National Astronomy Meeting

Abstracts Book

2010 April 12–16

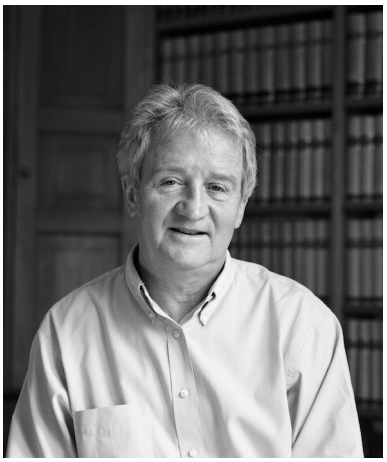
Contents

RAS NAM UKSP•MIST GLASGOW 2010

University of Glasgow

Welcome!

Andy Fabian



As President of the Royal Astronomical Society (RAS), it gives me great pleasure to welcome you to Glasgow University for the 2010 RAS National Astronomy Meeting, the UK's largest annual astronomy and space science event. More than 500 scientists are registered for the Meeting, from postgraduate students to senior researchers and academic staff. During the week, we will discuss and present cutting-edge science from across our field, from the upper atmosphere of the Earth to galaxies in the early Universe. In the UK we are not only outstanding in our field, ranking second to the US, but outstanding at communicating our work. Astronomy's profile in the media is higher than ever, has an enduring popularity with students in our schools and is cited by many as a key factor for inspiring entry into a career in science. So at NAM2010 we can celebrate the best of our science in an institution where astronomy has been taught for half a millennium, and researched in depth since the 1760 appointment of Alexander Wilson as the first Regius Chair of Astronomy, rightly celebrated in this 250th anniversary year. Glasgow is a great place for our annual Meeting to take place and whatever your area of work I hope to see and talk to many of you in the days ahead.

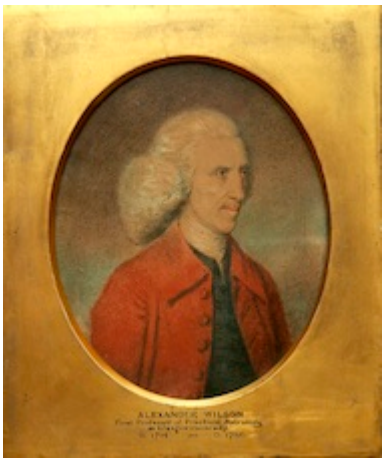
Andy Fabian, President of the Royal Astronomical Society

John C Brown

On behalf of the LOC, SOC and all local Glasgow area astronomers, professional and amateur, I extend to all NAM 2010 delegates a very warm welcome to our fine city and to the GU Campus NAM site. We also wish to thank RAS/NAM for accepting our invitation to this site in recognition of the 250th Anniversary of our Regius Chair of Astronomy. Solar physics, MIST and Astronomy have undergone advances unimaginable in Wilson's day and astonishing even since the last Glasgow NAM (then an RAS Out of Town Meeting) in 1989. Enjoy all the latest science news here but also make sure you take some time to enjoy our city, environs, and legendary hospitality

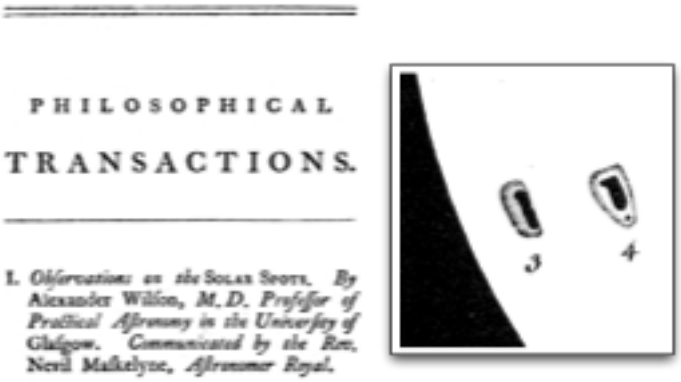
John C Brown, 10th Regius Chair of Astronomy and 10th Astronomer Royal for Scotland

250 years of the Regius Chair of Astronomy in Glasgow: Alexander Wilson, first Regius Chair



Alexander Wilson MA, MD was the first appointee (1760-1784) to the Regius Chair of Practical Astronomy, University of Glasgow (founded 1451). This followed establishment of the first dedicated University Observatory in 1757, based on an instrument collection donated by Alexander McFarlane of Jamaica. Refurbishment of the instruments after their deleterious voyage were carried out for £5 by James Watt, at that time a 19 year old University instrument maker. There have been ten Regius Chairs to date, the current incumbent, John C Brown, being also 10th Astronomer Royal for Scotland.

Born in St Andrews, Wilson graduated MA (1733) there and became an apprentice to a London surgeon and apothecary. He returned to St Andrews in 1739 to start a type foundry business which moved to Glasgow in 1744, supplying the University printers. In business partnership with James Watt and Joseph Black, he made some of the earliest scientific thermometers which played a central role in Black's work on theories of latent and specific heat. Prior to his Chair appointment, Wilson had invented a new process for type, made telescopes, flown thermometers on kites, and made specific gravity beads for liquid testing including spirit 'proof' strength. While Regius Chair he was Clerk of Senate and founder member of the Royal Society of Edinburgh, as well as being very active in several areas of research, most famously for his observational discovery [*Philosophical Transactions* (1683–1775), 64:1–30 (1774), doi:10.1098/rstl.1774.0001, ADS:1774RSPT...64....1W] of the apparent depression of sunspots below the photosphere, today termed the Wilson Effect.



PHILOSOPHICAL

TRANSACTIONS.

I. *Observations on the* SOLAR SPOTS. *By* Alexander Wilson, *M. D. Professor of Practical Astronomy in the University of* Glasgow. *Communicated by the Rev.* Nevil Maskelyne, *Astronomer Royal.*

[Image of Wilson courtesy of James Babington Smith, Wilson descendant; excerpts of Wilson paper courtesy of the Royal Society]

Acknowledgements

The Local Organising Committee Lyndsay Fletcher (LOC chair), John Brown (LOC Deputy Chair), Rachael McLauchlan (Secretary), Matthew Cartmell (Department of Mechanical Engineering), Sara Diegoli (Scottish Universities Physics Alliance), Declan Diver, Helen Fraser (University of Strathclyde), Norman Gray, Giles Hammond, Iain Hannah, Ik Siong Heng, Nic Labrosse, Alec MacKinnon (Department of Adult and Continuing Education), Peter Murray, Matt Pitkin, Bonnie Steves (Glasgow Caledonian University), Graham Woan.

The Scientific Organising Committee Martin Hendry (SOC Chair), John Brown, Eduard Kontar (UKSP SOC chair), Annette Ferguson (ROE IfA, University of Edinburgh), Wayne Holland (UKATC, University of Edinburgh), Andy Taylor (ROE IfA, University of Edinburgh), Alan Thompson (BGS Edinburgh, MIST SOC chair), Ian Bonnell (University of St. Andrews), Jane Greaves (University of St. Andrews), Sheila Rowan (University of Glasgow).

The UKSP SOC Gerry Doyle (Armagh), Rekha Jain (Sheffield,) Eduard Kontar (Glasgow; chair), Duncan MacKay (St Andrews), David Pontin (Dundee).

The MIST Council

All of the **session convenors** for putting together such an excellent scientific programme.

Our team of NAM helpers Matt Abernathy, Marina Battaglia, Riccardo Bassiri, Euan Bennet, Nicola Beveridge, Christina Burge, Paul Campsie, Ewan Dickson, Matt Edgar, Hoda Ghodsi, Colin Gill, David Graham, Jingnan Guo, Karen Haughian, Erin Macdonald, Procheta Mallik, Heather Ratcliffe, Hamish Reid, Satoru Sakai, Ignacio Santiago, Edward Thomson, Fraser Watson.

John Brown, Lucie Green, Chris Lintott, Fiona Speirits, Fred Watson, and Jim Wild as outreach event presenters.

Fred Watson, Marnie Ogg, The Glasgow Skeptics and The Admiral Bar ('Science in the Pub').

All the schools who participated in the schools' poster session.

We would also like to thank the following in the **University of Glasgow** for their help and advice: Ishbel Duncan and Lucinda Hay (The Conference and Visitor Services Office), Cha Hannaway and Bill Young (AV and IT), Ellen Thompson (Hospitality Services), Patrick Nwaozuzu (FInance and Purchasing Office), Stuart Forsyth (Corporate Communications), Anne Plissi and Jacqueline Heuchan (Physics and Astronomy Accounts Office), Alan Bowman (Physics and Astronomy Stores).

Thanks to Iain Hannah for the image of the Glasgow University Cloisters used on our Abstract Book and banners.

Social Events

Monday 12th April

Reception: Glasgow City Chambers The meeting reception will be hosted by Glasgow City Council in the City Chambers, situated in the heart of the city centre. This reception includes drinks and canapés. Advanced reservation was required: you will need to show your conference badge to enter.

This is expected to run from 18.30 to 20.00.

Science in the Pub: The Admiral Bar A "Science in the Pub" Q&A panel session, led by Fred Watson of AAO, is planned for Monday 12th from 20.30–23.00 directly after the Civic Reception. Fred Watson makes frequent appearances on Australian radio and TV, which, together with his books, public lectures and astronomy tourism expeditions, have resulted in several awards.

The venue will be the The Admiral Bar in the City Centre, about a 10/15 min walk from the City Chambers (Google directions). The venue is a regular haunt of Glasgow Skeptics in the Pub who are kindly assisting with that event. Advanced registration was required, and a light buffet will be provided for those who did register: show your conference badge to enter.

Tuesday 13th April

5-a-side Football: Kelvinhall International Sports Arena This year's competition will occur indoors in a sporting venue that has held many an international sporting event, the Kelvinhall, just a few moments walk from the University.

The competition is expected to run from 18.30 to 21.00.

Wednesday 14th April

Dinner & Ceilidh: Kelvingrove Art Gallery and Museum The meeting dinner will be followed by a traditional ceilidh both in the spectacular Kelvingrove Art gallery and Museum, situated just down the hill from the University.

Please bring your conference badge, which also shows the menu choices which you made at registration.

The dinner is expected to run from 19.00 to 24.00.

Hubble 3D preview at Glasgow Science Centre IMAX

The Glasgow Science Centre is showing the new Hubble 3D IMAX film, and their preview event has fallen on the 14th. They have kindly offered 100 tickets for NAM delegates, so if you are unable to go to the conference dinner, this is another alternative. Email Sharon Lyons (`sharon.lyons@glasgowsciencecentre.org`) as soon as possible, if you want to book a ticket.

You can find a map of these locations at `http://bit.ly/9v6jsq`

All week

While in Glasgow make sure to visit the Glasgow Science Centre, who have special rates for NAM delegates. See page 9 for details.

La Vallée Blanche *(H) 360 Byres Road, Glasgow, G12 8AY., Food served: Tue–Fri noon–2.15pm, 5.30–10.30pm; Sat noon–11.30pm; Sun noon–10.30pm. Closed Mon. Capacity: 76.*
La Vallée Blanche succeeds in showing sensitivity to shrinking budgets without compromising on taste. Just as its name and cosy chalet inspired décor imply, the 'White Valley' turns out the sort of traditional French food you could devour after a day in the mountains. The menu changes throughout the year to favour seasonal local produce.

