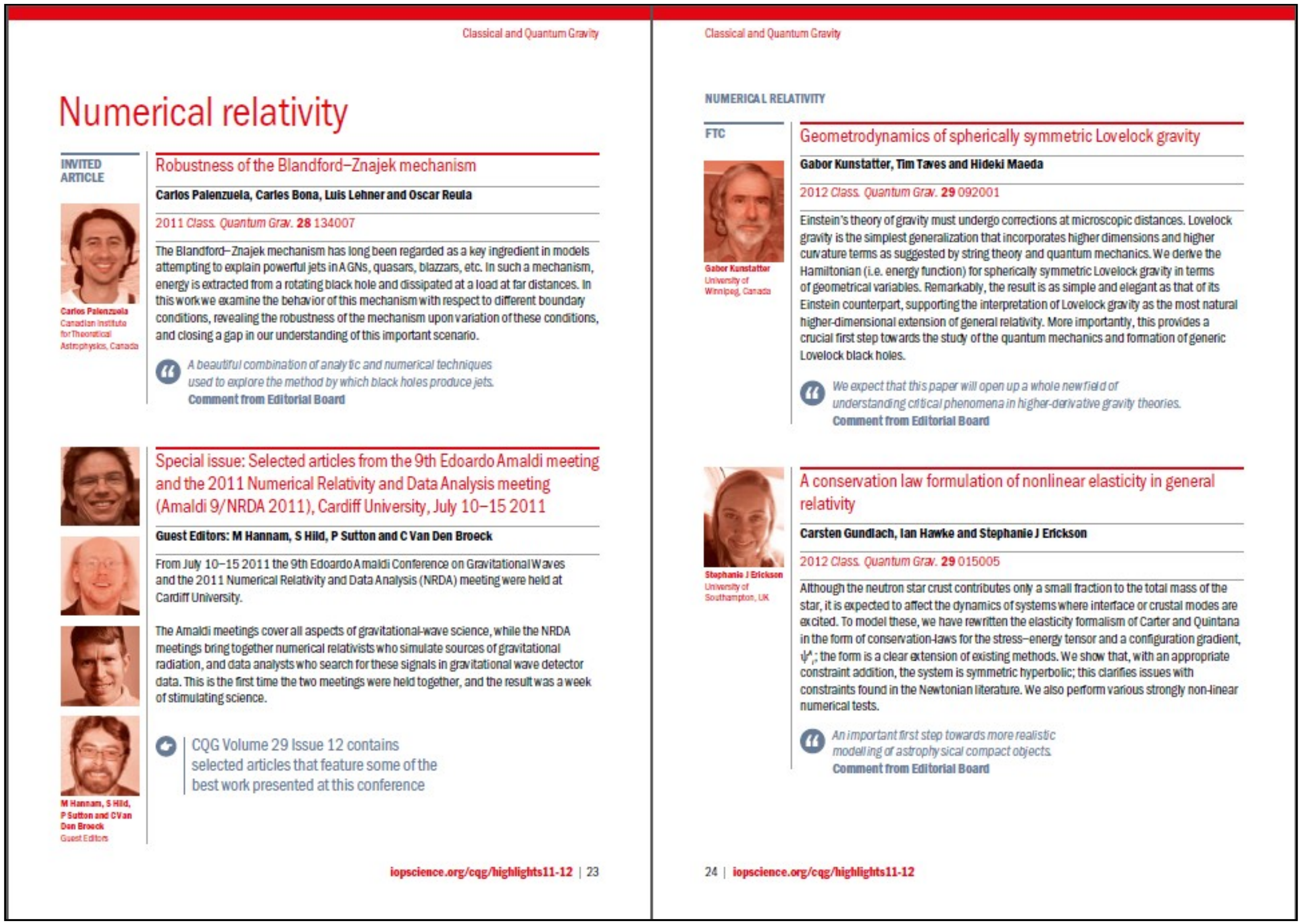
- Highly interesting articles are selected by the board at the annual board meeting.
- These articles are promoted in a number of ways

# Promotion





# Numerical relativity

INVITED ARTICLE

## Robustness of the Blandford–Znajek mechanism

**Carlos Palenzuela, Carles Bona, Luis Lehner and Oscar Reula**

2011 *Class. Quantum Grav.* **28** 134007

The Blandford–Znajek mechanism has long been regarded as a key ingredient in models attempting to explain powerful jets in AGNs, quasars, blazzars, etc. In such a mechanism, energy is extracted from a rotating black hole and dissipated at a load at far distances. In this work we examine the behavior of this mechanism with respect to different boundary conditions, revealing the robustness of the mechanism upon variation of these conditions, and closing a gap in our understanding of this important scenario.

