Astronomy and Astrophysics
Research Report 2008

Adopted by the Governing Board
of the School of Cosmic Physics
on 4th March 2009

Contents

1 Highlights

In 2008 the combined Astronomy and Astrophysics Section has:

- published 52 refereed publications with a further 22 preprints submitted and three volumes of conference proceedings being edited;
- made the front cover of *Astronomy and Astrophysics* twice;
- had the review article *High energy astrophysics with ground-based gamma ray detectors* by F Aharonian, J Buckley, T Kifune and G Sinnis listed as one of the 10 highlights of 2008 by the editors of *Reports on Progress in Physics*.
- organised a school, a workshop and a major international conference;
- submitted and successfully defended four PhD and one MSc theses;
- overseen the introduction of the BlueGene-based national capability computing service;
- facilitated through e-INIS a major upgrade of the national capacity service and commenced planning of the e-INIS national data service;
- increased the number of brown dwarfs with detected outflows to 5 (this was the subject of a press release at the Belfast meeting of the RAS);
- through the HESS collaboration detected TeV emission from the remnant of SN1006 and also from the radio galaxy Cen A
- proposed a quantitative numerical MHD model for the M87 jet which is in good agreement with the observations;
- implemented the JETset database;
- continued to expand the programme of events and open nights in Dunsink within resource limitations - the total number of visitors is now approaching 2000 per year.

2 Staff

Senior Professors Luke Drury, Evert Meurs

Professors Felix Aharonian, Tom Ray

Emeritus Professors Denis O'Sullivan, Alex Thompson, Ian Elliott, Tao Kiang

Honorary Professor of Computational Science Jean-Christophe Desplat, Associate Director of ICHEC

Schroedinger Fellows Andy Lim, Carlos del Burgo, Masha Chernyakova

EU Marie Curie Fellow Stefano Gabici

IRCSET Fellows Deirdre Coffey (from 1st Nov), Paul Dempsey, Linda Podio

SFI-funded Researchers Rachel Curran (to 31st Jan)

Visiting Scientists Mark Dieckmann (Norköping University, Sweden), Turlough Downes (on secondment from DCU)

Hamilton Scholars Sean Delaney, Jonathan Mackey, Denys Malyshev, Elisa Nichelli (to 3rd Apr), Lisa Fallon (from 1st Sep), Laure Barreyre (from 1st Oct), Nakisa Nooraee (from 17th Nov)

Experimental Officer (IT support unit) Stephane Dudzinski

Senior Technical Officer (Dunsink Observatory) Mike Smyth

Technical Officers Anne Grace, Hilary O'Donnell, Eileen Flood

Secretarial and Reception Phyllis Daly, two vacancies

IT support Phillipe Grange

Groundsmen (Dunsink Observatory) Thomás Mac Grioffa, Bartlomiej Migas

e-INIS project coordinator and outreach officer Keith Rochford (from 16th June)

JETSET project positions Emma Whelan (academic administrator), Jose Gracia (researcher), Fabio de Colle (researcher, to 19th Dec) Perikles Rammos (database architect, from 1st Sep)

Research Associates Dr Peter Duffy, UCD; Professor A Lawrence FRSE, Royal Observatory Edinburgh; Professor Brian McBreen, UCD; Dr VF Polcaro, Istituto di Astrofisica Spaziale; Dr Mark Wilkinson, Institute of Astronomy, University of Cambridge; Dr Laura Norci, DCU; Dr Brian Espey, TCD; Dr Matthew Redman, NUIG; Dr Justin Donnelly, DIT; Mr Brendan Jordan; Dr Gareth Murphy, Grenoble; Dr Stephen O'Sullivan, UCD; Dr Dazhuang Zhou, Houston; Mr John Walsh, TCD; Dr Brenda Frye, DCU (from 5 Sep).

