Annual Report for 2016

Centre for Astrophysics and Planetary Science

School of Physical Sciences
University of Kent

http://astro.kent.ac.uk
## Contents of Annual Report

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1 General Objectives

CAPS was established to act as a forum to draw together all those with research interests in astronomy and space science. As a Unit with an international reputation, it would attract visitors and provide a consolidated basis for funding. The Centre has proven to be an invaluable focus not only for research activity, but also providing a strong public profile for astronomical and space science activity within Kent.

CAPS has two main sub-groups, each with four faculty members. These are: Solar System Science and Star Formation, although CAPS members regularly publish over a much wider variety of astrophysical topics. The Solar System group studies phenomena from planets, to asteroids and comets, and down to sub-micron interplanetary dust. The Star Formation group studies molecular clouds, protostars and star clusters. CAPS has grown from 4 faculty members in 2008 to 8 now with over 30 active researchers including two post-docs, one experimental officer, 20 postgraduate research students, and other visiting and associated staff.

Mission Statement. CAPS exists to:
(a) act as a Forum to bring together all those with research interests in Astrophysics and Planetary Science,
(b) advance the Frontiers of knowledge in astronomy and space science with top quality research,
(c) Foster interest in the study of our Universe,
(d) Further astronomy to the surrounding community and provide an expert and accessible resource.

The general Strategy of the Centre is:

1. To provide a focus for astronomical and planetary science research that crosses disciplinary borders, and to construct a larger coherent grouping.
2. To provide an opportunity to exchange ideas and information between departments and other interested parties.
3. To raise the profile of Kent in the international community, acting as a host for short and long term visitors, supporting collaborations and the use of external facilities.
4. To act as a body for hosting seminars, workshops and conference.
5. To raise the profile and awareness of astronomy and planetary science in Kent by involving schools, amateur astronomers and the general public.
6. To provide a common infrastructure, sharing archival data, knowledge and computing resources.
7. To provide a forum for cross fertilisation of doctoral and postdoctoral training and support, and to support their interests nationally.
8. To provide a local host for Astronomy in the South-East of England through the SEPnet and SEPNet-Astro Community.
CAPS Annual 2016

2 2016 Summary

CAPS thrived in 2016, with a high number of quality publications, extensive public engagement and several workshops organised. The Centre published 24 journal papers in 2016. A full seminar programme and other research, training and teaching resources were provided (see the webpages http://astro.kent.ac.uk).

The Triennial Report for the Centre was accepted by the University Research Board. It is available from: http://astro.kent.ac.uk/annualreports.html

The Beacon Observatory is now well established as a working observatory serving research, teaching and outreach activities, going beyond expectations. Regular reports are posted here.

In REF2014, CAPS represented the entire Kent physics Unit of Assessment, in the national Research Excellence Framework, the 5-year research evaluation exercise other research groups all contain physicists but were submitted to other UoAs. We obtained a creditable rating with 27\% 4* research activity, placing Kent 13th in the country overall and top in the country for small-to-medium physics groups (under 20 academics). We also came top in the University for REF funding per FTE.

Growth. CAPS is part of the rapidly expanding School of Physical Sciences which now has 35 faculty members organised within four research groups. In addition to Physics with Astronomy, a unique Astronomy and Space Science degree (BSc and MPhys) is offered at Kent. The annual intake exceeds 60 astronomy degree and 80 straight physics students. We train and supply researchers for the aerospace industry (e.g. Airbus) as well as for commerce and science sectors. The strain due to inflated teaching duties has impacted on research time and research quality. This has been felt for several years and the balance is now being redressed to maintain both research and teaching vitality.

