Institution:	University of Northumbria at Newcastle
Unit of Assessment:	10 - Mathematical Sciences

a. Overview

Mathematical Sciences research at Northumbria University involves staff from the *Department of Mathematics & Information Sciences*. The Unit has more than doubled its number of academic staff over the 2008-2013 period, growing by an additional 13 academic staff, including 7 ECRs. The Unit has a strong research culture with frequent overseas visitors, allowing the exchange of ideas, prompting collaborations and providing new opportunities to disseminate scientific results. The key research themes of the Unit are (a) nonlinear waves & integrable systems, and (b) magnetohydrodynamics (MHD), with a third emerging theme of (c) biomathematics.

b. Research strategy

Strategic Aims 2008-2013 At the end of the RAE 2008 period, the Unit operated as a small, but successful, applied mathematics group and was submitted as part of UoA25 (General Engineering). The strategy since 2008 has been to grow high-quality research focused on the mathematical modelling of problems in the physical and life sciences, with a focus on the underlying nonlinear processes. The three specific objectives have been to:

(i) strengthen the academic staff base with high-quality appointments from outstanding candidates across the world,

(ii) create two distinctive applied themes of research within the broad area of nonlinear processes: (a) nonlinear waves & integrable systems and (b) magnetohydrodynamics,

(iii) promote integration into a multi-national collaborative research culture.

To achieve these objectives, the recruitment process has been revised to attract internationally-excellent researchers, to emphasise the quality of research outputs, to involve recently-appointed staff in recruitment decisions, and to use Skype-screening interviews for overseas applicants. Initial appointments during the period have then been built upon to extend the research themes of nonlinear waves & integrable systems and magnetohydrodynamics. A strategic decision was taken to ensure new appointments retained and developed external links across the world and the University's Visiting Professors scheme has been used to bring in external expertise, alongside travel funding and sabbatical periods for staff to visit external centres of excellence.

Achievement of Strategy 2008-2013 As a consequence of the appointments strategy, the Unit has more than doubled the number of academic staff. Thirteen of the fourteen staff submitted for consideration in UoA10 have been appointed during the period, with only **Professor Angelova** having been submitted in RAE2008.

Six of these staff (**Atkinson**, **Goussev**, **Huard**, **Lombardo**, **Moro** and **Sommacal**) focus on nonlinear waves & integrable systems. **Dr Atkinson**, who leads in discrete integrable systems, joined from the University of Sydney following on from an Australian Research Council Personal Fellowship. **Dr Goussev** joined from the Max Planck Institute for the Physics of Complex Systems and prior to that held a Humboldt Research Fellowship. Prior to appointment, **Dr Huard** held a FQRNT (Canada) Personal Research Fellowship entitled "*Rank k solutions of multidimensional quasilinear systems*". **Dr Lombardo** held a Personal EPSRC Postdoctoral Fellowship and was previously a Netherlands Organisation for Scientific Research Laureate; the award was granted because of her ground-breaking work on Automorphic Lie Algebras. **Dr Moro** joined the Unit from SISSA (International School for Advanced Studies, Trieste, Italy) where he was an ERC research assistant. **Dr Sommacal** joined from North Carolina State University (USA) and previously held a Personal Research Fellowship at Institut des Hautes Études Scientiques, France.

Four of the new appointments (**Botha**, **McLaughlin**, **Morton** and **Zharkova**) focus on MHD, primarily in the mathematical modelling of solar and astrophysical processes. **Dr Botha** joined from the Warwick University and his research involves solving the nonlinear three-dimensional MHD PDEs, including the use of high-performance computing. **Dr McLaughlin** joined from the St Andrews University and is an expert on the behaviour of MHD waves in the neighbourhood of magnetic null points (e.g. invited, refereed review: McLaughlin *et al.*, 2011, *Space Science Review*, **158**, 205). **Dr Morton** is an expert in MHD wave theory and its application to solar data; 'magnetoseismology'. His key publications include a ground-breaking observational analysis of

MHD waves in the solar atmosphere (e.g. Morton *et al.*, 2012, *Nature Communications*, **3**, 1315). **Professor Zharkova** joins from Bradford University, bringing expertise in particle-in-cell numerical simulations, as well as being an international authority on sunquakes (having first reported/discovered them in Kosovichev and Zharkova, 1998, *Nature*, **393**, 317).