3 Research Reports

3.1 Brown Dwarf Outflow Studies

Emma Whelan and T. P. Ray

Work on outflow activity from brown dwarfs remained a strong focus of activity throughout the year. Further ESO observing time was granted for this project and using this data, plus spectra taken from the ESO data archive, a further three BD outflows were discovered and analysed. This brings the total known to five. One paper was accepted by ApJ letters in December 2008 and a second is in preparation. These optical outflows are similar to those driven by Classical T Tauri stars and they are now assumed to be scaled down from T Tauri outflows. Interestingly, analysis also revealed new information on the disks of these brown dwarfs. It is now obvious that planet forming processes, seen to be active in the disks of low mass protostars are also at work in brown dwarf disks (Whelan et al 2008, accepted). Other work included the study of protostellar jet launching at high angular resolution using spectro-astrometry and integral field spectroscopy, measurements of disk rotation in T Tauri disks using spectro-astrometry, and the building of the JETSET database of jet observations. Observing time on both the WHT and the VLT was granted in 2008 for the study of jet launching. In December 2008, E Whelan was awarded a Marie Curie Individual Fellowship, to continue her studies of jet launching; she will begin this fellowship in Spring 2009.

3.2 First Detection of an Atomic Jet from an Embedded Protostar

T. P. Ray with O. Dionatos, B. Nisini and JETSET Consortium Members

Deep Spitzer spectra were obtained along the molecular jet from the highly embedded protostar L1448-C. Atomic lines from the fundamental transitions of [Fe II], [Si II], and [S I] have been detected for the first time, showing the presence of an embedded atomic jet at low excitation. Pure rotational lines of molecular hydrogen were also found. From the different line ratios, it was found that conditions in the atomic jet were very different from those of more evolved sources. In addition only a fraction (0.05-0.2) of Fe and Si was observed to be in gaseous form, indicating that many refractory elements are still locked up in dust in such early-stage jets. Moreover a comparison with the SiO abundance recently derived in the jet from an analysis of several SiO submillimeter transitions shows that the Si/SiO abundance ratio is approximately 100. It follows that most of the silicon released from grains by sputtering and grain-grain collisions remains in atomic form.

3.3 Detailed observational studies of stellar outflows

Linda Podio

The aim of this research is to investigate the properties of stellar jets both on large and small scales, in order to derive stringent observational constraints on the theoretical models proposed for the jet launching and propagation. As one approach, we are using the spectro-astrometric

technique to investigate the origin of permitted lines which are easily excited in the circumstellar region of young accreting stars. These lines may include contributions from both the accretion columns and the outflowing material, and thus their analysis can shed light on the central engine for the jet launching and its relationship with magnetospheric accretion. As another approach, we are applying spectral diagnostic techniques to analyse atomic and molecular forbidden lines which are excited in the shocks caused by the jet interaction with the interstellar medium. These techniques are very effective in deriving the physical/dynamical conditions of the gas in the jet and to investigate the shock structure.

3.4 Automatic Pipeline from Jet Simulations to Synthetic Observations

Jose Gracia

One of the most annoying problems in astrophysics is the fact that observations record photon flux in a detector far away from the source, while models predict the plasma state in terms of density, temperature, chemical composition, etc. However, calculating the plasma emission is highly non-trivial, in particular for thermal emission line processes in proto-stellar jets and accretion disks. *OpenSESAMe* – a tool to calculate synthetic emission maps and spectra from MHD simulations or analytical models – was developed and made publicly available on the institute's webpage. Modellers and observers wishing to quantitatively compare their results, feed *OpenSESAMe* with numerical simulations and detector characteristics and obtain synthetic observations that can be analysed exactly the same way as their real counterparts.

3.5 MHD models for jets

Jose Garcia

A project to develop MHD models and synthetic synchrotron emisssion maps for the jet of M87 was completed. This model for the first time quantitatively reproduces such key observational constraints as the opening angle over several orders of magnitude in distance from the core, the pronounced limb-brightening, position and magnetic field in the optical knot HST-1, and the jet to counter-jet brightness ratio.

Jose Gracia also concluded several projects related to MHD jet formation processes. Together with collaborators at Univ Shinshu (Taiwan) and Univ Athens (Greece), they could show that under resistive MHD conditions typical MHD jet formation configurations may not reach steady-state as they would in ideal MHD. Using the tool *OpenSESAme* to calculate synthetic emission maps, they also showed that standard self-similar MHD disk-wind solutions cannot easily reproduce the observed width of YSO jets, but need to be truncated at a finite distance. The truncation radius is consistent with observational constraints on the size of the disk-wind launching region.

3.6 High Resolution Spectroscopy of Brown Dwarfs

Carlos del Burgo

CdB has been working on the comparison of atmosphere models with high-resolution spectroscopy of brown dwarfs obtained with the spectrograph NIRSPEC (Hawaii, USA). The results of this work has been submitted to Astronomy and Astrophysics (del Burgo et al. 2008). CdB has regularly visited the IAC to work with his collaborators on these projects.

