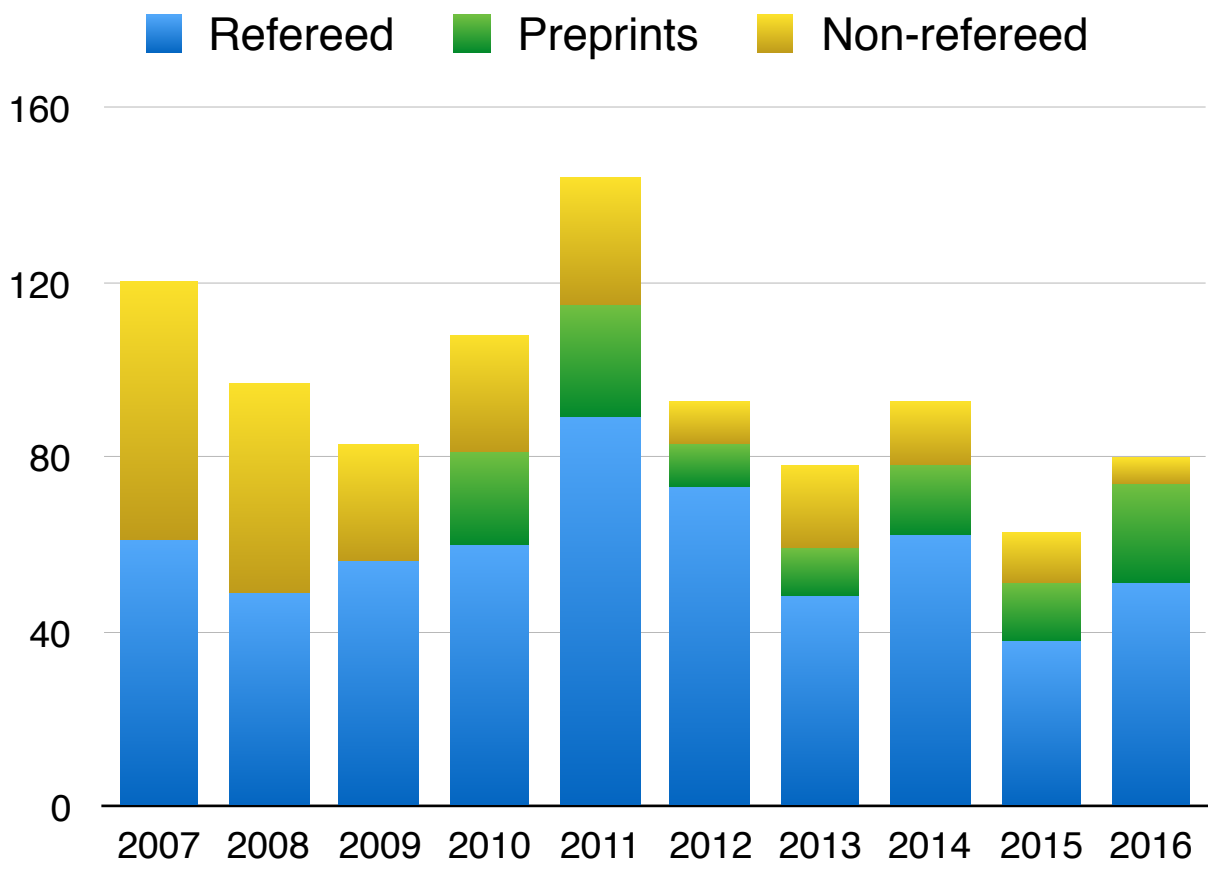
Astronomy and Astrophysics Report for 2016

Submitted to the Governing Board at its meeting on 1st March 2017

1. Research output and activities

The primary research output of the section consists of peer-reviewed publications in the leading astronomical and astrophysical journals. The section has a green open-access publishing policy whereby all publications are placed as preprints on the freely accessible arXiv server. To this end DIAS supports arXiv with a modest financial contribution. During the calendar year **seventy three papers** were published, or posted as preprints on arXiv, and with at least one co-author from the section as well as **six** non-refereed papers. Full details can be found in the detailed bibliography at the end of this report (which replaces the former summary text). In some ways what is more interesting than the raw number of papers is the trend over time which shows considerable year on year fluctuations, but no major change over the last decade.



Note that pre 2010 preprints were classified as non-refereed and not treated as a separate category.

In addition to research papers, talks and conference presentations are an important means of communicating our research to our peers and a useful measure of the esteem in which we are held. During the year the following were delivered.

Felix Aharonian:

1. Rome, Italy, workshop "Towards a large field-of-view TeV experiment" (14.01-15.01.2016) ***Evidence for a PeVatron in the Galactic Center: is it Sgr A*?***
2. Rio de Janeiro, Brazil, workshop "2nd LATTES Meeting" (14.03-15.03, 2016) ***Scientific objectives of ground-based gamma-ray detectors***
3. Paris, France, APPEC Town Meeting, (6.04.2016) ***High Energy Universe: Gamma Rays***
4. Dublin, Ireland, Contested Astrophysics Workshop (12.04.-14.04.2016) ***The challenge of Extreme Accelerators***
5. 10th Cosmic Ray International Seminar CRIS2016, Ischia, Italy (4.07-8.07.2016) ***Probing Cosmic Accelerators***
6. The Lake Baykal Three Messenger Conference, Listvyanka, Russia (29.08-03.09.2016) ***Exploring the Galactic PeVatrons with multi-TeV gamma rays, neutrinos and X-rays***
7. Beyond a PeV: particle acceleration to extreme energies in cosmic sources, Paris, France, Sep 13-16, 2016 ***Hard X-rays as distinct signatures of PeVatrons***
8. Paris, France, Sources of Galactic Cosmic Rays Workshop; Paris, France; (07.12.-09.12.2016.) ***Theoretical understanding of the origin of Galactic Cosmic Rays (Summary)***

Luke Drury:

9. San Vito di Cadore, Italy, Opening talk at "Cosmic rays beyond the standard model II" (18.9 - 23.9) **Cosmic Ray Origin(s) revisited**
10. San Vito di Cadore, Italy, ***Closing summary*** at "Cosmic rays beyond the standard model II" (18.9 - 23.9)

Jonathan Mackey:

11. Athens, Greece, invited review at the "Dynamics of Star and Planet Formation" symposium of the European Week of Astonomy and Space Science (4-8 July) ***Origin and role of feedback in the context of star formation and star clusters***

Eamon O'Gorman:

12. Uppsala, Sweden, Coolstars-19 (June) ***Very Long Baseline ALMA observations of Betelgeuse***

Tom Ray:

13. Cargese, Corsica, invited set of lectures (23 May – 1 June) on **"Jets from Young Stars"**, at the Cargese School on Astrophysical Jets, CNRS/CEA/International Space Science Institute.
14. Dublin Institute of Technology, Institute of Physics: (24 September) invited talk on **"A Tale of Two Eclipses: Proving Einstein Right"**

15. University College Dublin, (2 December) invited talk on **"Microwave Kinetic Inductance Detectors"**

Antonella Natta:

16. Gothenburg (June 16) **The Physics of Circumstellar Disks,** as part of a four-week event on "The Origin of Habitable Planets" organized by the Gothenburg Centre for Advanced Studies in Science and Technology and directed by Dr Leonardo Testi.

Colm Coughlan:

17. Zandvoort aan Zee, The Netherlands, (5-6 April), invited talk on **"Observing Young Stellar Objects with LOFAR"**, at the 2016 LOFAR Community Science Workshop.

Alessio Carrati o Garatti:

18. Dublin, (7-9 September), invited talk on **"Accretion Bursts Over the Mass Spectrum of Young Stellar Objects: the ESO View"**, at the Irish National Astronomy Meeting (INAM), University College Dublin.
19. Heidelberg, (24-26 October), invited talk on **"Analysis of the First Disk-Mediated Accretion Burst in a High-Mass YSO"** at the Planet and Star Formation Meeting, Max Planck Institute for Astronomy.

Rebecca Garcia Lopez:

20. Bilbao (18-22 July), invited talk on **"IR Interferometry with the Second Generation VLTI Instruments: GRAVITY and MATISSE",** Sociedad Española de Astronomía (SEA) Annual Meeting.
21. Heidelberg, (24-26 October), invited talk on **"The Inner AU Regions of Protoplanetary Disks"** at the Planet and Star Formation Meeting, Max Planck Institute for Astronomy.

Maria Koutoulaki:

22. Cargese, Corsica, (23 May – 1 June) talk on **"High and Medium Spectral Resolution Interferometric Observations of the Herbig B[e] star HD50138",** at the Cargese School on Astrophysical Jets, CNRS/CEA/International Space Science Institute. This work was also presented (7-9 September) as a poster at the Irish National Astronomy Meeting (INAM), University College Dublin.

Ruben Fedriani:

23. Cargese, Corsica, (23 May – 1 June) poster on **"IRAS 13481-6142: a Massive Young Stellar Object Driving a Parsec-Scale Jet"**, at the Cargese School on Astrophysical Jets, CNRS/CEA/International Space Science Institute. This work was also presented (7-9 September) as a poster at the Irish National Astronomy Meeting (INAM), University College Dublin.

Donna Rodgers-Lee:

24. La Laguna, Tenerife, (29 August) invited talk on **"Angular Momentum Transport in Weakly Ionised Protoplanetary Disks",** at PIPA2016: Partially Ionized Plasmas in Astrophysics.

Andrew Taylor:

25. Galactic Cosmic Rays Workshop, Paris, France (7-9 Dec) ***"Extragalactic Cosmic Rays above the Iron Knee"***

26. LAPP Annecy (Seminar), France (12-16 Sep) ***"New Insights into the Extragalactic Magnetic Fields Using Gamma-Ray Blazars"***

27. ECRS2016, Torino, Italy (5-9 Sep) ***"Extragalactic Cosmic Rays above the Iron Knee "***

28. Gamma2016, Heidelberg, Germany (11-15 Jul) ***"Extragalactic Rapporteur Talk"***

29. RICAP16, Rome, Italy (21-24 Jun) ***"Detection of VHE Gamma-Rays from AGN close to z ~ 1"***

30. GSSI, L'Aquila (Seminar), Italy (18 May) ***"Extragalactic Cosmic Rays above the Iron Knee"***

31. Workshop on Perspectives on the Extragalactic Frontier, Trieste, Italy (2-6 May) ***"HESSI/II Extragalactic Source Properties"***

32. Next-Generation Techniques for UHE Astroparticle Physics, Chicago, USA (29 Feb- 2 Mar) ***"Extragalactic Cosmic Rays above the Iron Knee"***

Conference and workshop organisation is another important contribution to scientific research. During the year members of the section were involved in running the following research events.

Heidelberg, Germany, **6th Heidelberg International Symposium on High-Energy Gamma-Ray Astronomy (11.-15.07.2016)** F.A. Aharonian, W. Hofmann, F.M. Rieger

Dublin, Ireland, two Workshops on **"Contested Astrophysics" 12-14 Apr** and **"Climate science, disagreement, and policy: a multidisciplinary investigation" 10-12 Nov,** both organised as part of the "When Experts Disagree" IRC-funded interdisciplinary project by L Drury and M Baghramian.

J. Mackey hosted a small workshop for the **StarBench project** at Dunsink Observatory 18-20 May, attended by Robin Williams (AWE), Thomas Haworth (Imperial College London), and Thomas Bisbas (University of Florida and MPE Garching). The workshop consisted of follow-up work on our 2015 paper (Bisbas et al., 2015) and preparatory work on new benchmark tests for numerical simulations. ICHEC kindly provided computational support through the Class C project dsast017c. Thomas Haworth gave a DIAS seminar on 20 May as part of his visit. J. Mackey also invited Robert Izzard (DIAS seminar 10 June) and James Dale (DIAS seminar 16 Nov) to discuss collaborations, and both visitors also gave public outreach talks at Dunsink Observatory during their visits.

A further indication of scientific merit is the receipt of significant awards.

Rebeca Garcia Lopez was awarded a H2020 Marie Skłodowska-Curie Individual Fellowship commencing November 2016.

Alessio Caratti o Garatti has been made a Scientific Co-Investigator on the James Webb Space Telescope (JWST). This prestigious position guarantees him time on JWST when it is launched in October 2018.

Maria Koutoulaki, the PhD student working with Rebeca Garcia Lopez on GRAVITY, was awarded an Irish Research Council (IRC) Government of Ireland Postgraduate Scholarship for the 3 remaining years of her postgraduate studies.

2. Contributions to third level education

J. Mackey supervised the MSc Space Science internship of Samuel Green, as part of his Masters programme in Space Science and Technology at UCD. Sam did a 12 week project on ``Stellar Wind Simulations: The Bubble Nebula'', learning to use the ICHEC supercomputing facilities, run hydrodynamic simulations, and analyse the results using Python scripts. He continued this work as a research intern until the end of 2016, and starts a PhD at DIAS (registered at UCD) in January 2017, developing his work into a research project.

Erin Higgins took up the 2016 Lindsay Scholarship jointly at Armagh Observatory and Planetarium and at DIAS, beginning September 2016 and registered at QUB. J. Vink is the Armagh supervisor and J. Mackey is the DIAS supervisor. She is investigating the evolution of massive stars in low-metallicity environments and nebulae that they produce.

Eamon O'Gorman supervised a Trinity College Dublin senior sophister student named Anton Feeney-Johansson at DIAS between October and December 2016. Anton worked with very high angular resolution radio data of the closest red supergiant Antares obtained with the Karl G. Jansky VLA. He spatially resolved the star at multiple wavelengths and from this, he was able to calculate the temperature profile of the star's atmosphere. His work included the first resolved images of a star, other than the Sun, at wavelengths longer than 6 cm.

Alessio Caratti o Garatti supervised the final year project of an Astrophysics student, Kim Heary, from Dublin City University (DCU) on "Disclosing High Mass Star Formation". In addition, he also co-supervised, with Tom Ray and Deirdre Coffey of University College Dublin (UCD and a DIAS Research Associate), Ruben Fedriani. R. Fedriani is registered as a PhD student in UCD and he is jointly funded by DIAS and UCD.

Rebeca Garcia Lopez, supervised the final year project of an Astrophysics student, Conor O'Donnell, from DCU on "Investigating the Origin of Brown Dwarfs and Low Mass Stars", and co-supervised, with Tom Ray and Deirdre Coffey, a PhD student Maria Kouloulaki. Maria is now funded, through DIAS, with Irish Research Council support.

Tom Ray completed a course of lectures on "Galactic Dynamics and Structure" to the Junior Sophister students in Trinity College Dublin.

Andrew Taylor and Felix Aharonian supervised the PhD thesis work of Carlo Romoli who is working on analysis of data from the new large H.E.S.S. CT5 telescope, in particular observations of flaring activity in AGNs.

Andrew Taylor supervised the work of 4th year summer student Emma Goodwin.

Ruben Fedriani assisted in laboratory work for the Devices and Electronics Components (PHYC20090) course at University College Dublin.

Maria Koutoulaki assisted in laboratory work for the Thermal Physics and Materials (PHYC20030) course at University College Dublin.

Felix Aharonian gave the following courses of lectures**:** ***Lectures on "Gamma Ray Astronomy"*** Gran Sasso Science Institute ,L'Aquila, Italy; ***Lectures "Gamma Ray Astrophysics" (8 lectures)*** Universidade Federal de Santa Catarina Florianópolis, Brazil; ***Lectures on "Relativistic Outflows in Astrophysics"*** Moscow Engineering Physics Institute, Moscow, Russia.

A series of didactic lectures for young researchers in the section was held with contributions on **Radiation and absorption processes in high energy astrophysics** by Felix Aharonian; **Diffusive shock acceleration theory** by Luke Drury; **HII regions and stellar wind bubbles produced by massive stars** by Jonathan Mackey; **Radiative transfer in discs** by Antonella Natta; and **Chemistry for Astronomers** by Malcolm Walmsley.

3. Research infrastructures and community service

MIRI

The section continued to make significant contributions to the Mid-Infrared Instrument (MIRI) which was delivered by ESA to NASA as one of the two European contributions to the James Webb Space Telescope (JWST). Early in the year MIRI was integrated with the other 3 main instruments and became part of the Integrated Science Instrument Module (ISIM) before undergoing a series of optical, electrical and mechanical tests at cryogenic temperatures. Vibration testing of the telescope assembly plus instrument assembly known as the Optical Telescope Integrated Science Module (OTIS) began at the end of the year. One minor problem occurred during testing but this has now been rectified and JWST is still on schedule to be launched in October 2018.

The current focus within DIAS is on the development of MIRI data analysis tools in Python including the MIRI Simulator or MIRISim (Martin Topinka) and interface to the telescope pipeline (Patrick Kavanagh). This work is being done in collaboration with the Space Telescope Science Institute in Baltimore. M. Topinka has been working as a member of the High Redshift and Exoplanet Guaranteed Time Observation (GTO) teams. Due to his expertise with MIRISim, he provides simulation and software support to these teams.
P. Kavanagh has been working as a member of the SN1987A GTO team. His primary responsibility is parallel observations with MIRI and JWST's near-infrared camera (NIRCAM) to observe nearby regions of interest in the Large Magellanic Cloud while observations of SN1987A are taken.

A. Caratti o Garatti, who became a member of the MIRI Science Team, assisted with beta-testing of the MIRI software and also helped make preparations for DIAS GTO time on JWST in connection with outflows from young stars and their disks.

During the year, Tom Ray (MIRI Co-Principal Investigator) was successful in obtaining 300,000 euro of funding from ESA to support DIAS work in connection with MIRI until the JWST launch.