The Wee Curry Shop *(B) 23 Ashton Lane, Glasgow, G12 8SJ, Food served: Mon–Thu noon–2.30pm, 5.30–10.30pm; Fri/Sat noon–11pm; Sun 5.30–10.30pm. Capacity: 31.*
If chain restaurants are the anathema to good eating, then its good to see the Mother India stable continuing to defy received wisdom with their growing line of Wee Curry Shops. There are branches also in Byres Road and at Cowcaddens.

Useful numbers, and emergency information

Glasgow Taxis (hackney cabs) 0141 429 7070. Local Taxi Ranks: Hillhead subway station and opposite Botanical Gardens (Great Western Road/Byres Road intersection).

Private Hire: West End Radio Cars 0141954 7070, Canniesburn Taxis 0141 956 3333, Glasgow Airport Taxis 0141 888 6363.

Public Transport Traveline Scotland `http://www.travelinescotland.com/welcome.do`, 0871 200 22 33 (charges vary).

Strathclyde Partnership for Transport (SPT) `http://www.spt.co.uk/`

Firstbus Glasgow `http://www.firstgroup.com/ukbus/scotland/swscot/home/`

Scotrail `http://www.scotrail.co.uk/`, 08457 48 49 50 (National Rail Enquiries).

Glasgow University contacts (from an internal phone, dial last 4 digits) switchboard 0141 330 2000, NAM2010 Registration Area 0141 330 0157, Media Relations Officer (Stuart Forsyth) 0141 330 4831 .

RAS Press Officers Robert Massey 0794 124 8035, Anita Heward 0775 603 4243

Health and emergency services

The emergency phone number in the UK is 999.

Accident and Emergency
Western Infirmary
Dumbarton Road
Glasgow, G11 6NT
Phone: 0141 211 2000

Emergency dental treatment
Glasgow Dental Hospital and School
(Call 0141 232 6323 – no walk-in)
378 Sauchiehall Street
Glasgow, G2 3JZ
Evening service via NHS24 on
08454 24 24 24
`http://www.nhs24.com`.

Doctor's surgeries
26 Bank Street
Glasgow, G12 8ND
Phone: 0141 339 5513

31 Buckingham Terrace
Glasgow, G12 8ED
Phone: 0141 211 6210

Pharmacies
277 Byres Road
Glasgow, G12 8TL
Phone: 0141 339 1954
08:00 – 20:00

1278 Argyle Street
Glasgow, G3 8AA
Phone: 0141 339 3353
08:30 – 18:00

693 Great Western Road
Glasgow, G12 8RA
Phone: 0141 339 0012
09:00 – 21:00

Security

Glasgow West End Police Office
(Open 24 hours)
609-611 Dumbarton Road
Glasgow, G11 6HY
Phone: 0141 532 3592

Glasgow University Campus Security
Gatehouse
University Avenue
0141 330 4444
or x4444 from any University phone

sessions

Monday 12th, 1545–1730

Bute P01: Galaxy Formation and Evolution in the Low-Redshift Universe With Multi-Wavelength Spectroscopic Surveys
G255 P02: Massive Stars: New Views of their Formation and Progeny
G226 P03: 10 Years of Cluster: the Past, Present and Future of Multi-point Measurements of Space Plasmas
Fore P04: New Views of Solar Active Regions from Hinode and STEREO
G466 P05: STFC Current Facilities

Tuesday 13th, 1045–1230

G255 P06: Science on the Way to SKA - Session 1
Bute P07: First results from the Herschel Space Observatory
G226 P08: Magnetospheric physics of Jovian-type planets and Ultra-cool dwarfs
Fore P09: UKSP / MIST Missions Forum: the State of the Art and Future: Opportunities
G466 P10: Software Astronomy: How to Do Astronomy by Looking Through a Computer

Tuesday 13th, 1545–1730

Bute P11: The Dark Art of Dark Matter - Session 1
G466 P12: Water in the Solar System and Beyond
G226 P13: Magnetospheres and Ionospheres Throughout the Universe
Fore P14: Magnetic Coupling of the Solar Atmosphere: Magneto-Seismology of the Solar Atmosphere
G255 P15: VISTA: Performance and Surveys

Wednesday 14th, 1045–1230

Bute P16: Science on the Way to SKA - Session 2
G466 P17: A New Era in Astrochemical Star Formation
G226 P18: General MIST Science Session 1
Fore P19: Energetic Particles in the Solar System and Astrophysical Plasmas: Observations and Theory
G255 P20: Explosions in the Distant Universe - Session 1

Wednesday 14th, 1545–1730

Bute P21: The Dark Art of Dark Matter - Session 2
G466 P22: Disks and Stars at Extremely High Angular Resolution
Fore P23: Magnetic Reconnection
G226 P24: Solar Influences in the Heliosphere
G255 P25: Explosions in the Distant Universe - Session 2

Thursday 15th, 1045–1230

Bute P26: The Sloan Digital Sky Survey: the Legacy and Future
G466 P27: Stellar Populations in Galaxies
G226 P28: General MIST Science Session 2
Fore P29: Modelling of Dynamic Solar Plasmas
G255 P30: Pulsar Astrophysics

Friday 16th, 1045–1230

Bute P31: The Role of Feedback in Galaxy Evolution
G226 P32: Stellar and Exoplanetary Magnetism
G466 P33: Public Engagement in Astronomy, Solar and Solar System Physics
Fore P34: UKSP General Session
G255 P35: New Technologies for Future Instruments, Telescopes and Missions

P01 Galaxy Formation and Evolution in the Low-Redshift Universe With Multi-Wavelength Spectroscopic Surveys

[2010 April 12, 15:45, p43]

We can now study the low redshift Universe ($z < 0.5$) using extensive population statistics with very large galaxy numbers and high redshift completeness levels. In this session, we look forward to contributions on new galaxy survey analyses, which make extensive use of multi-wavelength datasets by combining information from SDSS, GALEX, Herschel, UKIDSS, etc., on highlights from the new GAMA survey, and on results from the most recent galaxy formation models.

The "Galaxy And Mass Assembly" (GAMA) survey is a major redshift survey for galaxy formation with an already unique spectral energy distribution coverage: GALEX-UV, SDSS-optical, UKIRT-NIR, Herschel-FIR and GMRT-radio. GAMA has measured since 2008 over 90k new spectra over 150 sq.deg., probing in a systematic and comprehensive manner the faint galaxy population over a timespan of four billion years ($z<0.5$).

A NAM session focussed around GAMA science and similar multi-wavelength opportunities in the low redshift Universe is ideally timed with the first GAMA data release planned for mid-2010. The major science goals covered by GAMA comprise multi-wavelength galaxy group studies, the evolution of the baryonic content of the Universe and the efficiency with which galaxies form as function of environment.

Organised by: Peder Norberg (IfA, University of Edinburgh), Ivan Baldry (Liverpool John Moores University)

15:45 Aaron Robotham: Galaxy And Mass Assembly (GAMA): The next generation survey of surveys.

16:05 David Hill: GAMA photometry and the Cosmic Spectral Energy Distribution

16:20 Alfredo Carpineti: The colours, AGN properties, environments and star formation histories of bulge dominated post-mergers in the local universe

16:40 Cristina C. Popescu: Modelling the UV/optical FIR/submm emission from Spiral Galaxies

17:00 Claire Burke: Scale Size Evolution of Brightest Galaxies

17:15 Poster adverts

Posters Leonidas Christodoulou: Galaxy Clustering Using Photometric Redshifts

Emma Curtis Lake: Studying galaxy evolution with FMOS (Fibre Multi-Object Spectrograph)

Ignacio Ferreras: A new approach to disentangling star formation histories from survey data

Jennifer Gupta: A new sample of "blazars" to study the relationship between radio-loud AGN and galaxy formation

Edo Ibar: The radio spectral index of sub-millimetre galaxies.

Russell Johnston: Robust methods to probe source evolution in galaxy redshift surveys

Lee Kelvin: GAMA: Single and Multi-Component Galaxy Modelling

Erin Macdonald: The ALFALFA HI Absorption Survey

Matthew Prescott: Red and Blue Satellite Galaxies in the Galaxy and Mass Assembly Survey

Awat Rahimi: Abundance gradients in simulated galaxy discs

Dmitrij Semionov: Modelling radiation fields in galaxies using a new radiation transfer code

Boon Kok Tan: NGC 2976 & NGC 3351: 12CO(3-2) Observations and its Correlation with PAH 8um

P02 Massive Stars: New Views of their Formation and Progeny [2010 April 12, 15:45, p45]

Massive stars, despite their rarity, play a disproportionate role in galaxies since they dominate their ionizing budget, chemical enrichment and feedback. This session will focus upon topical questions relating to the properties and evolution of high mass stars (mass-loss; significance of Luminous Blue Variable stage; binary statistics) and their progeny (core-collapse SN; magnetars; GRBs) and would involve latest results from Tarantula survey ESO large programme, PanSTARRs etc.

The advent of new instruments (SCUBA-2), satellites (Herschel) and progress in finding the earliest stages of massive star formation (eg the IR dark clouds) - as well as the recent renewed interest in models of how massive stars form - also make it timely to hold a session dedicated to the formation of massive stars. In this session we aim to draw together all the exciting work being done in the UK in this field, which we also hope will act as a catalyst to drive future collaborations in the UK community for ALMA projects.

Organised by: Paul Crowther (University of Sheffield), Stuart Lumsden (University of Leeds)

15:45 Adam Avison: Probing Sites of Massive Star Formation: The Methanol MultiBeam Survey

16:05 Heather Cooper: The RMS Survey: Near Infra-Red Spectroscopy of Massive Young Stellar Objects In The Northern Hemisphere

16:25 Ben Davies: A Massive Star is Born: the circumstellar disk, envelope, and bi-polar outflow of W33A

16:40 Christopher Evans: The VLT-FLAMES Tarantula Survey

17:00 Matthew Austin: An ultraviolet study of the the weak wind problem in O stars

17:15 Andrew Mason: High-Mass X-ray Binaries in the NIR: Orbital solutions of two highly obscured systems.

Posters Jane Buckle: A wide-field, high-resolution view of NGC2264

Simon Clark: Multiple generations of massive star formation in cluster complexes

Stacey Habergham: Type Ibc supernovae in disturbed galaxies: evidence for a top-heavy IMF

Mark Rushton: The evolution of the peculiar variable V838 Monocerotis 2002-2009

P03 10 Years of Cluster: the Past, Present and Future of Multi-point Measurements of Space Plasmas [2010 April 12, 15:45, p46]

In 2010, ESA's Cluster mission will have been orbiting the Earth for 10 years making measurements of the magnetosphere, bow shock and solar wind. During this time, Cluster has helped to improve our understanding of various aspects of solar terrestrial and plasma physics including magnetosphere-ionosphere coupling, waves and currents in the magnetosphere, reconnection and flux transport, and plasma shocks. In the coming years, Cluster will be able to make the first multi-point investigations of auroral acceleration processes. With proposals for new multi-spacecraft missions under consideration, and with Cluster having reached this milestone, it is timely to review these 10 years worth of observations and consider how these observations can help us in preparing for future multi-spacecraft missions such as Cross-Scale and MMS.