These appointments have fulfilled objectives (i) and (ii) of our research strategic aims. In pursuing objective (iii), we have led and been involved in several interdisciplinary projects via both national and international collaborations, and this has enhanced the overall research strength of the Unit (see Section e for examples of interdisciplinary research). An additional appointment with expertise in applications of statistics to biology/medicine, Dr Peter Philipson, is submitted to UoA3.

Forward Strategy Our 2008-2013 research strategy has resulted in the formation of two distinctive, but complementary, applied themes of research within the broad area of nonlinear processes. The first objective of our forward strategy is to grow each of these two themes such that the Unit will become two distinct, but interacting, research groups. The forward strategy will be to grow the volume and capacity of these two areas, and to ensure high quality during the growth.

In addition to these two main themes, the Unit now also has expertise and has been awarded external research funding for work in biomathematics. For example, **Professor Angelova** is PI of the multi-disciplinary project "*Models for ageing and technological solutions for improving and enhancing the quality of life*", funded by FP7 People Marie Curie Actions programme (2011-2014) and is Co-I on the research grant "*Enabling environment: modelling well-being in ageing*", funded by the Lifelong Health and Wellbeing Cross-Council Programme led by the MRC (2009-2010). The Unit also organised the London Mathematical Society regional meeting and an associated international workshop entitled "*Mathematics of Human Biology*" in June 2012. Thus, building on **Professor Angelova**'s FP7 and MRC grants, and upon the expertise of our other new appointments, including **Dr De Matteis** (joining from University of Milan), **Dr Ledesma-Aguilar** (joining from Oxford), **Dr Li** (joining from Imperial) and Dr Philipson (joining from UCL), our second future objective is to grow our expertise in biomathematics into a third, mature, distinctive theme.

In the period 2008-2013, there has been significant investment into the Unit, as part of the University's corporate strategy and the associated Strategic Investment Funding (which included investment of £367k in the Unit in the REF period). This represents an exciting new era for Mathematical Sciences research at the University, and the Unit will be further strengthened by appointments in the next five years (2014-2019). The University corporate strategy coupled with an increase in the number of our mathematics and statistics undergraduate students (doubling in the last four years) has created a sustainable financial foundation for this growth to be realised.

c. People, including: i. Staffing strategy and staff development

Evidence staffing strategy relates to research strategy and physical infrastructure

Our staffing strategy since 2008 has had three elements. We have sought to:

- Sustain and build capacity and volume in core research themes;
- Develop and reward a high-quality research culture among academic staff;
- Strengthen and revitalise the academic staff base with high-quality appointments.

Our staffing strategy and appointments have directly contributed to strengthening our core research themes, i.e. achieving research strategic objective (ii), as evidenced by, e.g., high-impact publications, invited talks at international conferences, and RCUK and FP7 grant income. Another of our research strategy objectives was to strengthen the staff base with high-quality appointments from outstanding candidates across the world, and thus is clearly linked to our staffing strategy (Section b). During the REF period, the University has also invested in two internally-funded research assistants to support the growth and forward momentum of the Unit: Dr Sujan Rajbhandari (2009-2012) to work on a collaborative project between Mathematics and Engineering; and Dr Gary Verth (2010-2011) to work in the area of MHD.

Evidence about career development support incl. RAs, ECRs and established academic staff

The Unit meets weekly for a series of research seminars. These meetings are used to report and disseminate scientific results in a collegial and constructive way, for networking activities, to disseminate funding and staff development opportunities, and to contribute to PGR progress. There are three designated meetings per annum to discuss overall strategy, plan research activities and discuss funding. Strategic discussions at these meetings led to successful bids to the London Mathematical Society to host our "*Mathematics of Human Biology*" and "*Integrable*

Systems in Newcastle" workshops in June 2012 and October 2013, respectively.