GRAVITY

GRAVITY is the new near-infrared interferometer for the European Southern Observatory (ESO) in Paranal, Chile. Construction and testing of the instrument is being led by the Max Planck Institute for Extra-Terrestrial Physics near Munich. During the year A. Caratti o Garatti and R. Garcia Lopez:

- Assisted on site (February and March) with the commissioning of GRAVITY using both the 8-m class primary telescopes (UTs) as well as the Auxiliary (1m) Telescopes (ATs).
- Led the development and coordination of the low mass Young Stellar Object (YSO) and high-mass YSO programs within the GRAVITY Guaranteed Time Observer (GTO) program (Principal Lead Garcia Lopez). This involved a number of planning and data reduction workshops help in Grenoble (January and June).
- Achieved the first detection of extended outflow/wind emission on milliarcsecond scales in a young version of the Sun (Classical T Tauri star) and over a range of velocities.

- Worked with the GRAVITY team to develop the data-reduction pipeline and debugging of the fringe tracker software.

In addition, A. Caratti o Garatti and R. Garcia Lopez participated in the GRAVITY GTO meeting at the Max Planck Institut für Extraterestrial Physics, Garching (9-10 November) where they presented the GRAVITY GTO programs on YSOs and showed early GRAVITY commissioning results. Finally, A. Caratti o Garatti, R. Garcia Lopez and M. Koutoulaki attended a GRAVITY meeting in Grenoble (12-16 December) on data reduction and analysis of the instrument's data.

LOFAR

LOFAR is the European low frequency radio interferometer managed by ASTRON. While its core is in the Netherlands, it has outlying nodes in several European countries including the UK, France, Germany, Sweden and Poland. During the year, funding was approved by Science Foundation Ireland (SFI) for a consortium, led by Trinity College Dublin but including DIAS, to build a LOFAR station in Birr, Co. Offaly. Cost is estimated to be 1.5 Million Euro and construction is expected to be complete in late Summer 2017. Ground works to level the site were finished by the end of 2016.

DIAS is playing a role in not only obtaining science from LOFAR but also assisting with its development and encouraging usage by the Irish community. In particular during the year Colm Coughlan and Rachael Ainsworth:

- Developed a calibration and reduction strategy to handle tens of terabytes of data from LOFAR using the facilities at the Irish Centre for High-End Computing (ICHEC) and at DIAS.
- Achieved the first detection of a young star with LOFAR (thereby opening up a whole new radio window on these objects) and found the first evidence for radio self-absorption in an outflow from a young star.
- Worked as members of the LOFAR Long-baseline Working Group (based in ASTRON) to develop calibration strategies and pipelines to handle the challenges presented by large bandwidths and long baselines at these frequencies.

RadioNet

RadioNet is a consortium of 28 institutions in Europe, the Republic of Korea and South Africa, with the aim of integrating, at European level, world-class infrastructures for research in radio astronomy. These include radio telescopes, telescope arrays, data archives and the European Very Long Baseline Interferometry Network (EVN). Aside from supporting access it also develops software and hardware for the astronomy community conscious that we are on a development path towards the Square Kilometre Array (SKA).

RadioNet was successful in bidding for funding under the H2020 call: *Integrating and Opening Research Infrastructures of European Interest*. Total funding to the network is 10 Million Euro and, as DIAS was part of this bid, it will receive just over 100,000 Euro to work on software development (as part of the RINGS project). The intention is that the software will, for all four Stokes parameters, take account of the dispersive effects of the Earth's Ionosphere which is particularly important at low radio frequencies as used for example by LOFAR. Funding will support a postdoctoral fellow for approximately two years.

H.E.S.S.

DIAS continued as a partner in the H.E.S.S. collaboration operating a system of imaging atmospheric Cherenkov telescopes in Namibia. Andrew Taylor was appointed convenor of the extragalactic working group, and also leader of the task force working on data reduc-

tion for the new large CT5 telescope which is expected to significantly lower the energy threshold.

Astro-H/Hitomi
The Japanese Astro-H X-ray mission in which the section was a partner through Felix Aharonian was successfully launched on 17 February and renamed Hitomi. Unfortunately the satellite self-destructed due to a sequence of unfortunate errors with the attitude control system on 26 March, but not before it had demonstrated that its micro-bolometer X-ray detectors were capable of yielding spectra of unprecedented quality with an observation of the Perseus cluster showing unexpectedly small amounts of doppler-broadening in the X-ray lines from the hot intracluster gas.

Microwave Kinetic Inductance Detectors (MKIDs)
Tom Ray was successful in obtaining support (approximately 1.7 Million Euro including overheads) from Science Foundation Ireland to start an MKIDs group in the DIAS. Funding is for 3 postdoctoral fellows and 3 PhD students. The work will be done in collaboration with CRANN (the **C**entre for **R**esearch on **A**daptive **N**anostructures and **N**anodevices) in TCD, the University of Oxford, the University of Maynooth and the Space Research Organisation of the Netherlands (SRON). The intention is to build the first optical/near-infrared MKID camera to be manufactured in Europe and to develop a new read-out system for these devices based on the Square Kilometer Array (SKA) correlator boards.

J. Mackey is PI of the project "Evolution and Explosion of Massive Stars (EEstars)", funded by the IRC New Foundations 2016 programme, to organise meetings of the Massive Stars community in the Republic and Northern Ireland during 2017, with the aim of encouraging and developing cross-border collaboration.

J. Mackey is on the board of the RADICALS project (RAdiation Dynamics Including Chemistry for AstrophysicaL Simulations) led by Prof. Leen Decin at KU Leuven (Belgium), supported by DiRAC and Intel in the UK. This multi-year project started in January 2016 to develop a code for modelling astrochemistry, magnetohydrodynamics, and radiative transfer.

Luke Drury continued as chair of the European Space Agency's Astronomy Working Group until the end of the year and thus *ex officio* as a member also of the Space Science Advisory Committee. In this capacity he was asked to chair the visiting committee for the International Space Science Institute in Bern which inspected the Institute from 6-8 May on behalf of ESA and the Swiss funding authorities. He was also co-chair of the Scientific Assessment Review Panel and *ex officio* a member of the Senior Science Committee for the ESA "New Ideas" call.

Luke Drury served on the Scientific Steering Committee of PRACE, the European Partnership providing access to high performance computing, and attended the PRACE-days meeting in Prague on 9-12 May.

DIAS submitted a proposal for a national data curation facility on behalf of ICHEC to the SFI research infrastructure call.

Luke Drury represented the Royal Irish Academy at meetings of the Euro-ICSU management group, including a face to face meeting in Bern on 11 March and hosting a physical meeting of the entire Euro-ICSU membership in Dublin on 15-16 September. He also attended and voted on behalf of Ireland at the extraordinary joint meeting of ICSU and the ISSC held in Oslo on 24 October to agree a merger of the two organisations.

Tom Ray continued his role as Chair of the Physical, Chemical and Mathematical Sciences Committee of the Royal Irish Academy and also served on its Membership Science Advisory Committee. He is a member of the e-MERLIN Steering Committee of the Science, Technologies Facilities Council (STFC), and the Management Committee for Armagh Observatory and Planetarium. Other posts include membership of the European Interferometry Imitative Science Council, the European RadioNet Board, the ESA MIRI Steering Committee, the Marie Skłodowska-Curie Fellowship Physics Panel and the Staff Exchange Panel.

J. Mackey spoke at the Dublin information day about the Royal Society-SFI University Research Fellowship programme (TCD, 1 July) to share his experiences of the application process and the benefits of this new programme available to Irish-based researchers.

Luke Drury continued to serve as chair of the E-CAM e-infrastructure centre of excellence. During the year a major strategic decision was made to move the coordination and management of the project from UCD to EPFL following the departure of the previous project administrator and a change of leadership at CECAM. The general assembly of E-CAM was held in the Maison de la Simulation in Orsay, France, 7-8 October.

4. Public engagement and outreach

The School's statutory public lecture for 2016 was delivered by Professor Tim Palmer, a Royal Society Research Professor at the University of Oxford in TCD on 24 November. His lecture entitled "**The physics of climate change; what we know and what we are uncertain about"** was organised in association with the IRC-funded interdisciplinary research project between Prof Maria Baghramian and Luke Drury on expert disagreement and was very well attended. The speaker was introduced by the Provost of Trinity, Professor Paddy Prendergast, who emphasised the historical importance of the statutory public lecture series.

J. Mackey started helping to plan and organise public outreach and education events at Dunsink Observatory in 2016. This included the regular public open nights in winter, the Solarfest in June, Culture Night in September, Space Week in October, and Science Week in November.

Jonathan Mackey was PI on a successful grant application to SFI to fund the installation of two meteor cameras and a radio antenna at Dunsink as part of the education and public engagement work for Science Week. The cameras and antenna are now installed and recording meteors (plus planes and airborne wildlife), and the data will be used for Schools projects and Citizen Science during 2017 by linking with the NEMETODE network of meteor cameras.

Among those who gave presentation at public outreach events in Dunsink were DIAS staff Luke Drury, Tom Ray, Jonathan Mackey, Martin Topinka, Andrew Castillo Taylor, Rebeca Garcia Lopez, Alessio Caratti O Garatti and Patrick Kavanagh; DIAS PhD students Sam Green, Carlo Romoli, Maria Kalliopi Kputoulaki and Ruben Fedriani Lopez; former DIAS staff Colm Coughlan, Rachael Ainsworth, Paul Dempsey, Sean Delaney, Paul Dawson, Denis Malishev and Yurii Babyk; external Irish speakers Masha Chernyakova DCU/Dias, Brian Espey TCD, David Malone NUI Maynooth, Niall Smyth CIT Cork, Emma Whelan/Kavanagh NUI Maynooth, Deirdre Coffey UCD and Aline Vidotto TCD; international speakers Robert Izzard (University of Cambridge), Jim Dale (University of Hertfordshire), Eamon Scullion (Northumbria University Newcastle upon Tyne), Mark Townley (Solar Astrophotographer from England); and from the Irish amateur community Tom O'Donoghue (Astrophotographer) IAS members John Flannery, Deirdre Kelleghen, John Dolan, Samuel Bayden, Peter Denman, John O'Neill, IFAS members Michael O'Connell. Kevin Smyth, Michael Grehan, Seanie Morris and IAA member Terry Mosley. The voluntary assistance of the Irish Astronomical Society with providing assistance and stewards for events in Dunsink is gratefully acknowledged.

Tom Ray spoke to the Irish Astronomical Society about "The new radio sky" on 25 April.

In association with Blackrock castle observatory (CIT), ESERO Ireland, SFI, Space Industries Skillnet and Enterprise Ireland Dunsink hosted the 2016 Space Industry day on 4 October as part of Space Week Ireland. A highlight of the day was the keynote address by Mark McCaughrean, Senior Science Advisor at the European Space Agency on "ESA's big year in space 2016".

Luke Drury in cooperation with the Japanese Embassy in Ireland produced press releases and gave media interviews associated with the launch and subsequent failure of Hitomi.

Luke Drury was interviewed on RTE's Prime Time in their coverage of the Steorn collapse.

Dunsink observatory was made available as a film location for a documentary about the Voyager missions.

In November A. Caratti o Garatti, M. Walmsley, and T. Ray, published five press releases concerning the Nature Physics paper: "Disk-Mediated Accretion Burst in a High-Mass Young Stellar Object"

Luke Drury continued as chair of the Institute-wide communications working group which has redesigned the Institute web pages and coordinated our social media presence.

BIBLIOGRAPHY OF PUBLICATIONS
ASTRONOMY AND ASTROPHYSICS
2016

(1) H. E. S. S. Collaboration, et al.: Detailed spectral and morphological analysis of the shell type SNR RCW 86
ArXiv e-prints (2016) arXiv:1601.04461

Aims: We aim for an understanding of the morphological and spectral properties of the supernova remnant RCW 86 and for insights into the production mechanism leading to the RCW 86 very high-energy gamma-ray emission. Methods: We analyzed High Energy Spectroscopic System data that had increased sensitivity compared to the observations presented in the RCW 86 H.E.S.S. discovery publication. Studies of the morphological correlation between the $0.5-1$ keV X-ray band, the $2-5$ keV X-ray band, radio, and gamma-ray emissions have been performed as well as broadband modelling of the spectral energy distribution with two different emission models.

Results: We present the first conclusive evidence that the TeV gamma-ray emission region is shell-like based on our morphological studies. The comparison with $2-5$ keV X-ray data reveals a correlation with the $0.4-50$ TeV gamma-ray emission. The spectrum of RCW 86 is best described by a power law with an exponential cutoff at $E\_\mathrm{cut} = (3.5 \pm 1.2_{\mathrm{stat}})$ TeV and a spectral index of $\Gamma = 1.6 \pm 0.2$. A static leptonic one-zone model adequately describes the measured spectral energy distribution of RCW 86, with the resultant total kinetic energy of the electrons above 1 GeV being equivalent to ~0.1% of the initial kinetic energy of a Type I a supernova explosion. When using a hadronic model, a magnetic field of $B \approx 100\,\mu$G is needed to represent the measured data. Although this is comparable to formerly published estimates, a standard E^{-2} spectrum for the proton distribution cannot describe the gamma-ray data. Instead, a spectral index of $\Gamma_{\mathrm{p}} \approx 1.7$ would be required, which implies that $\approx 7 \times 10^{49} / n_{\mathrm{cm}^{-3}}$ erg has been transferred into high-energy protons with the effective density $n_{\mathrm{cm}^{-3}} = n/1\,\mathrm{cm}^{-3}$. This is about 10% of the kinetic energy of a typical Type Ia supernova under the assumption of a density of $1\,\mathrm{cm}^{-3}$.

(2) Werner, N., et al.: Deep Chandra observation and numerical studies of the nearest cluster cold front in the sky
Monthly Notices of the Royal Astronomical Society (2016) **455** 846-858. DOI
http://arxiv.org/abs/arXiv:1506.06429

We present the results of a very deep (500 ks) Chandra observation, along with tailored numerical simulations, of the nearest, best resolved cluster cold front in the sky, which lies 90 kpc (19 arcmin) to the north-west of M 87. The northern part of the front appears the sharpest, with a width smaller than 2.5 kpc (1.5 Coulomb mean free paths; at 99 per cent confidence). Everywhere along the front, the temperature discontinuity is narrower than 4-8 kpc and the metallicity gradient is narrower than 6 kpc, indicating that diffusion, conduction and mixing are suppressed across the interface. Such transport processes can be naturally suppressed by magnetic fields aligned with the cold front. Interestingly, comparison to magnetohydrodynamic simulations indicates that in order to maintain the observed sharp density and temperature discontinuities, conduction must also be suppressed along the magnetic field lines. However, the northwestern part of the cold front is observed to have a non-zero width. While other explanations are possible, the broadening is consistent with the presence of Kelvin-Helmholtz instabilities (KHI) on length-scales of a few kpc. Based on comparison with simulations, the presence of KHI would imply that the effective viscosity of the intracluster medium is

suppressed by more than an order of magnitude with respect to the isotropic Spitzer-like temperature dependent viscosity. Underneath the cold front, we observe quasi-linear features that are ~10 per cent brighter than the surrounding gas and are separated by ~15 kpc from each other in projection. Comparison to tailored numerical simulations suggests that the observed phenomena may be due to the amplification of magnetic fields by gas sloshing in wide layers below the cold front, where the magnetic pressure reaches ~5-10 per cent of the thermal pressure, reducing the gas density between the bright features.

(3) Zdziarski, Andrzej A., et al.: The high-energy gamma-ray detection of G73.9+0.9, a supernova remnant interacting with a molecular cloud
Monthly Notices of the Royal Astronomical Society (2016) **455** 1451-1458. DOI
http://arxiv.org/abs/arXiv:1509.04046

We have analysed the Fermi Large Area Telescope (LAT) data on the SNR G73.9+0.9. We have confirmed a previous detection of high-energy γ-rays from this source at a high significance of $\simeq 12\sigma$. The observed spectrum shows a significant curvature, peaking in EF_E at ~1 GeV. We have also calculated the flux upper limits in the mm-wavelength and X-ray ranges from Planck and XMM-Newton, respectively. We have inspected the intensity of the CO ($1 \rightarrow 0$) emission line and found a large peak at a velocity range corresponding to the previously estimated source distance of ~4 kpc, which may indicate an association between a molecular cloud and the supernova remnant (SNR). The γ-ray emission appears due to interaction of accelerated particles within the SNR with the matter of the cloud. The most likely radiative process responsible for the γ-ray emission is decay of neutral pions produced in ion-ion collisions. While a dominant leptonic origin of this emission can be ruled out, the relativistic electron population related to the observed radio flux will necessarily lead to a certain level of bremsstrahlung γ-ray emission. Based on this broad-band modelling, we have developed a method to estimate the magnetic field, yielding $B \gtrsim 80\,\mu$G at our best estimate of the molecular cloud density (or less at a lower density). G73.9+0.9 appears similar, though somewhat weaker, to other SNRs interacting with a local dense medium detected by the LAT.

