

Institution: University of Portsmouth
Unit of Assessment: 9 Physics
Title of case study: High Impact Public Engagement in Cosmology
<p>1. Summary of the impact</p> <p>The Institute of Cosmology and Gravitation (ICG) runs a successful programme of community engagements with local schools, science centres and tourist attractions to influence public awareness and understanding of the world-class research we perform. In 2012-13, ICG engaged with 4858 people, including 2412 school children. Through our “Cosmology Masterclass”, we have inspired hundreds of A-level students from across the region; 60% said we had increased their interest in university. In 2012-13, staff engaged with 50 different schools across the UK. For the last 3 years, we have interacted with thousands of people running <i>BBC Stargazing Live</i> partner events, receiving almost unanimous praise from the public via our feedback.</p>
<p>2. Underpinning research</p> <p>Over the last decade, cosmology has experienced a golden age of discovery leading to a detailed view of our Universe full of stars, gas, galaxies, photons, dark matter and dark energy. Moreover, the Universe also provides a diverse set of physical conditions ideal for testing fundamental laws of physics, while also having a profound impact on the engagement of science by the public, by addressing philosophical questions like the origin of the Universe and the possibility of life beyond Earth.</p> <p>Over the same period, the Institute of Cosmology and Gravitation (ICG) has grown to become a centre of research excellence in astrophysics and cosmology. Building on the success of RAE2008, where 75% of the ICG research was judged to be “internationally excellent” or better (ranked in the top six departments in the Applied Mathematics UoA), we have broadened and strengthened our research base to include a deeper involvement in large international cosmological experiments and study the details of how galaxies have evolved over the lifetime of the Cosmos. This growing body of underpinning research has been vital to inform our high impact public engagement by ICG staff.</p> <p>In addition to our high productivity in publishing high impact research papers, ICG staff also hold prestigious leadership roles in several international collaborations that are helping to shape the present cosmological paradigm, e.g., David Bacon is joint lead of the LOFAR Surveys Cosmology Working Group, Claudia Maraston is chair of the Sloan Digital Sky Survey III (SDSS-III) BOSS Galaxy Evolution Working Group (WG), Rita Torejio is co-chair of the SDSS-III BOSS Large Scale Structure WG. Furthermore, Bob Nichol, Will Percival and Daniel Thomas are chairs of the Dark Energy Survey (DES) Supernova, LSS and Galaxy Evolution WGs respectively. Involvement in such key cosmological experiments ensures that our public engagement activities are topical, showing a clear connection between the physics of the Universe and how we test that physics.</p> <p>Our team has received several prestigious awards over recent years demonstrating the quality of our staff and their ability to communicate their passion for cosmology. For example, Tasinato presently holds a STFC Advanced Fellow, while David Bacon was an RCUK fellow until 2012. Percival and Koyama have both won ERC Starting Grants (2008-13) as well as the Philip Leverhulme prize. Percival further won the RAS Fowler Award in 2008, while Nichol won a Marie Curie Award in the same year. David Wands was awarded the Daiwa-Adrian Prize in 2010 for his international collaborative cosmology work. Claudia Maraston held a Marie Curie Excellence Team Grant for 2007-11. Karen Masters received the 2008 IAU Gruber fellowship (2008-2010), the only UK winner of this prize in the world, and a Leverhulme Early Career fellow (2010-2012).</p> <p>ICG staff are at the forefront of recent cosmological research and have used their knowledge to facilitate high impact public engagement through coordinated events as described below.</p>

3. References to the research

As outlined in Section B3 of REF document 01.2012 (“*Panel criteria and working methods*”), we provide a body of cosmological research that underpins our high impact public engagement programme. This research has directly influenced the emergence of the standard cosmological model and has thus directly relevant to our recent public engagement activities, both locally and nationally. These results are also directly used in our public engagement events.