Staff development takes place in a variety of ways, including: *(1)* Newly-appointed staff are allocated a mentor and a lighter teaching load (25-50% of a full teaching load as appropriate for one academic year) to allow them to establish their research and international profile; *(2)* Financial support for attendance at national and international conferences and workshops to maintain and develop a high international research profile; *(3)* Research sabbaticals and secondments in a scheme decided by competitive application and providing a sabbatical for one semester every three years. E.g. Professor Angelova and Dr McLaughlin were awarded sabbaticals in 2012 and 2013, respectively, and Dr. Lombardo has been awarded one in 2014; *(4)* Advice and mentoring for progression to Reader and Professor based on track record of quality of publications, record of external funding and esteem; *(5)* Opportunities for co-supervision of PGR students by Research Fellows (alongside senior and more experienced supervisors) to enhance their development and career prospects; *(6)* An Academic Development Programme including modules on *Bidding and Funding* and *Grant Proposal Writing*; *(7)* A Research Support blog of relevant (inter)national funding opportunities, policy analysis and training events; *(8)* A Postgraduate Certificate in Higher Education Practice which includes a research practice module for new academic and research staff; *(9)* Staff development is reviewed annually as part of the appraisal system, alongside an online 'Personal Research and Innovation Plan', which records achievements and planning of research-related activities over the previous and forthcoming twelve months.

Evidence about implementation of the Concordat to Support Development of Researchers

The University and Unit are committed to implementing the Concordat to Support the Career Development of Researchers, and staff attend training and development courses provided under the University's Action Plan, which summarises the strategic commitment to developing and supporting research and careers, e.g. an ECR (Dr McLaughlin) is included in all Faculty research committees and a cross-University ECR Forum exists to take account of ECR perspectives.

Info. on staff with Personal Research Fellowships won in an open competition

Dr Atkinson held an Australian Research Council Personal Research Fellowship ("*Algebraic interpretations of discrete integrable equations*", DP110104151, AUD$246k, 2011-2013) which established new connections with finite geometry, the theory of elliptic functions and combinatorial mathematics. **Dr Ledesma-Aguilar** held a Marie Curie Intra-European Fellowship (FP7-People-2010-IEF 273406; April 2011 - March 2013), which utilised theoretical and numerical modelling to investigate the interplay between microswimmers and their environment. **Dr Lombardo** held an EPSRC Research Fellowship (EP/E044646/2) "*Automorphic Lie Algebras - at the interface of mathematics and physics*" until July 2011. **Dr Huard** held a FQRNT (Canada) Personal Research Fellowship ("*Rank k solutions of multidimensional quasilinear systems*", August 2010 - August 2012, #139584). **Dr Huard** and **Dr Morton** are both University "Anniversary Research Fellows"; University-funded personal (independent) research fellowships won in open competition from over 200 national and international applications. **Dr Sommacal** was awarded a "*Visiteur de longue durée*" Personal Research Fellowship at Institut des Hautes Études Scientiques entitled "*Towards a Theory of Chaos Explained as Travel on Riemann Surfaces"* (November 2010 - April 2011).

Info. on international staff appointments (incoming and outgoing), recruitment and visiting Scholars

The recruitment process has been revised to facilitate internationally-excellent applicants via Skype pre-screening interviews for overseas applicants. The result is a high-quality, international staff base, e.g. South African (**Botha**), Russian (**Goussev**), Canadian (**Huard**), Mexican (**Ledesma-Aguilar**) and Ukrainian (**Zharkova**). The Unit has four Visiting Professors: *(1)* **Professor Francesco Calogero** (Università degli Studi di Roma "La Sapienza"; a world-leader in integrable systems and joint-recipient of the 1995 Nobel Peace Prize); *(2)* **Professor V. Hussin** (Univ. of Montreal); *(3)* **Professor J.P. Gazeau** (Univ. Paris 7); and *(4)* **Professor N Petkov** (Univ. of Groningen); all are involved in research collaborations, grant preparation, and research training.