(4) Mackey, Jonathan, et al.: Detecting stellar-wind bubbles through infrared arcs in H ii regions
Astronomy and Astrophysics (2016) **586** A114 DOI
http://arxiv.org/abs/arXiv:1512.06857

Mid-infrared arcs of dust emission are often seen near ionizing stars within H ii regions. A possible explanations for these arcs is that they could show the outer edges of asymmetric stellar wind bubbles. We use two-dimensional, radiation-hydrodynamics simulations of wind bubbles within H ii regions around individual stars to predict the infrared emission properties of the dust within the H ii region. We assume that dust and gas are dynamically well-coupled and that dust properties (composition, size distribution) are the same in the H ii region as outside it, and that the wind bubble contains no dust. We post-process the simulations to make synthetic intensity maps at infrared wavebands using the torus code. We find that the outer edge of a wind bubble emits brightly at 24 μm through starlight absorbed by dust grains and re-radiated thermally in the infrared. This produces a bright arc of emission for slowly moving stars that have asymmetric wind bubbles, even for cases where there is no bow shock or any corresponding feature in tracers of gas emission. The 24 μm intensity decreases exponentially from the arc with increasing distance from the star because the dust temperature decreases with distance. The size distribution and composition of the dust grains has quantitative but not qualitative effects on our results. Despite the simplifications of our model, we find good qualitative agreement with observations of the H ii region RCW 120, and can provide physical explanations for any quantitative differences. Our model produces an infrared arc with the same shape and size

as the arc around CD -38°11636 in RCW 120, and with comparable brightness. This suggests that infrared arcs around O stars in H II regions may be revealing the extent of stellar wind bubbles, although we have not excluded other explanations.

(5) Csengeri, T., et al.: ATLASGAL-selected massive clumps in the inner Galaxy. II. Characterisation of different evolutionary stages and their SiO emission
Astronomy and Astrophysics (2016) **586** A149 DOI
http://arxiv.org/abs/arXiv:1511.05138

Context. The processes leading to the birth of high-mass stars are poorly understood. The key first step to reveal their formation processes is characterising the clumps and cores from which they form.

Aims: We define a representative sample of massive clumps in different evolutionary stages selected from the APEX Telescope Large Area Survey of the Galaxy (ATLASGAL), from which we aim to establish a census of molecular tracers of their evolution. As a first step, we study the shock tracer, SiO, mainly associated with shocks from jets probing accretion processes. In low-mass young stellar objects (YSOs), outflow and jet activity decreases with time during the star formation processes. Recently, a similar scenario was suggested for massive clumps based on SiO observations. Here we analyse observations of the SiO (2-1) and (5-4) lines in a statistically significant sample to constrain the change of SiO abundance and the excitation conditions as a function of evolutionary stage of massive star-forming clumps.

Methods: We performed an unbiased spectral line survey covering the 3-mm atmospheric window between 84-117 GHz with the IRAM 30 m telescope of a sample of 430 sources of the ATLASGAL survey, covering various evolutionary stages of massive clumps. A smaller sample of 128 clumps has been observed in the SiO (5-4) transition with the APEX telescope to complement the (2-1) line and probe the excitation conditions of the emitting gas. We derived detection rates to assess the star formation activity of the sample, and we estimated the column density and abundance using both an LTE approximation and non-LTE calculations for a smaller subsample, where both transitions have been observed.

Results: We characterise the physical properties of the selected sources, which greatly supersedes the largest samples studied so far, and show that they are representative of different evolutionary stages. We report a high detection rate of >75% of the SiO (2-1) line and a >90% detection rate from the dedicated follow-ups in the (5-4) transition. Up to 25% of the infrared-quiet clumps exhibit high-velocity line wings, suggesting that molecular tracers are more efficient tools to determine the level of star formation activity than infrared colour criteria. We also find infrared-quiet clumps that exhibit only a low-velocity component (FWHM ~ 5-6 km s^{-1}) SiO emission in the (2-1) line. In the current picture, where this is attributed to low-velocity shocks from cloud-cloud collisions, this can be used to pinpoint the youngest, thus, likely prestellar massive structures. Using the optically thin isotopologue (^{29}SiO), we estimate that the (2-1) line is optically thin towards most of the sample. Furthermore, based on the line ratio of the (5-4) to the (2-1) line, our study reveals a trend of changing excitation conditions that lead to brighter emission in the (5-4) line towards more evolved sources. Our models show that a proper treatment of non-LTE effects and beam dilution is necessary to constrain trends in the SiO column density and abundance.

Conclusions: We conclude that the SiO (2-1) line with broad line profiles and high detection rates is a powerful probe of star formation activity in the deeply embedded phase of the evolution of massive clumps. The ubiquitous detection of SiO in all evolutionary stages suggests a continuous star formation process in massive clumps. Our analysis delivers a more robust estimate of SiO column density and abundance than previous studies and questions the decrease of jet activity in massive clumps as a function of age. The observed increase of excitation conditions towards the more evolved clumps suggests a higher pressure in the shocked gas towards more evolved or more massive clumps in our sample.

(6) Adrián-Martínez, S., et al.: The prototype detection unit of the KM3NeT detector
European Physical Journal C (2016) **76** 54 DOI
http://arxiv.org/abs/arXiv:1510.01561

A prototype detection unit of the KM3NeT deep-sea neutrino telescope has been installed at 3500m

depth 80 km offshore the Italian coast. KM3NeT in its final configuration will contain several hundreds of detection units. Each detection unit is a mechanical structure anchored to the sea floor, held vertical by a submerged buoy and supporting optical modules for the detection of Cherenkov light emitted by charged secondary particles emerging from neutrino interactions. This prototype string implements three optical modules with 31 photomultiplier tubes each. These optical modules were developed by the KM3NeT Collaboration to enhance the detection capability of neutrino interactions. The prototype detection unit was operated since its deployment in May 2014 until its decommissioning in July 2015. Reconstruction of the particle trajectories from the data requires a nanosecond accuracy in the time calibration. A procedure for relative time calibration of the photomultiplier tubes contained in each optical module is described. This procedure is based on the measured coincidences produced in the sea by the ˆ{40}K background light and can easily be expanded to a detector with several thousands of optical modules. The time offsets between the different optical modules are obtained using LED nanobeacons mounted inside them. A set of data corresponding to 600 h of livetime was analysed. The results show good agreement with Monte Carlo simulations of the expected optical background and the signal from atmospheric muons. An almost background-free sample of muons was selected by filtering the time correlated signals on all the three optical modules. The zenith angle of the selected muons was reconstructed with a precision of about 3°.

(7) Garcia Lopez, Rebeca, et al.: Investigating the origin and spectroscopic variability of the near-infrared H I lines in the Herbig star VV Ser
Monthly Notices of the Royal Astronomical Society (2016) **456** 156-170. DOI
http://arxiv.org/abs/arXiv:1511.03181

The origin of the near-infrared (NIR) H I emission lines in young stellar objects are not yet understood. To probe it, we present multi-epoch LBT-LUCIFER spectroscopic observations of the Paδ, Paβ, and Brγ lines observed in the Herbig star VV Ser, along with Very Large Telescope Interferometer-AMBER Brγ spectro-interferometric observations at medium resolution. Our spectroscopic observations show line profile variability in all the H I lines. The strongest variability is observed in the redshifted part of the line profiles. The Brγ spectro-interferometric observations indicate that the Brγ line emitting region is smaller than the continuum emitting region. To interpret our results, we employed radiative transfer models with three different flow configurations: magnetospheric accretion, a magnetocentrifugally driven disc wind, and a schematic bipolar outflow. Our models suggest that the H I line emission in VV Ser is dominated by the contribution of an extended wind, perhaps a bipolar outflow. Although the exact physical process for producing such outflow is not known, this model is capable of reproducing the averaged single-peaked line profiles of the H I lines. Additionally, the observed visibilities, differential and closure phases are best reproduced when a wind is considered. Nevertheless, the complex line profiles and variability could be explained by changes in the relative contribution of the magnetosphere and/or winds to the line emission. This might indicate that the NIR H I lines are formed in a complex inner disc region where inflow and outflow components might coexist. Furthermore, the contribution of each of these mechanisms to the line appears time variable, suggesting a non-steady accretion/ejection flow.

(8) Ogrean, G. A., et al.: Frontier Fields Clusters: Deep Chandra Observations of the Complex Merger MACS˜J1149.6+2223
The Astrophysical Journal (2016) **819** 113 DOI
http://arxiv.org/abs/arXiv:1603.06010

The Hubble Space Telescope Frontier Fields cluster MACS J1149.6+2223 is one of the most complex merging clusters, believed to consist of four dark matter halos. We present results from deep (365 ks) Chandra observations of the cluster, which reveal the most distant cold front (z = 0.544) discovered to date. In the cluster outskirts, we also detect hints of a surface brightness edge that could be the bow shock preceding the cold front. The substructure analysis of the cluster identified several components with large relative radial velocities, thus indicating that at least some collisions occur almost along the line of sight. The inclination of the mergers with respect to the plane of the sky poses significant observational challenges at X-ray wavelengths. MACS J1149.6+2223 possibly hosts a steep-spectrum radio halo. If the steepness of the radio halo is confirmed, then the radio spectrum, combined with the relatively regular ICM morphology, could indicate that MACS J1149.6+2223 is an old merging cluster.

(9) Taylor, Andrew M.: Space science: Cosmic rays beyond the knees
Nature (2016) **531** 43-44. DOI

The development of a radio technique for detecting cosmic rays casts fresh light on the origins of some of these accelerated particles, and suggests that they might have travelled much farther than was previously thought. See Letter p.70

(10) HESS Collaboration, et al.: Acceleration of petaelectronvolt protons in the Galactic Centre
Nature (2016) **531** 476-479. DOI
http://arxiv.org/abs/arXiv:1603.07730

Galactic cosmic rays reach energies of at least a few petaelectronvolts (of the order of 10^{15} electronvolts). This implies that our Galaxy contains petaelectronvolt accelerators ('PeVatrons'), but all proposed models of Galactic cosmic-ray accelerators encounter difficulties at exactly these energies. Dozens of Galactic accelerators capable of accelerating particles to energies of tens of teraelectronvolts (of the order of 10^{13} electronvolts) were inferred from recent γ-ray observations. However, none of the currently known accelerators – not even the handful of shell-type supernova remnants commonly believed to supply most Galactic cosmic rays – has shown the characteristic tracers of petaelectronvolt particles, namely, power-law spectra of γ-rays extending without a cut-off or a spectral break to tens of teraelectronvolts. Here we report deep γ-ray observations with arcminute angular resolution of the region surrounding the Galactic Centre, which show the expected tracer of the presence of petaelectronvolt protons within the central 10 parsecs of the Galaxy. We propose that the supermassive black hole Sagittarius A* is linked to this PeVatron. Sagittarius A* went through active phases in the past, as demonstrated by X-ray outburstsand an outflow from the Galactic Centre. Although its current rate of particle acceleration is not sufficient to provide a substantial contribution to Galactic cosmic rays, Sagittarius A* could have plausibly been more active over the last 10^6-10^7 years, and therefore should be considered as a viable alternative to supernova remnants as a source of petaelectronvolt Galactic cosmic rays.

(11) Tazzari, M., et al.: Multiwavelength analysis for interferometric (sub-)mm observations of protoplanetary disks. Radial constraints on the dust properties and the disk structure
Astronomy and Astrophysics (2016) **588** A53 DOI
http://arxiv.org/abs/arXiv:1512.05679

Context. The growth of dust grains from sub-μm to mm and cm sizes is the first step towards the formation of planetesimals. Theoretical models of grain growth predict that dust properties change as a function of disk radius, mass, age, and other physical conditions. High angular resolution observations at several (sub-)mm wavelengths constitute the ideal tool with which to directly probe the bulk of dust grains and to investigate the radial distribution of their properties.

Aims: We lay down the methodology for a multiwavelength analysis of (sub-)mm and cm continuum interferometric observations to self-consistently constrain the disk structure and the radial variation of the dust properties. The computational architecture is massively parallel and highly modular.
 Methods: The analysis is based on the simultaneous fit in the uv-plane of observations at several wavelengths with a model for the disk thermal emission and for the dust opacity. The observed flux density at the different wavelengths is fitted by posing constraints on the disk structure and on the radial variation of the grain size distribution.

Results: We apply the analysis to observations of three protoplanetary disks (AS 209, FT Tau, DR Tau) for which a combination of spatially resolved observations in the range ~0.88 mm to ~10 mm is available from SMA, CARMA, and VLA. In these disks we find evidence of a decrease in the maximum dust grain size, $a_{\rm max}$, with radius. We derive large $a_{\rm max}$ values up to 1 cm in the inner disk 15 AU ≤ R ≤ 30 AU and smaller grains with $a_{\rm max} \sim 1$ mm in the outer disk ($R \gtrsim 80$ AU). Our analysis of the AS 209 protoplanetary disk confirms previous literature results showing $a_{\rm max}$ decreasing with radius.

Conclusions: Theoretical studies of planetary formation through grain growth are plagued by the lack of direct information on the radial distribution of the dust grain size. In this paper we develop a multiwavelength analysis that will allow this missing quantity to be constrained for statistically relevant samples of disks and to investigate possible correlations with disk or stellar parameters.

(12) Guidi, G., et al.: Dust properties across the CO snowline in the HD 163296 disk from ALMA and VLA observations
Astronomy and Astrophysics (2016) **588** A112 DOI
http://arxiv.org/abs/arXiv:1601.07542

Context. To characterize the mechanisms of planet formation it is crucial to investigate the properties and evolution of protoplanetary disks around young stars, where the initial conditions for the growth of planets are set. The high spatial resolution of Atacama Large Millimeter/submillimeter Array (ALMA) and Karl G. Jansky Very Large Array (VLA) observations now allows the study of radial variations of dust properties in nearby resolved disks and the investigation of the early stages of grain growth in disk midplanes.

Aims: Our goal is to study grain growth in the well-studied disk of the young, intermediate-mass star HD 163296 where dust processing has already been observed and to look for evidence of growth by ice condensation across the CO snowline, which has already been identified in this disk with ALMA.

Methods: Under the hypothesis of optically thin emission, we compare images at different wavelengths from ALMA and VLA to measure the opacity spectral index across the disk and thus the maximum grain size. We also use a Bayesian tool based on a two-layer disk model to fit the observations and constrain the dust surface density.

Results: The measurements of the opacity spectral index indicate the presence of large grains and pebbles (≥1 cm) in the inner regions of the disk (inside ˜50 AU) and smaller grains, consistent with ISM sizes, in the outer disk (beyond 150 AU). Re-analyzing ALMA Band 7 science verification data, we find (radially) unresolved excess continuum emission centered near the location of the CO snowline at ˜90 AU.

Conclusions: Our analysis suggests a grain size distribution consistent with an enhanced production of large grains at the CO snowline and consequent transport to the inner regions. Our results combined with the excess in infrared scattered light suggests there is a structure at 90 AU involving the whole vertical extent of the disk. This could be evidence of small scale processing of dust at the CO snowline.

(13) Kurosawa, Ryuichi, et al.: Probing the wind-launching regions of the Herbig Be star HD 58647 with high spectral resolution interferometry
Monthly Notices of the Royal Astronomical Society (2016) **457** 2236-2251. DOI
http://arxiv.org/abs/arXiv:1601.02209

We present a study of the wind-launching region of the Herbig Be star HD 58647 using high angular (λ/2B = 0.003 arcsec) and high spectral (R = 12 000) resolution interferometric Very Large Telescope Interferometer (VLTI)-Astronomical Multi-Beam combiner (AMBER) observations of the near-infrared hydrogen emission line, Brγ. The star displays double peaks in both Brγ line profile and wavelength-dependent visibilities. The wavelength-dependent differential phases show S-shaped variations around the line centre. The visibility level increases in the line (by ∼0.1) at the longest projected baseline (88 m), indicating that the size of the line emission region is smaller than the size of the K-band continuum-emitting region, which is expected to arise near the dust sublimation radius of the accretion disc. The data have been analysed using radiative transfer models to probe the geometry, size and physical properties of the wind that is emitting Brγ. We find that a model with a small magnetosphere and a disc wind with its inner radius located just outside of the magnetosphere can well reproduce the observed Brγ profile, wavelength-dependent visibilities, differential and closure phases, simultaneously. The mass-accretion and mass-loss rates adopted for the model are $\dot{M}_a = 3.5\times10^{-7}$ and $\dot{M}_{dw} = 4.5\times10^{-8} M_\odot\,\mathrm{yr}^{-1}$, respectively ($\dot{M}_{dw}/\dot{M}_a = 0.13$). Consequently, about 60 per cent of the angular momentum loss rate required for a steady accretion with the measured accretion rate is provided by the disc wind. The small magnetosphere in HD 58647 does not contribute to the Brγ line emission significantly.

(14) Marcowith, A., et al.: The microphysics of collisionless shock waves
Reports on Progress in Physics (2016) **79** 046901 DOI
http://arxiv.org/abs/arXiv:1604.00318

Collisionless shocks, that is shocks mediated by electromagnetic processes, are customary in space physics and in astrophysics. They are to be found in a great variety of objects and environments: magnetospheric and heliospheric shocks, supernova remnants, pulsar winds and their nebulæ, active galactic nuclei, gamma-ray bursts and clusters of galaxies shock waves. Collisionless shock microphysics enters at different stages of shock formation, shock dynamics and particle energization and/or acceleration. It turns out that the shock phenomenon is a multi-scale non-linear problem in

time and space. It is complexified by the impact due to high-energy cosmic rays in astrophysical environments. This review adresses the physics of shock formation, shock dynamics and particle acceleration based on a close examination of available multi-wavelength or in situ observations, analytical and numerical developments. A particular emphasis is made on the different instabilities triggered during the shock formation and in association with particle acceleration processes with regards to the properties of the background upstream medium. It appears that among the most important parameters the background magnetic field through the magnetization and its obliquity is the dominant one. The shock velocity that can reach relativistic speeds has also a strong impact over the development of the micro-instabilities and the fate of particle acceleration. Recent developments of laboratory shock experiments has started to bring some new insights in the physics of space plasma and astrophysical shock waves. A special section is dedicated to new laser plasma experiments probing shock physics.