Organised by: Colin Forsyth (University College, London, MSSL), Andrew Walsh (University College, London, MSSL), Andrew Fazakerley (University College, London, MSSL), Elizabeth Lucek (Imperial College, London), Matt Taylor (European Space Agency)

15:45 C. Philippe Escoubet: 10 Years of Cluster: Highlights of Multi-point Measurements in Space Plasmas

16:15 Khurom Kiyani: Using Cluster's observations of the solar wind to investigate collisionless plasma turbulence -- current results and outlook for the future

16:30 Andrew Walsh: The Magnetotail Plasma Sheet Revisited: Cluster PEACE Statistics

16:45 Jonathan Eastwood: Average properties of the magnetic reconnection ion diffusion region in the Earth's magnetotail: 2001 – 2005 Cluster observations and comparison with simulations

17:00 Roger Duthie: Do BBF events contribute to inner magnetosphere dipolarisation? A three year statistical study using concurrent Cluster and Double Star observation

17:15 Colin Forsyth: Multi-spacecraft observations of auroral electron acceleration by Cluster

Posters Mike Hapgood: Extending Cluster JSOC science operations over the past ten years

Matt Taylor: Here, there and everywhere: getting a feel for boundary layer evolution using multipoint measurements

P04 **New Views of Solar Active Regions from Hinode and STEREO** [2010 April 12, 15:45, p48]

Since their launch in 2006, the Hinode and STEREO spacecrafts have provided us with new insights into the physics of solar active regions. The combination of three telescopes aboard Hinode is offering unprecedented coverage from optical to X-rays thereby enabling studies of the coupling between different layers of the solar atmosphere. Using the observations recorded by the Extreme-ultraviolet Imaging Spectrometer (EIS) aboard Hinode we have measured physical plasma parameters such as electron density, temperature and flows in active regions as a whole, as well as in individual coronal structures. The EUV Imager aboard STEREO has provided us with true 3-dimensional topology of active regions. The new observational results obtained by Hinode and STEREO have provided us with some very important constraints on the theoretical modelling of active region loops. In order to explain the new observations there have been significant advances in the modelling of active region loops. Therefore, it is worthwhile and timely that we compare our theoretical models with observational results.

Organised by: Alison Wallace (University College, London, MSSL), Helen Mason (DAMTP, Cambridge), Giulio del Zanna (DAMTP, Cambridge)

15:45 Alan Hood: What can theory do for you?

16:00 Giulio Del Zanna: Hinode/EIS observations of active region loops

16:15 Len Culhane: Plasma Motions and Magnetic Reconnection Heating in the 2007, May 19 Flare

16:30 Durgesh Tripathi: Active region moss: basic physical plasma parameters and their time variability

16:45 Sarah Matthews: Coronal signatures of a sunspot light-bridge

17:00 Lucie Green: What can Hinode observations tell us about eruptions from sigmoidal active regions?

17:15 Poster adverts

Posters Caroline Alexander: X-ray Bright Point Topology Study with Hinode and STEREO

David Graham: Observations of flare ribbon densities using Hinode/EIS

Iain Hannah: Regularized inversion techniques for recovering DEMs from Hinode/XRT data

Abstracts

Life on Titan
William Bains (Rufus Scientific / MIT)

Living things have distinct characteristics that constrain their possible chemistry, and hence where and how we might look for them. I will discuss the example of Titan: could there be life on the surface? Major limitations are the stability, solubility and reactivity of the chemicals that make up life, and energy sources to drive metabolism. I will review how these constraints can be used to put limits on where life might occur, and the biochemistry that we might look for either remotely or when we get there. The surface of Titan does not look promising, but if there is life there it will be simple, explosively unstable under Earth conditions, and (to us) extremely smelly.

The SuperWASP Project
Andrew Cameron (University of St Andrews) with D. Pollacco, C. Hellier, R. West, and WASP Consortium

The WASP consortium is currently the world's leading producer of extra-solar planets transiting bright stars. Its two automated wide-field camera arrays, SuperWASP on La Palma and WASP-South at Sutherland, each image some 15 percent of the sky with a cadence of 7 to 8 minutes for between 4 and 8 hours each night. Automated software identifies stars exhibiting the one-percent dips in light, recurring every few days, that betray the presence of a compact sub- stellar companion. Efficient winnowing of likely candidates for radial-velocity followup, in collaboration with the Geneva and IAP/Haute-Provence planet search teams, has led to the discovery of some 30 transiting planets to date. In this presentation I will announce a number of newly confirmed WASP planets. WASP's published planet discoveries are enriching our understanding of the closest-orbiting gas giant planets around other stars. They include the hottest, most inflated and shortest period planets yet identified. Many have relatively mundane circular orbits in the stellar equatorial plane. Others have highly disturbed eccentric, inclined and even retrograde orbits. They reveal a rich set of planetary formation and migration histories. Some are grossly inflated by a combination of extreme irradiation and tidal energy dissipation. A small number orbit so close to their stars that tidal orbit decay will lead to their destruction within the main-sequence lifetimes of their host stars. Above all, the WASP systems are bright. Their dayside thermal radiation is accessible to SPITZER and has even been detected from the ground, revealing a wealth of information about their atmospheric thermal structure and chemistry. I will preview the first public release of processed light curve data from the initial year of the WASP project, which will take place this year.

Design challenges in the construction of ELTs
Colin Cunningham (UK Astronomy Technology Centre)

The European Extremely Large Telescope is reaching completion of its design phase. Like any major project, it has to balance cost, risk and performance in order to be affordable on a competitive time-scale and be able to satisfy ambitious science goals. I will describe how this balance has been achieved whilst maintaining the aspiration to build the world's largest optical/IR telescope with built in adaptive optics. I will emphasize UK roles in addressing the considerable challenges of developing the primary mirror consisting of 984 segments, the adaptive optics systems, and the instrument suite. Finally, I will show some of the exciting prospects for scientific, technological and industrial benefits to the UK.

Probing Cosmology with the CMBR
George Efstathiou (Kavli Institute for Cosmology)

The Planck Mission was launched successfully in May last year. I will give a summary of the scientific aims of the Planck Mission and a brief overview of its current status. I will also place the Planck mission in context with ground and suborbital CMB experiments and other probes of early universe cosmology.

The Early Stages of Star Formation
Jennifer Hatchell (University of Exeter)

Where do stars form? How long does it take? What controls their masses? These questions and more are being addressed by mapping surveys of molecular clouds at long wavelengths (infrared and submillimetre), which provide a census of dense cores and the stars forming within them. I will show how the advances in technology which allow us to map large areas are mirrored in our increased understanding of the early, embedded stages of star formation, and look towards the future with Herschel and SCUBA2.

The High Energy Sun
Bob Lin (Univ. of California, Berkeley)

The Sun is the most prolific and energetic natural particle accelerator in the solar system. Large solar flares are the most powerful explosions in the solar system, releasing up to $\sim 10^{32}$-33 ergs in 100-1000 s, with $\gtrsim$10-50% of this energy going to accelerating electrons to $\sim$ 20 keV to $\sim$ 100s of MeV, and a comparable amount to accelerating ions to $\sim$ MeV to GeV energies. Imaging by the RHESSI (Ramaty High Resolution Solar Spectroscopic Imager) spacecraft of the hard X-ray (HXR)/$\gamma-$ray continuum and $\gamma-$ray line emission produced by the accelerated electrons and ions, respectively, show that the process of magnetic reconnection underlies both the flare energy release and the acceleration of electrons and ions. In large Solar Energetic Particles (SEP) events, ions up to $\sim$ 100 GeV and electrons up to $\sim$ 10s of MeV, well into the galactic cosmic ray energy range, are detected in situ near 1 AU. These appear to be accelerated by collisionless shock waves driven by fast ($\gtrsim$1000km/s) coronal mass ejections (CMEs) with of order $\sim$ 10 % of the total CME energy going into the SEPs, the same efficiency as required for supernova shocks to accelerate galactic cosmic rays. The most common ($\gtrsim$100s/month near solar maximum) solar acceleration occurs high in the corona and produces the impulsive SEP events observed in the interplanetary medium, that are dominated by $\sim 0.1 - 100$ keV electrons and by $\sim$ 10 keV to MeV per nucleon ions with enormous (up to $\gtrsim$10,000) enrichments in the isotope 3He and in ultraheavy elements. The acceleration mechanisms are, at best, poorly understood; upcoming missions going close to the Sun, such as ESA's Solar Orbiter (~ 0.28 AU) and NASA's Solar Probe Plus (~ 9.5 solar radii), promise to provide key relevant measurements.

The ESA Cosmic Vision Programme
Mark McCaughrean (ESA)

I will present a brief overview of the ESA space science and robotic exploration programme,

covering missions currently in operation (including Herschel, Planck, and Rosetta) and those in preparation (LISA Pathfinder, Gaia, JWST, BepiColombo, and the ExoMars missions). The majority of my talk will concentrate on the status and promise of the missions currently under study as part of the Cosmic Vision programme, and the roadmap for new opportunities over the coming decade.

Plasma phenomena on all cosmic scales
Don Melrose (University of Sydney)

I will give a brief historical review of the development of the field of plasma astrophysics, emphasizing the problems that motivated the field, and the new plasma-physics ideas that were introduced to address these problems. I will then discuss the present-day status of three generic problems in plasma astrophysics: 1. resonant scattering and particle acceleration; 2. coherent radio emission mechanisms; and 3. dissipation in collisionless astrophysical plasmas.

Proto-planetary disks and planetary migration
Richard Nelson (Queen Mary, University of London)

The discovery of extrasolar planets with a wide range of orbital configurations suggests that orbital migration plays a fundamental role during the formation of planetary systems. During the talk I will review our current understanding of planetary migration, and its dependence on the physical properties of protoplanetary discs, with the role of disc thermodynamics and turbulence being highlighted. Models of planetary system formation including migration will be presented.

Gravitational Astronomy
Bangalore Sathyaprakash (Cardiff University)

The first direct detection of gravitational waves are expected within the next five to six years when advanced LIGO and Virgo detectors begin to operate. The first detection, while a landmark, is only the beginning of what promises to be a new tool for observational astronomy, cosmology and fundamental physics. In my talk I will discuss the current status of gravitational-wave observations and capabilities of future detectors. I will show how future observations might impact our understanding of astrophysical phenomena (e.g., neutron stars, black holes, supernovae, GRGs), fundamental physics (e.g., matter under extreme conditions, strong-field tests of GR, dark energy) and cosmology (e.g., cosmological parameters, black hole seeds, stochastic backgrounds from the early Universe).

Exploring the Universe with Gamma-Ray bursts
Nial Tanvir (University of Leicester)

Thanks to their extraordinary luminosities, $\gamma-$ray bursts can be seen at very high redshifts, and as such provide powerful tools for exploring early structure formation and reionization. Spectroscopy of their afterglows gives redshifts, and potentially also information about chemical enrichment of their hosts and the state of the intergalactic-medium close to the burst. Identification and characterisation of their faint hosts and neighbouring galaxies opens a new window on galaxy evolution. Recently GRB 090423 was detected at redshift z=8.2, highlighting the promise of GRBs for probing the very high redshift universe. I will review this work and other recent developments in the field, including the status of host galaxy searches.