Evidence of how the submitting Unit supports equalities and diversity

The Unit is committed to providing an environment in which diversity is valued and encouraged, where there is equal access to opportunities and services, and in which all prospective and existing staff and students are treated fairly, with equity, dignity and mutual respect. This is reflected in several initiatives: e.g. research staff are included within the Equal Pay Audit, work-life balance opportunities are available and promoted, and the Concordat Action Plan is supported.

c. People, including: ii. Research students

University and Faculty procedures, which govern the Unit's PGR processes, are compliant with the QAA Quality Code for HE for Research Degrees (Chapter B11, published June 2012).

Info. on PGR recruitment, such as approaches to recruitment Between 2008 and 2013, the number of PGR students has increased from two to twelve. The significant increase in PhD recruitments is a direct result of the expansion of research expertise in the Unit. Approximately half of our PGR studentships are University-funded, with studentships won via a competitive-bidding process, representing an investment of £288k in the Unit. The others are self-funded or government-funded, e.g. Mr Rytis Dobranskis is funded by a STFC doctoral training studentship (ST/J5000938/1).

Info. on training and support mechanisms Initial training in skills and knowledge required for good research practice is provided by the University Graduate School, which delivers a structured training and development programme, including workshops on time management, communication, networking and career management. All PGR students have at least two supervisors to ensure that sufficient specialism and depth of experience is provided for successful PhD completion. ECRs are involved in co-supervising PGR students alongside experienced academics (with significant completion records). All supervisors must complete a university-level training course before supervising. Students present their work orally at least six times during their PhD, such as at the Unit's weekly research seminars and at the Faculty research seminar series. The University's performance in the Higher Education Academy's Postgraduate Research Experience Survey is positive in all areas.

Lectures and seminars on specialist technical topics are delivered at Unit level, and PGR students also benefit from the MAGIC (Mathematics Access Grid: Instruction and Collaboration) consortium programme, which the Unit joined in 2013. The Unit's weekly research seminars are also a forum for PGRs to present their progress twice per annum in a friendly atmosphere where they receive immediate and constructive feedback. This is all in addition to intermittent conferences and relevant workshops hosted by the Unit, e.g. the *12th IMA Conference for Early Career Mathematicians* (May 2010), the *28th International Conference on Group-Theoretical Methods in Physics* (hosted by the Unit in July 2010), *Mathematics of Human Biology* (June 2012), and the *2013 International Conference* of the Royal Statistical Society (hosted in September 2013) and *Integrable Systems in Newcastle* (October 2013). Funding is available for each PGR to attend at least one national/international conference per year. Students are also encouraged to apply for travel grants and have been successful with the Royal Society, IoP, IMA, RAS and others. PGRs also visit external research institutions to develop international collaborations, e.g. Mr V. Knibbeler presented his research at Vrije Universiteit Amsterdam (March 2012); Mr J. Easton presented his research at Stellenbosch University (SA) in July 2013. The Unit also hosts external PhD students for extended periods, e.g. Mr Juan Duque (Complutense Univ., Madrid) via the visiting programme: "*Moncloa Campus de Excelencia Internacional*", and supports an undergraduate summer research programme, e.g. funded by undergraduate research bursaries from Nuffield Foundation and RAS.

Info. on progress monitoring PGR students complete a PGR Development Portfolio at the start of their studies which allows them and the supervisory team to monitor and update their research training needs. Both the portfolio and overall progress is reviewed by an independent panel via a formal Annual Progression process. This is assessed at Faculty-level and provides permission to proceed and, coupled with the monthly progress reports, provides overall guidance and feedback.

d. Income, infrastructure and facilities

Info. on provision and operation of specialist infrastructure and facilities, and evidence of investments (current and planned) in infrastructure and facilities

The Unit has received investment totalling £377k in infrastructure and equipment in the 2008-2013 period (excluding Strategic Investment Funding in staff totalling £367k and excluding investment in PhD studentships totalling £288k). Recent investment includes a dedicated Mathematical Modelling Laboratory (39.85 m^2) providing a high-quality infrastructure of ten PCs and six powerful high-performance servers (two 256-GB RAM, 8-TB HDD servers and four 132-GB RAM, 10-TB HDD servers). Other capital investment in the Unit in the 2008-2013 period totals £179k including £41k for an access-grid node and IOCOM video-conferencing technology and software required for

the MAGIC network/programme, which the Unit joined in 2013.