(15) Shetye, J., et al.: High-cadence observations of spicular-type events on the Sun
Astronomy and Astrophysics (2016) **589** A3 DOI
http://arxiv.org/abs/arXiv:1601.08087

Context. Chromospheric observations taken at high-cadence and high-spatial resolution show a range of spicule-like features, including Type-I, Type-II (as well as rapid blue-shifted excursions (RBEs) and rapid red-shifted excursions (RREs) which are thought to be on-disk counterparts of Type-II spicules) and those which seem to appear within a few seconds, which if interpreted as flows would imply mass flow velocities in excess of 1000 km s^{-1}.

Aims: This article seeks to quantify and study rapidly appearing spicular-type events. We also compare the multi-object multi-frame blind deconvolution (MOMFBD) and speckle reconstruction techniques to understand if these spicules are more favourably observed using a particular technique.
 Methods: We use spectral imaging observations taken with the CRisp Imaging SpectroPolarimeter (CRISP) on the Swedish 1-m Solar Telescope. Data was sampled at multiple positions within the Hα line profile for both an on-disk and limb location.

Results: The data is host to numerous rapidly appearing features which are observed at different locations within the Hα line profile. The feature's durations vary between 10-20 s and lengths around 3500 km. Sometimes, a time delay in their appearance between the blue and red wings of 3-5 s is evident, whereas, sometimes they are near simultaneous. In some instances, features are observed to fade and then re-emerge at the same location several tens of seconds later.

Conclusions: We provide the first statistical analysis of these spicules and suggest that these observations can be interpreted as the line-of-sight (LOS) movement of highly dynamic spicules moving in and out of the narrow 60 mÅ transmission filter that is used to observe in different parts of the Hα line profile. The LOS velocity component of the observed fast chromospheric features, manifested as Doppler shifts, are responsible for their appearance in the red and blue wings of Hα line. Additional work involving data at other wavelengths is required to investigate the nature of their possible wave-like activity.

(16) Yang, Rui-zhi & Aharonian, Felix: On the GeV excess in the diffuse γ-ray emission towards the Galactic centre
Astronomy and Astrophysics (2016) **589** A117 DOI
http://arxiv.org/abs/arXiv:1602.06764

Aims: The Fermi-LAT γ-ray data have been used to study the morphological and spectral features of the so-called GeV excess - a diffuse radiation component recently discovered towards the Galactic centre.

Methods: We used the likelihood method to analyze Fermi-LAT data. Our study does confirm the existence of such an extra component in the diffuse γ-ray emission at GeV energies. Based on a detailed morphological analysis, a spatial template that fits the data best was generated and adopted.

Results: Using this template, the energy distribution of γ-rays was derived in the 0.3-30 GeV energy interval. The spectrum appeared to have less distinct ("bump"-like) structure than previous reported. We argue that the morphology of this radiation component has a bipolar rather than a spherically symmetric structure as has been assumed a priori in previous studies.

Conclusions: This finding excludes the associations of the GeV excess with Dark Matter. We briefly discuss the radiation mechanisms and possible source populations that could be responsible for this new component of diffuse gamma radiation.

(17) Caratti o Garatti, A., et al.: Tracing jet emission at the base of a high-mass YSO. First AMBER/VLTI observations of the Brγ emission in IRAS 13481-6124
Astronomy and Astrophysics (2016) **589** L4 DOI
http://arxiv.org/abs/arXiv:1603.06860

Aims: To probe the circumstellar environment of IRAS 13481-6124, a 20$M_{\odot}$high-mass young stellar object (HMYSO) with a collimated parsec-scale jet and an accretion disc, we investigate the origin of its Brγ emission line through near-infrared (NIR) interferometry.

Methods: We present the first AMBER/VLTI observations of the Brγ emitting region in an HMYSO at medium spectral resolution (R = 1500).

Results: Our AMBER/VLTI observations reveal a spatially and spectrally resolved Brγ line in emission with a strong P Cygni profile, indicating outflowing matter with a terminal velocity of ~500 km s^{-1}. Visibilities, differential phases, and closure phases are detected in our observations within the spectral line and in the adjacent continuum. Both total visibilities (continuum plus line emitting region) and pure-line visibilities indicate that the Brγ-emitting region is more compact (2-4 mas in diameter or ~6-13 au at 3.2 kpc) than the continuum-emitting region (~5.4 mas or ~17 au). The absorption feature is also spatially resolved at the longest baselines (81 and 85 m) and has a visibility that is slightly smaller than the continuum-emitting region. The differential phases at the four longest baselines display an "S"-shaped structure across the line, peaking in the blue- and red-shifted high-velocity components. The calibrated photocentre shifts are aligned with the known jet axis, i.e they are probably tracing an ionised jet. The high-velocity components (v_r ~ 100-500 km s^{-1}) are located far from the source, whereas the low-velocity components (0-100 km s^{-1}) are observed to be closer, indicating a strong acceleration of the gas flow in the inner 10 au. Finally, a non-zero closure phase along the continuum is detected. By comparing our observations with the synthetic images of the continuum around 2.16 μm, we confirm that this feature originates from the asymmetric brightness distribution of the continuum owing to the inclination of the inner disc.

Based on observations collected at the VLT (ESO Paranal, Chile) with programmes 090.C-0371(B).

(18) Doroshenko, Victor, et al.: Evidence for a binary origin of a central compact object
Monthly Notices of the Royal Astronomical Society (2016) **458** 2565-2572. DOI
http://arxiv.org/abs/arXiv:1508.03557

Central compact objects (CCOs) are thought to be young thermally emitting isolated neutron stars that were born during the preceding core-collapse supernova explosion. Here, we present evidence that at least in one case the CCO could have been formed within a binary system. We show that the highly reddened optical source IRAS 17287-3443, located 25 arcsec away from the CCO candidate XMMUJ173203.3-344518 and classified previously as a post asymptotic giant branch star, is indeed surrounded by a dust shell. This shell is heated by the central star to temperatures of ~90 K and observed as extended infrared emission in 8-160 μm band. The dust temperature also increases in the vicinity of the CCO which implies that it likely resides within the shell. We estimate the total dust mass to be $\sim 0.4 - 1.5\,M_{\odot}$ which significantly exceeds expected dust yields by normal stars and thus likely condensed from supernova ejecta. Taking into account that both the age of the supernova remnant and the duration of active mass-loss phase by the optical star are much shorter than the total lifetime of either object, the supernova and the onset of the active mass-loss phase of the companion have likely occurred approximately simultaneously. This is most easily explained if the evolution of both objects is interconnected. We conclude, therefore, that both stars were likely members of the same binary system disrupted by a supernova.

(19) Voisin, F., et al.: ISM gas studies towards the TeV PWN HESS J1825-137 and northern region
Monthly Notices of the Royal Astronomical Society (2016) **458** 2813-2835. DOI
http://arxiv.org/abs/arXiv:1604.00090

HESS J1825-137 is a pulsar wind nebula (PWN) whose TeV emission extends across ~1 . Its large

asymmetric shape indicates that its progenitor supernova interacted with a molecular cloud located in the north of the PWN as detected by previous CO Galactic survey (e.g. Lemiere, Terrier & Djannati-Ataï). Here, we provide a detailed picture of the interstellar medium (ISM) towards the region north of HESS J1825-137, with the analysis of the dense molecular gas from our 7 and 12 mm Mopra survey and the more diffuse molecular gas from the Nanten CO(1-0) and GRS ^{13}CO(1-0) surveys. Our focus is the possible association between HESS J1825-137 and the unidentified TeV source to the north, HESS J1826-130. We report several dense molecular regions whose kinematic distance matched the dispersion measured distance of the pulsar. Among them, the dense molecular gas located at (RA, Dec.) = (18^h421h,-13.282°) shows enhanced turbulence and we suggest that the velocity structure in this region may be explained by a cloud-cloud collision scenario. Furthermore, the presence of a H α rim may be the first evidence of the progenitor supernova remnant (SNR) of the pulsar PSR J1826-1334 as the distance between the H α rim and the TeV source matched with the predicted SNR radius $R_{SNR} \sim 120$ pc. From our ISM study, we identify a few plausible origins of the HESS J1826-130 emission, including the progenitor SNR of PSR J1826-1334 and the PWN G018.5-0.4 powered by PSR J1826-1256. A deeper TeV study however, is required to fully identify the origin of this mysterious TeV source.

(20) Christodoulou, Dimitris M., et al.: Dominance of outflowing electric currents on decaparsec to kiloparsec scales in extragalactic jets
Astronomy and Astrophysics (2016) **591** A61 DOI
http://arxiv.org/abs/arXiv:1605.08991

Context. Helical magnetic fields embedded in the jets of active galactic nuclei (AGNs) are required by the broad range of theoretical models that advocate for electromagnetic launching of the jets. In most models, the direction of the magnetic field is random, but if the axial field is generated by a Cosmic Battery generated by current in the direction of rotation in the accretion disk, there is a correlation between the directions of the spin of the AGN accretion disk and of the axial field, which leads to a specific direction for the axial electric current, azimuthal magnetic field, and the resulting observed transverse Faraday-rotation (FR) gradient across the jet, due to the systematic change in the line-of-sight magnetic field.

Aims: We consider new observational evidence for the presence of a nested helical magnetic-field structure such as would be brought about by the operation of the Cosmic Battery, and make predictions about the expected behavior of transverse FR gradients observed on decaparsec and kiloparsec scales.

Methods: We have jointly considered 27 detections of transverse FR gradients on parsec scales, four reports of reversals in the directions of observed transverse FR gradients observed on parsec-decaparsec scales, and five detections of transverse FR gradients on decaparsec-kiloparsec scales, one reported here for the first time. We also consider seven tentative additional examples of transverse FR gradients on kiloparsec scales, based on an initial visual inspection of published Very Large Array FR maps of 85 extragalactic radio sources, for three of which we have carried out quantitative analyses in order to quantitatively estimate the significances of the gradients.

Results: The data considered indicate a predominance of transverse FR gradients in the clockwise direction on the sky (i.e., net axial current flowing inward in the jet) on parsec scales and in the counter-clockwise direction on the sky (i.e., net axial current flowing outward) on scales greater than about 10 pc, consistent with the expectations for the Cosmic Battery. The predominance of counter-clockwise FR gradients on larger scales has been established at the 3σ confidence level.
 Conclusions: The collected results provide evidence for a reversal in the direction of the net azimuthal magnetic field determining the ordered component of the observed FR images, with distance from the jet base. This can be understood if the dominant azimuthal field on parsec scales corresponds to an axial electric current flowing inward along the jet, whereas the (weaker) dominant azimuthal field on kiloparsec scales corresponds to a outward-flowing current in the outer sheath of the jet and/or an extended disk wind. This is precisely the current/magnetic field structure that should be generated by the Cosmic Battery.

(21) Manara, C. F., et al.: Evidence for a correlation between mass accretion rates onto young stars and the mass of their protoplanetary disks
Astronomy and Astrophysics (2016) **591** L3 DOI

http://arxiv.org/abs/arXiv:1605.03050

A relation between the mass accretion rate onto the central young star and the mass of the surrounding protoplanetary disk has long been theoretically predicted and observationally sought. For the first time, we have accurately and homogeneously determined the photospheric parameters, mass accretion rate, and disk mass for an essentially complete sample of young stars with disks in the Lupus clouds. Our work combines the results of surveys conducted with VLT/X-Shooter and ALMA. With this dataset we are able to test a basic prediction of viscous accretion theory, the existence of a linear relation between the mass accretion rate onto the central star and the total disk mass. We find a correlation between the mass accretion rate and the disk dust mass, with a ratio that is roughly consistent with the expected viscous timescale when assuming an interstellar medium gas-to-dust ratio. This confirms that mass accretion rates are related to the properties of the outer disk. We find no correlation between mass accretion rates and the disk mass measured by CO isotopologues emission lines, possibly owing to the small number of measured disk gas masses. This suggests that the mm-sized dust mass better traces the total disk mass and that masses derived from CO may be underestimated, at least in some cases.

(22) Reid, A., et al.: Magnetic Flux Cancellation in Ellerman Bombs
The Astrophysical Journal (2016) **823** 110 DOI
http://arxiv.org/abs/arXiv:1603.07100

Ellerman Bombs (EBs) are often found to be co-spatial with bipolar photospheric magnetic fields. We use Hα imaging spectroscopy along with Fe i 6302.5 Å spectropolarimetry from the Swedish 1 m Solar Telescope (SST), combined with data from the Solar Dynamic Observatory, to study EBs and the evolution of the local magnetic fields at EB locations. EBs are found via an EB detection and tracking algorithm. Using NICOLE inversions of the spectropolarimetric data, we find that, on average, $(3.43\pm0.49) \times 10^{24}$ erg of stored magnetic energy disappears from the bipolar region during EB burning. The inversions also show flux cancellation rates of $10^{14} - 10^{15}$Mxs^{-1} and temperature enhancements of 200 K at the detection footpoints. We investigate the near-simultaneous flaring of EBs due to co-temporal flux emergence from a sunspot, which shows a decrease in transverse velocity when interacting with an existing, stationary area of opposite polarity magnetic flux, resulting in the formation of the EBs. We also show that these EBs can be fueled further by additional, faster moving, negative magnetic flux regions.

(23) Sun, Xiao-na, Yang, Rui-zhi, Mckinley, Benjamin, & Aharonian, Felix: Giant lobes of Centaurus A as seen in radio and gamma-ray images obtained with the Fermi-LAT and Planck satellites
ArXiv e-prints (2016) arXiv:1606.03053

The {\gamma}-ray data of Fermi-LAT on the giant lobes of Centaurus A are analysed together with the high frequency radio data obtained with the Planck satellite. The large {\gamma}-ray photon statistics, accumulated during seven years of observations, and the recently updated Fermi collaboration software tools allow substantial extension of the detected {\gamma}-ray emission towards higher energy, up to 30 GeV, and lower energy, down to 60 MeV. Moreover, the new {\gamma}-ray data allow us to explore the spatial features of {\gamma}-ray emission of the lobes. For the north lobe, we confirm, with higher statistical significance, our earlier finding on the extension of {\gamma}-ray emission beyond the radio image. Moreover, the new analysis reveals significant spatial variation of {\gamma}-ray spectra from both lobes. On the other hand, the Planck observations at microwave frequencies contain important information on spectra of synchrotron emission in the cutoff region, and thus allow model-independent derivation of the strength of the magnetic field and the distribution of relativistic electrons based on the combined {\gamma}-ray and radio data. The interpretation of multiwavelength spectral energy distributions (SEDs) of the lobes within a pure leptonic model requires strong enhancement of the magnetic field at the edge of the south lobe. Alternatively, a more complex, leptonic-hadronic model of the {\gamma}-ray emission, postulating a non-negligible contribution of the {\pi}^0 -decay component at highest energies, can explain the {\gamma}-ray data with a rather homogeneous distribution of the magnetic field over the giant lobes.

(24) Abdalla, H., et al.: Extended VHE gamma-ray emission towards SGR1806-20, LBV1806-20, and stellar cluster Cl*1806-20
ArXiv e-prints (2016) arXiv:1606.05404

Using the High Energy Spectroscopic System (H.E.S.S.) telescopes we have discovered a steady and

extended very high-energy (VHE) gamma-ray source towards the luminous blue variable candidate LBV1806-20, massive stellar cluster Cl*1806-20, and magnetar SGR1806-20. The new VHE source, HESSJ1808-204, was detected at a statistical significance of >6sigma (post-trial) with a photon flux normalisation $(2.9 \pm 0.4\_stat \pm 0.5\_sys) \times 10^{-13}$\,ph\,cm^{-2}\,s^{-1}\,TeV^{-1} at 1TeV and a power-law photon index of $2.3 \pm 0.2\_stat \pm 0.3\_sys$. The luminosity of this source (0.2 to 10 TeV; scaled to distance d=8.7kpc) is $L\_VHE \sim 1.6 \times 10^{34} (d/8.7kpc)^2$\,erg\,s^{-1}. The VHE gamma-ray emission is extended and is well fit by a single Gaussian with statistical standard deviation of $0.095^\circ \pm 0.015^\circ$. This extension is similar to that of the synchrotron radio nebula G10.0-0.3, which is thought to be powered by LBV1806-20. The VHE gamma-ray luminosity could be provided by the stellar wind luminosity of LBV1806-20 by itself and/or the massive star members of Cl*1806-20. Alternatively, magnetic dissipation (e.g. via reconnection) from SGR1806-20 can potentially account for the VHE luminosity. The origin and hadronic and/or leptonic nature of the accelerated particles responsible for HESSJ1808-204 is not yet clear. If associated with SGR1806-20, the potentially young age of the magnetar (650yr) can be used to infer the transport limits of these particles to match the VHE source size. This discovery provides new interest in the potential for high-energy particle acceleration from magnetars, massive stars, and/or stellar clusters.

(25) Ainsworth, Rachael E., et al.: GMRT detections of low-mass young stars at 323 and 608 MHz
Monthly Notices of the Royal Astronomical Society (2016) **459** 1248-1258. DOI
http://arxiv.org/abs/arXiv:1603.06836

We present the results of a pathfinder project conducted with the Giant Metrewave Radio Telescope (GMRT) to investigate protostellar systems at low radio frequencies. The goal of these investigations is to locate the break in the free-free spectrum where the optical depth equals unity in order to constrain physical parameters of these systems, such as the mass of the ionized gas surrounding these young stars. We detect all three target sources, L1551 IRS 5 (Class I), T Tau and DG Tau (Class II), at frequencies 323 and 608 MHz (wavelengths 90 and 50 cm, respectively). These are the first detections of low-mass young stellar objects at such low frequencies. We combine these new GMRT data with archival information to construct the spectral energy distributions for each system and find a continuation of the optically thin free-free spectra extrapolated from higher radio frequencies to 323 MHz for each target. We use these results to place limits on the masses of the ionized gas and average electron densities associated with these young systems on scales of ~1000 au. Future observations with higher angular resolution at lower frequencies are required to constrain these physical parameters further.