3.7 Ultra-precise photometry from space

Carlos del Burgo

CdB has been leading a multidisciplinary group of engineers and scientists aimed at developing the conceptual optical design of a low-resolution space-born optical spectrograph that is principally motivated to study FGK stars and transiting extra-solar planets. The instrument is designed to be on-board a micro-satellite. Microsatellites will offer an extremely economical means to obtain the large quantity of space-based measurements that will be vital in the future if we are to properly study the full range of transiting planet discoveries. The instrument must be capable of measuring ultra-precise optical spectro-photometry of point-like sources, in particular, bright solar-type stars. The expected precision to be achieved is better than 5 micro-magnitudes. This precision is unreachable even from large-aperture ground-based facilities due to scintillation noise resulting from air turbulence in the earths atmosphere and variable weather conditions that hinder long-term observations.

CdB is associated partner leader of the FP7 Marie Curie ITN network RoPACS (Rocky Planets around Cool Stars), which is a pan European consortium including 10 research institutes of 6 countries and the industrial partner Astrium. RoPACS is focussed to discover and study extra-solar planets around cool stars, which are the most common potential planet hosts.

3.8 Kuiper-Belt objects

Carlos del Burgo

CdB is a team scientist of the Key Herschel programme DUNES (DUst around NEarby Stars), granted 140 hours. DUNES will use the unique photometric capabilities of Herschel to perform a deep and systematic survey of faint, cold debris disks around nearby FGK stars. Our sample is sensitivity-limited, volume-limited (below 20 pc), with stars of stellar ages ranging from about 0.1 to 10 Gyr. Some M- and A-type stars will be observed in collaboration with DEBRIS Herschel OTKP, so that the whole sample spans stellar masses from 0.2 to 2 solar masses. PACS and SPIRE photometric observations at wavelengths between 70 and 500 microns will be performed to characterize, model and constrain the disks. Our programme will make possible to find and study faint extra-solar analogues to the Edgeworth-Kuiper Belt objects. Also granted observing time to perform follow-up observations. CdB visited LAEFF and UAM to participate in meetings and work on the preparation of the additional data.

3.9 Shells in elliptical galaxies

Carlos del Burgo

CdB lead a paper on NGC 5982 (del Burgo, Carter & Sikkema 2008, A&A, 477, 105). A figure of the paper was selected as cover of A&A. The distribution of dust traced by optical obscuration (as seen by HST optical data) and infrared emission (as seen by Spitzer infrared data). Our HST data gauge small amounts of dust in the central regions of the sample, while the Spitzer data reveals the presence of a significant amount of cold dust forming a central disk in NGC 5982. In this galaxy shells are detected for the first time from mid-infrared emission and two new external shells are found (del Burgo et al. 2008). We analysed the colours of a prominent shell revealing its blue V-I and [3.6]-[4.5] colours with respect the underlying galaxy.

3.10 An ACS Treasury survey of the Coma Cluster

Carlos del Burgo

The ACS Coma Cluster is an HST Treasury programme (ID: GO10861) that was awarded 164 orbits in Cycle 15 to perform a survey of thousands of galaxies down to MV -9 mag in the filters F475W and F814W. The survey was completed by 28% and interrupted due to critical technical problems with the ACS. CdB has been co-I of a proposal submitted to the HST to continue the analysis of Coma Cluster using also near-infrared observations. CdB visited the Liverpool John Moores University to collaborate with Prof. Dave Carter on the analysis of the HST/ACS images.

3.11 La Palma International Time Programme: Fossil groups

Carlos del Burgo

CdB is co-I of a La Palma International Time Programme that has been granted 26 observing nights. The objective is to understand the merging history and evolution of fossil groups. This will be achieved by studying the observational properties of the brightest group galaxies and their environment. CdB has participated in the run of observations of November 2008.

3.12 Interstellar medium of the Milky Way

Carlos del Burgo, with collaborators in the IAC

CdB has been working on the analysis of the anomalous emission detected in a few dust clouds with Prof. Rafael Rebolo and collaborators (IAC, Spain).

