Institution: University of Portsmouth

Unit of Assessment: 9 Physics

a. Overview

This submission comprises 17 category A researchers, including all academic staff in the Institute of Cosmology and Gravitation (ICG). The ICG is a research institute of almost 50 researchers (including academic staff, graduate students, postdoctoral and visiting researchers) addressing fundamental questions in cosmology and astrophysics.

14 researchers from the ICG formed the basis of the Portsmouth submission to the Applied Mathematics sub-panel in RAE2008. 75% of our research was judged to be world-leading (15%) or internationally excellent (60%). Expansion of our research in survey cosmology and the underpinning astrophysics, and membership of the South-East Physics network (SEPnet), has led to this submission to UoA9, while research in the mathematics department forms a separate submission to UoA10.

b. Research strategy

Our primary strategic objective for the period 2008-13 has been ***to enhance the international profile of the ICG as a centre of excellence for cosmology and astrophysics***. This has been achieved through:

(1) Developing a coherent and collaborative research effort, focussed on the interface between astrophysical theory and observations.

We bring together experts in theoretical cosmology, observational cosmology and galaxy evolution in order to address some of the biggest questions in science today, and fully exploit the latest observational programmes. These science goals are closely aligned with Science and Technology Facilities Council (STFC) Science Challenges: *How did the universe begin and how is it evolving? What are the fundamental constituents of and fabric of the universe and how do they interact?* We cultivate a collaborative research culture both within the ICG and through strong international collaborations, supported through major investment in facilities (see section (d)), an active visitors programme, staff travel and exchanges.

Research in theoretical cosmology develops models of the Universe based on Einstein's general relativity and generalisations motivated by developments in fundamental physics. Future observations require more sophisticated theoretical models, going beyond standard Newtonian and linear treatments to develop more realistic relativistic and non-linear models. Highlight results include predictions of primordial non-Gaussianity from inflation in the very early universe (Koyama, Tasinato and Wands), relativistic effects in large-scale structure (Bacon, Bruni and Maartens), numerical N-body simulations in modified gravity (Koyama and Zhao), and a second-order Einstein-Boltzmann code (Crittenden, Koyama and Wands). Strategic university investment has been used to purchase a local supercomputer, SCIAMA, for both numerical simulations and large data processing tasks (see section (d)).

Observational cosmology and galaxy evolution uses massive surveys of the astronomical sky to determine the content and structure of the universe and how it evolves. Highlight results include state-of-the-art measurements of the integrated Sachs-Wolfe effect (Crittenden and Nichol), the imprint of baryon acoustic oscillations in the large-scale galaxy distribution (Percival, Pieri and

Ross), understanding galaxy morphology and formation histories (Maraston, Masters, Nichol, Thomas, Tojeiro) and the development of new stellar population models, obtaining the best determined mass function of the most massive galaxies in the Universe (Maraston and Thomas).

(2) Establishing leading roles in international collaborations

The ICG has made strategic investments to secure major roles in surveys such as the Sloan Digital Sky Survey (SDSS) and the Dark Energy Survey (DES), often using early involvement, committing relatively modest sums. This is now paying dividends in terms of leading roles in these collaborations coming to fruition over next few years (see section (e)). For example, ICG has more leadership roles in DES than any other institution (coordinating Large-Scale Structure, Galaxy Evolution and Supernovae working groups). This will remain our focus through involvement in future surveys including SDSS-IV, the European Space Agency (ESA) Euclid satellite and the Square Kilometre Array (SKA).

(3) Expanding the impact of ICG research in national and international agencies

ICG staff serve on numerous panels and committees including NASA/ESA science teams, steering groups for large collaborations (including SDSS and DES) and research council advisory, grant and fellowship panels (see section (e)). Portsmouth is a member of SEPnet (South-East Physics network), which develops regional collaborations, through joint supervision of research students, workshops and meetings, drawing on the breadth of expertise, best-practice and resources. ICG was instrumental in establishing the SEPnet-astro research theme, developing international expertise in the region for the next generation of radio astronomy surveys, including construction of the LOFAR-UK station at Chilbolton. Nichol (2008-09) was the first theme chair of SEPnet-astro (now Bacon, since 2009).