(26) Yang, Ruizhi, Aharonian, Felix, & Evoli, Carmelo: Radial distribution of the diffuse γ -ray emissivity in the Galactic disk
Physical Review D (2016) **93** 123007 DOI
http://arxiv.org/abs/arXiv:1602.04710

The Fermi-LAT data accumulated over 7 years of γ -ray observations, together with the high resolution gas (CO & HI) and the dust opacity maps, are used to study the emissivity of γ -rays induced by interactions of cosmic rays (CRs) with the interstellar medium. Based on the dust opacity templates, the γ -ray emissivity was measured for 36 segments of the Galactic plane. Furthermore, the γ -ray emissivity was evaluated in six Galactocentric rings. Both the absolute emissivity and the energy spectra of γ -rays derived in the interval 0.2-100 GeV show significant variations along the galactic plane. The density of CRs, derived under the assumption that γ -rays are predominately produced in CR interactions with the interstellar gas, is characterized by a strong radial dependence. In the inner Galaxy the CR density substantially exceeds the density in the outer parts of the Galaxy: by a factor of a few at 10 GeV, and by more than an order of magnitude at 1 TeV. Remarkably, the energy distribution of CRs appears to be substantially harder than the energy spectrum obtained from direct measurements of local CRs. At the same time, the flux and the energy spectrum of multi-GeV protons derived from γ -ray data in the outskirts of the Galaxy is quite close to the measurements of local CRs.

(27) Leurini, S., Menten, K. M., & Walmsley, C. M.: Physical characteristics of bright Class I methanol masers
Astronomy and Astrophysics (2016) **592** A31 DOI
http://arxiv.org/abs/arXiv:1605.09406

Context. Class I methanol masers are thought to be tracers of interstellar shock waves. However, they

have received relatively little attention mostly as a consequence of their low luminosities compared to other maser transitions. This situation has changed recently and Class I methanol masers are now routinely used as signposts of outflow activity especially in high extinction regions. The recent detection of polarisation in Class I lines now makes it possible to obtain direct observational information about magnetic fields in interstellar shocks.

Aims: We make use of newly calculated collisional rate coefficients for methanol to investigate the excitation of Class I methanol masers and to reconcile the observed Class I methanol maser properties with model results.

Methods: We performed large velocity gradient calculations with a plane-parallel slab geometry appropriate for shocks to compute the pump and loss rates which regulate the interactions of the different maser systems with the maser reservoir. We study the dependence of the pump rate coefficient, the maser loss rate, and the inversion efficiency of the pumping scheme of several Class I masers on the physics of the emitting gas.

Results: We predict inversion in all transitions where maser emission is observed. Bright Class I methanol masers are mainly high-temperature (>100 K) high-density (n(H_2) ~ 10^7-10^8 cm^{-3}) structures with methanol maser emission measures, ξ, corresponding to high methanol abundances close to the limits set by collisional quenching. Our model predictions reproduce reasonably well most of the observed properties of Class I methanol masers. Class I masers in the 25 GHz series are the most sensitive to the density of the medium and mase at higher densities than other lines. Moreover, even at high density and high methanol abundances, their luminosity is predicted to be lower than that of the 44 GHz and 36 GHz masers. Our model predictions also reflect the observational result that the 44 GHz line is almost always stronger than the 36 GHz maser. By comparison between observed isotropic photon luminosities and our model predictions, we infer maser beam solid angles of roughly 10^{-3} steradian.

Conclusions: We find that the Class I masers can reasonably be separated into three families: the (J + 1)$_{-1}$-J$_0$-E type series, the (J + 1)$_0$-J$_1$-A type, and the J$_2$-J$_1$-E lines at 25 GHz. The 25 GHz lines behave in a different fashion from the other masers as they are only inverted at high densities above 10^6 cm^{-3} in contrast to other Class I masers. Therefore, the detection of maser activity in all three families is a clear indication of high densities.

(28) Ambrogi, L., De Oña Wilhelmi, E., & Aharonian, F.: On the potential of atmospheric Cherenkov telescope arrays for resolving TeV gamma-ray sources in the Galactic plane
Astroparticle Physics (2016) **80** 22-33. DOI
http://arxiv.org/abs/arXiv:1603.04365

The potential of an array of imaging atmospheric Cherenkov telescopes to detect gamma-ray sources in complex regions has been investigated. The basic characteristics of the gamma-ray instrument have been parameterized using simple analytic representations. In addition to the ideal (Gaussian form) point spread function (PSF), the impact of more realistic non-Gaussian PSFs with tails has been considered. Simulations of isolated point-like and extended sources have been used as a benchmark to test and understand the response of the instrument. The capability of the instrument to resolve multiple sources has been analyzed and the corresponding instrument sensitivities calculated. The results are of particular interest for weak gamma-ray emitters located in crowded regions of the Galactic plane, where the chance of clustering of two or more gamma-ray sources within 1 deg is high.

(29) Prosekin, A. Yu., Kelner, S. R., & Aharonian, F. A.: Polarization of radiation of electrons in highly turbulent magnetic fields
ArXiv e-prints (2016) arXiv:1607.01522

We study the polarization properties of the jitter and synchrotron radiation produced by electrons in highly turbulent anisotropic magnetic fields. The net polarization is provided by the geometry of the magnetic field the directions of which are parallel to a certain plane. Such conditions may appear in the relativistic shocks during the amplification of the magnetic field through the so-called Weibel instability. While the polarization properties of the jitter radiation allows extraction of direct information on the turbulence spectrum as well as the geometry of magnetic field, the polarization of the synchrotron radiation reflects the distribution of the magnetic field over its strength. For the isotropic distribution of monoenergetic electrons, we found that the degree of polarization of the synchrotron

radiation is larger than the polarization of the jitter radiation. For the power-law energy distribution of electrons the relation between the degree of polarization of synchrotron and jitter radiation depends on the spectral index of the distribution.

(30) Crocker, Roland M., et al.: Sub-luminous '1991bg-Like' Thermonuclear Supernovae Account for Most Diffuse Antimatter in the Milky Way
ArXiv e-prints (2016) arXiv:1607.03495

Observations by the INTEGRAL satellite reveal that the Galaxy glows with the radiation from the annihilation of $(5.0\_-1.5^{+1.0}) \times 10^{43}$ electron-positron pairs every second. Constrained to be injected into the interstellar medium (ISM) at only mildly relativistic energies, it is highly plausible most positrons originate from the β^+ decay of radionuclides synthesised in stars or supernovae. However, none of the initially most likely candidates – massive stars, core-collapse (CC) supernovae (SNe) or ordinary thermonuclear supernovae (SNe Ia) – have Galactic distributions that match the spatial distribution of positron injection across the Milky Way. Here we show that a class of transient positron source occurring in stars of age >5 Gyr can explain the global distribution of positron annihilation in the Galaxy. Such sources, occurring at a present Galactic rate ~ 0.002 year^{-1} and typically synthesising ~ 0.03 solar masses of the β^+-unstable radionuclide ^{44}Ti, can simultaneously explain the absolute positron luminosity of the Galaxy and the abundance of ^{44}Ca in mainstream solar system material. Our binary evolution models show that mergers of helium-white dwarf (WD) and carbon-oxygen (CO) WD binary systems satisfy these age and rate requirements and plausibly match the ^{44}Ti yield requirements. The ^{56}Ni yield, delay time, and rates of these mergers strongly suggests they are the sub-luminous, thermonuclear SNe known as SN1991bg-like (SNe 91bg). These supernovae are, therefore, likely the main source of Galactic positrons. ONeMg WDs from the same WD population plausibly birth (via accretion induced collapse) the millisecond pulsars plausibly responsible for the 'Galactic Centre Excess'.

(31) H. E. S. S. Collaboration, et al.: A search for very high-energy flares from the microquasars GRS 1915+105, Circinus X-1, and V4641 Sgr using contemporaneous H.E.S.S. and RXTE observations
ArXiv e-prints (2016) arXiv:1607.04613

Microquasars are potential γ-ray emitters. Indications of transient episodes of γ-ray emission were recently reported in at least two systems: Cyg X-1 and Cyg X-3. The identification of additional γ-ray-emitting microquasars is required to better understand how γ-ray emission can be produced in these systems. Theoretical models have predicted very high-energy (VHE) γ-ray emission from microquasars during periods of transient outburst. Observations reported herein were undertaken with the objective of observing a broadband flaring event in the γ-ray and X-ray bands. Contemporaneous observations of three microquasars, GRS 1915+105, Circinus X-1, and V4641 Sgr, were obtained using the High Energy Spectroscopic System (H.E.S.S.) telescope array and the Rossi X-ray Timing Explorer (RXTE) satellite. X-ray analyses for each microquasar were performed and VHE γ-ray upper limits from contemporaneous H.E.S.S. observations were derived. No significant γ-ray signal has been detected in any of the three systems. The integral γ-ray photon flux at the observational epochs is constrained to be $I_{>560\,\mathrm{GeV}} < 7.3 \times 10^{-13}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$, $I_{>560\,\mathrm{GeV}} < 1.2 \times 10^{-12}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$, and $I_{>240\ \mathrm{GeV}} < 4.5 \times 10^{-12}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$ for GRS 1915+105, Circinus X-1, and V4641 Sgr, respectively. The γ-ray upper limits obtained using H.E.S.S. are examined in the context of previous Cherenkov telescope observations of microquasars. The effect of intrinsic absorption is modelled for each target and found to have negligible impact on the flux of escaping γ-rays. When combined with the X-ray behaviour observed using RXTE, the derived results indicate that if detectable VHE γ-ray emission from microquasars is commonplace, then it is likely to be highly transient.

(32) Hitomi Collaboration, et al.: Hitomi constraints on the 3.5 keV line in the Perseus galaxy cluster
ArXiv e-prints (2016) arXiv:1607.07420

High-resolution X-ray spectroscopy with Hitomi was expected to resolve the origin of the faint unidentified E=3.5 keV emission line reported in several low-resolution studies of various massive systems, such as galaxies and clusters, including the Perseus cluster. We have analyzed the Hitomi first-light observation of the Perseus cluster. The emission line expected for Perseus based on the XMM-Newton signal from the large cluster sample under the dark matter decay scenario is too faint to be detectable in the Hitomi data. However, the previously reported 3.5 keV flux from Perseus was anomalously high compared to the sample-based prediction. We find no unidentified line at the reported flux level. The high flux derived with XMM MOS for the Perseus region covered by Hitomi is excluded at >3-sigma

within the energy confidence interval of the most constraining previous study. If XMM measurement uncertainties for this region are included, the inconsistency with Hitomi is at a 99% significance for a broad dark-matter line and at 99.7% for a narrow line from the gas. We do find a hint of a broad excess near the energies of high-n transitions of Sxvi (E=3.44 keV rest-frame) – a possible signature of charge exchange in the molecular nebula and one of the proposed explanations for the 3.5 keV line. While its energy is consistent with XMM pn detections, it is unlikely to explain the MOS signal. A confirmation of this interesting feature has to wait for a more sensitive observation with a future calorimeter experiment.

(33) Hitomi Collaboration, et al.: The quiescent intracluster medium in the core of the Perseus cluster
Nature (2016) **535** 117-121. DOI
http://arxiv.org/abs/arXiv:1607.04487

Clusters of galaxies are the most massive gravitationally bound objects in the Universe and are still forming. They are thus important probes of cosmological parameters and many astrophysical processes. However, knowledge of the dynamics of the pervasive hot gas, the mass of which is much larger than the combined mass of all the stars in the cluster, is lacking. Such knowledge would enable insights into the injection of mechanical energy by the central supermassive black hole and the use of hydrostatic equilibrium for determining cluster masses. X-rays from the core of the Perseus cluster are emitted by the 50-million-kelvin diffuse hot plasma filling its gravitational potential well. The active galactic nucleus of the central galaxy NGC 1275 is pumping jetted energy into the surrounding intracluster medium, creating buoyant bubbles filled with relativistic plasma. These bubbles probably induce motions in the intracluster medium and heat the inner gas, preventing runaway radiative cooling – a process known as active galactic nucleus feedback. Here we report X-ray observations of the core of the Perseus cluster, which reveal a remarkably quiescent atmosphere in which the gas has a line-of-sight velocity dispersion of 164 ± 10 kilometres per second in the region 30-60 kiloparsecs from the central nucleus. A gradient in the line-of-sight velocity of 150 ± 70 kilometres per second is found across the 60-kiloparsec image of the cluster core. Turbulent pressure support in the gas is four per cent of the thermodynamic pressure, with large-scale shear at most doubling this estimate. We infer that a total cluster mass determined from hydrostatic equilibrium in a central region would require little correction for turbulent pressure.

(34) Lis, D. C., et al.: Star Formation and Feedback: A Molecular Outflow-Prestellar Core Interaction in L1689N
The Astrophysical Journal (2016) **827** 133 DOI
http://arxiv.org/abs/arXiv:1605.01239

We present Herschel,[11] ALMA Compact Array (ACA), and Caltech Submillimeter Observatory observations of the prestellar core in L1689N, which has been suggested to be interacting with a molecular outflow driven by the nearby solar-type protostar IRAS 16293-2422. This source is characterized by some of the highest deuteration levels observed in the interstellar medium. The change in the NH_2D line velocity and width across the core provides clear evidence of an interaction with the outflow, traced by the high-velocity water emission. Quiescent, cold gas characterized by narrow line widths is seen in the NE part of the core, while broader, more disturbed line profiles are seen in the W/SW part. Strong N_2D^+ and ND_3 emission is detected with ACA extending S/SW from the peak of the single-dish NH_2D emission. The ACA data also reveal the presence a compact dust continuum source with a mean size of ~1100 au, a central density of $(1-2) \times 10^7$ cm^{-3}, and a mass of 0.2-0.4 $M_\odot$. The dust emission peak is displaced $\sim 5\prime$ to the south with respect to the N_2D^+ and ND_3 emission, as well as the single-dish dust continuum peak, suggesting that the northern, quiescent part of the core is characterized by spatially extended continuum emission, which is resolved out by the interferometer. We see no clear evidence of fragmentation in this quiescent part of the core, which could lead to a second generation of star formation, although a weak dust continuum source is detected in this region in the ACA data.

(35) Adrián-Martínez, S., et al.: Letter of intent for KM3NeT 2.0
Journal of Physics G Nuclear Physics (2016) **43** 084001 DOI
http://arxiv.org/abs/arXiv:1601.07459

The main objectives of the KM3NeT Collaboration are (i) the discovery and subsequent observation of high-energy neutrino sources in the Universe and (ii) the determination of the mass hierarchy of

neutrinos. These objectives are strongly motivated by two recent important discoveries, namely: (1) the high-energy astrophysical neutrino signal reported by IceCube and (2) the sizable contribution of electron neutrinos to the third neutrino mass eigenstate as reported by Daya Bay, Reno and others. To meet these objectives, the KM3NeT Collaboration plans to build a new Research Infrastructure consisting of a network of deep-sea neutrino telescopes in the Mediterranean Sea. A phased and distributed implementation is pursued which maximises the access to regional funds, the availability of human resources and the synergistic opportunities for the Earth and sea sciences community. Three suitable deep-sea sites are selected, namely off-shore Toulon (France), Capo Passero (Sicily, Italy) and Pylos (Peloponnese, Greece). The infrastructure will consist of three so-called building blocks. A building block comprises 115 strings, each string comprises 18 optical modules and each optical module comprises 31 photo-multiplier tubes. Each building block thus constitutes a three-dimensional array of photo sensors that can be used to detect the Cherenkov light produced by relativistic particles emerging from neutrino interactions. Two building blocks will be sparsely configured to fully explore the IceCube signal with similar instrumented volume, different methodology, improved resolution and complementary field of view, including the galactic plane. One building block will be densely configured to precisely measure atmospheric neutrino oscillations.

(36) Haid, S., et al.: Supernova blast waves in wind-blown bubbles, turbulent, and power-law ambient media
Monthly Notices of the Royal Astronomical Society (2016) **460** 2962-2978. DOI
http://arxiv.org/abs/arXiv:1604.04395

Supernova (SN) blast waves inject energy and momentum into the interstellar medium (ISM), control its turbulent multiphase structure and the launching of galactic outflows. Accurate modelling of the blast wave evolution is therefore essential for ISM and galaxy formation simulations. We present an efficient method to compute the input of momentum, thermal energy, and the velocity distribution of the shock-accelerated gas for ambient media (densities of $0.1 \geq n_0[\mathrm{cm}^{-3}] \geq 100$) with uniform (and with stellar wind blown bubbles), power-law, and turbulent (Mach numbers M from 1to100) density distributions. Assuming solar metallicity cooling, the blast wave evolution is followed to the beginning of the momentum conserving snowplough phase. The model recovers previous results for uniform ambient media. The momentum injection in wind-blown bubbles depend on the swept-up mass and the efficiency of cooling, when the blast wave hits the wind shell. For power-law density distributions with $n(r) \sim r^{-2}$ (for $n(r) > n_{floor}$) the amount of momentum injection is solely regulated by the background density n_{floor} and compares to $n_{uni} = n_{floor}$. However, in turbulent ambient media with lognormal density distributions the momentum input can increase by a factor of 2 (compared to the homogeneous case) for high Mach numbers. The average momentum boost can be approximated as p_{turb}/{p_{{0}}} =23.07 (n_{{0,turb}}/1 cmˆ{-3})ˆ{-0.12} + 0.82 (ln (1+b^2{M}^{2}))ˆ{1.49}(n_{{0,turb}}/1 cmˆ{-3})ˆ{-1.6}. The velocity distributions are broad as gas can be accelerated to high velocities in low-density channels. The model values agree with results from recent, computationally expensive, three-dimensional simulations of SN explosions in turbulent media.