Carlos Palenzuela
Canadian Institute for Theoretical Astrophysics, Canada

*A beautiful combination of analytic and numerical techniques used to explore the method by which black holes produce jets.*
**Comment from Editorial Board**

## Special issue: Selected articles from the 9th Edoardo Amaldi meeting and the 2011 Numerical Relativity and Data Analysis meeting (Amaldi 9/NRDA 2011), Cardiff University, July 10–15 2011

**Guest Editors: M Hannam, S Hild, P Sutton and C Van Den Broeck**

From July 10–15 2011 the 9th Edoardo Amaldi Conference on Gravitational Waves and the 2011 Numerical Relativity and Data Analysis (NRDA) meeting were held at Cardiff University.

The Amaldi meetings cover all aspects of gravitational-wave science, while the NRDA meetings bring together numerical relativists who simulate sources of gravitational radiation, and data analysts who search for these signals in gravitational wave detector data. This is the first time the two meetings were held together, and the result was a week of stimulating science.

CQG Volume 29 Issue 12 contains selected articles that feature some of the best work presented at this conference

M Hannam, S Hild, P Sutton and C Van Den Broeck
Guest Editors





NUMERICAL RELATIVITY

FTC

## Geometrodynamics of spherically symmetric Lovelock gravity

**Gabor Kunstatter, Tim Taves and Hideki Maeda**

2012 *Class. Quantum Grav.* **29** 092001

Einstein's theory of gravity must undergo corrections at microscopic distances. Lovelock gravity is the simplest generalization that incorporates higher dimensions and higher curvature terms as suggested by string theory and quantum mechanics. We derive the Hamiltonian (i.e. energy function) for spherically symmetric Lovelock gravity in terms of geometrical variables. Remarkably, the result is as simple and elegant as that of its Einstein counterpart, supporting the interpretation of Lovelock gravity as the most natural higher-dimensional extension of general relativity. More importantly, this provides a crucial first step towards the study of the quantum mechanics and formation of generic Lovelock black holes.

Gabor Kunstatter
University of Winnipeg, Canada

*We expect that this paper will open up a whole new field of understanding critical phenomena in higher-derivative gravity theories.*
**Comment from Editorial Board**

## A conservation law formulation of nonlinear elasticity in general relativity

**Carsten Gundlach, Ian Hawke and Stephanie J Erickson**

2012 *Class. Quantum Grav.* **29** 015005

Although the neutron star crust contributes only a small fraction to the total mass of the star, it is expected to affect the dynamics of systems where interface or crustal modes are excited. To model these, we have rewritten the elasticity formalism of Carter and Quintana in the form of conservation-laws for the stress–energy tensor and a configuration gradient, $\psi^A{}_i$; the form is a clear extension of existing methods. We show that, with an appropriate constraint addition, the system is symmetric hyperbolic; this clarifies issues with constraints found in the Newtonian literature. We also perform various strongly non-linear numerical tests.

Stephanie J Erickson
University of Southampton, UK

*An important first step towards more realistic modelling of astrophysical compact objects.*
**Comment from Editorial Board**

# Promotion: CQG+

CQG+

News and views brought to you by the journal *Classical and Quantum Gravity*

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## Promotion: Other

# CQG and Open Access

# What is Open Access?

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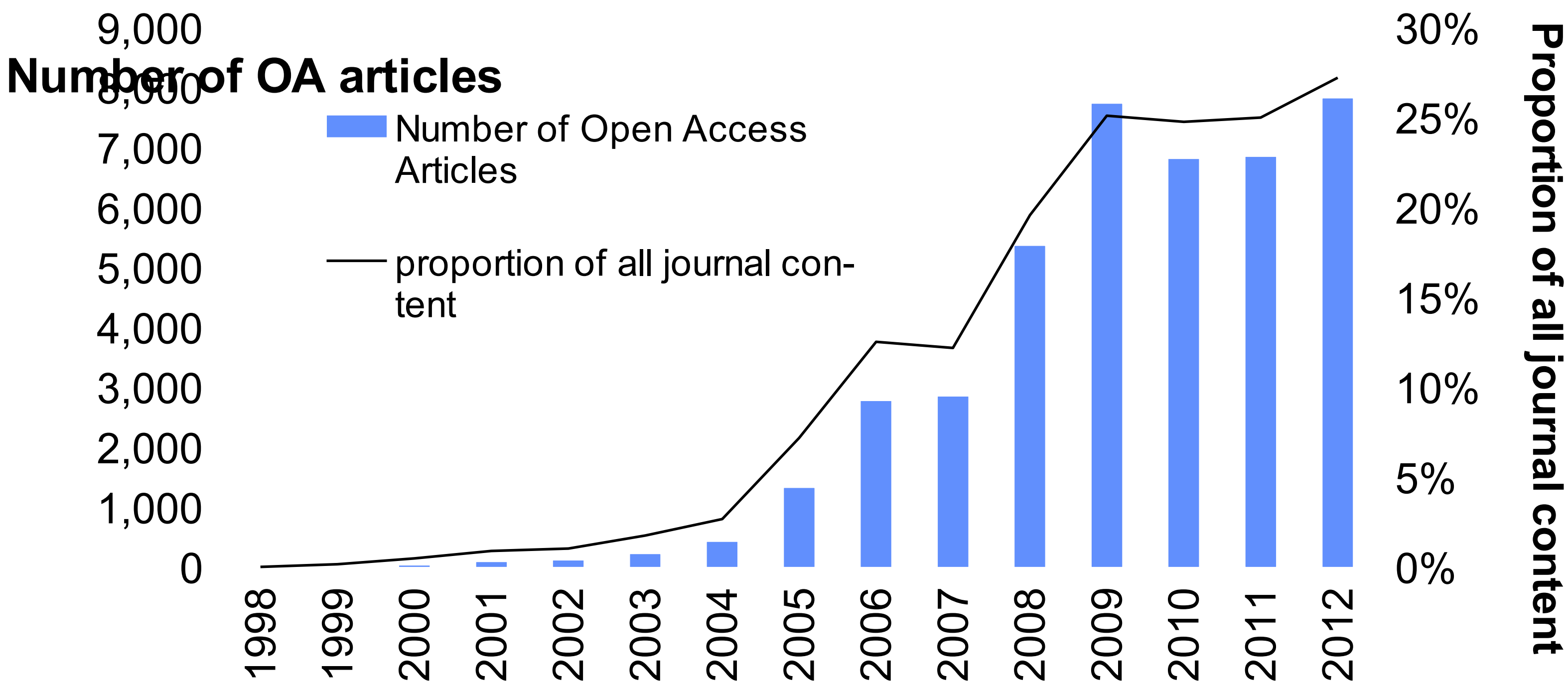
- any time