Our strategic objectives for 2013-20 include

- *to consolidate the ICG's position as an internationally-leading centre of research excellence*
- *to strengthen ICG leadership roles in major collaborations including surveys such as SDSS-IV, ESA's Euclid satellite and the Square Kilometre Array*
- *to support research exchanges, visits and collaborations, and encourage fellowship applications from candidates of the highest calibre*
- *to grow external funding and diversify our sources of income, through inter-disciplinary and inter-sectoral links, building on our strong international profile*
- *to maximise the impact of ICG research working with our SEPnet partners to extend outreach activities, especially to widen participation, and develop a programme of activities to exploit the commercial potential of our research*

We enjoy strong support from the University of Portsmouth in line with the university's strategic aims to support internationally excellent research in areas with critical mass, as a vehicle for the delivery of research excellence, research income, collaboration and impact.

Future research goals include

- *to relate inflationary models in the early universe to particle physics theories in light of the latest experimental and observational results*
- *to develop cosmological tests of general relativity using future surveys (including SKA)*
- *to develop and optimise future galaxy surveys (including eBOSS/SDSS-IV, DESI and Euclid) and to make precise measurements of both cosmic expansion and structure growth from them*

- *to study the redshift evolution of the galaxy population through imaging surveys (including DES) and detailed stellar population properties, morphology and kinematics of nearby galaxies using spectroscopic data (including MaNGA/SDSS-IV)*
- *to obtain the highest accuracy in the determination of galaxy properties with stellar population models, removing the uncertainty in cosmic chronometers*

c. People, including:

i. Staffing strategy and staff development

Our strategy is to attract top early-career researchers internationally and then support and develop these researchers into more senior roles. 7 out of our 17 category A staff are early career researchers. Early career researchers are helped to establish research teams through PhD student and post-doctoral support in line with strategic investments (e.g., Capozzi working with Maraston and Thomas on DES, Kapinska working with Bacon on LOFAR, and a new appointment to work with Masters and Thomas on SDSS-IV/MaNGA). We have a strong record in promoting academic staff who have demonstrated research leadership. Since 2008 Koyama, Maraston, Percival and Thomas have all been promoted to reader, and Percival has since been promoted to professor.

All staff are guaranteed £2k per year for research travel, supplemented by up to £2k per year for collaboration meetings. Staff are able to take extended research leave. Wands was Visiting Professor at the Yukawa Institute, Kyoto (2010). Maartens holds a 0.7FTE position as SKA research professor at the University of the Western Cape, South Africa (2010-15).

We have an active visitors programme supported by STFC, Royal Society and departmental funding. From January 2008 to July 2013 ICG hosted 486 research visits by 358 different researchers from 134 different institutions in 25 different countries (see http://research.icg.port.ac.uk/visitors/). We attract fellowship candidates of the highest calibre, drawing on international links, research environment and access to survey data. Fellowships since RAE2008 include EC Marie Curie, Gruber Foundation IAU, Leverhulme Early Career, Royal Society international incoming short visit, and national fellowships from Brazil, China, Italy, Japan, Mexico and Spain. We have hosted staff on sabbaticals from Japan and the US. Matt Bershady (Wisconsin), project scientist for SDSS-IV, will spend his 2013/14 sabbatical as Leverhulme Visiting Professor at the ICG. Levon Pogosian (Simon Fraser University, Vancouver) is a regular visitor to the ICG and Visiting Reader.