The SWARM Mission
Kathy Whaler (University of Edinburgh)

In 1999, the International Union of Geodesy and Geophysics adopted a resolution to establish an International Decade of Geopotential Field Research, heralding the start of a decade of continuous monitoring of the magnetic field by near-Earth orbiting satellites, and important advances in space-based gravity field observation. For much of the International Decade, multi-satellite vector magnetic observations have been available, leading to much better models of the main field and its rate of change, and improved understanding of the influence of magnetospheric and ionospheric fields on attempts to isolate the internal field signal. However, much remains to be done. For instance, even during the particularly quiet solar activity conditions that have characterised much of the last few years, and after enormous effort on data processing and selection algorithms, magnetospheric and ionospheric field effects remain in data used to produce internal field models, so our signal identification and separation is far from perfect; 'comprehensive models' that are intended to parameterise and model known internal field sources and magnetospheric/ionospheric current systems are still only appropriate for magnetically quiet times. However, the demonstrated power from having available simultaneous multi-satellite information has led to ESA approval for a satellite constellation SWARM within the Earth Explorer programme, scheduled for launch in 2011. In this talk, I will describe the SWARM mission development and anticipated applications of the data, including how the end-to-end simulator study was used to improve the constellation design over that in the original proposal, and the potential of SWARM for investigating atmospheric processes related to climate and weather, such as space weather and radiation hazards, as well as the better definition of the 'geological' magnetic field signal and near-Earth external magnetic fields.

The James Webb Space Telescope
Gillian Wright (University of Edinburgh)

The James Webb Space Telescope (JWST), the successor to Hubble, is a large, 6.5m diameter, infrared-optimized space telescope, scheduled for launch in 2014. It will have a suite of four instruments designed to enable wide ranging science from the first luminous galaxies and galaxy evolution to the formation of planets and the evolution of our own Solar System. In this talk I describe the science themes that have driven the observatory design, the enabling technologies and technical status of the mission and the instrument capabilities, in particular for the mid-infrared instrument MIRI. I will also summarise the plans for operations.

Galaxies and Stellar Populations
Rosie Wyse (Johns Hopkins University)

I will discuss how studying resolved stars in the nearby Universe can be used to infer conditions at high redshift, trace how galaxies evolve and constrain the nature of dark matter. This approach is complementary to direct study of systems at high redshift, but I will show that analysis of individual stars allows one to break degeneracies, such as between star formation rate and stellar Initial Mass Function, that complicate the analysis of unresolved, distant galaxies.

P01

Scale Size Evolution of Brightest Galaxies
Claire Burke (Astrophysics Research Institute LJMU) with C. Collins, and J. Stott

Scale sizes of elliptical galaxies have been a topic of discussion recently due to the unexpected result that these objects evolve from a compact state. We present our preliminary results of scale size measurements of brightest cluster galaxies (BCGs) at z$\sim$ 1, using deep imaging from HST and Subaru MOIRCS of $\sim$ 10 BCGs in both the optical and near infra-red. We find robust BCG scale sizes of $\sim$ 10kpc, and infer that this is evidence for mild size evolution of this homogeneous population since z$\sim$ 1. We discuss implications of this result, in concert with the recent result of no mass evolution of these galaxies over the same period, for cosmological models of the late time evolution of massive early type galaxies.

The colours, AGN properties, environments and star formation histories of bulge dominated post-mergers in the local universe
Alfredo Carpineti (Imperial College) with S. Kaviraj, and Galaxy Zoo team

Galaxy merging is a fundamental aspect of the standard hierarchical galaxy formation paradigm. In Darg et al.(2010MNRAS.401.1043) we have created a large, homogeneous set of mergers through direct visual inspection of the entire SDSS using the GalaxyZoo project, a public user interface on the world wide web for the morphological classification of galaxies. At the time of writing, over 200,000 volunteers have submitted over 80 million classifications yielding a robust catalogue of around 3000 mergers which has been presented in Darg et al. We explore a subset of galaxies from this catalogue that are 'post-mergers', where the remnant appears to be in the final stages of relaxation. We focus on post-mergers that show evidence for a dominant bulge, making them plausible progenitors of early-type galaxies. For this set of galaxies we explore their GALEX-SDSS UV/optical colours, AGN activity, local environments and star formation histories. 64% of our galaxies are either quiescent or show LINER-like emission, while the rest are either star forming (9%) or have Seyfert AGNs (25%). We find that the plausible mass ratios for the mergers that created these systems are between 1:1 and 1:10, with a median value of around 1:3. The spheroidal postmergers have bluer colours than the general elliptical galaxy population, most likely due to merger-induced star formation. Comparison with stellar models suggests that the star formation activity in most of these systems peaked less than 1 Gyrs ago, suggesting that some of star formation recently discovered in early-type galaxies is merger-driven.

Galaxy Clustering Using Photometric Redshifts
Leonidas Christodoulou (University of Sussex) with Jon Loveday, and GAMA Team

The GAMA spectroscopic release offers a unique opportunity to calibrate photometric redshifts from SDSS down to r=19.4. Taking advantage of the fact that GAMA offers a truly representative subset of SDSS we construct a catalogue of $\sim$ 5 million

objects, using an artificial neural network (ANNz). Moreover, we carry out an extensive error analysis to check for possible biases in our redshifts estimation. We also show independent estimations of the underlying redshift distribution, using a weighting method (Cunha et al, 2009), which recovers more accurately the redshift distribution. This allows as to reveal the weakness and the strengths of the two methods. Having done that, we measure the two point angular correlation function in luminosity bins and then using Limber's approximation we calculate the spatial correlation function. Finally we compare with the results in the literature from spectroscopic surveys. However, because of the use of photometric redshifts our work extends to intrinsically faint objects with magnitude down to M=-14.

Studying galaxy evolution with FMOS (Fibre Multi-Object Spectrograph)

Emma Curtis Lake (University of Oxford) with Gavin Dalton, Thomas Mauch, Naruhisa Takato, Naoyuki Tamura, Ian Smail, Philip Best, Jim Geach, David Sobral, and FMOS team

FMOS (Fibre Multi-Object Spectrograph) is now available on the Subaru Telescope for obtaining near-infrared spectra in the J and H bands. With 400 target fibres, within a wide field of view, this instrument provides the means to extend the results from low redshift spectroscopic surveys using the same lines as detected in the optical. In particular, star formation can be traced by H-αemission between $\sim 0.5 < z < 1.7$. I will give overview of FMOS and present initial results, including spectroscopic targeting of HiZELS (High-Z Emission Line Survey) objects.

A new approach to disentangling star formation histories from survey data

Ignacio Ferreras (University College London – MSSL)

Large, homogeneous surveys such as SDSS or GAMA allow us to apply multivariate techniques based at extracting differences between the stellar populations of galaxies in a model-independent way. In this talk I will present recent and ongoing research focused on a volume-limited sample of early-type galaxies from SDSS. Principal Component Analysis (PCA) is used to define two estimators of average age and recent star formation which is then applied to subsamples of close pairs of early-types (i.e. the precursors of dry mergers) or to samples classified according to the mass of the parent halo in order to quantify the effect of environment on the star formation history of galaxies. Future directions for the promising field of multivariate analysis of photo-spectroscopic data will be presented.

A new sample of "blazars" to study the relationship between radio-loud AGN and galaxy formation

Jennifer Gupta (Jodrell Bank Centre for Astrophysics) with Ian Browne

Radio-loud active galactic nuclei are now recognised to be vital in the process of galaxy formation, by providing feedback which regulates the star-formation process. Logically it follows that in order to understand galaxy formation and evolution, we must understand AGN. However, the details of how AGN feedback happens is a difficult problem; there are many unanswered questions, such as what triggers the bursts of AGN activity, how long do the bursts of activity last and how do the bursts evolve. Blazars are a subset of radio-loud AGN where one of the radio jets is directed towards the observer at a small angle to the line of sight. Therefore in blazars we get the most direct view of the relativistic jets that may ultimately provide the feedback. We have defined a new sample of nearby blazar-like objects, attempting to minimise the selection effects in order to understand the fundamental and intrinsic properties of these objects. The Survey of Extragalactic Nuclear Spectral Energies (SENSE) sample contains 151 compact radio core objects within $z < 0.2$. Here we present the SENSE sample with an emphasis on the ways in which we are using multiwavelength observations of the sample to probe the physics of blazars in the low-redshift Universe.

GAMA photometry and the Cosmic Spectral Energy Distribution

David Hill (University of St Andrews) with Lee Kelvin, Simon Driver, Aaron Robotham, and GAMA Team

The cosmic spectral energy distribution (CSED) describes the mean radiation field within the sampled volume of the Universe. It can give insight into the star formation history, and the initial mass function. Its measurement requires accurate photometry from a number of filters, which has previously led to discrepancies between optical and NIR parameters. We introduce the GAMA photometric pipeline - a method for generating consistent colours over a range of passbands. We describe the generation of Gigapixel mosaics and matched aperture catalogues from UKIDSS and SDSS data. We quantify the systematic offsets in best-fitting luminosity function parameters produced by using different aperture types, detection thresholds or total magnitude systems. Finally, we introduce a CSED, produced using the GAMA survey, and compare it to theoretical models.

The radio spectral index of sub-millimetre galaxies.

Edo Ibar (UK Astronomy Technology Centre) with R.J. Ivison, P.N. Best, K. Coppin, A. Pope, Ian Smail, and J.S. Dunlop

We have employed the Giant Metre-wave Radio Telescope and the Very Large Array to map the Lockman Hole. At 610 and 1400MHz, we reach noise levels of 15 and 6microJy/beam, respectively, with well-matched resolutions ($\sim$ 5arcsec). At this depth, we obtained reliable detections for about half of the known sub-mm galaxies (SMGs) in the field (SCUBA, AzTEC and MAMBO). For radio-identified SMGs, which are typically at z $\sim$ 2, we measure a mean radio spectral index of $\alpha(1400, 610)$ = -0.75 ± 0.06 (where $S_\nu \sim \nu^\alpha$) and standard deviation of 0.29, between approximate rest-frame frequencies of 1.8 and 4.2GHz. The slope of their continuum emission is indistinguishable from that of local star-forming galaxies and suggests that extended optically thin synchrotron emission dominates the radio output of SMGs. Cooling effects by synchrotron emission and Inverse Compton scattering off the cosmic microwave background do not seem to affect their radio spectral energy distributions. For those SMGs judged by Spitzer mid-infrared colours and spectroscopy to host obscured active galactic nuclei (AGN), we find a clear deviation from the rest of the sample - they typically have steeper radio spectral indices, $\alpha(1400, 610) \lesssim -1.0$. These findings suggest these mid-IR-/AGN-selected SMGs may have an intrinsically different injection mechanism for relativistic particles, or they might reside in denser environments. This work provides a reliable spectral template for the estimation of far-IR/radio photometric redshifts, and will enable accurate statistical K-corrections for the large samples of SMGs expected with SCUBA-2 and Herschel.

Robust methods to probe source evolution in galaxy redshift surveys

Russell Johnston (University of the Western Cape)

One of the most fundamental, and still relevant, statistical challenges in modern observational cosmology is accurately determining the galaxy luminosity function. Determining the luminosity function of galaxies remains a vital and fundamental tool for assessing the statistical nature of galaxy formation and evolution. Pertinent to this area of study is accurately characterising source evolution in galaxy redshift surveys.

I will present a recently developed method that robustly constrains luminosity evolutionary models by exploiting the properties of the magnitude completeness test developed by Rauzy (2001) and Johnston, Teodoro & Hendry (2007), combined with a maximum entropy approach. This statistical approach has the potential advantage over traditional approaches by not making any assumption of the parametric form of the underlying luminosity function and is also independent the spatial distribution of galaxies.