The Mathematical Modelling Laboratory has specialised software for high-level numerical computation, including (but not limited to) research licences for the full *MATLAB* suite, *Mathematica*, *MAPLE* and *IDL*. Research software investment in the Unit totalled £13k, not including *MATLAB* provision (provided by a University site-license) nor *IDL* (provided under a STFC STARLINK agreement). This investment in dedicated software and computer equipment has directly supported our key themes, i.e. research strategy objective (ii), during the REF period. E.g. our 256-GB RAM, 8-TB HDD servers have allowed the Unit to perform state-of-the-art high-resolution 3D MHD numerical simulations. With regards to future investment, plans are in place to relocate all the mathematics and statistics staff into a single area, i.e. offices will be physically in close proximity as well as co-located near to the Mathematical Modelling Laboratory.

The University has an online Open Access research repository, Northumbria Research Link, which the Unit uses to showcase its research (alongside, e.g., arXiv.org). In addition to central IT services, the Unit benefits from a local (Faculty-level) dedicated IT support team who possess specialist knowledge of mathematical software, and a dedicated 139 m^2 departmental PGR suite.

Info. on the research funding portfolio, including future plans The Unit has received external research funding from EU FP7, EPSRC, MRC, LMS, NWO and the US Air Force, including:

- **Professor Angelova** is the coordinator and PI of the multi-disciplinary three-nation project "*Models for ageing and technological solutions for improving and enhancing the quality of life*", funded by FP7 People Marie Curie Actions (International Research Staff Exchange Scheme; FP7-PEOPLE-2009-IRSES 247541; 2011-2014; €189k);
- **Professor Angelova** was also PI of EPSRC grant "*Workshop: Group-Theoretical methods in Physics*" (EP/I009183/1, 2010, £15k);
- **Professor Angelova** was the mathematics lead and co-investigator in a multi-disciplinary research grant, "*Enabling environment: modelling wellbeing in ageing*", funded by the Lifelong Health and Wellbeing Cross-Council Programme led by MRC (G0900012, 2009-10, £50k);
- **Dr Lombardo** was PI of EPSRC grant "*Automorphic Lie Algebras - at the interface of mathematics and physics*" (EP/E044646/2, 2007-2011, total £312k with £98.7k to the Unit);
- The Unit organised London Mathematical Society regional meetings "*Mathematics of Human Biology*" (June 2012) and "*Integrable Systems in Newcastle"* (Oct 2013), supported by LMS grants totalling £11k (including funding from the 'Celebrate new appointments: scheme 1').
- **Dr Lombardo** received NWO (Netherlands Organisation for Scientific Research) funding totalling £7.1k (2842214) to facilitate collaborations with Vrije Universiteit Amsterdam.
- **Dr Goussev** is PI of EPSRC grant "*Mathematical Analysis of Domain Wall Motion in Nanowires*" (EP/K024116/1, 2013-2016, £43.4k) in collaboration with University of Bristol;
- **Dr McLaughlin** is PI of a US Air Force Office for Scientific Research (US AFOSR) grant entitled "*The Hunt for the Missing Modes: Revealing the True Nature of the Solar Wind*" (FA8655-13-1-3067, 2013-2014, £47.4k).
- Info. on consultancies and professional services A specialist workshop on Wavelet Analysis was developed by the Unit and delivered in April 2010 and again in Dec 2011. The workshop was attended by (registration-fee paying) external clients and industry members.

e. Collaboration and contribution to the discipline or research base

Info. on support for and exemplars of research collaborations The Unit has extensive academic collaborations both nationally and internationally. Here, we define *research collaboration* as resulting in at least one peer-reviewed journal paper. Publication data from ISI Web of Knowledge show that the 14 members of the Unit generated 160 refereed, journal publications in the 2008-2013 period (average of 11.4 per FTE). These included co-authoring with colleagues from 85 different, international, organisations, drawn from across 23 countries. These 160 articles were published in 58 different journals, with 76% published in quartile one journals (ranked by impact factor in subject-category, according to ISI Web of Knowledge journal citation reports; data generated Nov 2013).