*[1] Boughn & Crittenden, 2004, “*A correlation between the cosmic microwave background and large-scale structure in the Universe*”, *Nature*, 427, 45. DOI: [10.1038/nature02139](https://doi.org/10.1038/nature02139) (428 citations on Thomson Web of Knowledge) which established the Integrated Sachs-Wolfe effect as a key probe of dark energy

[2] Bamford, Nichol, et al. 2009 “*Galaxy Zoo: the dependence of morphology and colour on environment*”, *MNRAS*, 393, 1324. DOI: [10.1111/j.1365-2966.2008.14252.x](https://doi.org/10.1111/j.1365-2966.2008.14252.x) (126 citations on Thomson Web of Knowledge)

[3] Eisenstein et al. (including Nichol as a major author), 2005, “*Detection of the Baryon Acoustic Peak in the Large-Scale Correlation Function of SDSS Luminous Red Galaxies*”, *The Astrophysical Journal*, 633, 560. DOI: [10.1086/466512](https://doi.org/10.1086/466512) which demonstrated the power of the Baryon Acoustic Oscillation scale for cosmological constraints (1624 citations on Thomson Web of Knowledge)

*[4] Percival, Cole, Eisenstein, Nichol, et al., 2007, “*Measuring the Baryon Acoustic Oscillation scale using the Sloan Digital Sky Survey and 2dF Galaxy Redshift Survey*” *MNRAS* 381, 1053. DOI: [10.1111/j.1365-2966.2007.12268.x](https://doi.org/10.1111/j.1365-2966.2007.12268.x) (428 citations on Thomson Web of Knowledge)

[5] Kessler et al. (including Nichol as an author), 2009, “*First-Year Sloan Digital Sky Survey II Supernova Results: Hubble Diagram and Cosmological Parameters*”, *The Astrophysical Journal Supplements*, 185, 32. DOI: [10.1088/0067-0049/185/1/32](https://doi.org/10.1088/0067-0049/185/1/32) (279 citations on Thomson Web of Knowledge)

*[6] Wands, Malik, Lyth, Liddle, 2000, “*A New approach to the evolution of cosmological perturbations on large scales*”, *Physical Review D* 62, 043527. DOI: [10.1103/PhysRevD.62.043527](https://doi.org/10.1103/PhysRevD.62.043527) (346 citations on Thomson Web of Knowledge)

Underlined names are ICG researchers present at the University of Portsmouth during the published research. We identify with asterisk the three papers required to judge research quality.

4. Details of the impact

The ICG undertakes a broad range of outreach activities, which regularly reaches thousands of people per year (4858 in 2012-13; 6424 in 2011-12). In addition, the ICG has invested resources in a dedicated programme of “high impact” sustainable events that optimize our public engagement that draws upon our leading cosmological research above, thus ensuring our impact is topical, well-informed and inspiring.

The first of these regular (at least annual) events is the ICG “*Cosmology Masterclass*” which began in 2010 through a collaboration with Portsmouth Grammar School (PGS) [1]. These one-day events are designed to supplement the A-level national curriculum (specifically the Cosmology module of OCR Physics G485 and the IB Physics Astrophysics option), providing students with an expert view of basic concepts such as the expansion of the Universe (through the Hubble Diagram of supernovae based on ICG-related research [see 5 above]) and different types of galaxies [see 2 above]. Since 2010, we have expanded the reach of the event to include 120 PGS students a year and, since 2012, many local state-run schools: Portsmouth College, South Downs College (2012, 2013), Ryde Academy, Farnborough, Bay House School, Brentside High School, Isle of Wight College, St. John’s College, Christ the King Sixth. The feedback from teachers and students has been positive, e.g., 60% of non-PGS students indicated our Masterclass may have increased their

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interest in a wider range of university courses [1,2]. Furthermore, thirteen students have subsequently joined us for summer Nuffield bursary placements or for work experience, of which four cite their ICG research experience as helping them decide on pursuing a STEM subject at university and aided in their UCAS application [1,3]. The next Masterclass is December 2013.

In addition to the PGS, we continue to work with the University Education Liaison and Outreach Team as outlined in our Impact Template (REF3a) to engage school pupils of all ages during campus visits and have provided many one-off school visits upon request, e.g. in 2012-13, ICG researchers engaged with more than 50 different schools across the UK (28 in 2011-12). Since 2011, when we begun collecting detailed demographical information, ICG researchers have reached over 6000 school pupils [4].