GAMA: Single and Multi-Component Galaxy Modelling

Lee Kelvin (St Andrews) with Aaron Robotham, Simon Driver, Ewan Cameron, David Hill, and GAMA Team

I present results from the GAMA structural decomposition pipeline (GAMA-SIGMA; Structural Investigation of Galaxies via Model Analysis) for all GAMA objects with optical-to-near-IR imaging from the SDSS & UKIDSS-LAS surveys. I show that photometric modelling shorter than the i band restricts the recoverability of galactic properties, and discuss the role of dust in changing our view of the Universe. I also demonstrate how full bulge-disk-bar decomposition is required in order to gain further insight into the formation and evolution of galaxies, and discuss its application to $\sim$ 12,000 nearby galaxies in the forthcoming high-resolution/deep VST & VISTA imaging of the GAMA fields.

The ALFALFA HI Absorption Survey

Erin Macdonald (University of Glasgow) with Jeremy Darling, and ALFALFA Team

We present the results of a wide-area pilot survey to search for cold Neutral Hydrogen (HI) 21 cm absorption utilizing the Arecibo Legacy Fast Arecibo L-Band Feed Array (ALFALFA) Survey. This survey is the first to conduct a wide-area (517.0 deg^2) ''blind'' search for HI absorption in the local universe. The survey spans $10.9^h < \alpha < 14.95^h$ and $+7.7^\circ < \delta < 6.3^\circ$ centred on the Virgo Cluster. The full ALFALFA survey is an HI emission survey that covers $-650 \sim$ km $\sim$ s$^{-1} < cz < 17,500 \sim$ kms^{-1} (11% of this span is lost to radio frequency interference and Galactic HI emission) resulting in a Δz = 0.054 along each line of sight. When completed, the ALFALFA survey will span 7000 deg^2. Our survey is sensitive to HI absorption lines towards radio sources stronger than 8.4 mJy. This includes 8983 sources for a total search path of $\Delta z = 485.1$. There are 243 sources toward

which all damped Ly-α systems ($N(HI) > 2 \times 10^{20}$ cm^{-2}) could be detected, and 3282 sources toward which $N(HI) > 2 \times 10^{21}$ cm^{-2} columns could be detected. We detect one previously known HI absorption line in UGC 6081, confirming our method is feasible, but make no new detections. Using these data, we calculate an upper limit to the HI column density distribution function and its moments. This pilot survey demonstrates the value and feasibility of large-area radio absorption line searches that are not yet possible with optical telescopes and provides a baseline for future HI 21 cm absorption line surveys planned for new radio facilities, such as SKAMP, ASKAP, MEERKAT and the ATA.

Modelling the UV/optical FIR/submm emission from Spiral Galaxies

Cristina C. Popescu (Jeremiah Horrocks Institute, UCLan) with Richard J. Tuffs

We present a comprehensive library of spectral energy distributions of spiral galaxies in the MIR-submm range calculated as a function of a minimal set of physical parameters using an updated and enhanced version of the model of Popescu et al. (2000). We describe how this set of dust/PAH re-emission SEDs can be self-consistently combined with the existing library of UV/optical dust attenuations calculated using the same model (Tuffs et al. 2004) to invert an observed set of broad-band photometry of a galaxy spanning the UV/optical - FIR/submm range to derive the intrinsic (i.e. as would be observed in the absence of dust) UV/optical emission of the galaxy. Using real and simulated data we illustrate the application of the SED modelling technique to the derivation of star formation rates and star formation histories of optically selected spiral galaxies in the local Universe observed by GAMA and Herschel. Specifically, we quantify how the amplitude and wavelength dependence of the UV/optical attenuation is related to the amplitude and colour of the FIR/submm continuum emission measured using the PACS and SPIRE instruments, and describe how to utilise morphological information from higher resolution optical observations of GAMA galaxies (such as linear sizes of disks and the bulge-disk decompositions) in the interpretation of the panchromatic observations.

Red and Blue Satellite Galaxies in the Galaxy and Mass Assembly Survey

Matthew Prescott (LJMU Astrophysics Research Institute) with Ivan K. Baldry, Phil A. James, and GAMA Team

The role of blue-sequence satellite galaxies in the fuelling of disk galaxies. A long-standing problem for disk galaxies is the origin of the continuing gas supply required to explain their star formation and chemical abundance properties. One possible source is from gas-rich satellites, either through minor mergers ('cannibalism') or from the gas component only of the dwarf being transferred to the disk galaxy, with the gas removal occurring either through tides or through supernova-driven winds. An initial search for gas-rich companions of field disk galaxies using wide-field H αimaging shows that Magellanic Cloud-like satellites are surprisingly rare. The scarcity of gas-rich companions could be indicative of the efficiency with which they have been gas-stripped and transformed into red-sequence, passive dwarfs. In this talk I will present the preliminary results of a study on the red-to-blue ratio of dwarf galaxies around isolated field disk galaxies selected from the GAMA survey, and the variation in this ratio as a function of projected separation.

Abundance gradients in simulated galaxy discs

Awat Rahimi (University College London – MSSL) with Daisuke Kawata, Chris B. Brook, Brad K. Gibson, and Carlos Allende-Prieto

TBC

Galaxy And Mass Assembly (GAMA): The next generation survey of surveys.

Aaron Robotham (St Andrews) with GAMA Team

The GAMA survey is the latest generation photometric and redshift survey. It will cover the full SED of galaxies, from the FUV to the radio, and is complemented by 130,000 redshifts obtained from the AAT over a 3 year period (finishing May 2010). GAMA will probe structure over the scales of 1kpc to 1Mpc, helping us to understand galaxy formation, the energy output of the Universe, and the role of groups and clusters in galaxy evolution.

Modelling radiation fields in galaxies using a new radiation transfer code

Dmitrij Semionov (Jeremiah Horrocks Institute, UCLan)

We describe a new ray tracing radiation transfer (RTR) code being developed at UCLan, optimised for calculating the distribution of radiation fields in dusty galaxies. Primary applications will be to model images and integrated SEDs in direct and dust re-radiated light of synthetic galaxies calculated self consistently with CDM cosmology.

NGC 2976 & NGC 3351: 12CO(3-2) Observations and its Correlation with PAH 8um

Boon Kok Tan (University of Oxford) with Jamie Leech, Dimitra Rigopoulou, and NGLS team members

We present 12C$O(3-2)$ maps of NGC 2976 and NGC 3351 obtained using the James Clerk Maxwell Telescope. Both galaxies are part of the Nearby Galaxy Legacy Survey (NGLS). We combine these data with the 12C$O(3-2)$ maps from Nobeyama Radio Observatory and Berkeley Illinois Maryland Association interferometer to derive CO line-ratio map. The value of 12C$O(3-2)$ to 12C$O(1-0)$ line ratio we obtained was within 0.2--0.6 range. Using this ratio, we derived the total molecular gas mass of 3 $\times 10^7$ solar mass for NGC 2976 and 7.55x10^8 solar mass for NGC 3351. We present spectral maps and discuss the velocity field and the velocity dispersion of the two galaxies. We find that these velocity components are very similar to the data from the VLA survey of HI emission. Using 8 um Spitzer data, we investigated the correlation of the 12C$O(3-2)$ intensity with the PAH 8 micron surface brightness. We study the radial distribution of these star formation tracers in the two galaxies and suggest that the correlation is good at high surface brightness region. We extend this study to include the total surface brightness of the 12C$O(3-2)$ and the PAH 8 μm emission of 17 galaxies within the NGLS samples. We find that the correlation is very good at large spatial scale, as both physical parameters trace active star formation.

P02

An ultraviolet study of the the weak wind problem in O stars

Matthew Austin (UCL) with Raman Prinja

Learning the finer details about mass-loss from stars of early spectral type is imperative. The impact of this energetic phenomenon is great, across a large slice of astrophysics. Recently, determining true mass-loss rates in O stars has been hampered by discordant spectral diagnostics. We describe an effort to compute the run of ion fraction with effective stellar temperature for the whole O star range, for C, N, O, P, S and Si. We give details concerning the project undertaken to fit C IV resonance line profiles in late O dwarfs and highlight the magnitude of the current problem.

Probing Sites of Massive Star Formation: The Methanol MultiBeam Survey

Adam Avison (Jodrell Bank Centre for Astrophysics) with Gary Fuller, James Caswell, James Green, and MMB Collaboration

The Methanol Multibeam survey is a galactic plane survey for Class II methanol masers at 6.7GHz. These unique tracers of massive star formation have been observed using a purpose built seven beam receiver on the Parkes radio telescope, with high resolution counterpart observations taken at the Australia Telescope Compact Array to achieve high accuracy positions.

The southern hemisphere observations is now complete and the first catalogue of MMB results covering the galactic center region (345^o-$> 0^o$-$> 6^o$) has recently been released (Caswell 2009). This along with a complete survey of the Large Magellanic Cloud (Green 2008) highlight the interesting results the survey is already yielding. Work is currently ongoing to compare the locations of massive star formation signposted by the 6.7GHz masers with other data of the galactic plane i.e. infrared surveys (MIPS,GLIMPSE), excited OH masers and soon to be taken molecular line observations. In this talk I will address the latest results of the MMB survey and its future prospects.

Survey of type Ib/c supernova progenitors in nearby star-forming galaxies.

Joanne Bibby (University of Sheffield) with Paul Crowther

Pre-supernova broad-band imaging of galaxies has revealed the red supergiant (RSG) progenitor of Type II SNe. However, whilst Wolf-Rayet (WR) stars are believed to be the progenitor of Type Ib/c SNe a direct observational link is yet to be established. By surveying ~ 10 nearby star-forming spiral galaxies with VLT and Gemini we aim to produce a catalogue of WR stars which can be referred to when a Type Ib/c SNe occurs.

I summarize the narrow-band imaging technique used to identify WR stars, along with Multi-Object Spectroscopy MOS) confirmation. I consider the limitations of ground-based imaging with comparison to HST archival data. By degrading the spatial resolution of a representative sample of LMC Wolf-Rayet stars, to that of a typical galaxy in our sample, we address the question of completeness. We ask would the WR emission still be observed or would it be diluted to the point it was no longer detectable?

Finally, I will discuss completed surveys in our sample and how they are being used to investigate whether the spatial location of different WR subtypes correlates with the light distribution of the host galaxy. Moreover, we can compare the spatial location of the WR stars with both Type Ib/c SNe and GRBs.

A wide-field, high-resolution view of NGC2264

Jane Buckle (University of Cambridge) with J.S. Richer

Understanding the physics of where and how stars form is a fundamental astrophysical question. The processes associated with star formation are important: on large scales, in the structure and evolution of galaxies, to small scales, in the formation of planets. Star formation occurs in dense cores in molecular clouds, and massive stars form in clusters of mixed mass stars. Studies of young clusters are therefore essential for understanding massive star formation.

NGC2264 is an attractive region to study; at 800 pc it is one of the nearest regions of clustered star formation, and contains two young protoclusters. One of these is thought to be forming a massive star of 10-20 solar masses in the centre of the cluster, from the gravitational merger of intermediate-mass cores.

We present wide-field, high resolution 2-D and 3-D imaging of this star forming region covering 1 square degree, in UKIRT WFCAM H2 narrow-band 1-0$S(1)$ line emission and JCMT HARP J=3-2 CO emission. Through CO spectral imaging, we can provide a complete census of protostellar outflow activity in the region, investigating the dynamic impact of the outflows on the natal cloud. H2 emission highlights the youngest flows, from emission arising in gas shocked by the impact of outflows. We use this imaging data to measure the extent of the very youngest flows in the star forming clusters.