Collaborative research with other groups and with industry is supported through remission from teaching, periods of research leave and travel funds. Examples of research collaborations include (but are not limited to): *(1)* **Professor Angelova**'s FP7 project (FP7-PEOPLE-2009-IRSES 247541) with Institute of Biophysics (Bulgarian Academy of Sciences) and Fachhochschule

Frankfurt am Main (Univ. of Applied Sciences, Germany); *(2)* **Dr Goussev**'s collaboration with Univ. of Bristol (e.g. Northumbria=EP/K024116/1, Bristol=EP/K02390X/1) on ferromagnetism; *(3)* **Dr Sommacal** and Professor Calogero's collaboration on chaotic motions for dynamical systems aimed at creating a theory of Chaos in terms of 'travels' on Riemann surfaces (recognised as an important tool for understanding Chaos and referenced in the Wolfram Mathworld Encyclopedia).

Info. on support for and examples of interdisciplinary research The University organises a dedicated programme of thematic interdisciplinary University-wide Research Forums, in which unit staff have made significant contributions, for example, **Professor Angelova** and **Dr Li** led interdisciplinary collaborative projects involving mathematical models of health and ageing processes arising from a Research Forum entitled "*Health and Wellbeing*"). University Business Development Managers also support collaborations between academic staff and business, e.g. through the development of applications for collaborative Technology Strategy Board research projects and KTPs. For example, in 2011, PGR Helen Gibson (supervisor=Prof Angelova) led the modelling side of an Industrial Mathematics KTP Programme (£15k, co-funded by EPSRC).

The Unit's interdisciplinary projects include (but not limited to): **Dr Ledesma-Aguilar** utilises theoretical and numerical modelling to investigate wetting-based destabilisation mechanisms (e.g. Ledesma-Aguilar *et al.*, 2011, *Nature Materials*, **10**, 367) and wetting-entrainment regimes under microfluidic conditions (e.g. Ledesma-Aguilar *et al.*, 2013, *PRL*, 1**10**, 4502). **Dr Morton** is an international authority on image processing of chromospheric observations (e.g. Morton *et al.*, 2012, *Nature Communications*, **3**, 1315), and applies the dispersion relation of MHD modes to solar physics observational data in an inversion technique called magnetoseismology (e.g. Morton *et al.*, 2012, *ApJ*, **744**, 5). **Professor Angelova** collaborates with engineers applying experimental wavelet-denoising techniques to optical wireless communication systems and utilises numerical simulations of discrete-wavelet-transform and artificial-neural-networks-based receiver architecture to minimise performance degradation (e.g. Rajbhandari *et al.*, 2013, *Optics Express*, **21**, 13779). **Dr Li** applies Bayesian spatio-temporal models to data arising from health and social sciences, including evaluating policing strategies (Li *et al.*, 2013, *Environment and Planning A*, **45**, 2012), modelling disease surveillance (Li *et al.*, 2012, *Biostatistics*, **13**, 695), and parameter identifiability and redundancy in complex models (Little, Heidenreich and Li, 2010, *PLos One*, **5**, e8915).

Info. on how research collaborations have informed research activities and strategy
Visiting Professor Francesco Calogero's wealth of experience has significantly influenced and contributed to the growth of the "nonlinear waves & integrable systems" theme of the Unit. **Professor Angelova**'s research collaborations and grant success in the area of biomathematics, coupled with the (relevant) expertise of new appointments **Dr De Matteis**, **Dr Ledesma-Aguilar** and **Dr Li**, have contributed to our future research strategy (namely our second objective to grow our expertise in biomathematics into a third, mature, distinctive theme).