(37) Liu, Ruo-Yu, Taylor, Andrew M., Wang, Xiang-Yu, & Aharonian, Felix A.: Indication of a local fog of subankle ultrahigh energy cosmic rays
Physical Review D (2016) **94** 043008 DOI
http://arxiv.org/abs/arXiv:1603.03223

During their propagation through intergalactic space, ultrahigh energy cosmic rays (UHECRs) interact with the background radiation fields. These interactions give rise to energetic electron/positron pairs and photons which in turn feed electromagnetic cascades, contributing to the isotropic gamma-ray background (IGRB). The gamma-ray flux level generated in this way highly depends upon the UHECR propagation distance, as well as the evolution of their sources with redshift. Recently, the Fermi-LAT Collaboration reported that the majority of the total extragalactic gamma-ray flux originates from extragalactic point sources. This posits a stringent upper limit on the IGRB generated via UHECR propagation, and subsequently constrains their abundance in the distant Universe. Focusing on the contribution of UHECR at energies below the ankle within a narrow energy band ($(1 - -4) \times 10^{18}$ eV), we calculate the diffuse gamma-ray flux generated through UHECR propagation, normalizing the total cosmic ray energy budget in this band to that measured. We find that in order to not over-produce the new IGRB limit, a local "fog" of UHECR produced by nearby sources may exist, with

a possible non-negligible contribution from our Galaxy. Following the assumption that a given fraction of the observed IGRB at 820 GeV originates from UHECR, we obtain a constraint on the maximum distance for the majority of their sources. With other unresolved source populations still contaminating the new IGRB limit, and UHECR above the ankle invariably contributing also to this background, the results presented here are rather conservative.

(38) Fontani, F., et al.: Magnetically regulated fragmentation of a massive, dense, and turbulent clump
Astronomy and Astrophysics (2016) **593** L14 DOI
http://arxiv.org/abs/arXiv:1608.08083

Massive stars, multiple stellar systems, and clusters are born of the gravitational collapse of massive, dense, gaseous clumps, and the way these systems form strongly depends on how the parent clump fragments into cores during collapse. Numerical simulations show that magnetic fields may be the key ingredient in regulating fragmentation. Here we present ALMA observations at ˜ 0.25" resolution of the thermal dust continuum emission at ˜ 278 GHz towards a turbulent, dense, and massive clump, IRAS 16061-5048c1, in a very early evolutionary stage. The ALMA image shows that the clump has fragmented into many cores along a filamentary structure. We find that the number, the total mass, and the spatial distribution of the fragments are consistent with fragmentation dominated by a strong magnetic field. Our observations support the theoretical prediction that the magnetic field plays a dominant role in the fragmentation process of massive turbulent clumps.

(39) Ansdell, M., et al.: ALMA Survey of Lupus Protoplanetary Disks. I. Dust and Gas Masses
The Astrophysical Journal (2016) **828** 46 DOI
http://arxiv.org/abs/arXiv:1604.05719

We present the first high-resolution sub-millimeter survey of both dust and gas for a large population of protoplanetary disks. Characterizing fundamental properties of protoplanetary disks on a statistical level is critical to understanding how disks evolve into the diverse exoplanet population. We use the Atacama Large Millimeter/Submillimeter Array (ALMA) to survey 89 protoplanetary disks around stars with $M\_* > 0.1 M_\odot$ in the young (1-3 Myr), nearby (150-200 pc) Lupus complex. Our observations cover the 890 μm continuum and the ^{13}CO and C^{18}O 3-2 lines. We use the sub-millimeter continuum to constrain $M_{\rm dust}$ to a few Martian masses ($0.2 - -0.4) M_{oplus}$) and the CO isotopologue lines to constrain $M_{\rm gas}$ to roughly a Jupiter mass (assuming an interstellar medium (ISM)-like [CO]/[H_2] abundance). Of 89 sources, we detect 62 in continuum, 36 in ^{13}CO, and 11 in C^{18}O at $> 3\sigma$ significance. Stacking individually undetected sources limits their average dust mass to $\lesssim 6$ Lunar masses (0.03 $M_\oplus$), indicating rapid evolution once disk clearing begins. We find a positive correlation between M_{rmdust} and M_*, and present the first evidence for a positive correlation between $M_{\rm gas}$ and M_*, which may explain the dependence of giant planet frequency on host star mass. The mean dust mass in Lupus is 3 times higher than in Upper Sco, while the dust mass distributions in Lupus and Taurus are statistically indistinguishable. Most detected disks have $M_{\rm gas} \lesssim 1 M_{\rm Jup}$ and gas-to-dust ratios < 100 assuming an ISM-like [CO]/[H_2] abundance; unless CO is very depleted, the inferred gas depletion indicates that planet formation is well underway by a few Myr and may explain the unexpected prevalence of super-Earths in the exoplanet population.

(40) Wang, Ke, et al.: A Census of Large-scale (≥ 10 PC), Velocity-coherent, Dense Filaments in the Northern Galactic Plane: Automated Identification Using Minimum Spanning Tree
The Astrophysical Journal Supplement Series (2016) **226** 9 DOI
http://arxiv.org/abs/arXiv:1607.06452

Large-scale gaseous filaments with lengths up to the order of 100 pc are on the upper end of the filamentary hierarchy of the Galactic interstellar medium (ISM). Their association with respect to the Galactic structure and their role in Galactic star formation are of great interest from both an observational and theoretical point of view. Previous "by-eye" searches, combined together, have started to uncover the Galactic distribution of large filaments, yet inherent bias and small sample size limit conclusive statistical results from being drawn. Here, we present (1) a new, automated method for identifying large-scale velocity-coherent dense filaments, and (2) the first statistics and the Galactic distribution of these filaments. We use a customized minimum spanning tree algorithm to identify filaments by connecting voxels in the position-position-velocity space, using the Bolocam Galactic Plane Survey spectroscopic catalog. In the range of $7.^\circ 5 \leq l \leq 194^\circ$, we have identified 54 large-scale filaments

and derived mass (~ $(10^3 - -10^5)M_\odot$), length (10-276 pc), linear mass density ($54 - -8625 M_\odot pc^{-1}$), aspect ratio, linearity, velocity gradient, temperature, fragmentation, Galactic location, and orientation angle. The filaments concentrate along major spiral arms. They are widely distributed across the Galactic disk, with 50% located within ±20 pc from the Galactic mid-plane and 27% run in the center of spiral arms. An order of 1% of the molecular ISM is confined in large filaments. Massive star formation is more favorable in large filaments compared to elsewhere. This is the first comprehensive catalog of large filaments that can be useful for a quantitative comparison with spiral structures and numerical simulations.

(41) H. E. S. S. Collaboration, et al.: The supernova remnant W49B as seen with H.E.S.S. and Fermi-LAT
ArXiv e-prints (2016) arXiv:1609.00600

The supernova remnant (SNR) W49B originated from a core-collapse supernova that occurred between one and four thousand years ago, and subsequently evolved into a mixed-morphology remnant, which is interacting with molecular clouds (MC). γ-ray observations of SNR/MC associations are a powerful tool to constrain the origin of Galactic cosmic-rays, as they can probe the acceleration of hadrons through their interaction with the surrounding medium and subsequent emission of non-thermal photons. The detection of a γ-ray source coincident with W49B at very high energies (VHE; E > 100 GeV) with the H.E.S.S. Cherenkov telescopes is reported together with a study of the source with 5 years of Fermi-LAT high energy γ-ray (0.06 - 300 GeV) data. The smoothly-connected combined source spectrum, measured from 60 MeV to multi-TeV energies, shows two significant spectral breaks at 304 ± 20 MeV and $8.4\_{-2.5}^{+2.2}$ GeV, the latter being constrained by the joint fit from the two instruments. The detected spectral features are similar to those observed in several other SNR/MC associations and are found to be indicative of γ-ray emission produced through neutral-pion decay.

(42) H. E. S. S. Collaboration, et al.: H.E.S.S. observations of RX J1713.7-3946 with improved angular and spectral resolution; evidence for gamma-ray emission extending beyond the X-ray emitting shell
ArXiv e-prints (2016) arXiv:1609.08671

Supernova remnants exhibit shock fronts (shells) that can accelerate charged particles up to very high energies. In the past decade, measurements of a handful of shell-type supernova remnants in very-high-energy gamma rays have provided unique insights into the acceleration process. Among those objects, RX J1713.7-3946 (also known as G347.3-0.5) has the largest surface brightness, allowing us in the past to perform the most comprehensive study of morphology and spatially resolved spectra of any such very-high-energy gamma-ray source. Here we present extensive new H.E.S.S. measurements of RX J1713.7-3946, almost doubling the observation time compared to our previous publication. Combined with new improved analysis tools, the previous sensitivity is more than doubled. The H.E.S.S. angular resolution of 0.048° (0.036° above 2 TeV) is unprecedented in gamma-ray astronomy and probes physical scales of 0.8 (0.6) parsec at the remnant's location. The new H.E.S.S. image of RX J1713.7-3946 allows us to reveal clear morphological differences between X-rays and gamma rays. In particular, for the outer edge of the brightest shell region, we find the first ever indication for particles in the process of leaving the acceleration shock region. By studying the broadband energy spectrum, we furthermore extract properties of the parent particle populations, providing new input to the discussion of the leptonic or hadronic nature of the gamma-ray emission mechanism.

(43) Prosekin, A. Yu., Kelner, S. R., & Aharonian, F. A.: Polarization of radiation of electrons in highly turbulent magnetic fields
Physical Review D (2016) **94** 063010 DOI

We study the polarization properties of the jitter and synchrotron radiation produced by electrons in highly turbulent anisotropic magnetic fields. The net polarization is provided by the geometry of the magnetic field the directions of which are parallel to a certain plane. Such conditions may appear in the relativistic shocks during the amplification of the magnetic field through the so-called Weibel instability. While the polarization properties of the jitter radiation allows extraction of direct information on the turbulence spectrum as well as the geometry of magnetic field, the polarization of the synchrotron radiation reflects the distribution of the magnetic field over its strength. For the isotropic distribution of monoenergetic electrons, we found that the degree of polarization of the synchrotron radiation is larger than the polarization of the jitter radiation. For the power-law energy distribution of electrons the relation between the degree of polarization of synchrotron and jitter radiation depends on the spectral index of the distribution.

(44) Abdallah, H., et al.: Search for Dark Matter Annihilations towards the Inner Galactic Halo from 10 Years of Observations with H.E.S.S.
Physical Review Letters (2016) **117** 111301 DOI
http://arxiv.org/abs/arXiv:1607.08142

The inner region of the Milky Way halo harbors a large amount of dark matter (DM). Given its proximity, it is one of the most promising targets to look for DM. We report on a search for the annihilations of DM particles using γ -ray observations towards the inner 300 pc of the Milky Way, with the H.E.S.S. array of ground-based Cherenkov telescopes. The analysis is based on a 2D maximum likelihood method using Galactic Center (GC) data accumulated by H.E.S.S. over the last 10 years (2004-2014), and does not show any significant γ -ray signal above background. Assuming Einasto and Navarro-Frenk-White DM density profiles at the GC, we derive upper limits on the annihilation cross section $\langle\sigma v\rangle$. These constraints are the strongest obtained so far in the TeV DM mass range and improve upon previous limits by a factor 5. For the Einasto profile, the constraints reach $\langle\sigma v\rangle$ values of $6\times10^{-26}\,\mathrm{cm^3 s^{-1}}$ in the W^+W^- channel for a DM particle mass of 1.5 TeV, and $2\times10^{-26}\,\mathrm{cm^3 s^{-1}}$ in the $\tau^+\tau^-$ channel for a 1 TeV mass. For the first time, ground-based γ -ray observations have reached sufficient sensitivity to probe $\langle\sigma v\rangle$ values expected from the thermal relic density for TeV DM particles.

(45) Testi, L., et al.: Brown dwarf disks with ALMA: Evidence for truncated dust disks in Ophiuchus
Astronomy and Astrophysics (2016) **593** A111 DOI
http://arxiv.org/abs/arXiv:1606.06448

Context. The study of the properties of disks around young brown dwarfs can provide important clues on the formation of these very low-mass objects and on the possibility of forming planetary systems around them. The presence of warm dusty disks around brown dwarfs is well known, based on near- and mid-infrared studies.

Aims: High angular resolution observations of the cold outer disk are limited; we used ALMA to attempt a first survey of young brown dwarfs in the ρ Oph star-forming region.

Methods: All 17 young brown dwarfs in our sample were observed at 890 μm in the continuum at $0\farcs5$ angular resolution. The sensitivity of our observations was chosen to detect $\sim 0.5 M_\oplus$ of dust.

Results: We detect continuum emission in 11 disks (~65% of the total), and the estimated mass of dust in the detected disks ranges from ~0.5 to ~6$M_\oplus$. These disk masses imply that planet formation around brown dwarfs may be relatively rare and that the supra-Jupiter mass companions found around some brown dwarfs are probably the result of a binary system formation. We find evidence that the two brightest disks in ρ Oph have sharp outer edges at $R \lesssim 25$ AU, in contrast to disks around Taurus brown dwarfs. This difference may suggest that the different environment in ρ Oph may lead to significant differences in disk properties. A comparison of the M_{disk}/M_* ratio for brown dwarf and solar-mass systems also shows a possible deficit of mass in brown dwarfs, which could support the evidence for dynamical truncation of disks in the substellar regime. These findings are still tentative and need to be put on firmer grounds by studying the gaseous disks around brown dwarfs and by performing a more systematic and unbiased survey of the disk population around the more massive stars.

(46) Daemgen, Sebastian, et al.: Brown dwarf disks with Herschel: Linking far-infrared and (sub)-mm fluxes
Astronomy and Astrophysics (2016) **594** A83 DOI
http://arxiv.org/abs/arXiv:1607.07458

Brown dwarf disks are excellent laboratories to test our understanding of disk physics in an extreme parameter regime. In this paper we investigate a sample of 29 well-characterized brown dwarfs and very low-mass stars, for which Herschel far-infrared fluxes and (sub)-mm fluxes are available. We measured new Herschel/PACS fluxes for 11 objects and complement these with (sub)-mm data and Herschel fluxes from the literature. We analyze their spectral energy distributions in comparison with results from radiative transfer modeling. Fluxes in the far-infrared are strongly affected by the shape and temperature of the disk (and hence stellar luminosity), whereas the (sub)-mm fluxes mostly depend on disk mass. Nevertheless, there is a clear correlation between far-infrared and (sub)-mm fluxes. We argue that the link results from the combination of the stellar mass-luminosity relation and a scaling between disk mass and stellar mass. We find strong evidence of dust settling to the disk

midplane. The spectral slopes between near- and far-infrared are mostly between -0.5 and -1.2 in our sample, which is comparable to more massive T Tauri stars; this may imply that the disk shapes are similar as well, although highly flared disks are rare among brown dwarfs. We find that dust temperatures in the range of 7-15 K, calculated with $T \approx 25(L/L_{\odot})^{0.25}$ K, are appropriate for deriving disk masses from (sub)-mm fluxes for these low luminosity objects. About half of our sample hosts disks with at least one Jupiter mass, confirming that many brown dwarfs harbor sufficient material for the formation of Earth-mass planets in their midst.

Herschel is a ESA space observatory with science instruments provided by European-led Principal Investigator consortia and with important participation from NASA.

(47) Liseau, R., et al.: ALMA's view of the nearest neighbors to the Sun. The submm/mm SEDs of the α Centauri binary and a new source
Astronomy and Astrophysics (2016) **594** A109 DOI
http://arxiv.org/abs/arXiv:1608.02384

Context. The precise mechanisms that provide the nonradiative energy for heating the chromosphere and corona of the Sun and other stars are at the focus of intense contemporary research.

Aims: Observations at submm and mm wavelengths are particularly useful to obtain information about the run of the temperature in the upper atmosphere of Sun-like stars. We used the Atacama Large Millimeter/submillimeter Array (ALMA) to study the chromospheric emission of the α Centauri binary system in all six available frequency bands during Cycle 2 in 2014-2015.

Methods: Since ALMA is an interferometer, the multitelescope array is particularly suited for the observation of point sources. With its large collecting area, the sensitivity is high enough to allow the observation of nearby main-sequence stars at submm/mm wavelengths for the first time. The comparison of the observed spectral energy distributions with theoretical model computations provides the chromospheric structure in terms of temperature and density above the stellar photosphere and the quantitative understanding of the primary emission processes.

Results: Both stars in the α Centauri binary system were detected and resolved at all ALMA frequencies. For both α Cen A and B, the existence and location of the temperature minima, first detected from space with Herschel, are well reproduced by the theoretical models of this paper. The temperature minimum for α Cen B is lower than for A and occurs at a lower height in the atmosphere, but for both stars, T_{min}/T_{eff} is consistently lower than what is derived from optical and UV data. In addition, and as a completely different matter, a third point source was detected in Band 8 (405 GHz, 740 μm) in 2015. With only one epoch and only one detection, we are left with little information regarding that object's nature, but we conjecture that it might be a distant solar system object.

Conclusions: The submm/mm emission of the α Cen stars is indeed very well reproduced by modified chromospheric models of the quiet Sun. This most likely means that the nonradiative heating mechanisms of the upper atmosphere that are at work in the Sun are also operating in other solar-type stars.