# Growth of OA content in IOP journals: 1998 - 2012



# Open access definitions

The Gold road

- After an article is accepted, the author pays to make that article open access
- Payment is called an article publication charge (APC)
- Typically published under a Creative Commons licence e.g. CC-BY

creative commons

# Open Access definitions

## Subscription

- Authors publish at no charge
- Libraries pay to access

## Gold Open Access

- Authors pay to publish
- Free to read and re-use by anyone anywhere

## Hybrid: Subscription/Open Access

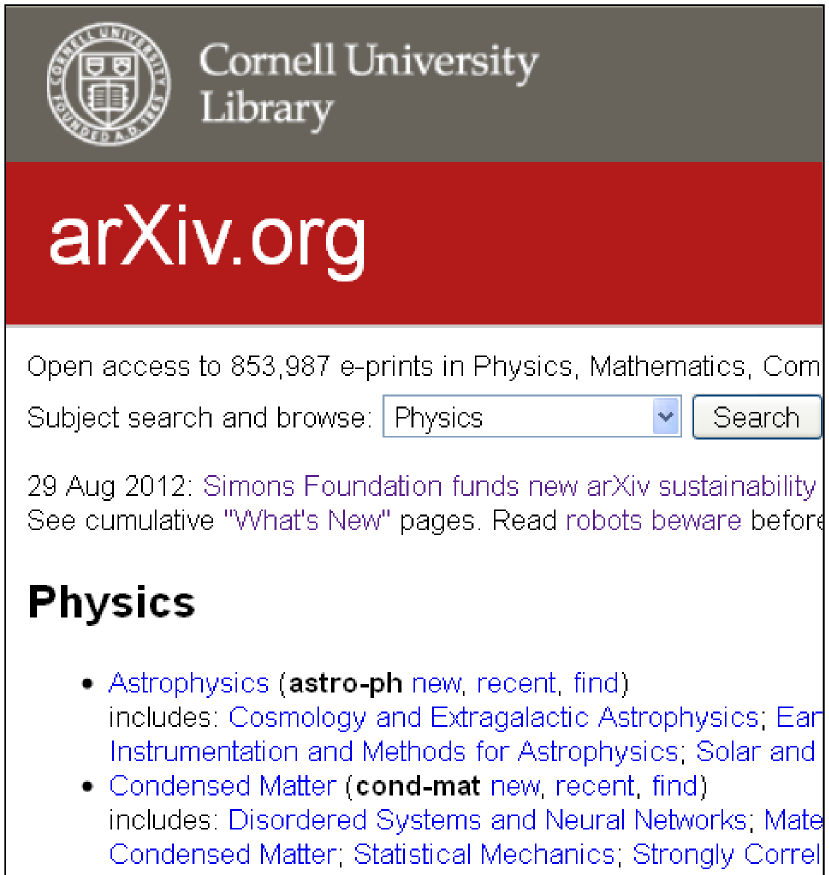
Subscription journal with option to pay an APC to make an article open access (under same conditions as above)

# Open access definitions

The Green road

- Accepted manuscript is uploaded to a repository where it is freely available
- Usually after an embargo period e.g. 6, 12, 24, 36 months

# Open access definitions




ArXiv

- Preprints often appear on ArXiv before submission to journals

# The RCUK policy (image from The Publishers Association)

# Impact of Open Access

CQG authors may wish to

1. Publish on a Gold OA basis
2. Publish on a Green OA basis
3. Publish preprints on ArXiv
4. Publish on a subscription basis

All 4 options are still available