Examples of leadership in the academic community Esteem indicators are listed below by members of the Unit. Between two and four items are provided as appropriate for career stage, specifically ECR = 2 and Professor = 4, and three esteem indicators for all other staff:

Professor Angelova : **i) 11 invited talks** (including "*27th Intern'l Colloquium on Group-Theoretical Physics*", Armenia, 2008; "*Special Functions, Lie Algebras and Orthogonal Polynomials*" conference, Czech Republic, 2011; "*Beauty in Physics*" conf., Mexico, 2012); **ii) Principal Organiser of Symposia** ("*28th Intern'l Colloquium on Group-Theoretical Methods in Physics*", [Chair], Newcastle, 2010, 130 international participants; IEEE Intelligent Systems Conf., Bulgaria, 2012; Mathematics of Human Biology: LMS regional meeting, [Chair], 2012); **iii) learned societies and professional bodies** (Vice-Chair IOP NE Branch 2003-2010; awarded Fellowship of the IOP in 2012; Committee member of Northern Branch of the LMS); **iv) Editorships and Guest Editorships** (Editorial Board "*Bioinformatics and Biology Insights*" journal; Guest Editor of "*Physical and Mathematical Aspects of Symmetry*", *J. Phys. Conf. Series*, volume **284**, 2011).

Dr Atkinson : **i) Australian Research Council Postdoctoral Fellow** (2011-2013); **ii) Invited Visiting Fellow** Isaac Newton Institute for Mathematical Sciences, Cambridge, "*Discrete Integrable Systems*", Feb-June 2009; **iii) 3 invited talks** (Discrete Integrable Systems workshop, Lorentz Centre, NL, 2011; ASIDE Summer School, China, 2012; Nonlinear Dynamical Systems Workshop, Australia, 2012).

Dr Botha (ECR) : **i) 4 invited talks** (including DAMTP, Cambridge, 2008); **ii) Registered with**

South African Council for Natural Scientific Professions (South Africa's legislated regulatory body for Professional Natural Scientists, comparable to registering with UK's General Medical Council).

Dr De Matteis : **i) 5 invited talks** (including "*5th Italian-Japanese Workshop on Liquid Crystals*", Italy, 2010; University of Cagliari, Italy, 2012; University of Milan-Bicocca, Italy, 2012); **ii) Invited Visiting Fellow** Newton Institute for Mathematical Sciences, Cambridge, "*Mathematics of Liquid Crystals*", Jan-June 2013; **iii) Awarded** Lizzanello Personal Research Fellowship (Centro di Ricerca Matematica "Ennio De Giorgi", Scuola Normale Superiore di Pisa, Italy, 2008-2009).

Dr Goussev : **i) 9 invited talks** (including Univ. of Arizona, USA, 2009; Heidelberg University, Germany, 2011; Univ. of Strasbourg, France, 2011); **ii) invited, refereed review article** on *Loschmidt echoes*: Goussev *et al.*, 2012, *Scholarpedia*, **7**(8):11687 (accessed over 7,400 times electronically, as of November 2013); **iii) international workshop/conference co-organiser** ("*Transition State Theory*", Univ. of Bristol, 2009).

Dr Huard (ECR) : **i)** FQRNT (Canada) **Personal Research Fellowship** and **Anniversary Research Fellowship** (Northumbria Univ.); **ii) 3 invited talks** ("*Nonlinear Physics, Theory and Experiment V*", Italy, 2008; Université du Québec à Trois-Rivières, 2010; SISSA, Italy, 2011).

Dr Ledesma-Aguilar (ECR) : **i) Marie Curie Intra European Fellowship** (2011-2013) and Fulford Junior Research Fellowship (Somerville College, Oxford); **ii) 6 invited talks** (including "*XV Enzo Levi Seminar*", Mexico, 2008; Univ. of Barcelona, Spain, 2008; Univ. of Lyon, France, 2011).