Awards. The Centre has received support through the award of time on facilities to the estimated value of £6 Million over the last five years. This is the allocated in-kind value to CAPS as Principle Investigators. The University benefits from this invisible income without any visible expenditure in terms of space, facilities or other human resources. Hence, this research income is not just turnover but is actually profit. As Co-Investigators, the value cannot be plausibly estimated but is many times higher. In addition, an STFC consolidated grant has been awarded and directed towards solar system science by Burchell and Price (£406k, 2013-2016) and will now includes Lowry for the period 2016-2018 to the value £850k. Price also holds a STFC/Aurora grant (£100K).

Teaching. Since 2005/6 the undergraduate population taking Astro-related degrees has risen from 46 to 172 in 2012, remaining constant in 2013. In addition, the CAPS staff are
heavily involved in the straight physics programmes which have suffered even higher success.

A wide range of world-leading facilities were utilized. CAPS contributes directly to this international facility. Facilities which were employed in the reported results include the Herschel and Spitzer Space Observatories (ESA/NASA), the Very Large Telescope (ESO, Chile), VISTA (ESO, Chile), the SMART spacecraft (NASA), the Rosetta spacecraft (ESA), and UKIRT.

Internally, the High-Velocity Impact Lab and the Forge Supercomputer were in full use. Both facilities will need some investment to sustain their discovery capabilities. The Impact Lab is running out of space and a solution must be found. The Forge supercomputer is heading towards full capacity and we anticipate the need for replacement in 2016.

Open Access. We endeavor to publish all our journal papers on the open access site astro-ph. Positions are helds Editor-in-Chief of two open access journals.

3 January – April 2016 Triannual Update

Highlights

A paper was published in *Science* with Jon Hillier as co-author: “Cassini detects interstellar dust grains”

Abstract: The interstellar medium contains an array of small solid particles known as dust grains. Altobelli et al. used the dust analyzer on the Cassini probe to detect 36 interstellar dust grains as they passed by Saturn, and they measured the grains’ elemental abundances. The results show that, remarkably, these grains lack carbon-bearing compounds and have been homogenized in the interstellar medium into silicates with iron inclusions.

An International Workshop was held on campus:

James Urquhart organized this two-day workshop on star formation hosted at the School (http://astro.kent.ac.uk/~jsu/workshop_2016/index.html), which was supported by SEPNet and the Faculty of Sciences Internationalisation Mobility Fund. A number of CAPS members presented their research.

A Workshop on Cosmology was held at the University in January, organized by students with Michael Smith as the mentor. It was entitled: *Realising the Potential of Future Science Surveys*. It ran 10-12 January 2016, the venue was Woolf College.
Student prize winner. Chrysa Avdellidou participated and gave a talk at the LPSC conference in Houston, TX (20-25/03/16). She won the LPI prize for the best abstract contribution in this conference (1,500 dollars).

External Appointment. Penny Wozniakiewicz has been elected as one of the three UK Planetary Forum committee members, effective from 1st July this year. As a committee member, she will be co-responsible for organising the yearly conference, the planetary session at the annual NAM meeting as well as keeping the website and UKPF mailing list up to date.

Student awarded Arecibo time. Agata Rozek is PI on a proposal ‘Observations of a near-Earth asteroid (85990) 1999 JV6 with Arecibo Planetary Radar’ that has been awarded grade B, and scheduled for 6 nights between 13-19 January 2016 (project ID R3036) http://www.naic.edu/vscience/schedule/tpfiles/RozektagR3036tp.ps

Jakob Deller has just been awarded a prestigious international prize for PhD thesis work - the Springer Thesis prize. Jakob defended his thesis in September, which will now be published in the Springer Theses Series that recognizes outstanding PhD research which makes a significant advance in the field. The competition is international across all areas of science.

Figure 1: Participants of Workshop on Milky Way apart from photographer

**Beacon Observatory:**
The Beacon Observatory has been used for most of the clear nights in the report
period, despite the loss of funding to support the observatory assistants. Observations have been carried out on 45 days since beginning January.

From the end of August to now we have taken 8767 science frames with a total integration time of 350hrs. In total observations have been carried out on 69 days so far (totalling 464hrs).