3.13 Formation of Structure in Low-Beta Regions of the ISM

Andy Lim

Absorption observations indicate that significant fluctuations in physical conditions in interstellar clouds exist on scales comparable to, or even smaller than, the dissipation length associated with ion-neutral friction. Earlier work on the behaviour of fast-mode MHD waves in magnetically-dominated regions of the Interstellar Medium showed that such waves can produce large density contrasts in regions where their behaviour is nonlinear. The non-linear steepening of the waves leads to a significant slow-mode component in the system which can generate large density contrasts.

Previous work with 1D and 2D simulations has concentrated on detailed dissipation microphysics and simple geometries. I am now performing 3D simulations of these systems using an ICHEC class B project obtained for this purpose with a view to investigating more complex geometries and whether the peak densities achieved can be enhanced by collisions in full 3D. Although, one might not, in general, expect the structures generated to collide in a 3D system, this might be more likely in this situation due to the constraining effect of the strong magnetic field.

Future work using the same ICHEC project will investigate whether shear boundary layers, such as are found at the surfaces of Giant Molecular Clouds in active star-forming regions, are a suitable source of the high-frequency waves which are the most efficient at generating structure.

3.14 MHD Simulations of Star-forming Regions

Andy Lim

Star-forming regions of the ISM are typically observed to have a low plasma parameter, β (ratio of gas pressure to magnetic pressure, $\beta = P_g/P_m$) and many studies of structure formation in such regions (including that above) have assumed magnetically dominated initial conditions. They have not, however, addressed the question of how such low-β regions can arise. Following an earlier study of a highly idealised situation in which a spherical cloud of gas with moderate β is compressed by a higher external pressure (which was published in ApJL) I am studying several other situations in which a cloud can find itself in a region of higher pressure. For example, a could may be overtaken by a shock wave generated the overlapping supernova remnants from an OB cluster, or the cloud and its surroundings may be subjected to a general systemic compression upon entering the density wave of a spiral arm.

In thermally unstable gas, these types of phenomena can lead to a reduction in the plasma parameter of up to two orders of magnitude, which can accelerate star-formation in GMCs which are in the early stages of their lives. Initial 2D axi-symmetric simulations are engouraging and I have prepared a proposal for an ICHEC class B project to perform full 3D simulations to be submitted shortly.

3.15 Radiative Effects in the Interstellar Medium

J Mackey and A Lim

J. Mackey has continue to work on developing a modular Magneto-Hydrodynamics (MHD) code with ionising radiative transfer, in order to study certain radiative effects in the interstellar medium. Development and testing has taken somewhat longer than anticipated, but is now complete enough to begin testing theories relating to the evolution of ionised Hydrogen regions (HII regions) which grow around young massive stars. The project was awarded 275,000 hours of computer time on the new ICHEC supercomputing system, "Stokes," enabling Mackey and Lim to perform state of the art computational studies of the growth of HII regions. They are currently analysing and improving their code's performance on the new system, and in early 2009 will run the simulations they have prepared. Analysing the results of these simulations will be a major part of JM's Ph.D. thesis.

3.16 Simulated Polarimetric Observations of Stellar Jets

Andy Lim with Rachel Curran (Palermo)

Polarimetry is at the forefront of modern methods for the measurement of astrophysical magnetic fields. This project is in collaboration with Rachel Curran (ex-DIAS) and aims to compute the expected polarised emission from dust (and possibly CO/H2) in the molecular knots which form in the stems and cocoons of jets from Young Stellar Objects.

Since the mechanisms producing this emission occur on fast timescales we intend to post-process the emission from pre-calculated jet models. To this end A Lim has performed a series of axisymmetric simulations of jets with varying magnetic field strengths and topologies; using an adaptive mesh such models can be run on a reasonably powerful PC. These simulations include a small chemical network incorporatiing the dominant paths of H2 formation and destruction, and we are currently working on a microphysics algorithm to determine the expected emission and polarisation from the numerical data.

These results will be directly comparable to polarimetric observations from dacilities such as ALMA and our objective is to compare the physical conditions resulting in polarised emission from our models with those inferred from similar emission in real objects. This will allow us to estimate the veracity of the measurement of astrophysical magnetic fields which is still a notoriously difficult endeavour.