Dr Li (ECR) : **i) New Investigator Award** (American Statistical Association Conference: Radiation and Health, Colorado, 2008); **Young Academic Award** (Model Uncertainty Conference, Warwick, 2010); **ii) 2 invited talks** (Radiation Effects Research Foundation, Japan, 2008; Small Area Estimation Conference, Spain, 2009).

Dr Lombardo : **i) EPSRC Postdoctoral Fellowship**; Netherlands Org. for Scientific Research Laureate; **ii) 17 invited talks** (incl. UK-Japan Winter School on Symmetry and Integrability, 2010; Universiteit van Amsterdam, 2011; British Mathematical Colloquium, 2012); **iii) Guest Editorships** ("*Nonlinear evolution equations and dynamical systems*", *J.Nonlinear Math. Phys.*, **15**, 2008; "*Current Trends in Integrability and Nonlinear Phenomena*", *J.Phys.A: Math.Theor.* **42**, 2009; "*Nonlinear phenomena, optical and quantum solitons*", *Phil. Trans. A Royal Soc.*, **369**, 2011).

Dr McLaughlin (ECR) : **i) PI of NASA international satellite campaign** JOP216; **ii) ten invited talks** (including Univ. of Warwick, 2008; 1st UK-Ukrainian Solar Conference, Crimea, 2011; Marie Curie-Sklodowska University, Poland, 2011).

Dr Moro : **i) 12 invited talks** (including UCCS Mathematics Colloquium, Colorado, USA, 2011; Ohio State University, USA, 2011; SIAM Conference of Nonlinear Waves and Coherent Structures, USA, 2012); **ii) Member** of the Italian Institute for High Mathematics and London Mathematical Society; **ii) international workshop/conference co-organiser** ("*Integrable systems in Pure and Applied Mathematics*", [in honour of Professor Boris Dubrovin 60th birthday], Sardinia, 2010; "*International Workshop on Dispersive Shocks*", Italy, 2012).

Dr Morton (ECR) : **i) 6 invited talks** (including Indo-UK solar MHD workshop, India, 2013; National Astronomy Meeting, 2013; DAMTP, Cambridge, 2013); **ii) PI and Co-I** on successful proposals for observing time at international telescopes (Dunn Solar Telescope, New Mexico, 2012a; 2012b; 2013; Swedish Solar Telescope, Spain, 2012); **invited NASA Science team member** for High-resolution Coronal Imager (Hi-C) sounding rocket re-flight.

Dr Sommacal (ECR) : **i) 12 invited talks** (including *"Darboux Days: 2nd workshop on Nonlinearity and Geometry"*, Poland, 2008; Univ. of Colorado, 2009; SIMAI Biannual Congress, Italy, 2012); **ii) international workshop/conf. co-organiser** ("*Integrability and Physics*", [in honour of Prof Antonio Degasperis 70th birthday], Italy, 2011; "*NEEDS: Nonlinear Evolution Equations and Dynamical Systems*", Sardinia, 2009; Crete, 2012; "*Integrable Systems in Newcastle*", 2013).

Professor Zharkova : **i) 13 invited talks** (including 7th International Astrophysics Conf., Hawaii, 2008; Intern'l Symp. in Solar-Terrestrial Physics, Russia, 2010; Asia Oceania Geosciences Society Conf., India, 2010; Singapore, 2012); **ii) Inter'l Advisory Board** (project evaluations for e.g. NASA Living with a Star Panel, 2008-2011; Austrian Academy, 2008; EU FP7 Space Programme, 2010; NASA Solar Panel, 2012); **iii) Intern'l workshop/conf. co-organiser** (World Congress in Engineering, 2008; 2009; 2010; 2011; KES Intern'l Conf. in Agent and Multi-Agent Systems, Manchester, 2010); **iv) Intern'l space missions** (Co-I for STIX instrument on "*Solar Orbiter*" spacecraft, ESA; Co-I of "*Interheliozond*" mission, Russian Federal Space Program).