(48) Sun, Xiao-na, Yang, Rui-zhi, Mckinley, Benjamin, & Aharonian, Felix: Giant lobes of Centaurus A as seen in radio and γ-ray images obtained with the Fermi-LAT and Planck satellites
Astronomy and Astrophysics (2016) **595** A29 DOI

The γ-ray data of Fermi-LAT on the giant lobes of Centaurus A are analysed together with the high frequency radio data obtained with the Planck satellite. The large γ-ray photon statistics, accumulated during seven years of observations, and the recently updated Fermi-LAT collaboration software tools allow substantial extension of the detected γ-ray emission towards higher energy, up to 30 GeV, and lower energy, down to 60 MeV. Moreover, the new γ-ray data allow us to explore the spatial features of γ-ray emission of the lobes. For the north lobe, we confirm, with higher statistical significance, our earlier finding on the extension of γ-ray emission beyond the radio image. Moreover, the new analysis reveals significant spatial variation of γ-ray spectra from both lobes. On the other hand, the Planck observations at microwave frequencies contain important information on spectra of synchrotron emission in the cutoff region, and thus allow model-independent derivation of the strength of the magnetic field and the distribution of relativistic electrons based on the combined γ-ray and radio data. The interpretation of multiwavelength spectral energy distributions of the lobes within

a pure leptonic model requires strong enhancement of the magnetic field at the edge of the south lobe. Alternatively, a more complex, leptonic-hadronic model of the γ-ray emission, postulating a non-negligible contribution of the π^0-decay component at highest energies, can explain the γ-ray data with a rather homogeneous distribution of the magnetic field over the giant lobes.

(49) CTA Consortium, The, et al.: Contributions of the Cherenkov Telescope Array (CTA) to the 6th International Symposium on High-Energy Gamma-Ray Astronomy (Gamma 2016)
ArXiv e-prints (2016) arXiv:1610.05151

List of contributions from the Cherenkov Telescope Array (CTA) Consortium presented at the 6th International Symposium on High-Energy Gamma-Ray Astronomy (Gamma 2016), July 11-15, 2016, in Heidelberg, Germany.

(50) Kraus, S., et al.: V346 Normae: first post-outburst observations of an FU Orionis star
Monthly Notices of the Royal Astronomical Society (2016) **462** L61-L65. DOI
http://arxiv.org/abs/arXiv:1607.03114

During their formation phase, stars gain most of their mass in violent episodic accretion events, such as observed in FU Orionis (FUor) and EXor stars. V346 Normae is a well-studied FUor that underwent a strong outburst beginning around 1980. Here, we report on photometric and spectroscopic observations, which show that the visual/near-infrared brightness has decreased dramatically between the 1990s and 2010 ($\Delta R \approx 10.9$ mag, $\Delta J \approx 7.8$ mag and $\Delta K \approx 5.8$ mag). The spectral properties of this fading event cannot be explained by variable extinction alone, but indicate a drop in accretion rate by two to three orders of magnitude. This is the first time that a member of the FUor class has been observed to switch to a very low accretion phase. Remarkably, in the last few years (2011-2015) V346 Nor has brightened again at all near-infrared wavelengths, indicating the onset of a new outburst event. The observed behaviour might be consistent with the clustered luminosity bursts that have been predicted by recent gravitational instability and fragmentation models for the early stages of protostellar evolution. Given V346 Nor's unique characteristics (concerning outburst duration, repetition frequency and spectroscopic diagnostics), our results also highlight the need to revisit the FUor/EXor classification scheme.

(51) Abdalla, H., et al.: H.E.S.S. Limits on Linelike Dark Matter Signatures in the 100 GeV to 2 TeV Energy Range Close to the Galactic Center
Physical Review Letters (2016) **117** 151302 DOI
http://arxiv.org/abs/arXiv:1609.08091

A search for dark matter linelike signals iss performed in the vicinity of the Galactic Center by the H.E.S.S. experiment on observational data taken in 2014. An unbinned likelihood analysis iss developed to improve the sensitivity to linelike signals. The upgraded analysis along with newer data extend the energy coverage of the previous measurement down to 100 GeV. The 18 h of data collected with the H.E.S.S. array allow one to rule out at 95% C.L. the presence of a 130 GeV line (at l =-1.5 ° , b =0 ° and for a dark matter profile centered at this location) previously reported in Fermi-LAT data. This new analysis overlaps significantly in energy with previous Fermi-LAT and H.E.S.S. results. No significant excess associated with dark matter annihilations was found in the energy range of 100 GeV to 2 TeV and upper limits on the gamma-ray flux and the velocity weighted annihilation cross section are derived adopting an Einasto dark matter halo profile. Expected limits for present and future large statistics H.E.S.S. observations are also given.

(52) Zanin, R., et al.: Gamma rays detected from Cygnus X-1 with likely jet origin
Astronomy and Astrophysics (2016) **596** A55 DOI
http://arxiv.org/abs/arXiv:1605.05914

Aims: We probe the high-energy (>60 MeV) emission from the black hole X-ray binary system, Cygnus X-1, and investigate its origin.

Methods: We analyzed 7.5 yr of data by Fermi-LAT with the latest Pass 8 software version.

Results: We report the detection of a signal at 8σ statistical significance that is spatially coincident with Cygnus X-1 and has a luminosity of 5.5×10^{33} erg s^{-1}, above 60 MeV. The signal is correlated with the hard X-ray flux: the source is observed at high energies only during the hard X-ray spectral state,

when the source is known to display persistent, relativistic radio-emitting jets. The energy spectrum, extending up to 20 GeV without any sign of spectral break, is well fit by a power-law function with a photon index of 2.3 ± 0.2. There is a hint of orbital flux variability, with high-energy emission mostly coming around the superior conjunction.
 Conclusions: We detected GeV emission from Cygnus X-1 and probed that the emission is most likely associated with the relativistic jets. The evidence of flux orbital variability indicates the anisotropic inverse-Compton on stellar photons as the mechanism at work, thus constraining the emission region to a distance 10^{11}-10^{13} cm from the black hole.

(53) Sanna, A., et al.: Momentum-driven outflow emission from an O-type YSO. Comparing the radio jet with the molecular outflow
Astronomy and Astrophysics (2016) **596** L2 DOI
http://arxiv.org/abs/arXiv:1611.00408

Aims: We seek to study the physical properties of the ionized jet emission in the vicinity of an O-type young stellar object (YSO) and to estimate the efficiency of the transfer of energy and momentum from small- to large-scale outflows.

Methods: We conducted Karl G. Jansky Very Large Array (VLA) observations, at both 22 and 45 GHz, of compact and faint radio continuum emission in the high-mass star-forming region G023.01-00.41 with an angular resolution between 0".3 and 0".1 and a thermal rms on the order of 10 μJy beam^{-1}.

Results: We discovered a collimated thermal (bremsstrahlung) jet emission with a radio luminosity (L_{rad}) of 24 mJy kpc^2 at 45 GHz in the inner 1000 AU from an O-type YSO. The radio thermal jet has an opening angle of 44° and carries a momentum rate of 8×10^{-3}M$_\odot$ yr^{-1}km s^{-1}. By combining the new data with previous observations of the molecular outflow and water maser shocks, we can trace the outflow emission from its driving source through the molecular clump across more than two orders of magnitude in length (500 AU-0.2 pc). We find that the momentum-transfer efficiency between the inner jet emission and the extended outflow of entrained ambient gas is near unity. This result suggests that the large-scale flow is swept up by the mechanical force of radio jet emission, which originates from within 1000 AU of the high-mass YSO.

(54) Aliu, E., et al.: A Search for Very High Energy Gamma Rays from the Missing Link Binary Pulsar J1023+0038 with VERITAS
The Astrophysical Journal (2016) **831** 193 DOI
http://arxiv.org/abs/arXiv:1609.01692

The binary millisecond radio pulsar PSR J1023+0038 exhibits many characteristics similar to the gamma-ray binary system PSR B1259-63/LS 2883, making it an ideal candidate for the study of high-energy nonthermal emission. It has been the subject of multiwavelength campaigns following the disappearance of the pulsed radio emission in 2013 June, which revealed the appearance of an accretion disk around the neutron star. We present the results of very high energy (VHE) gamma-ray observations carried out by the Very Energetic Radiation Imaging Telescope Array System before and after this change of state. Searches for steady and pulsed emission of both data sets yield no significant gamma-ray signal above 100 GeV, and upper limits are given for both a steady and pulsed gamma-ray flux. These upper limits are used to constrain the magnetic field strength in the shock region of the PSR J1023+0038 system. Assuming that VHE gamma rays are produced via an inverse Compton mechanism in the shock region, we constrain the shock magnetic field to be greater than ~2 G before the disappearance of the radio pulsar and greater than ~10 G afterward.

(55) H. E. S. S. Collaboration, et al.: Deeper H.E.S.S. Observations of Vela Junior (RX J0852.0-4622): Morphology Studies and Resolved Spectroscopy
ArXiv e-prints (2016) arXiv:1611.01863

Aims. The gamma-ray emission from the shell-type supernova remnant (SNR) RX J0852.0-4622 is studied in order to better characterize its spectral properties and its distribution over the SNR. Methods. The analysis of an extended H.E.S.S. data set at very-high energies (E > 100 GeV) permits detailed studies of the morphology and the spectrum of the whole RX J0852.0-4622 region, as well as spatially-resolved spectroscopy. The H.E.S.S. data are combined with archival data from other wavebands and

interpreted in the framework of leptonic and hadronic models. The joint Fermi-LAT-H.E.S.S. spectrum allows the direct determination of the spectral characteristics of the parent particle population in leptonic and hadronic scenarios using only GeV-TeV data. Results. An updated analysis of the H.E.S.S. data shows that the spectrum of the entire SNR connects smoothly to the high-energy spectrum measured by Fermi-LAT. The increased data set makes it possible to demonstrate that the H.E.S.S. spectrum deviates significantly from a power law and is well described by both a curved power law and a power law with an exponential cut-off at an energy of Ecut = (6.7 +/- 1.2_stat +/- 1.2_syst) TeV. The joint Fermi-LAT-H.E.S.S. spectrum allows the unambiguous identification of the spectral shape as a power law with an exponential cut-off. No significant evidence is found for a variation of the spectral parameters across the SNR, suggesting similar conditions of particle acceleration across the remnant. A simple modeling using one particle population to model the SNR emission demonstrates that both leptonic and hadronic emission scenarios remain plausible. It is also shown that at least a part of the shell emission is likely due to the presence of a pulsar wind nebula around PSR J0855-4644.

(56) Vig, S., et al.: Dust and Gas environment of the young embedded cluster IRAS 18511+0146
ArXiv e-prints (2016) arXiv:1611.01910

IRAS 18511+0146 is a young embedded (proto)cluster located at 3.5 kpc surrounding what appears to be an intermediate mass protostar. In this paper, we investigate the nature of cluster members (two of which are believed to be the most massive and luminous) using imaging and spectroscopy in the near and mid-infrared. The brightest point-like object associated with IRAS 18511+0146 is referred to as S7 in the present work (designated UGPS J185337.88+015030.5 in the UKIRT Galactic Plane survey). Seven of the nine objects show rising spectral energy distributions (SED) in the near-infrared, with four objects showing Br-gamma emission. Three members: S7, S10 (also UGPS J185338.37+015015.3) and S11 (also UGPS J185338.72+015013.5) are bright in mid-infrared with diffuse emission being detected in the vicinity of S11 in PAH bands. Silicate absorption is detected towards these three objects, with an absorption maximum between 9.6 and 9.7 um, large optical depths (1.8-3.2), and profile widths of 1.6-2.1 um. The silicate profiles of S7 and S10 are similar, in contrast to S11 (which has the largest width and optical depth). The cold dust emission investigated using Herschel HiGal peaks at S7, with temperature at 26 K and column density N(H2) ~ 7 x 10^(22) cm^(-2). The bolometric luminosity of IRAS 18511 region is L ~ 1.8 x 10^4 L_sun. S7 is the main contributor to the bolometric luminosity, with L (S7) > 10^4 L_sun. S7 is a high mass protostellar object with ionised stellar winds, evident from the correlation between radio and bolometric luminosity as well as the asymmetric Br-gamma profile. The differences in silicate profiles of S7 and S11 could be due to different radiation environment as we believe the former to be more massive and in an earlier phase than the latter.

(57) O'Gorman, Eamon, Harper, Graham M., & Vlemmings, Wouter: Detection of thermal radio emission from a single coronal giant
ArXiv e-prints (2016) arXiv:1611.08412

We report the detection of thermal continuum radio emission from the K0 III coronal giant Pollux (β Gem) with the Karl G. Jansky Very Large Array (VLA). The star was detected at 21 and 9 GHz with flux density values of 150 ± 21 and $43 \pm 8\,\mu$Jy, respectively. We also place a 3σ_rms upper limit of $23\,\mu$Jy for the flux density at 3 GHz. We find the stellar disk-averaged brightness temperatures to be approximately 9500, 15000, and < 71000 K, at 21, 9, and 3 GHz, respectively, which are consistent with the values of the quiet Sun. The emission is most likely dominated by optically thick thermal emission from an upper chromosphere at 21 and 9 GHz. We discuss other possible additional sources of emission at all frequencies and show that there may also be a small contribution from gyroresonance emission above active regions, coronal free-free emission and free-free emission from an optically thin stellar wind, particularly at the lower frequencies. We constrain the maximum mass-loss rate from Pollux to be less than $3.7 \times 10^{-11}\,M_{\odot}$ yr^{-1} (assuming a wind terminal velocity of 215 km s^{-1}), which is about an order of magnitude smaller than previous constraints for coronal giants and is in agreement with existing predictions for the mass-loss rate of Pollux. These are the first detections of thermal radio emission from a single (i.e., non-binary) coronal giant and demonstrate that low activity coronal giants like Pollux have atmospheres at radio frequencies akin to the quiet Sun.

(58) Ainsworth, Rachael E., et al.: A GMRT survey of regions towards the Taurus molecular cloud at 323 and 608 MHz
Monthly Notices of the Royal Astronomical Society (2016) **462** 2904-2917. DOI

http://arxiv.org/abs/arXiv:1607.07245

We present observations of three active sites of star formation in the Taurus molecular cloud complex taken at 323 and 608 MHz (90 and 50 cm, respectively) with the Giant Metrewave Radio Telescope (GMRT). Three pointings were observed as part of a pathfinder project, targeted at the young stellar objects (YSOs) L1551 IRS 5, T Tau and DG Tau (the results for these target sources were presented in a previous paper). In this paper, we search for other YSOs and present a survey comprising of all three fields; a by-product of the large instantaneous field of view of the GMRT. The resolution of the survey is of order 10 arcsec and the best rms noise at the centre of each pointing is of order 100 μJy beam^{-1} at 323 MHz and 50 μJy beam^{-1} at 608 MHz. We present a catalogue of 1815 and 687 field sources detected above $5\sigma_{rms}$ at 323 and 608 MHz, respectively. A total of 440 sources were detected at both frequencies, corresponding to a total unique source count of 2062 sources. We compare the results with previous surveys and showcase a sample of extended extragalactic objects. Although no further YSOs were detected in addition to the target YSOs based on our source-finding criteria, these data can be useful for targeted manual searches, studies of radio galaxies or to assist in the calibration of future observations with the Low-Frequency Array towards these regions.

(59) Rodgers-Lee, D., Ray, T. P., & Downes, T. P.: Global multifluid simulations of the magnetorotational instability in radially stratified protoplanetary discs
Monthly Notices of the Royal Astronomical Society (2016) **463** 134-145. DOI
http://arxiv.org/abs/arXiv:1608.02808

The redistribution of angular momentum is a long standing problem in our understanding of protoplanetary disc (PPD) evolution. The magnetorotational instability (MRI) is considered a likely mechanism. We present the results of a study involving multifluid global simulations including Ohmic dissipation, ambipolar diffusion and the Hall effect in a dynamic, self-consistent way. We focus on the turbulence resulting from the non-linear development of the MRI in radially stratified PPDs and compare with ideal magnetohydrodynamics simulations. In the multifluid simulations, the disc is initially set up to transition from a weak Hall-dominated regime, where the Hall effect is the dominant non-ideal effect but approximately the same as or weaker than the inductive term, to a strong Hall-dominated regime, where the Hall effect dominates the inductive term. As the simulations progress, a substantial portion of the disc develops into a weak Hall-dominated disc. We find a transition from turbulent to laminar flow in the inner regions of the disc, but without any corresponding overall density feature. We introduce a dimensionless parameter, α_{RM}, to characterize accretion with $\alpha_{RM} \gtrsim 0.1$ corresponding to turbulent transport. We calculate the eddy turnover time, t_{eddy}, and compared this with an effective recombination time-scale, t_{rcb}, to determine whether the presence of turbulence necessitates non-equilibrium ionization calculations. We find that t_{rcb} is typically around three orders of magnitude smaller than t_{eddy}. Also, the ionization fraction does not vary appreciably. These two results suggest that these multifluid simulations should be comparable to single-fluid non-ideal simulations.

(60) H. E. S. S. Collaboration, et al.: Gamma-ray blazar spectra with H.E.S.S. II mono analysis: the case of PKS 2155-304 and PG 1553+113
ArXiv e-prints (2016) arXiv:1612.01843

The addition of a 28 m Cherenkov telescope (CT5) to the H.E.S.S. array extended the experiment's sensitivity to lower energies. The lowest energy threshold is obtained using monoscopic analysis of data taken with CT5, providing access to gamma-ray energies below 100 GeV. Such an extension of the instrument's energy range is particularly beneficial for studies of Active Galactic Nuclei with soft spectra, as expected for those at a redshift > 0.5. The high-frequency peaked BL Lac objects PKS 2155-304 (z = 0.116) and PG 1553+113 ($0.43 < z < 0.58$) are among the brightest objects in the gamma-ray sky, both showing clear signatures of gamma-ray absorption at E > 100 GeV interpreted as being due to interactions with the extragalactic background light (EBL). Multiple observational campaigns of PKS 2155-304 and PG 1553+113 were conducted during 2013 and 2014 using the full H.E.S.S. II instrument. A monoscopic analysis of the data taken with the new CT5 telescope was developed along with an investigation into the systematic uncertainties on the spectral parameters. The energy spectra of PKS 2155-304 and PG 1553+113 were reconstructed down to energies of 80 GeV for PKS 2155-304, which transits near zenith, and 110 GeV for the more northern PG 1553+113. The measured spectra, well fitted in both cases by a log-parabola spectral model (with a 5.0 sigma statistical preference for non-zero curvature for PKS 2155-304 and 4.5 sigma for PG 1553+113), were found consistent with

spectra derived from contemporaneous Fermi-LAT data, indicating a sharp break in the observed spectra of both sources at E ˜ 100 GeV. When corrected for EBL absorption, the intrinsic H.E.S.S. II mono and Fermi-LAT spectrum of PKS 2155-304 was found to show significant curvature. For PG 1553+113, however, no significant detection of curvature in the intrinsic spectrum could be found within statistical and systematic uncertainties.