3.17 Computational studies of ISM turbulence

T. Downes

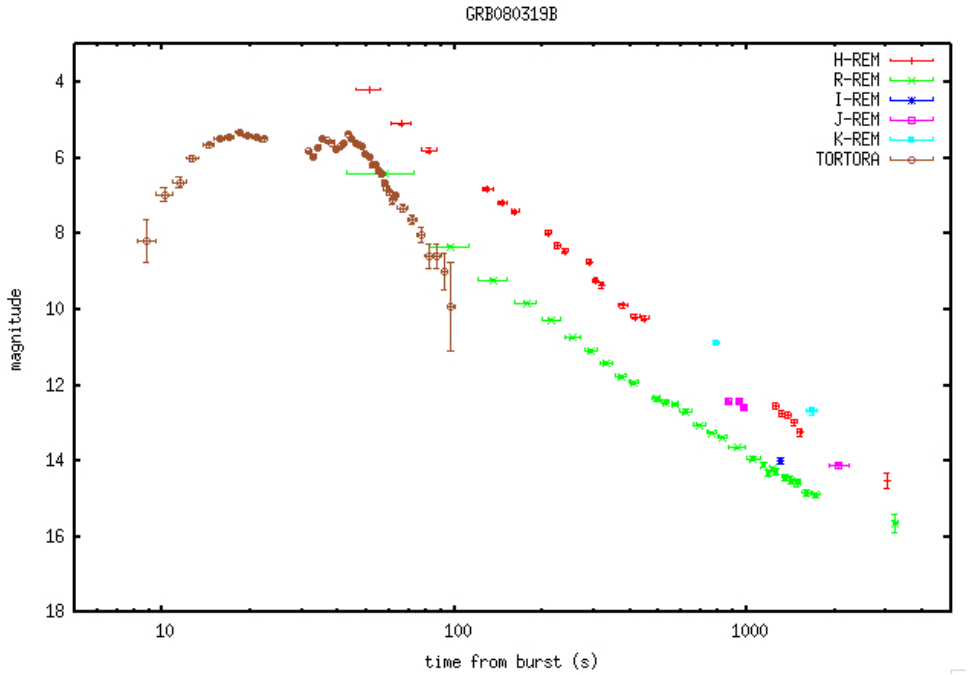
The decay of turbulence in a partially ionized and magnetised medium is being studied using the national capability computing resource (BlueGene). The code uses a novel numerical scheme which allows an explicit treatment of both Hall and ambi-polar diffusion effects. These will be the first simulations to include these effects at this level of detail and is expected to throw

light on both the question of the decay and the statistical properties of turbulence in molecular clouds.

3.18 Gamma Ray Bursts: REM Telescope observations

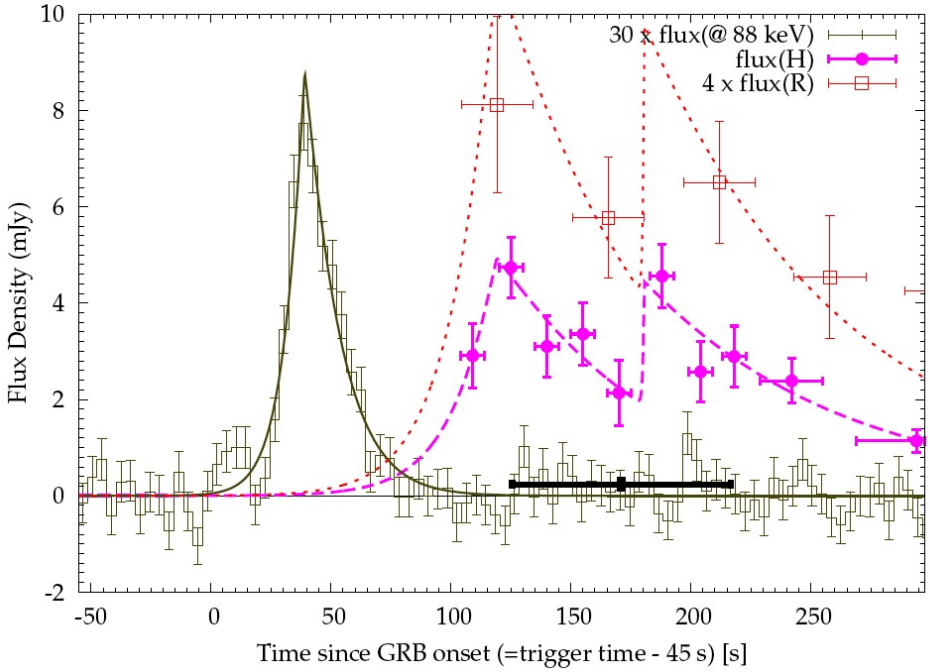
S. Vergani, P. Ward, E.J.A. Meurs, L. Norci (DCU), E. Molinari, S. Covino, et al. (Brera Observatory)

Several Gamma Ray Burst (GRB) afterglows were detected throughout the year with the REM Telescope. An outstanding case was GRB080319B, the so-called naked-eye GRB (as it had reached naked-eye visibility at peak brightness). This generated a well-covered early lightcurve, which is now being analysed.