We have maintained our record of appointing senior research fellows to permanent academic positions in the ICG, including most recently Tasinato. Funds from Faculty research investment have been used to support four senior postdocs to work as independent research fellows (Masters, Ross, Tojeiro and Zhao). These fellowships are intended to provide a stepping-stone to senior research fellowships and permanent posts, while enhancing ICG research. Masters won an IAU fellowship and then a Leverhulme Early Career fellowship, and has been awarded a proleptic lectureship at the end of her current fellowship. Tojeiro has been awarded an STFC Rutherford fellowship, which she will take up at St Andrews in early 2014. Zhao has been awarded a 3-year fellowship as part of the “1000Plan Program for Young Talents” at the National Astronomical Observatory China.

We have achieved strong growth in numbers of post-doctoral researchers since RAE2008, supported by external grants (see section (d)) and strategic Faculty support. University funding is used to underwrite postdoctoral appointments or contract extensions while grant applications or renewals are pending in order to recruit and retain the best researchers. Posts are advertised internationally, and we attract outstanding candidates from leading institutions around the world.

Recent appointees have come from Chicago, John Hopkins, UPenn, Zurich and Heidelberg.

The University is committed to the Concordat to Support the Career Development of Researchers, with progress against an agreed action plan monitored by the University Research Committee. Research staff are represented on departmental, faculty and university committees, and the university Research Staff Forum provides feedback, as well as being a source of guidance and advice. The University was awarded the European Commission HR Excellence in Research Award in 2013. All newly appointed ICG academic and research staff have a research mentor and have review meetings after 1, 3 and 6 months to support their induction and subsequent career development, in addition to university induction events. All staff have an annual performance development review with their line manager, including discussion of longer-term development needs and aspirations. We provide support with internal peer review of grant proposals and mock interviews. Postdoctoral researchers have gone on to postdoctoral positions in MPA, Munich (Beifiori and Henriques), senior fellowships at KIAS, Korea (Song) and JPL, Pasadena (Shapiro) and permanent posts in Institut d'Astrophysique, Paris (Pitrou).

We are committed to actively promoting the role of women within the ICG along with other groups traditionally under-represented in science. Physics at Portsmouth is a supporter of the Institute of Physics Juno Project. The University joined the Athena SWAN charter in 2011 and will apply for Athena SWAN bronze award in April 2014. The ICG intends to apply for silver award and Masters is on the University Athena SWAN committee. A key goal of SEPnet2 is to promote diversity in physics, with a centrally funded diversity lead and departmental champions. The University has taken external audits by bodies including Stonewall Workplace Index and Working Families. The latest University staff survey by Capita, placed Portsmouth top as an employer of choice amongst 26 higher education institutions surveyed in the last 12 months.

ii. Research students

Research students are a vital element in our research environment. The ICG has a current cohort of 18 PhD students. 28 students have successfully completed their PhDs in the REF period. During that time only one student has withdrawn (after one year) and two students were required to resubmit their thesis (one subsequently passed, one still pending). None have failed.

We offer 4-5 PhD bursaries each year, including 2-3 funded by STFC doctoral training grants with the remainder funded by university bursaries. We will provide at least one new SEPnet studentship per year for the next five years to support collaborations within the network. We have used the flexibility offered by STFC and university funding to offer extensions into a 4th year where this will maximise scientific output and boost research careers. We have also awarded two 6-month Studentship Enhancement Programme fellowships, in conjunction with bursary extensions, to the top STFC-funded graduates.

We attract first class students from universities in SEPnet and across the UK, mainly supported by STFC bursaries, and using our strong international links we have recruited a number of exceptional students from around the EU, notably Sweden, Germany and Italy, supported by university bursaries. Successful PhD graduates have gone on to postdoctoral positions including NOAO, Arizona (Pforr), Barcelona (Hoyle), Geneva (Hollenstein), MPA, Garching (Johansson), and Caltech/JPL (Pietrobon and Raccanelli). We also attract overseas students either supported by national governments (China, Portugal and Mexico) or self-funded. We have established joint PhD programmes with Rome and Milan, where students funded by Italian scholarships spend at least one year in Portsmouth. ICG staff also supervise visiting PhD students, including recent visitors from China, Greece, South Africa, Spain and Switzerland.