Since 2006, the ICG has worked with Intech; our local science centre near Winchester, which attracted 140,000 visitors in 2012. Over the last 3 years, we have contributed to the Intech “*World Space Week*” [5], including developing hands-on demos about dark matter, components of the Universe (using Lego) and talks about telescopes (all linked to our research). These annual festivals have significant reach engaging thousands of people, typically doubling the normal visitor rate at Intech. A vast majority of our feedback is positive especially for the “*After Dark*” events run by ICG researchers (Dominic Galliano, Tim Clemson) aimed at adult audiences [5,6]. At our last “*World Space Week*” (Oct 2013), we reached 716 people, including 634 children.

Our final high impact event exploits the national media coverage generated by BBC *Stargazing LIVE*. Starting in 2011, we ran a small event at Gunwharf Quays (local shopping centre) to allow passing shoppers the opportunity to look through a telescope (in many cases for the first time). In 2012, we expanded the reach of the event to include 25 members of the ICG (coordinated by Karen Masters) to help promote a significant *StargazingLIVE* event at the Portsmouth Spinnaker Tower. This event was initiated by the BBC and became their flagship event for BBC South. In collaboration with PGS teachers and students and Hampshire Astronomical Society, we provided many activities and demonstrations on all floors of the Spinnaker Tower including astronomically-themed crafts, “*Science on Tap*”, “*Genius Bar*”; all of which drew on our cosmological knowledge. Overall, 450 ticketed guests attend the whole event, with over a hundred passers-by engaging with ICG researchers at the base of the tower. In 2013, we repeated the event, but this time using the HMS Warrior 1860 and the Mary Rose Museum as our venue (also in collaboration with University of Portsmouth Physics Society, HMS Warrior 1860 and Mary Rose Trust education teams and the British Science Association). Again, we had over 450 ticketed guests (limited only by venue size) who experienced a wide range of activities, many of which were directly related to ICG research (e.g. hands-on demonstration of gravitational lensing). The impact was significant and unanimously positive [7] and we are already planning a major *StargazingLIVE* event for Jan 2014.

All our events were covered in the local media thus increasing the reach of the ICG engagement and all venues wish to continue their relationship with the ICG.

5. Sources to corroborate the impact

[1] Private communication from Acting Head of Physics, Portsmouth Grammar School.

[2] Statistical analysis of our feedback forms from the 2012 Cosmology Masterclass show the overwhelming positive impact of such events, e.g., an average score of 4.1 out of 5 for interest in our astrodome sessions, while 75% of teachers believed the lectures increased their students engagement in the subject. Examples of student comments from our masterclasses include: “*awe inspiring*”, “*enhanced my knowledge of higher level physics*”, “*sparked an interest in physics related courses*”, “*More interested in uni now*”.

[3] Two PGS students on Nuffield bursaries are now studying Mathematics at Cambridge and directly credit the importance of their ICG experience, i.e., “*clarified my ideas about career choices*” and “*really assured me that theoretical physics and applied mathematics is the right path*”. One student won the 2010 Excitec Platinum Award for his ICG project.

[4] Since 2011, the demographics of our school visits are 436 (KS1), 1636 (KS2), 1376 (KS3), 1122 (KS4) and 1447 (KS5). We have also engaged 662 teachers during this time.

[5] Private communication from Planetarium Manager, Intech Science Centre, Winchester.

[6] Visitor numbers for Intech for World Space Week are 1727 (2011) and 1256 (2012), of which approximately half are teachers and students (KS2, 3 & 4). The "After Dark" event attracted 160 and 132 members of the public in 2011 and 2012 respectively. Based on feedback forms, 64% of visitors to the ICG stand said they had learnt at least one new fact. Examples of testimonials include: *"Thanks for a memorable day"*, *"The pupils were very impressed and came back on Monday morning chatting all about the day they had"*.

[7] Of the 67 attendees that completed our 2013 *StargazingLive* questionnaire, 100% said they enjoyed the event. Examples of feedback include: *"didn't realise it could be so interesting"*, *"she came home buzzing with excitement and ready to go into school today to tell her teachers & friends all the new facts she'd learnt."*