The very early lightcurve of GRB080319B, the so-called "naked-eye burst". Data from the REM telescope and the Russian TORTORA camera mounted on REM.

Fits to the lightcurves of GRB070311 (detected by the INTEGRAL satellite) for REM data and also X-ray data from the Swift satellite have been analysed in terms of flares or pulses, for which refreshed shocks due to other shells ejected in the GRB event as well as density bumps in the surrounding medium are considered.



GRB070311 data at gamma-rays (crosses, from INTERGRAL), optical R-band (squares, REM data) and near-IR H-band (circles, REM data) fitted with a pulses model.

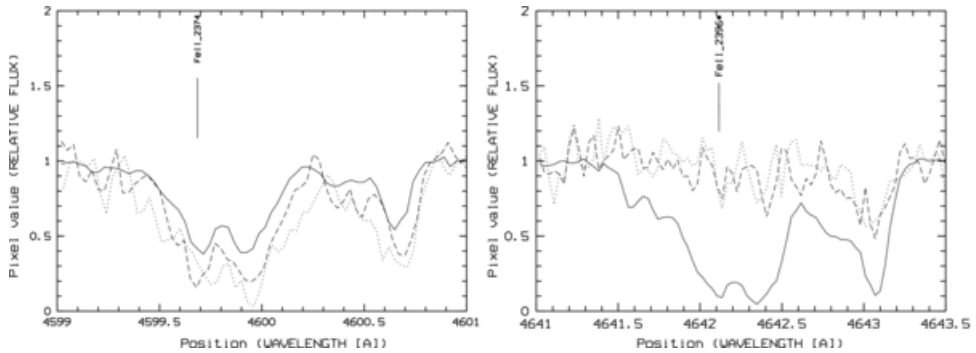
Further lightcurves that were studied with REM data include GRB070707, GRB071010A and GRB060908. The results obtained for the short/hard GRB070707 indicate a very faint emission level for the host galaxy and caution that proposed associations with bright, offset galaxies may be fortuitous, as the host galaxies may be too dim to be detected easily.

3.19 High resolution echelle spectroscopy of GRB afterglows

P. Ward, S. Vergani, E.J.A. Meurs, L. Norci (DCU), F. Fiore, V. DElia, S. Piranomonte (Rome Observatory)

High-resolution echelle spectroscopy is a relatively new and exciting tool for GRB astronomy. Data may now be obtained only minutes after a burst has occurred, which is important because of the transient nature and decreasing brightness of the afterglows. The echelle spectroscopy highlights the presence of intervening material along the line of sight, in the immediate surroundings of a burst as well as in separate intervening systems.

Observations of the naked-eye burst GRB080319B led to the highest signal-to-noise, high-resolution spectrum of a GRB afterglow ever obtained, with the strongest FeII fine structure lines ever observed for a GRB. The decrease in optical depth of these lines a few hours later demonstrates that the fine structure lines are due to UV pumping. The six absorption components of the main absorption system are found to be at distances 2-6 kpc from the GRB site.



Variability of normal (left) and fine structure (right) transitions of FeII. Time runs in the order full, dashed and dotted lines covering the first three hours of the outburst.

Detailed echelle spectra were also secured for the burst GRB080330. Assuming again UV pumping, the bluemost absorption component in the host galaxy system appears to be much closer in this case, at about 0.3 kpc from the GRB site. For this study, as well as the previous one on GRB080319B, we employed a novel time-dependent photo-excitation code.