Multiple generations of massive star formation in cluster complexes

Simon Clark (Open University) with M. Messineo, H. Parsons, B. Davies, and M. Thompson

The processes governing the formation of massive stars are poorly understood, primarily due to observational difficulties resulting from their rarity and high extinction. Nevertheless it is thought that they predominantly form in star aggregates, which in turn are found within larger cluster complexes associated with the natal GMC. We present the intial results of an extensive multiwavelength observing campaign aimed at constraining the star formation histories of such complexes and the properties of the cold protostellar cores and the (proto-)stars/clusters found within, in order to provide constraints on the physics yeilding them.

The RMS Survey: Near Infra-Red Spectroscopy of Massive Young Stellar Objects In The Northern Hemisphere

Heather Cooper (University of Leeds) with RMS Team

The RMS survey is the largest comprehensive, galaxy-wide survey of massive young stellar objects (MYSOs) to date. Colour cuts defined using 2MASS and MSX data were used to select mid-IR bright point sources from the MSX satellite survey, producing around 2000 candidate MYSOs. A series of multiwavelength follow-up observations have been done to classify these objects and characterise the MYSOs and H II regions. As the final stage of this process, near-IR spectra have been used to distinguish the remaining H II regions, old stars and other sources from the genuine MYSOs. With these near-IR follow-up observations complete in the northern hemisphere, and nearing completion in the southern hemisphere, the preliminary results and plans for exploitation of the near-IR data will be discussed.

A Massive Star is Born: the circumstellar disk, envelope, and bi-polar outflow of W33A

Ben Davies (Rochester Institute of Technology, NY) with S.L. Lumsden, M.G. Hoare, R.D. Oudmaijer, and W.-J. de Wit

The Young Stellar Object (YSO) W33A is one of the best known examples of a massive star still in the process of forming. We present near-infrared high spatial resolution integral-field spectroscopy of W33A, and find evidence for (a) a rotationally-flattened outer envelope at a radius of several thousand AU, (b) a hot circumstellar disk at a radius of 1-3 AU, and (c) a fast bi-polar ionised outflow on sub-milliarcsecond scales, which is aligned with the object's larger-scale outflow. From the kinematics of the material in the inner nebula, we find that the circumstellar disk orbits a central mass of $> 10 M_{\odot}$, while the outer envelope encloses a mass of $\sim 15 M_{\odot}$. These results therefore provide strong supporting evidence for the hypothesis that the formation mechanism for high-mass stars is qualitatively similar to that of low-mass stars.

The VLT-FLAMES Tarantula Survey

Christopher Evans (UK ATC)

30 Doradus in the Large Magellanic Cloud is the largest HII region in the Local Group, providing an ideal laboratory for studies of stellar and cluster evolution. I will give an overview of the VLT-FLAMES Tarantula Survey, an ESO Large Programme which has obtained multi-epoch optical spectroscopy of over 800 OB-type stars in 30 Dor to address fundamental questions of massive star evolution, such as multiplicity, mass-loss, chemical enrichment via rotation, and cluster dynamics.

Type Ibc supernovae in disturbed galaxies: evidence for a top-heavy IMF

Stacey Habergham (Astrophysics Research Institute) with J.P. Anderson, and P.A. James

We compare the radial locations of 169 core-collapse supernovae to the R-band and H αlight distributions of their host galaxies. When the galaxies are split into 'disturbed' and 'undisturbed' categories, a striking difference emerges. The disturbed galaxies have a central excess of core-collapse supernovae, and this excess is almost completely dominated by supernovae of types Ib, Ic and Ib/c, whereas type II supernovae dominate in all other environments. The difference cannot easily be explained by metallicity or extinction effects, and thus we propose that this is direct evidence for a stellar initial mass function that is strongly weighted towards high mass stars, specifically in the central regions of disturbed galaxies.

High-Mass X-ray Binaries in the NIR: Orbital solutions of two highly obscured systems.

Andrew Mason (Open University) with A.J. Norton, J.S. Clark, I. Negueruela, and P. Roche

I present NIR spectroscopy obtained using the VLT and ISAAC of two eclipsing X-ray pulsars, OAO 1657-415 and EXO 1722-363. Both of the high-mass donor stars in these systems have only recently been discovered, due to their high levels of extinction. I will initially discuss our work in spectrally classifying the two donor stars. The donor in the EXO 1722 system was found to be atypical of this class of HMXB. The donor within OAO 1657 was found to be a more evolved Ofpe/WN9 star. These results throw light on the unusual position of OAO 1657-415 in the Corbet diagram. We have constructed radial velocity curves for both of these systems, and I will present orbital solutions and the first NS mass determinations made utilising NIR spectroscopy for each system.

The evolution of the peculiar variable V838 Monocerotis 2002-2009

Mark Rushton (Jeremiah Horrocks Institute, UCLan) with M.T. Rushton, T.R. Geballe, A. Evans, and S.P.S. Eyres

The peculiar variable V838 Monocerotis was discovered in eruption in 2002 and transformed from a K-type star into the coolest known supergiant. Since then, its near-infrared spectrum has been dominated by strong molecular bands, and is reminiscent of that of an L-type brown dwarf. However, V838 Mon continues to evolve rapidly. We present near-infrared spectroscopy of the object obtained on multiple occasions between 2002 and 2009, showing the changes that have occured in that period. The cause of the outburst of V838 Mon is uncertain, but the discoveries of a B-type companion and a nearby cluster of stars shows the object is too young for a nova, or a very late thermal pulse. The leading explanation is a stellar merger.

P03

Do BBF events contribute to inner magnetosphere dipolarisation? A three year statistical study using concurrent Cluster and Double Star observation

Roger Duthie (University College London – MSSL) with Andrew Fazakerley, Iannis Dandouras, and Elizabeth Lucek

The observed dynamical phenomenon of flow in Earth's magnetotail which is intermittent, high-speed & non-field aligned is termed "bursty bulk flow" (BBF). Dipolarisation of the magnetic field within the night-side magnetosphere of Earth may be causally linked to BBFs. Both phenomena are attributed to the Earth's substorm cycle. Competing models attempting to explain substorm processes, and the causal link between BBF and dipolarisation, have still to be conclusively verified or falsified. These are chiefly the current disruption (Lui 1991) & near-Earth neutral line (Baker et al 1996) models. A statistical study has previously been performed (Takada et al 2006) through concurrent observations by Cluster 4 ("Tango") & Double Star Tan Ce 1, making use of magnetotail data from one year. It was found from this that a third of the BBF events detected by Cl4 had with them an associated detection of a dipolarisation event by TC1. The statistical results suggested that the spacecraft separation was generally shorter, and the magnetic field at TC1 typically had a smaller polar component, when association between detections was found. Additionally, near-geosynchronous region ($R \sim 6.6 R_E$) dipolarisations tended not to have an association with BBF event detections. The

present study extends the time interval to three years. The findings from the observation of BBF & field dipolarisations can thereby be fortified and improved. Issues raised by the previous study can be also be more fully addressed.

Lui (1991) A synthesis of magnetospheris substorm models, J. Geophys. Res., 96, 11,389-11,401 Baker et al (1996) Neutral line model of substorms; Past results and present view, J. Geophys. Res., 101, 4967-4989 Takada et al (2006) Do BBFs contribute to inner magnetosphere dipolarizations: Concurrent Cluster and Double Stare observations, Geophys. Res. Lett., 33, L21109

Average properties of the magnetic reconnection ion diffusion region in the Earth's magnetotail: 2001 – 2005 Cluster observations and comparison with simulations

Jonathan Eastwood (Imperial College London) with T.D. Phan, M Oieroset, and M.A. Shay

Collisionless magnetic reconnection plays a key role in the dynamics of the Earth's magnetosphere. Of particular importance is the diffusion region, since this is where the magnetic field ultimately reconnects. Although considerable progress has been made in recent years, many questions remain, in part because it is difficult to make in-situ observations of this region, and so relatively few individual events have been reported in the literature.

To address this problem, the Cluster magnetotail dataset from 2001 - 2005 (constituting 175 magnetotail passes) has been comprehensively surveyed for encounters with reconnection sites in the plasma sheet by searching for correlated reversals in the normal magnetic field and tailward/earthward plasma flow. This survey resulted in 33 events. Of these events, 23 (70%) were in qualitative agreement with the expected pattern of Hall fields, indicating a diffusion region encounter. Within the set of diffusion region encounters corresponding to anti-parallel reconnection, the absolute size of both the Hall electric and magnetic field were both found to vary from event to event. However, with appropriate normalization to the observed boundary conditions, consistent magnitudes of both the average peak Hall magnetic and the average peak Hall electric field are found. To better understand this experimental data, large particle-in-cell simulations were performed, normalized in the same way as the data. A comparison of the observed data and the predictions of simulations will be shown.

These results help to establish the occurrence rate of diffusion regions relative to macroscopic signatures and the average properties of the diffusion region in the Earth's magnetotail. We also discuss the most useful signatures for establishing experimentally the in-situ measurement of diffusion regions.

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10 Years of Cluster: Highlights of Multi-point Measurements in Space Plasmas

C. Philippe Escoubet (ESA/ESTEC) with M.G.G.T. Taylor, A. Masson, H. Laakso, and M. Goldstein

After almost 10 years of operations, the Cluster mission is fulfilling with great success its scientific objectives. The main goal of the Cluster mission, made of four identical spacecraft, is to study in three dimensions the small and medium-scale plasma structures in the key plasma regions of the Earth's environment: solar wind and bow shock, magnetopause, polar cusps, magnetotail, and auroral zone.

During the course of the mission, the relative distance between the four spacecraft has been varied from 100 to 10,000 km to study the scientific regions of interest at different scales. Since summer 2005, new multi-scale constellations have been implemented, where three spacecraft (C1, C2, C3) are separated by 10000 km, with the fourth one (C4) at a variable distance from 40 to 10000 km from C3.

We will highlight some of the main results from the last 10 years: evolution of black auroras, first direct measurements of electric currents, observation of the largest reconnection event of 2.5 million km in length, observations of gigantic surface waves, first evidence of reconnection in turbulent plasma and usage of interferometry to localise electromagnetic emissions. The presentation will also cover Cluster data accessibility, through the Cluster Science Data System (CSDS) and the Cluster Active Archive (CAA) which was implemented to provide a permanent archive of high resolution Cluster data from all instruments.

Multi-spacecraft observations of auroral electron acceleration by Cluster

Colin Forsyth (University College London – MSSL) with A.N. Fazakerley, A.P. Walsh, K. Garza, C.J. Owen, I. Dandouras, K-H. Fornacon, and E. Lucek

During recent years the orbit of the Cluster spacecraft has evolved such that the spacecraft pass through the auroral acceleration region close to perigee during the dayside season. This presents the opportunity to make multi-spacecraft measurements of this region for the first time.

We present a case study of an upward auroral current region observed by Cluster in December 2009. During this event, Cluster 1 and Cluster 3 were approximately located on the same magnetic field-line but separated by 1000 km. We show that the electron population was accelerated along the field-line between Cluster 1 and 3. Magnetic field observations confirm the presence of an upward current system. Based on these observations we estimate the size of the length of the acceleration region.