PhD students have a supervision team of at least two staff. SEPnet students are co-supervised by staff at partner institutions. Research students and their supervisor are expected to meet at least weekly, with an email record of discussions. New students attend a series of core lectures in their first semester on observational and theoretical cosmology, galaxies, stellar evolution, relativity and mathematical physics. In the second semester courses we offer more specialised short courses, such as cosmic microwave background, dark energy or astronomical statistics. Students also participate in research skills training through the university Graduate School Development Programme. They submit a written report at the end of their first year for a Major Review and are interviewed by two assessors. Subsequently students complete an Annual Review summarising progress and setting objectives, which is reviewed by the Faculty Research Degrees Committee. The ICG holds weekly seminars during term time with external speakers, after which students participate in a question-and-answer session with the speaker. We also hold weekly group meetings, which provide a forum for research discussions and an opportunity for students and postdocs to present their work. Students are encouraged to present their work at regional and national meetings (such as SEPnet research conferences and UK Cosmology) and collaboration meetings. Students are supported to attend at least 3 international schools/conferences during their PhD.

SEPnet2 will support a new Graduate Network providing a technical, professional and leadership skills programme, career advice, including employer engagement, internships and other employer-led workplace experience. Research students also receive training for outreach activities.

d. Income, infrastructure and facilities

ICG has seen strong growth in external grant income over the period 2008-13. Average annual external research income was £1.67M, more than 3 times the level reported in RAE2008. Funding for core research projects, previously held as several STFC standard grants and since 2008 as two rolling grants, has since 2013 been merged into a single consolidated grant. EU research income since 2008 totals over £2M, including Marie Curie awards and three major European Research Council (ERC) grants. We have recently won our first major EPSRC grant in collaboration with the University's Business School.

External grants since RAE2008 include

- STFC rolling grants in *Theoretical Cosmology* (2007-12 £1,423k, 2010-15 £1,432k)
- STFC rolling grants in *Survey Cosmology and Astrophysics* (2008-13 £1,112k, 2011-15 £982k)
- STFC consolidated grant in *Cosmology and Astrophysics* (2013-16, £1,379k)
- STFC grants *Euclid Definition Phase* and *B1 Phase* (PI Percival, £42k 2010-11, £9k 2011), *BigBOSS UK development* (PI Percival, 2011-13, £15k), *DESspec: Spectroscopic upgrade to Dark Energy Survey* (PI Nichol, 2012-14, £21k), *Cosmological perturbations: very early universe* (PI Nichol, 2013-15, £256k)
- UKSA grant *Euclid Implementation Phase* (PI Percival, 2012-15, £319k)
- Gemini *WFMOS Concept Design Study* (PI Nichol, 2008, $178k)
- STFC *Advanced Fellowships* (Bacon 2004-09, Percival 2005-10, Tasinato 2010-15)
- STFC *Postdoctoral Fellowships* (Koyama 2005-08, Martinez-Sansigre 2010-12)
- 4 STFC *Doctoral Training Grants* (2008-17, £1.1M)
- EPSRC grant investigating online volunteering (with Portsmouth Business School, co-I Masters, awarded 2013, collaboration with Oxford, Manchester and Leeds, £750k)
- Leverhulme Trust *Prize Fellowships* (Percival 2008-11, Koyama 2010-13), *Early Career Fellowship* (Masters 2010-12) and Visiting Professorship (Bershady, 2013-14)
- EU Marie Curie *Excellence team grant* (Maraston 2007-11 €1.4M)

- EU Marie Curie *Fellowships* (Papazoglou, Pieri, Shankaranarayanan, Vandersloot)
- Royal Society *Travel Grants* (Crittenden, Maartens, Thomas) and *Incoming Short Visit* (Wands)
- 2 Royal Astronomical Society *Travel Grants* (Masters, Melvin, 2012-13)
- IAU Symposium 295, "The intriguing life of massive galaxies", Beijing (Thomas, 2012);
- ERC *Starting Grants* (Koyama 2008-13 €500k, Percival 2008-13 €880k)
- ERC *Consolidator Grant* (Percival 2014-19, €2.15M)