(61) Coughlan, Colm P. & Gabuzda, Denise C.: High resolution VLBI polarization imaging of AGN with the maximum entropy method
Monthly Notices of the Royal Astronomical Society (2016) **463** 1980-2001. DOI
http://arxiv.org/abs/arXiv:1608.06812

Radio polarization images of the jets of Active Galactic Nuclei (AGN) can provide a deep insight into the launching and collimation mechanisms of relativistic jets. However, even at VLBI scales, resolution is often a limiting factor in the conclusions that can be drawn from observations. The maximum entropy method (MEM) is a deconvolution algorithm that can outperform the more common CLEAN algorithm in many cases, particularly when investigating structures present on scales comparable to or smaller than the nominal beam size with 'super-resolution'. A new implementation of the MEM suitable for single- or multiple-wavelength VLBI polarization observations has been developed and is described here. Monte Carlo simulations comparing the performances of CLEAN and MEM at reconstructing the properties of model images are presented; these demonstrate the enhanced reliability of MEM over CLEAN when images of the fractional polarization and polarization angle are constructed using convolving beams that are appreciably smaller than the full CLEAN beam. The results of using this new MEM software to image VLBA observations of the AGN 0716+714 at six different wavelengths are presented, and compared to corresponding maps obtained with CLEAN. MEM and CLEAN maps of Stokes I, the polarized flux, the fractional polarization and the polarization angle are compared for convolving beams ranging from the full CLEAN beam down to a beam one-third of this size. MEM's ability to provide more trustworthy polarization imaging than a standard CLEAN-based deconvolution when convolving beams appreciably smaller than the full CLEAN beam are used is discussed.

(62) Walls, M., Chernyakova, M., Terrier, R., & Goldwurm, A.: Examining molecular clouds in the Galactic Centre region using X-ray reflection spectra simulations
Monthly Notices of the Royal Astronomical Society (2016) **463** 2893-2903. DOI
http://arxiv.org/abs/arXiv:1609.00175

In the centre of our Galaxy lies a supermassive black hole, identified with the radio source Sagittarius A*. This black hole has an estimated mass of around 4 million solar masses. Although Sagittarius A* is quite dim in terms of total radiated energy, having a luminosity that is a factor of 10^{10} lower than its Eddington luminosity, there is now compelling evidence that this source was far brighter in the past. Evidence derived from the detection of reflected X-ray emission from the giant molecular clouds in the Galactic Centre region. However, the interpretation of the reflected emission spectra cannot be done correctly without detailed modelling of the reflection process. Attempts to do so can lead to an incorrect interpretation of the data. In this paper, we present the results of a Monte Carlo simulation code we developed in order to fully model the complex processes involved in the emerging reflection spectra. The simulated spectra can be compared to real data in order to derive model parameters and constrain the past activity of the black hole. In particular, we apply our code to observations of Sagittarius B2, in order to constrain the position and density of the cloud and the incident luminosity of the central source. The results of the code have been adapted to be used in XSPEC by a large community of astronomers.

(63) Malyshev, D. & Chernyakova, M.: Constraints on the spectrum of HESS J0632+057 from Fermi-LAT data
Monthly Notices of the Royal Astronomical Society (2016) **463** 3074-3077. DOI

We report on the results of ~7.5 yr of the very high energy (10-600 GeV) observations of HESS J0632+057 with Fermi-Large Area Telescope. In the highest energy band, 200-600 GeV, the source is detected with the statistical significance $\gtrsim 4.7\sigma$ at orbital phases 0.2-0.4 and 0.6-0.8 at which HESS J0632+057 is known to demonstrate enhanced emission in TeV energy band. The analysis did not reveal the emission from HESS J0632+057 at lower energies and different orbital phases. Using the upper limits on source's flux, we locate the break of the spectrum to > 140 GeV and low-energy slope < 1.6 (3σ statistical significance).

(64) Bozhinova, I., et al.: The disappearing act: a dusty wind eclipsing RW Aur
Monthly Notices of the Royal Astronomical Society (2016) **463** 4459-4468. DOI
http://arxiv.org/abs/arXiv:1609.05667

RW Aur is a young binary star that experienced a deep dimming in 2010-2011 in component A and a second even deeper dimming from summer 2014 to summer 2016. We present new unresolved multi-band photometry during the 2014-2016 eclipse, new emission line spectroscopy before and during the dimming, archive infrared photometry between 2014 and 2015, as well as an overview of literature data. Spectral observations were carried out with the Fibre-fed RObotic Dual-beam Optical Spectrograph on the Liverpool Telescope. Photometric monitoring was done with the Las Cumbres Observatory Global Telescope Network and James Gregory Telescope. Our photometry shows that RW Aur dropped in brightness to R = 12.5 in 2016 March. In addition to the long-term dimming trend, RW Aur is variable on time-scales as short as hours. The short-term variation is most likely due to an unstable accretion flow. This, combined with the presence of accretion-related emission lines in the spectra suggest that accretion flows in the binary system are at least partially visible during the eclipse. The equivalent width of [O I] increases by a factor of 10 in 2014, coinciding with the dimming event, confirming previous reports. The blueshifted part of the Hα profile is suppressed during the eclipse. In combination with the increase in mid-infrared brightness during the eclipse reported in the literature and seen in WISE archival data, and constraints on the geometry of the disc around RW Aur A we arrive at the conclusion that the obscuring screen is part of a wind emanating from the inner disc.

(65) Isella, Andrea, et al.: Ringed Structures of the HD 163296 Protoplanetary Disk Revealed by ALMA
Physical Review Letters (2016) **117** 251101 DOI

We present Atacama Large Millimeter and Submillimeter Array observations of the protoplanetary disk around the Herbig Ae star HD 163296 that trace the spatial distribution of millimeter-sized particles and cold molecular gas on spatial scales as small as 25 astronomical units (A.U.). The image of the disk recorded in the 1.3 mm continuum emission reveals three dark concentric rings that indicate the presence of dust depleted gaps at about 60, 100, and 160 A.U. from the central star. The maps of the ^{12}CO, ^{13}CO, and C ^{18}O J =2 -1 emission do not show such structures but reveal a change in the slope of the radial intensity profile across the positions of the dark rings in the continuum image. By comparing the observations with theoretical models for the disk emission, we find that the density of CO molecules is reduced inside the middle and outer dust gaps. However, in the inner ring there is no evidence of CO depletion. From the measurements of the dust and gas densities, we deduce that the gas-to-dust ratio varies across the disk and, in particular, it increases by at least a factor 5 within the inner dust gap compared to adjacent regions of the disk. The depletion of both dust and gas suggests that the middle and outer rings could be due to the gravitational torque exerted by two Saturn-mass planets orbiting at 100 and 160 A.U. from the star. On the other hand, the inner dust gap could result from dust accumulation at the edge of a magnetorotational instability dead zone, or from dust opacity variations at the edge of the CO frost line. Observations of the dust emission at higher angular resolution and of molecules that probe dense gas are required to establish more precisely the origins of the dark rings observed in the HD 163296 disk.

(66) H. E. S. S. Collaboration, et al.: First limits on the very-high energy gamma-ray afterglow emission of a fast radio burst. H.E.S.S. observations of FRB 150418
Astronomy and Astrophysics (2017) **597** A115 DOI
http://arxiv.org/abs/arXiv:1611.09209

Aims: Following the detection of the fast radio burst FRB150418 by the SUPERB project at the Parkes radio telescope, we aim to search for very-high energy gamma-ray afterglow emission.

Methods: Follow-up observations in the very-high energy gamma-ray domain were obtained with the H.E.S.S. imaging atmospheric Cherenkov telescope system within 14.5 h of the radio burst.

Results: The obtained 1.4 h of gamma-ray observations are presented and discussed. At the 99% C.L. we obtained an integral upper limit on the gamma-ray flux of $\Phi_\gamma\,(E > 350\,\mathrm{GeV}) < 1.33 \times 10^{-8}\,\mathrm{m}^{-2}\mathrm{s}^{-1}$. Differential flux upper limits as function of the photon energy were derived and used to constrain the intrinsic high-energy afterglow emission of FRB 150418.

Conclusions: No hints for high-energy afterglow emission of FRB 150418 were found. Taking absorption on the extragalactic background light into account and assuming a distance of z = 0.492 based on radio and optical counterpart studies and consistent with the FRB dispersion, we constrain the gamma-ray luminosity at 1 TeV to $L < 5.1 \times 10^{47}\,\mathrm{erg\,s^{-1}}$ at 99% C.L.

(67) Drury, Luke O.'C. & Strong, Andrew W.: Power requirements for cosmic ray propagation models involving diffusive reacceleration; estimates and implications for the damping of interstellar turbulence
Astronomy and Astrophysics (2017) **597** A117 DOI
http://arxiv.org/abs/arXiv:1608.04227

We make quantitative estimates of the power supplied to the Galactic cosmic ray population by second-order Fermi acceleration in the interstellar medium, or as it is usually termed in cosmic ray propagation studies, diffusive reacceleration. Using recent results on the local interstellar spectrum, following Voyager 1's crossing of the heliopause, we show that for parameter values, in particular the Alfvén speed, typically used in propagation codes such as GALPROP to fit the B/C ratio, the power contributed by diffusive reacceleration is significant and can be of order 50% of the total Galactic cosmic ray power. The implications for the damping of interstellar turbulence are briefly considered.

(68) H. E. S. S. Collaboration, et al.: Characterizing the γ-ray long-term variability of PKS 2155-304 with H.E.S.S. and Fermi-LAT
Astronomy and Astrophysics (2017) **598** A39 DOI
http://arxiv.org/abs/arXiv:1610.03311

Studying the temporal variability of BL Lac objects at the highest energies provides unique insights into the extreme physical processes occurring in relativistic jets and in the vicinity of super-massive black holes. To this end, the long-term variability of the BL Lac object PKS 2155-304 is analyzed in the high (HE, 100MeV < E < 300GeV) and very high energy (VHE, $E > 200\,\mathrm{GeV}$) γ-ray domain. Over the course of 9 yr of H.E.S.S. observations the VHE light curve in the quiescent state is consistent with a log-normal behavior. The VHE variability in this state is well described by flicker noise (power-spectral-density index) on timescales larger than one day. An analysis of 5.5 yr of HE Fermi-LAT data gives consistent results (, on timescales larger than 10 days) compatible with the VHE findings. The HE and VHE power spectral densities show a scale invariance across the probed time ranges. A direct linear correlation between the VHE and HE fluxes could neither be excluded nor firmly established. These long-term-variability properties are discussed and compared to the red noise behavior (β 2) seen on shorter timescales during VHE-flaring states. The difference in power spectral noise behavior at VHE energies during quiescent and flaring states provides evidence that these states are influenced by different physical processes, while the compatibility of the HE and VHE long-term results is suggestive of a common physical link as it might be introduced by an underlying jet-disk connection.

(69) Coughlan, Colm P., et al.: A LOFAR Detection of the Low-mass Young Star T Tau at 149 MHz
The Astrophysical Journal (2017) **834** 206 DOI
http://arxiv.org/abs/arXiv:1611.03282

Radio observations of young stellar objects (YSOs) enable the study of ionized plasma outflows from young protostars via their free–free radiation. Previous studies of the low-mass young system T Tau have used radio observations to model the spectrum and estimate important physical properties of the associated ionized plasma (local electron density, ionized gas content, and emission measure). However, without an indication of the low-frequency turnover in the free–free spectrum, these properties remain difficult to constrain. This paper presents the detection of T Tau at 149 MHz with the Low Frequency Array (LOFAR) – the first time a YSO has been observed at such low frequencies. The recovered total flux indicates that the free–free spectrum may be turning over near 149 MHz. The spectral energy distribution is fitted and yields improved constraints on local electron density ($(7.2 \pm 2.1) \times 10^3\,\mathrm{cm^{-3}}$), ionized gas mass ($(1.0 \pm 1.8) \times 10^{-6} \mathrm{M_\odot}$), and emission measure ($(1.67 \pm 0.14) \times 10^5\,\mathrm{pccm^{-6}}$).

(70) Lau, J. C., et al.: Interstellar gas towards the TeV γ-ray sources HESS J1640-465 and HESS J1641-463
Monthly Notices of the Royal Astronomical Society (2017) **464** 3757-3774. DOI
http://arxiv.org/abs/arXiv:1610.05444

We present a detailed analysis of the interstellar medium towards the tera electron volt (TeV) γ-ray sources HESS J1640-465 and HESS J1641-463 using results from the Mopra Southern Galactic Plane

CO Survey and from a Mopra 7 mm-wavelength study. The γ-ray sources are positionally coincident with two supernova remnants (SNRs) G338.3-0.0 and G338.5+0.1, respectively. A bright complex of H II regions connect the two SNRs and TeV objects. Observations in the CO(1-0) transition lines reveal substantial amounts of diffuse gas positionally coincident with the γ-ray sources at multiple velocities along the line of sight, while 7 mm observations in CS, SiO, HC_3N and CH_3OH transition lines reveal regions of dense, shocked gas. Archival H I data from the Southern Galactic Plane Survey was used to account for the diffuse atomic gas. Physical parameters of the gas towards the TeV sources were calculated from the data. We find that for a hadronic origin for the γ-ray emission, the cosmic ray enhancement rates are $\sim 10^3$ and 10^2 times the local solar value for HESS J1640-465 and HESS J1641-463, respectively.

(71) Taylor, Andrew M. & Giacinti, Gwenael: Cosmic rays in a galactic breeze
Physical Review D (2017) **95** 023001 DOI
http://arxiv.org/abs/arXiv:1607.08862

Motivated by the discovery of the nonthermal Fermi bubble features both below and above the Galactic plane, we investigate a scenario in which these bubbles are formed through galacto-centric outflow. Cosmic rays (CR) both diffusing and advecting within a galactic breeze outflow, interacting with the ambient gas present, give rise to γ -ray emission, providing an approximately flat surface brightness profile of this emission, as observed. Applying the same outflow profile further out within the disk, the resultant effects on the observable CR spectral properties are determined. A hardening in the spectra due to the competition of advective and diffusive propagation within a particular energy range is noted, even in the limiting case of equal CR diffusion coefficients in the disk and halo. It is postulated that this hardening effect may relate to the observed hardening feature in the CR spectrum at a rigidity of ≈ 200 GV.

(72) Romoli, C., Taylor, A. M., & Aharonian, F.: Cut-off characterisation of energy spectra of bright fermi sources: Current instrument limits and future possibilities
Astroparticle Physics (2017) **88** 38-45. DOI
http://arxiv.org/abs/arXiv:1608.01501

In this paper some of the brightest GeV sources observed by the Fermi-LAT were analysed, focusing on their spectral cut-off region. The sources chosen for this investigation were the brightest blazar flares of 3C 454.3 and 3C 279 and the Vela pulsar with a reanalysis with the latest Fermi-LAT software. For the study of the spectral cut-off we first explored the Vela pulsar spectrum, whose statistics in the time interval of the 3FGL catalog allowed strong constraints to be obtained on the parameters. We subsequently performed a new analysis of the flaring blazar SEDs. For these sources we obtained constraints on the cut-off parameters under the assumption that their underlying spectral distribution is described by a power-law with a stretched exponential cut-off. We then highlighted the significant potential improvements on such constraints by observations with next generation ground based Cherenkov telescopes, represented in our study by the Cherenkov Telescope Array (CTA). Adopting currently available simulations for this future observatory, we demonstrate the considerable improvement in cut-off constraints achievable by observations with this new instrument when compared with that achievable by satellite observations.

(73) Gvaramadze, V. V., et al.: IRAS 18153-1651: an H II region with a possible wind bubble blown by a young main-sequence B star
Monthly Notices of the Royal Astronomical Society (2017) **466** 1857-1867. DOI
http://arxiv.org/abs/arXiv:1612.03916

We report the results of spectroscopic observations and numerical modelling of the H II region IRAS 18153-1651. Our study was motivated by the discovery of an optical arc and two main-sequence stars of spectral type B1 and B3 near the centre of IRAS 18153-1651. We interpret the arc as the edge of the wind bubble (blown by the B1 star), whose brightness is enhanced by the interaction with a photoevaporation flow from a nearby molecular cloud. This interpretation implies that we deal with a unique case of a young massive star (the most massive member of a recently formed low-mass star cluster) caught just tens of thousands of years after its stellar wind has begun to blow a bubble into the surrounding dense medium. Our 2D, radiation-hydrodynamics simulations of the wind bubble and the H II region around the B1 star provide a reasonable match to observations, both in terms of morphology and absolute brightness of the optical and mid-infrared emission, and verify the young

age of IRAS 18153-1651. Taken together our results strongly suggest that we have revealed the first example of a wind bubble blown by a main-sequence B star.