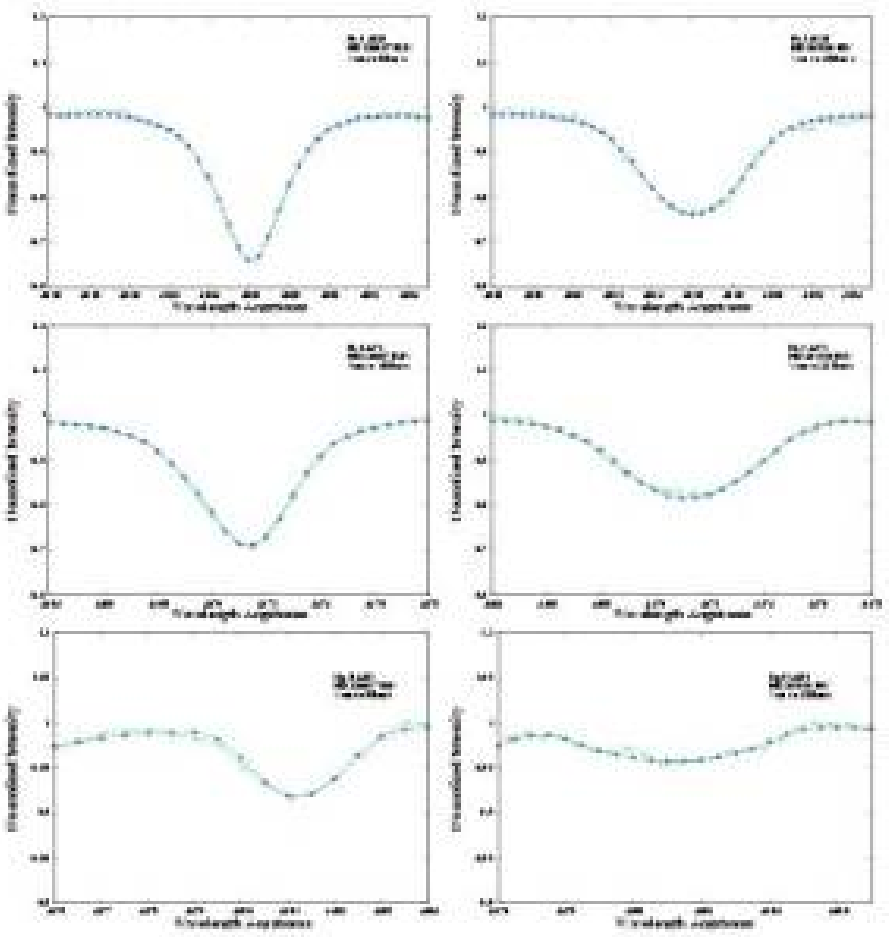
Several high-resolution echelle spectra of GRB afterglows, obtained with the VLT/UVES instrument over the past ca. 6 years, have been employed in a study of intervening absorption systems featuring MgII lines. A previously found excess of strong MgII absorbers in GRB afterglow spectra, compared to QSO lines of sight, appears to be less strong than had been concluded before. The picture that emerges from this study is that dust is not likely to be an important factor in causing a MgII excess for GRBs, while on the other hand a subtle gravitational lensing effect may be the reason for such a bias. The spectra also allow to search for the so-called damped Lyman-α systems, which appear to occur at a higher rate than is found for QSO lines of sight. As these systems tend to be encountered relatively close to the GRBs, it might be that (part of) this gas is somehow associated with the GRB.

3.20 Echelle spectroscopy of runaway stars

E.J.A. Meurs, C. O'Maoileidigh, L. Norci (DCU), C. Rossi and V.F. Polcaro (Rome)

Blaauw suggested in 1993 that excess rotation in runaway stars may be an indicator of close binary evolution as increased rotational velocity is a natural consequence of mass transfer to the companion star prior to the supernova explosion of the primary star. The implication is that the runaways were ejected via the supernova in a binary scenario.

Observations of OB runaway stars (without rotational velocity information) carried out at Loiano Observatory (Italy) demonstrate the excess rotation rates for O-type runaway stars, while this is not found for B-type runaways (that then are likely to have been dynamically ejected). A master list has now been generated that includes our new observational results as well as the rotational velocity values that were already available in the literature.



Examples of synthetic line profiles (blue) fitted to observed line profiles (green) for HD220057 (left, moderate rotational velocity of $\approx 100\,\mathrm{km\,s^{-1}}$ *and HD201901 (right, high rotational velocity of* $\approx 225\,\mathrm{km\,s^{-1}}$*. The upper two panel pairs are for HeI lines, the bottom for a HeII line.*

Observations at Loiano Observatory have been continued this year for OB stars generally, in order to measure radial velocities for OB stars that still lack a radial velocity determination. Again this is pursued with high-resolution echelle spectroscopy. In this way, a census of all Northern OB stars down to magnitude V=8 has almost been completed. The main objective is to find further, hitherto unrecognized runaway stars on the basis of larger than normal radial velocities.