ICG has been awarded over £1.1M from university strategic infrastructure funding since 2007. Major investments include membership of Dark Energy Survey since 2008, membership of Sloan Digital Sky Survey and full institutional membership of SDSS-III since 2011 (Portsmouth and Cambridge are the only UK full institutional members) and SDSS-IV since July 2013 (Portsmouth is the only UK full member). See section (e) for leading roles in the collaboration this has supported. The SCIAMA supercomputer (1008 core cluster) was commissioned in 2010. SEPnet funding provided dedicated technical support to run the machine and make it accessible and easy to use, supporting researchers develop and optimise codes, maximising the scientific output. £53k from university funds was contributed to support use of the COSMOS National Cosmology Supercomputer at the University of Cambridge.

Time awarded on national and international facilities not supported by UK research councils:

- Portsmouth is a member of the Dark Energy Survey collaboration, awarded 525 nights on Blanco 4m telescope (2012-2018) by NOAO time allocation panel, and 100 nights on Anglo-Australian Telescope (AAT) for DES follow-up spectroscopy (2013-2018)
- Nichol is PI on the BOSS ancilliary programme awarded 4000 fiber-hours on SDSS-III telescope by SDSS expert panel (2009)
- Nichol, Percival and Tojeiro are members of the VIMOS Public Extragalactic Redshift Survey (VIPERS) project awarded 372 hours on ESO Very Large Telescope
- Maraston, Nichol and Thomas are co-I's on the Galactic Mass Assembly (GAMA) project awarded 188 nights on the Anglo-Australian Telescope (AAT) (2008-13) awarded by the AAT international time allocation committee
- Maraston and Thomas are co-I's on the proposal "Is the IMF of massive ellipticals really bottom heavy?", awarded 15hrs on FLAMES/VLT (2012) by the Observing Panel Committee
- Maraston was co-I of a Cycle20 proposal HST GO-12979.04 "The Stellar Population Around the Intermediate-mass Black Hole ESO 243-49 HLX-1", awarded 10 orbits, Hubble Space Telescope (HST) telescope allocation committee (2012-13)
- Maraston is co-I on RESOLVE project awarded 20 nights on Southern Astrophysics Research (SOAR) Telescope
- Percival is part of DES/LSS project (with UCL) awarded 4million CPU hours on Dirac supercomputer as part of COSMOS proposal (PI: Shellard, Cambridge)
- Maraston is a core member of the SERVS survey awarded 1400hrs on Spitzer Space Telescope/IRAC (2008), 21hrs on CFHT/WHIRCAM (2010A), 7 nights on CTIO/Mosaic (2009B, 2010B), 4 nights on Subaru/SuprimeCAM (2009B), 77hrs on NRAO Very Large Array (2013), 11.7hrs on Gemini/GSAOI (2013B)
- Masters is project scientist for Galaxy Zoo and co-I on many related telescope proposals including 84 hrs as PI on NRAO Very Large Array (2013B)
- Masters is founder of 2MASS Tulley-Fisher (2MTF) collaboration, awarded 96 hrs as PI on NRAO Green Bank Telescope (2008B), 152 hrs as co-I on Parkes Radio Telescope (2008, 2011 and 2012)
- Masters is team member of Spitzer Survey of Stellar Structure in Galaxies (S^4G), awarded 637hrs as co-I (March 2008, Cycle-6 exploration science review panel and TAC)

All ICG staff and students enjoy an excellent working environment within our purpose-built new Dennis Sciama Building, costing approx. £4million, opened in 2009. All academic staff and senior research fellows have individual offices. Postdocs share with one or two others or visitors, while