We have re-installed the guide camera and it seems to be working, but will need some night-time testing. Nice images are available on the website or (mostly) facebook page of the Observatory).

**New Members**

Dr Lewis Dartnell joined CAPS giving his inaugural seminar in April entitles: Astrobiology on Mars: detecting signs of life and their degradation by cosmic radiation.

CAPS members are listed here: http://astro.kent.ac.uk/staff.html
Figure 2  NGC7129 VRI (30min each). The green fuzzy, South-West of the object, is HH103 - emission comes from the Halpha line in the Red filter.

**Funding & Proposals**

CAPS advertised two PhD studentships, one STFC funded (Urquhart) and one VC GTA (Miao).

Dirk Froebrich: Submitted as Col application for public survey with VISTA (VVV+), got to 2\textsuperscript{nd} stage, submitted now.

James Urquhart: submitted grant proposal to STFC

**Public Engagement**

Michael Smith gave an interview on BBC Radio Kent on the gravitational wave discovery in February.
Michael Smith covered the solar eclipse as seen from Langkawi Island, Malaysia. He also visited Singapore where he met his ex-PhD student Dr Ramachandran Babulshkan.

**Visitors**

Dr Karen Masters came from University of Portsmouth to talk on: Galaxy Zoo: Citizen Science for Research

Dr Kathy Romer came from the University of Sussex and held a talk entitled: Dark Energy: Might the Universe have been playing tricks on us?

**Events & Activity**

Ofer Lahav and Michael Smith introduced and held a panel forum after the showing of the new movie Star Men at the Gulbenkian Cinema on campus in February.

Anne Bucker PhD thesis passed
Jack Nicholas MSc thesis passed

Chrysa Avdellidou successfully defended her thesis. She got a 2-year internal ESA fellowship, to work at ESTEC, Netherlands, starting October 2016 on the analysis of lunar impact flashes and Near Earth Asteroid observations in collaboration with the National Observatory of Athens, the Observatory of Nice and the Impact Lab at UoK.

Hibbert, Wickham-Eade and New attended the LPSC conference in Houston, Texas, and all presented work from their PhDs.

Agata Rozek attended CUDA programming workshop organised at Kent, on 26 and 28/01/2016, led by Sam Coveney (Scienceable Skills).

Michael Smith provided the welcome for the SEPnet enterprise event: Connecting Industry and Researchers in Physics
A South East Physics Network (SEPnet) Event
Wednesday 27 January 2016 - 17.00-20.00, University of Kent

At this event, PhD student Greg Smith introduced his video which won him the prize of a trip to the Russian space centre.

Justyn Campbell-White spoke about the Beacon Observatory at three physics undergraduate open day events.
Figure 3. IC5070 (The Pelican Nebula) in VRI (60min each) as seen from the Beacon Observatory on campus. Courtesy of Dirk Froebrich.

Figure 4. Radio galaxy simulations from Donohoe & Smith 2016
May – September 2016 Triannual Update

Highlights

CAPS Reports will now take the form of Annual Reviews with short Triannual updates rather than full detailed activity each four months. This is due to the growth of the Centre.

One paper that may be brought to your attention for the journal is the following: Characterization of space dust using acoustic impact detection. Robert Corsaro, Frank Giovane, Jer-Chyi Liou, Mark Burchell, Michael Cole, Earl Williams, Nicholas Lagakos, Albert Sadilek, and Christopher Anderson. Journal of the Acoustical Society of America 140(2), 1429 -1438, 2016

The CAPS Triennial Review was approved by the University in January 2016.

The STFC has accredited SPS to continue to hold PhD Studentships after evaluation of the training and environment.

We welcome new students to the Centre including PhD students Sam Billington, Tanveer Bhachu, and MSc students Daniel Montague and Thomas Mangat.