Extending Cluster JSOC science operations over the past ten years

Mike Hapgood (STFC Rutherford Appleton Laboratory) with M.G. Hutchinson, M.A. Hapgood, T.G. Dimbylow, P.A. Chaizy, and A. McDermott

JSOC has successfully co-ordinated the science operations of ESA's cornerstone Cluster mission for ten years. The original mission duration was two years and extending the science operations beyond this period has been a technical and management challenge, especially as the spacecraft and instruments age, and staff leave and are replaced. Furthermore, the science goals of Cluster have evolved in response to scientific advances and to new scientific opportunities (provided by orbital evolution and by collaboration with new experiments in space and on the ground). Meeting these challenges has brought considerable improvements and positive insights in co-ordinating science operations, including the structured spreading of expertise within the team to minimise risk and increase flexibility as well as building-in increased automation and improved safety checking via rule-based planning techniques. Importantly, expertise has been gained in the theoretical and practical development and use of generic planning concepts and systems aiming at improving the scientific return and the cost efficiency of space science missions, including multi-point missions.

Using Cluster's observations of the solar wind to investigate collisionless plasma turbulence -- current results and outlook for the future

Khurom Kiyani (University of Warwick) with A. Turner, S.C. Chapman, B. Hnat, Yu. V. Khotyainstev, and F. Sahraoui

In-situ observations of magnetic fluctuations in the solar wind show an 'inertial range' of MHD turbulence, and at higher frequencies, a cross-over to scales where kinetic effects become important. This crossover is seen in the power spectral density (PSD) as a second broad-band power law region extending from the typical ion Larmor scale of the system to electron gyroscales. Theoretical studies of plasma turbulence predict the nature of the scaling in this region centred around predictions of the spectral slope and associated scaling exponents.

We present results from high-frequency magnetic field data from Cluster in intervals where the spacecraft were in quasi-stationary ambient solar wind and the instruments were operating in burst mode. The magnetic field data are from the fluxgate and search-coil magnetometers from the Cluster FGM experiment ($\sim$ 67Hz), and the STAFF experiment ($\sim$ 450 Hz). These data sets provide observations of this second scaling range over two decades in frequency. This high cadence allows a precise determination of the statistics at these small scales.

We perform a robust multiscale statistical analysis focusing on the PSD, PDFs of field fluctuations, higher-order statistics to quantify the scaling of fluctuations; as well as describing the degree of anisotropy in the fluctuations parallel and perpendicular to the average local magnetic field.

The study of solar wind turbulence presents some challenges to some recent and future missions. Currently Cluster still possesses some of the best accessible observations of kinetic scale electromagnetic waveforms – even after 10 years. To answer the open question of how collisionless turbulence is dissipated into heating the solar wind, we need to push further the telemetry and sensitivity of measurements from future missions. We conclude by discussing the sources of error from instrument noise and our outlook on how Cluster can inform future missions.

Here, there and everywhere: getting a feel for boundary layer evolution using multipoint measurements

Matt Taylor (European Space Agency) with I.J. Rae, C. Watt, K. Nykyri, B. Lavraud, A.N. Fazakerley, M.W. Dunlop, A. Borg, H. Laakso, C.P. Escoubet, A. Masson, M.N. Nishino, M. Lester, S.E. Milan, J.A. Davies, L. Kistler, C. Mouikis, M. Volwerk, A. Grocott, C. Forsyth, A.P. Walsh, A. Lui, C. Shen, Z. Pu, and J. Shi

On the 11th July 2006, during a period of northward IMF, the Geotail, Double Star 1 and Cluster spacecraft all crossed the magnetopause region within 2 hours (UT) of one another while separated by many hours in local time. During this time large-scale oscillations were observed in both ground based and spacecraft data. We utilize

Large amplitude transverse oscillations in a multi-stranded EUV prominence, triggered by transient disturbances

Jennifer Harris (University of Warwick) with C. Foullon, V.M. Nakariakov, and E. Verwichte

We present the analysis of two successive trains of large amplitude transverse oscillations in an EUV prominence, observed on the North-East limb on 30 July 2005. The oscillatory trains are triggered by transient disturbances produced by two successive flares, which occurred about 10 hours apart in the same remote active region (located just north of the equator, around 500 Mm from the prominence). We use the SOHO/EIT 195 Åimages with a 12 minute cadence to compare oscillatory properties spatially, in different strands of the prominence, and between the two successively excited oscillatory trains. The evolution of the prominence's apparent height above the limb is determined using 304/195 Åimage ratios from SOHO/EIT, and this correction is applied to account for the solar rotation. The various filamentary strands are seen to exhibit different oscillatory behaviour, in terms of their amplitudes, phases and periods. The largest amplitudes, which occur at the prominence apex, are over 20 km/s for the first oscillatory train and around 5 km/s for the second, while the period at this location is approximately 90 minutes in both cases. Some strands show decaying oscillations with a decay time of about 6 hours, while oscillations of other strands are decayless and last for seven cycles. We discuss how the observations may shed light on the nature of the oscillations and the triggering mechanism.

The Magnetic Properties of Flaring Active Regions

Paul Higgins (Trinity College Dublin) with Peter T. Gallagher, D. Shaun Bloomfield, and R.T. James McAteer

The SolarMonitor Active Region Tracking (SMART) algorithm is an automated system for detecting, tracking, and cataloging magnetic features throughout their evolution and decay. The SMART method will form the basis of active region extraction and tracking within the Heliophysics Integrated Observatory (HELIO). Magnetic properties such as total flux, flux imbalance, flux emergence rate, Schrijver's R-value, R* (a modified version of R), and Falconer's measurement of non-potentiality are determined for individual features throughout solar cycle 23. Solar flares measured by the GOES and HSI instruments are associated with detected features, and the relationship between flare size and magnetic property value is presented.

Hard X-Ray Structure of Loop Footpoints in a Solar Limb Flare

Eduard Kontar (University of Glasgow) with Natasha Jeffrey, Iain Hannah, and Marina Battaglia

We apply newly-developed X-ray visibility forward fitting technique to RHESSI data of a well-observed limb flare to investigate the energy and height dependence on sizes, shapes, and position of hard X-ray footpoint sources. The positions, the vertical extents and the widths of hard X-ray sources are measured as a function of energy. Our observations suggest that the vertical and horizontal sizes of footpoints are decreasing with energy while higher energy emission originates progressively deeper in the chromosphere. The characteristic widths of the hard X-ray footpoint source along the limb decrease with height and are consistent with a converging magnetic field in the footpoint. The vertical sizes of X-ray sources are larger than predicted by collisional thick-target transport in a single density scale height chromosphere but can be explained using a multi-threaded density structure of the loop.

New solar prominence diagnostics with EIS/Hinode

Nicolas Labrosse (University of Glasgow) with B. Schmieder, and P. Heinzel

Observations of a solar prominence obtained with the Extreme Ultraviolet Imaging Spectrometer (EIS) on Hinode are analysed. The observed decrease in brightness of EUV coronal lines can be due to two basic mechanisms: absorption and emissivity blocking. The absorption of coronal line radiation in EUV is due to the photoionisation of hydrogen, neutral and ionized helium. The second mechanism is the volume blocking, due to the presence of cool plasma, or of low density hot plasma (cavity). We illustrate these mechanisms using several EIS spectral windows, and concentrate on the raster at 256 A which contains the He II line blended with three other coronal lines. We present a technique to remove the blend between these lines, taking into account the absorption and emissivity blocking of the coronal lines, to retrieve the true He II line profile in order to make a diagnostic of the plasma in different parts of the prominence.

Kinetic Alfvén waves and proton velocity distribution in the solar wind

Xing Li (Aberystwyth University)

Observations of the solar wind have shown that proton velocity distribution functions have distinctive shapes: in the fast solar wind the proton temperature in the direction perpendicular to the background interplanetary magnetic field is higher than in the parallel direction. This suggests that a continuous heating mechanism is needed. The current understanding of incompressible MHD turbulence increasingly points to the importance of kinetic Alfvén waves. As the energy at large scales is converted to smaller scales, MHD turbulence theory dictates that the turbulent wave number will increase in the perpendicular direction while the parallel wave number is largely unchanged. We investigate the effect of kinetic Alfvén waves on the velocity distribution functions of protons in the solar wind. First we use linear Vlasov theory to obtain the property of kinetic Alfvén waves. These waves propagate in the direction almost perpendicular to the background magnetic field. We then numerically simulate how these waves will heat protons and shape the proton velocity distribution functions. At almost perpendicular direction, waves are usually regarded as near electrostatic. However, we will show that the magnetic field of these waves can not be neglected.

Simulations of magnetic flux emergence with an overlying field

David MacTaggart (St Andrews) with A.W. Hood

MHD simulations of flux emergence allow one to model the large-scale structure of the dynamic evolution of active regions. Models that include an overlying magnetic field, for the emerging field to interact with, allow for the possibility of interesting phenomena, such as CME initiation. In this talk we will consider some of these effects and discuss their implications.

Phase mixing of non-linear Alfvén waves

James McLaughlin (Northumbria University) with I. De Moortel, and A.W. Hood

We consider the behaviour of non-linear, non-ideal Alfvén wave propagation within an inhomogeneous environment in both 1D and 2D and find clear evidence for the ponderomotive effect and visco-resistive heating. The ponderomotive effect generates a longitudinal component to the transverse Alfvén wave – with a frequency twice that of the driving frequency. Analytical work shows the addition of resistive heating. This leads to a substantial increase in the local temperature and thus thermal pressure of the plasma, resulting in material being pushed along the magnetic field. Considering Alfvén wave propagation in 2D with an inhomogeneous density gradient, we find that the equilibrium density profile is significantly modified by both the flow of density due to visco-resistive heating and the non-linear response to the localised heating through phase mixing.

SDO/AIA response to coronal hole, quiet sun, active region and flare plasma

Brendan O'Dwyer (University of Cambridge) with Helen Mason, and Giulio Del Zanna

We examine the contribution of spectral lines and continuum emission to the channels of the Atmospheric Imaging Assembly (AIA) on the Solar Dynamics Observatory (SDO) in different regions of the solar corona. Synthetic spectra were obtained using sample differential emission measures (DEM) for coronal hole, quiet sun, active region and flare plasma. These synthetic spectra were convolved with the effective area of each channel, in order to determine the dominate contribution in different regions of the solar corona. We highlight the contribution of particular spectral lines which under certain conditions can dramatically affect the interpretation of SDO/AIA data.

Alfvén wave phase-mixing and damping in the ion cyclotron range of frequencies

James Threlfall (University of St Andrews) with I. De Moortel, and K.G. McClements

The phase mixing of shear Alfvén waves has been proposed as a mechanism for solar coronal heating [1] and such waves may also play an important role in flare heating and particle acceleration [2]. Any treatment of shear-Alfvén waves with frequencies that are a significant fraction of the ion gyrofrequency must take into account the Hall term in the generalised Ohm's law. We use a numerical scheme, Lare2D, to investigate how the phase-mixing and damping of a shear-Alfvén wave are affected by the inclusion of the Hall term, which splits it into a left-circularly polarised ion cyclotron wave and a right-circularly polarised whistler wave. The presence of a transverse gradient in wave propagation speed causes wave damping to occur via phase-mixing (Heyvaerts and Priest [1]), which can be affected by the dispersive properties of the ion cyclotron and whistler waves. Running Lare2D for the case of a single small amplitude perturbation, we have recovered results obtained by Hood et. al. [3] in the MHD limit. We are now using the code to model the damping of such a pulse in the Hall-MHD regime, and in the presence of equilibrium gradients.