PhD students are in larger shared offices. We have a seminar room for video-conferencing funded by SEPnet for graduate lectures, seminars and collaboration meetings. We have spent university investment funding on departmental computing and IT resources to ensure a high standard of computing equipment for all ICG researchers. SEPnet publishes an online list of infrastructure and equipment available to all partners.

e. Collaboration and contribution to the discipline or research base

International collaborations are supported by a number of awards including a Royal Society Research Network with South Africa (NRF) (PI Nichol, £240k, 2007-13), a Royal Society International Joint Project grant with Kyoto University (PI Koyama, £12k, 2009-11) and the Daiwa Anglo-Japanese Foundation, Daiwa Adrian Prize 2010 (PI Wands, £10k).

We play leading roles in major international collaborations in astronomy:

- Sloan Digital Sky Survey (SDSS): Nichol was spokesperson for the collaboration (2009-2011) and Masters is outreach coordinator for SDSS-IV
- Baryon Acoustic Oscillation Survey (BOSS), part of SDSS-III: Maraston is chair of Galaxy Evolution working group; Tojeiro is co-chair of Large-Scale Structure working group; Maraston, Nichol, Percival, Thomas and Tojeiro are SDSS-III BOSS “architects” in recognition of their substantial contribution to the whole collaboration, allowing them privileged authorship rights
- eBOSS (extended BOSS), part of SDSS-IV: Percival is survey scientist
- MaNGA, part of SDSS-IV: Nichol is member of steering committee; Thomas is Science Team chair; Masters is co-chair of Kinematics working group; Masters and Thomas are members of management committee
- Galaxy Zoo: Masters is project scientist
- Dark Energy Survey (DES): Nichol is on DES management council and DES-UK board and co-chair of Supernovae working group; Percival is coordinator of Large-Scale Structure working group; Thomas is coordinator of Galaxy Evolution working group; Bacon leads the mass mapping sub-group for Weak Lensing working group; Nichol, Percival and Thomas are DES “builders” (with similar status to SDSS architects)
- LOFAR (Low Frequency Radio Array): Nichol was member of LOFAR:UK management committee (2006-2010); Bacon is leading the Surveys Cosmology working group and is a Long Baseline group core team member; Masters was Spokesperson for LOFAR-UK (2009-13) and is on the management committee
- ESA Euclid Satellite: Nichol is on Euclid Consortium Board and member of the Euclid Science Team; Percival is Cosmology and Galaxy Clustering coordinator; Bacon is Gravitational Flexion work package coordinator; Maraston is work package coordinator for the Photometric Redshift working group; Koyama is non-standard cosmological simulation coordinator for Simulation working group; Zhao is a member of the Forecast and Simulation working groups; Koyama and Maartens are members of the Theory working group.
- ESO VIPER survey: Percival is on the VIPERS steering committee; Tojeiro is a “builder” in VIPERS.
- Square Kilometre Array (SKA): Maartens is SKA research professor at University of Western Cape, South Africa, and chair of the SKA Cosmology working group; Bacon is also a member of the Cosmology working group
- ICG researchers are involved in numerous other surveys including GAMA (Galactic Mass Assembly) and SERVS (Spitzer Extragalactic Representative Volume Survey), DESI (Dark Energy Spectroscopic Instrument), DESspec and WEAVE. See section (d).

We regularly host collaboration meetings and workshops in Portsmouth including the UK

Cosmology and Cosmic Superstrings meeting (September 2011), MaNGA meeting (2013), Dark Energy Survey Spring Collaboration meeting (June 2011), Open Puzzles in Galaxy Formation and Evolution (September 2010), VIPERS collaboration meeting (June 2010), Galaxy Zoo 2 Science meeting (October 2009), Unity of the Universe conference (June 2009), Modified Gravity on Cosmological Scales (June 2008). Portsmouth is part of UK Cosmo and Koyama is on the national organising committee. Maartens, Nichol and Percival were on the science committee that organised the first Euclid/SKA science conference (Oxford, 2013). In June 2014 we will host the National Astronomy Meeting in Portsmouth.