Beacon Observatory:

The Beacon Observatory has been used for most of the clear nights in the report period. Observations have been carried out on 49 days in the period May-Sep. In total 192hrs have been used.

Since the beginning of Sep 2015 we have taken ~13600 science frames with a total integration time of 411hrs. In total observations have been carried out on 117days so far (totalling 524hrs).

We have now enough statistics for some usage numbers:
Usable Nights per Month: 8.4 ± 3.8
Fractionof Nights used: 27% ± 12%
Usable Hours per Month: 37.5 ± 17.1
Usable Hours per clear night: 4.7 ± 1.4
Fraction of dark time used in clear nights: 55% ± 14%
Fraction of all dark time used: 15.3% ± 9.1%
There are no month/season specific usage stats available yet.

The observatory has mostly been used to support the HOYS-CAPS citizen science project. In total almost 900 observations have been done in support of this project. This data has been presented at an international conference and during a colloquium talk at St Andrews University.
We have established a calibration schedule that is now routinely run. We plan to set up an automatic data reduction pipeline during the next few months for all the data obtained.

The observatory was utilised during this years Space School.

Various nice images are available on the website or (mostly) facebook page of the observatory.

For more: https://www.kent.ac.uk/physical-sciences/news/front-page/observatory-one-anniversary.html

**Events & Activity**

Just some of the Conferences attended:
Dirk Froebrich presented citizen science talk at the Postgraduate Research Festival
Dirk Froebrich presented talk and poster at Star Formation 2016 conference in Exeter.

Col of application for public survey with VISTA (VVV+); 1900hrs of VISTA time as public survey has been granted for this.

Visited St Andrews University for invited colloquium talk
*Given 2 public outreach talks to amateurs*

Jingqi Miao attended the Star Formation 2016 conference in Exeter and presented a poster.

James Urquhart gave an invited talk at the VIALACTEA meeting in Rome.
Michael Smith attended the Exeter conference and a Big Data workshop in Abingdon.
Dr Kathy Romer from Sussex visited and gave a colloquium in April. Dark Energy: Might the Universe have been playing
Keith Hawking, a PhD student from Cambridge, gave a talk for CAPS entitled: Dissecting the Milky Way Using Large Spectroscopic surveys

MSc: Karl Landers passed with minor correction

**Funding & Proposals**

Tariq Zegmott won a Royal Astronomical Society grant, awarded in September. It was for funds to attend a planetary science winter school coming up in November.

Dirk Froebrich is CoI on application for public survey with VISTA (VVV+); 1900hrs of VISTA time as public survey has been granted for this.
Jingqi Miao submitted a proposal for using the 30 M IRAM radio telescope for a research project of dynamics and initial conditions in RDI-triggered star-forming regions: IC1396, as a Co-I with the PI Dr Aurora Sicilia-Aguilar on 14-Sept-2016.

Mercury’s transitted the Sun on Monday May 9 in the afternoon.
A rare event, visible from Canterbury, took place on the first day of the new term. The planet Mercury cut in front and move across the Sun. Our SpaceSoc followed the event on campus from the location of the telescopes at the Beacon Observatory, across Parkwood at East Oast. CAPS astronomers provided commentary although the weather did not play a positive role.

**Space School**

The 2016 summer Space School was highly successful with feedback showing 24 out of 25 having been inspired by the weekend. Emails from parents:

‘Once again, you have completely succeeded in energising our son! - He had a brilliant time and is insisting we book him in for next year :-) Thanks to you and the team for organising such a good fun, educational and exciting weekend for the kids.’

‘I just wanted to say thank you very much for the space school, my daughter had a great time, she found everyone friendly and helpful, and it has definitely enhanced her enthusiasm for physics. It all seemed very well organised and run from what I could tell.’