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[1] Heyvaerts, J. and Priest, E. R., Astron. Astrophys. 117, 220 (1983) [2] McClements, K.G. and Fletcher, L., Astrophys. J. 693, 1494 (2009) [3] Hood, A. W., Brooks, S.J., and Wright, A. N., Proc. R. Soc. Lond. A, 458, 2307 (2002)

Automated detection and tracking of magnetic fragments in decaying solar active regions

Fraser Watson (University of Glasgow) with Lyndsay Fletcher

The break up and decay of solar active regions is a process that is currently not well understood. To provide more insight into the nature of the decay, we have devised a method for automatically detecting magnetic fragments within active regions and tracking them through multiple images. This is done using 96 minute magnetograms taken by the MDI instrument on board SOHO and gives us 13 years of consistent data to work with. A catalogue of active region fragments has been completed for the year 2001, during the peak of the last solar cycle, and has allowed us to look at physical properties of the individual fragments, track their position and 'proper motion' and examine the overall fragment distributions. We hope to use the catalogue to determine possible causes of active region breakup and look for any trends that exist in this process. I will present the results of this preliminary analysis of the 117,242 fragments detected, along with some ideas for future use of the algorithms and catalogue.

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FIRST Explorer - spaceborne low-frequency radio astronomy using passive formation flying

Jan Bergman (Swedish Institute of Space Physics) with Richard Blott, Alistair Forbes, David Humphreys, David Robinsson, and Constantinos Stavrinidis

Space-borne low-frequency radio astronomy has been identified as a key science application for a conceptual pathfinder mission, using a novel space-flight concept called “passive formation flying”. The mission, FIRST Explorer (Formation-flying sub-Ionospheric Radio astronomy Science and Technology), is currently under study by the European Space Agency (ESA). Its objective is to demonstrate passive formation-flying and to perform unique science with a very high serendipity factor, by opening a new frequency window to astronomy. Traditionally, formation-flying requires continuous and minute corrections of the orbital elements and attitudes of the spacecraft. This increases the complexity, and associated risk, of controlling the formation, which often makes such studies infeasible for technological and economic reasons. Passive formation-flying offers a remedy to those problems. Spacecraft in a passive formation are allowed to drift and rotate slowly, but by using advanced metrology and statistical modelling methods, their relative positions, velocities, and orientations are determined with very high accuracy. The metrology data is used directly by the radio astronomy payload to compensate for spacecraft motions in software. The normally very stringent spacecraft control requirements are thereby relaxed, which significantly reduces mission complexity and cost.

Hydroxide catalysis bonding research for astronomical applications

Nicola Beveridge (University of Glasgow)

The Institute for Gravitational Research at the University of Glasgow has a well established history in the research of hydroxide catalysis bonding for ground and space based gravitational wave detector applications. Hydroxide catalysis bonding, used to bond silica suspension elements to silica mirrors and for bonding silica optics to Zerodur, produces strong, thermally conductive and low loss bonds. The technique can be applied to many other (oxide) materials and is therefore of interest for alternative purposes, including astronomical projects such as the Extremely Large Telescope where PZT material is bonded to silicon or silicon carbide, or optical filter applications where coated silica substrates to can be bonded onto silica discs in order to transfer coatings. This presentation is aimed at giving a brief overview of the research of a few of these applications.

HARMONI - A UK led first light spectrograph for the E-ELT

Fraser Clarke (University of Oxford) with Niranjan Thatte (PI)

HARMONI is a visible/near-infrared integral field spectrograph currently being considered as one of the first light instruments for the 42-m European Extremely Large Telescope. HARMONI will provide medium-high resolution ($R \sim 5000 - 20000$) spectroscopy in the V-K bands (0.47-2.5 microns) over an extended field of up to 10x5 arcseconds. It will provide a range of pixels scales of 40mas/pixel to sample the telescope's GLAO corrected PSF, down to 4mas/pixel to sample the diffraction limited images provided by the ATLAS-LTAO system.

I will outline the key science cases for HARMONI, ranging from extrasolar planets to high redshift galaxies, along with the key technologies which will make HARMONI possible.

The HARMONI consortium is UK-led (University of Oxford and UKATC), with French and Spanish partners, and offers the possibility of key UK involvement in the E-ELT at the very earliest opportunity. Along with 7 other instruments, HARMONI has recently completed a phase A conceptual study for ESO.

Lumped Element Kinetic Inductance Detectors suitable for large arrays of astronomical detectors.

Simon Doyle (Cardiff UNiversity) with Phil Mauskopf

The Lumped Element Kinetic Inductance Detector (LEKID) is a simple to fabricate, superconducting device suitable for use in large multiplexed detector arrays. To date the LEKID has demonstrated 200 micron detection of a cryogenic blackbody source and successful testing of a demonstration array operating at 2mm on the IRAM telescope in October 2009. Due to its combined absorbing and detecting elements the LEKID is an extremely simple detector to fabricate requiring only one deposition and etch step to produce an array of up to 1000 pixels being multiplexed onto a single feed-line. The LEKID is also a very compact detector making it ideal for producing arrays with high filling factors. The suitability of the LEKID for use in large arrays has prompted a return visit to the IRAM telescope with a dual band instrument in 2010. This presentation will give an overview of the LEKID detector as well as its use outside the mm and sub mm astronomy bands.

Milli-kelvin cooler for the XMS instrument on the International X-ray Observatory

Ian Hepburn (University College London – MSSL)

The worlds first cryogen free flight worthy adiabatic demagnetisation refrigerator for the cooling of cryogenic detectors to 50 mK was delivered to ESA in June 2008. This system was developed by MSSL in association with EADS Astrium under contract to ESA and developed as a technology development for the XEUS mission (now renamed the IXO). The ADR was constructed as a set of sub-systems in order to enable changes in technology and requirements at a later date to be integrated into the system. Vibration qualification was performed on the sub-systems to Ariane 5 levels.

In this presentation we present details of the delivered ADR, its sub-systems, the proposed 50 mK cooler for the cooling of the TES detectors on the X-ray microcalorimeter spectrometer instrument (XMS) for the International X-ray observatory and ongoing development in heat switch technology which will enable a continuous ADR to be constructed.

High-Precision Interferometry and Low-Loss materials for future Gravitational Wave Observatories

Stefan Hild (University of Glasgow)

Large-scale Michelson interferometers form the core of current and future Gravitational Wave Antennas. Since the days of Albert Michelson and Edward Morley, the sensitivity of Michelson interferometers has been improved by more than 12 orders of magnitude. To further improve our ability to scan the sky for gravitational wave signals a variety of innovative interferometric techniques and low loss materials are required. This will lead to 2nd and 3rd generation detectors such as Advanced LIGO and the Einstein Telescope.

This talk will survey current/future techniques in interferometry such as squeezed light, optical rigidity and other Quantum-Non-Demolition techniques. Furthermore, the properties of Silicon as a cryogenic material and the novel concept of a monolithic reflector based on micro-structured surfaces will also be presented. This allows the fabrication of highly reflective mirrors without the use of different materials, which results is an optical component with a low thermal noise.

Reducing risk in cryogenic instrument design: thermal conductivity measurements at the Cryogenic Instrumentation Research Lab

Julia Kennedy (Institute for Astronomy, University of Edinburgh) with A.L. Woodcraft

Poor knowledge of the physical properties of materials is a severe limitation on cryogenic design, and as instruments increase in complexity while budgets shrink this lack of knowledge is posing an increasing risk to costs and schedules.

Furthermore many new materials, particularly polymers, offer the prospect of improved performance but there is little information on their cryogenic properties.

Unfortunately, very few groups capable of making useful measurements are able to devote significant time to doing so. At the CIRL (Cryogenic Instrumentation Research Laboratory), we are carrying out a systematic programme of measurements of the thermal and electrical properties of materials from below 4 K to room temperature, concentrating on those of use in large cryogenic instruments.

These measurements are part of a UK government funded programme to improve the ability to construct cryogenic instruments in both academia and industry.

We present the results of initial measurements and discuss our plans for the near and longer-term future.

Novel deformable mirror developments for astronomy applications

Mel Strachan (UKATC)

The UKATC has been collaborating is a series of projects directed towards addressing the adaptive optic challenges posed by the European Extremely large telescope. We have developed novel technological solutions for both large deformable mirrors for telescope wavefront correction, and miniature deformable mirrors for use within instruments. Our large deformable mirror surface material, a compliant from of silicon carbide, offers a Young's Modulus comparable to glass but with greater, non-catastrophic, resistance to fracture. In combination with the extraordinary new material we have been working on a new low power actuator with a deflection capability of tens of microns.

Adaptive optic requirements for instrumentation such as EAGLE for the European extremely large telescope present an enormous challenge to deformable mirror technology. We have developed a unique approach using fabricated arrays of multilayer actuator technology to address the requirements of actuator density and deflection. Our programme of work has uncovered a novel approach which has led to a built in test capability. We will present the outcomes of our work which we believe will lead to a compact deformable mirror.

Probing the atmospheres of extrasolar worlds with a dedicated mission from space

Giovanna Tinetti (UCL) with M. Swain, M. Tessenyi, M. Ollivier, G. Vasisht, P. Deroo, J.P. Beaulieu, T. Henning, and THESIS team

The THESIS mission concept is a space-based, modest cost, low technical risk mission capable of characterizing the atmospheres of exoplanets, including super-Earths in the habitable zone. Significantly, THESIS does not require new technology. Building on the successes of the Spitzer and Hubble space telescopes, THESIS would be highly optimized for system stability (1 part in 10^5) and would deliver photon-noise-limited spectroscopy and photometry over the crucial 0.5 –16 micron wavelength range. This range of wavelengths contains signatures of water, methane, ammonia, carbon monoxide, and numerous other molecules, and includes molecules of potential prebiotic significance. Because molecules serve as probes of composition, conditions, and chemistry, molecular spectroscopy of the dayside and nightside regions of exoplanet atmospheres is the most powerful tool available for studying these objects. THESIS would be the first mission explicitly designed to characterize planets where life could exist; THESIS would profoundly advance our understanding of the physical conditions and likely the histories of exoplanets, ranging from hot-Jovians to super-Earths. THESIS would be a low-cost US-European mission with enormous discovery potential.

Astronomy at the highest energies: the Cherenkov Telescope Array

Richard White (University of Leeds)

Very-High Energy (VHE) $\gamma-$ray astronomy is dominated by Imaging Atmospheric Cherenkov Telescopes (IACTs) and is reliant upon the detection of Cherenkov radiation from electrons in cascades initiated by astrophysical $\gamma-$rays high in the Earth's atmosphere. Results from the latest generation of telescopes, such as HESS, MAGIC and VERITAS have revealed a sky rich with different classes of VHE object.

Still the limits of the IACT have not yet been reached, and to push the high-energy frontier of photon astronomy the Cherenkov Telescope Array (CTA) has been proposed. Comprising 50-100 IACTs of two to three sizes, CTA will provide an order of magnitude increase in sensitivity from $\sim 3 \times 10^{10}$ to $\sim 10^{14}$ eV. Despite the extreme energies, CTA will possess the best sensitivity and angular resolution at any energy above the hard X-ray band.

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