ICG members serve on numerous national and international peer review committees. *Nichol* was a member of ESA's Euclid Science Study Team (2007-09), Optimization Assessment Team (2010), Interim Science Working Team (2011) and Science Team (since 2011). *Nichol* was a member of ESA-NASA Figure of Merit science working group (2009) and member of NASA WFIRST Science Definition Team (2010-12). *Maraston* was ESO Observing Programmes Committee member and chair (2007-09) and *Thomas* was member and chair (2012). *Nichol* was chair of the STFC Far Universe Advisory Panel (2009-11) and member of Science Board (since 2013). *Percival and Wands* are members of the STFC Astronomy Grants Panel (Percival since 2013 and *Wands* 2009-10 and Theory Panel Chair from 2014). *Koyama* is a member of the STFC Fellowships Panel (2012-13) and *Crittenden* was a member (2009-10). *Maartens* is a member of the South African Astronomy Desk Reference Group, advising government on policy and strategy, and is editor-in-chief of General Relativity and Gravitation journal. *Wands* was on the editorial board of Classical and Quantum Gravity (2007-10), and *Wands* and *Koyama* are currently on the CQG advisory board (both since 2011). *Wands* is a co-editor of EPL (Europhysics Letters) (since 2011).

Other national and international recognition since 2008: *Koyama* awarded a Philip Leverhulme Prize (2009) and the Japanese Physical Society Young Scientist Award (2010); *Percival* awarded the Royal Astronomical Society Fowler Prize (2008) and a Philip Leverhulme Prize (2008); *Wands* elected a fellow of the International Society on General Relativity (2010) and led a team awarded the Daiwa-Adrian Prize (2010) for joint UK-Japan collaboration with Kyoto University; *Masters* awarded an IAU Fellowship by the Gruber Foundation (2008-10) and a Leverhulme Trust Early Career Fellowship (2010-12); *Tasinato* awarded an STFC Advanced Fellowship (2010-15); *Tojeiro* awarded an STFC Ernest Rutherford fellowship (to be held at Univ. of St Andrews, 2014-2019).

Invited plenary talks (http://icg.port.ac.uk/external_talks) since 2008 include: *Bacon:* 11th School of Cosmology, IESC, Cargese, 2012; Trans-Regio winter school, Tonale, Italy, 2010; *Bruni:* Summer School on Cosmology and Gravity, Pune, India, 2011; *Crittenden:* Yukawa Institute for Theoretical Physics workshop "Cosmological Perturbation and CMB", Kyoto, 2011; *Koyama:* "The Dark Universe", Heidelberg, 2011; 17th Itzykson Meeting "Dark Energy and Modified Gravity", Saclay, 2012; *Maartens:* 3rd Biennial Leopoldina Conference, Munich, 2008; Loops 2009, Beijing, 2009; *Maraston:* "From Re-ionization to Exoplanets: Spitzer's Growing Legacy", Caltech 2009; IAU symposium 277 "Tracing galaxies and their ancestors in the land of our ancestors", Burkina Faso, 2010; *Masters:* invited discourse at IAU General Assembly, Beijing, 2012; "Cosmic flows – observations and simulations", Marseille, 2013; *Nichol:* IAP Colloquium, Paris, 2010; "The Return of de Sitter II", MPA, Garching, 2013; *Percival:* Space Telescope Science Institute symposium "A Decade of Dark Energy", Baltimore, 2008; Les Houches School of Physics "Post-Planck Cosmology", 2013; *Tasinato:* "Planck and the Early Universe", Bonn, 2013; *Thomas:* "Synergistic Surveys of the Southern Sky", Swinburne, 2010; "Fornax, Virgo, Coma et al: Stellar Systems in Highly Dense Environments", ESO workshop, Garching, 2011; *Wands:* ICTP Cosmology Summer School, Trieste, 2008; Cosmo-12, Beijing, 2012.