*Webpage:* [http://astro.kent.ac.uk/mds/Spaceschool/](http://astro.kent.ac.uk/mds/Spaceschool/)
*Report:* [https://www.kent.ac.uk/physical-sciences/news/front-page/space-school-2016.html](https://www.kent.ac.uk/physical-sciences/news/front-page/space-school-2016.html)

**Royal Society Exhibition**

Stephen Lowry was part of a team co-hosting an exhibit related to UK’s involvement in the Rosetta comet space mission. SPS had several volunteers involved.

You can read more here:


The exhibit is featured here:

RAS Friday meeting “Icy worlds in the Solar System”, held at the Royal Astronomical Society (London) on Dec. 9th 2016. The main proposer and organiser was Kathryn Harriss eith Mark Burchell. There were 13 speakers and over 60 attendees. We held a An exciting mix of talks provided and interesting and successful meeting.

FROZEN WORLDS AND LANDSCAPES OF OUR SOLAR SYSTEM:

Duncan MacKay is making significant contributions by exploring creativity: See:

2. Open and Active Uncertainty in Prynne's 'Kazoo Dreamboats'  Tears In The Fence Vol 65 In Press
Mark Burchell gave an invited talk at the ISSI Bern Workshop on Cosmic Dust, Switzerland, Oct 31st – Nov 4th, 2016. Talk title: Comic Dust Too Small for Astrobiology?

Observatory Report:

The Beacon Observatory has been used for most of the clear nights in the report period (except over Christmas/New Year). Observations have been carried out on 42 nights in the period Oct-Jan. In total 265hrs have been used.

Since the beginning of Sep 2015 we have taken ~19200 science frames with a total integration time of 597hrs. In total observations have been carried out on 154 days so far (totalling 524hrs).

We have now enough statistics for some usage numbers:

Usable Nights per Month: 9.1 ± 3.9
Fraction of Nights used: 29.6% ± 12.5%
Usable Hours per Month: 44.6 ± 22.2
Usable Hours per clear night: 5.0 ± 1.4
Fraction of dark time used in clear nights: 53.7% ± 13.1%
Fraction of all dark time used: 16.2% ± 8.7%

There are no month/season specific usage stats available yet.

The observatory has mostly been used to support the HOYS-CAPS citizen science project. In total almost 1400 observations have been done in support of this project. We are preparing a first publication using some of the data.

We have set up an automatic data reduction pipeline which is now routinely run after every night of observations. It provides basic data reduction, astrometry, photometry, nightly seeing and background statistics and image stacking. The University of Leicester is interested in utilising the pipeline for their student observatory.

We used student project funding to upgrade the hard drives in the data reduction PC. This ensures data backup for the next two years. The Head of School has also given us financial support to purchase an automatic mirror cover and second outside humidity sensor which will protect the mirror much better and prolong its life.

Nice images are available on the website or (mostly) facebook page of the observatory. [https://www.facebook.com/groups/899402023437160/](https://www.facebook.com/groups/899402023437160/)
New Members

CAPS members are listed here:
http://astro.kent.ac.uk/staff.html

We welcome
Dr Kathryn H. Harriss appointment as lecturer for the duration of Pennys maternity leave

Other Activities

Justyn Campbell-White is preparing a SEPnet learning module, Introduction to virtual observatory tools for astronomers, after his proposal was accepted. It is due to be completed in March.

Conferences, Talks, Visits, Observing Trips

Justyn Campbell-White attended the ASTERICS Virtual Observatory workshop in Strasbourg and an Astrostatistics with R applications workshop at the RAS.

Dirk Froebrich held two public outreach talks, one in Wellesley House School, Broadstairs, one in Sutton-at-Hone Village Hall for Crayford Manor House Astronomical Society, Dartford.

Mark Burchell gave two outreach/public talks in the Autumn, both in Oct, one at Blean Rotary Society 2016, the other Univ. Kent Phys Soc.

Michael Smith attended a workshop on Big Data at Cosenor’s House, Abingdon, SEPnet Employer Engagement meeting in Hatfield and a RAS meeting on Radio Galaxies.

Michael Smith gave a talk to SEKAS entitled A Rough Guide To The Universe on Sat Oct 8th at Alkham Village Hall, and The Origin of Stars to the University Physics Society.

Student News and progress

Michael Knight submitted and is now making corrections
Chris Lynch and David Hastie also submitted.
# 6 Journal Publications 2016

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<td>McDermott, K. H.; Price, M. C.; Cole, M.; Burchell, M. J.</td>
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<td>Survivability of copper projectiles during hypervelocity impacts in porous ice: A laboratory investigation of the survivability of projectiles impacting comets or other bodies</td>
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<td>2016ApJ...821...19F</td>
<td>Fulle, M.; Marzari, F.; Della Corte, V.; Fornasier, S.; Sierks, H.; Rotundi, A.; Barbieri, C.; Lamy, P. L.; Rodrigo, R.; Koschny, D.; and 67 coauthors</td>
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<td>Evolution of the Dust Size Distribution of Comet 67P/Churyumov-Gerasimenko from 2.2 au to Perihelion</td>
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<td>Geologic mapping of the Comet 67P/Churyumov-Gerasimenko's Northern hemisphere</td>
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<td>Hung, Chao-Ling; Casey, Caitlin M.; Chiang, Yi-Kuan; Capak, Peter L.; Cowley, Michael J.; Darvish, Behnam; Kacprzak, Glenn G.; Kovač, K.; Lilly, Simon J.; Nanayakkara, Themiya; and 3 coauthors</td>
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<td>The Shaping of the Multipolar Pre-planetary Nebula CRL 618 by Multidirectional Bullets</td>
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<td>2016A&amp;A...591A...5L</td>
<td>Li, Guang-Xing; Urquhart, James S.; Leurini, Silvia; Csengeri, Timea; Wyrowski, Friedrich; Menten, Karl M.; Schuller, Frederic</td>
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<td>ATLASGAL: A Galaxy-wide sample of dense filamentary structures</td>
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<td>Huang, Po-Sheng; Lee, Chin-Fei; Moraghan, Anthony; Smith, Michael</td>
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<td>A new approach to modelling impacts on rubble pile asteroid simulants</td>
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<td>2016MNRAS.460.1039P</td>
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A search for ionized jets towards massive young

1.000 05/2016 A E F


Donohoe, Justin; Smith, Michael D.

The physical structure of radio galaxies explored

1.000 04/2016 A E

Leliwa-Kopystynski, J.; Wlodarczyk, I.; Burchell, M. J.

Analytical model of impact disruption of satellite

1.000 03/2016 A E F

Avdellidou, C.; Price, M. C.; Delbo, M.; Ioannidis, P.; Cole, M. J.

Survival of the impactor during hypervelocity collision

1.000 11/2016 A E F

Gicquel, A.; Vincent, J.-B.; Agarwal, J.; A'Hearn, M. F.; Bertini, I.; Bodewits, D.; Sierks, H.; Lin, Z.-Y.; Barbieri, C.; Lamy, P. L.; and 51 coauthors

Sublimation of icy aggregates in the coma of com

1.000 07/2016 A E

Harriss, Kathryn H.; Burchell, M. J.

A study of the observed shift in the peak position

1.000 06/2016 A E F


Physical properties and dynamical relation of the

1.000 04/2016 A E F


Observations and analysis of a curved jet in the c

1.000 04/2016 A E F

Snodgrass, Colin; Jehin, Emmanuel; Manfroid, Jean; Opitom, Cyrielle; Fitzsimmons, Alan; Tozzi, Gian Paolo; Faggi, Sara; Yang, Bin; Knight, Matthew M.; Conn, Blair C.; and 7 coauthors

Distant activity of 67P/Churyumov-Gerasimenk

1.000 03/2016 A E F


Are fractured cliffs the source of cometary dust j

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