3.21 OB runaway star lightcurves

E.J.A. Meurs, S. Reynolds (DCU)

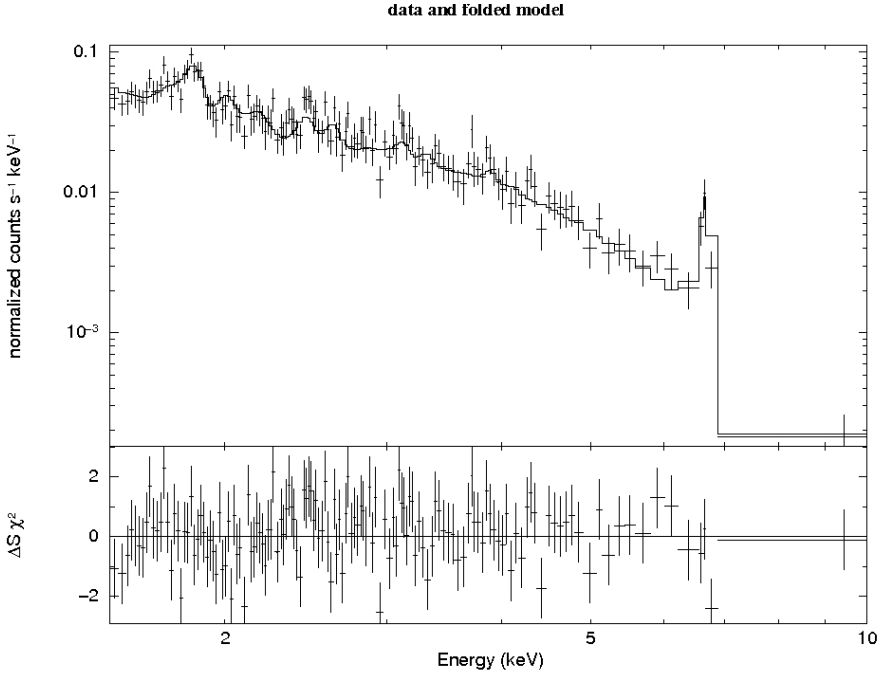
High-precision photometric lightcurves of OB runaway stars may offer an alternative avenue for recognizing any collapsed companions (i.e., neutron stars) to these stars. The presence of a (close) collapsed companion would be noticeable from the gravitational distortion of the shape of the normal star (the runaway star as such), which causes small, periodic light variations.

Recognizing a collapsed companion is relevant in view of the likely occurrence of a supernova in a binary that led to the observed high space velocities of these stars. A very appropriate database that is used for this investigation is provided by the results of photometric measurements that were carried out with the Hipparcos satellite. Other methods that have been availed of for finding such collapsed companions, but have not led to positive conclusions, relied on X-ray emission, pulsar radio signatures, or radial velocity variations.

3.22 High-energy emission from young stellar clusters

E.J.A. Meurs, P. Kavanagh (DCU), L. Norci (DCU)

The high-energy emission from very young stellar clusters may be modelled without yet having to deal with complications introduced by close-binary evolution. We have analysed X-ray data for the very young Galactic Super Star Cluster Westerlund 1. New evidence was uncovered to support a thermal origin for the diffuse hard X-ray emission component in this cluster, revealing a 6.7 keV Fe line. As to possible explanations for this line, a cluster wind as origin is likely, but not a supernova remnant, while at this stage the role of Pre-Main Sequence stars is not fully assessed yet.



X-ray spectrum, observed with XMM-Newton, for the inner 2' radius region of the very young star cluster Westerlund 1. The line feature at 6.7 keV is from Fe and indicates the thermal nature of the diffuse X-ray emission. The thermal model fit is shown with fit residuals in the lower panel.

3.23 High-energy sources in galaxies

E.J.A. Meurs, N. Nooraee

A project was started to study the spatial distribution of likely black hole binaries in several galaxies, using a recently uncovered luminosity break in X-ray Luminosity Functions for these objects.

3.24 Supernova candidates in the solar neighbourhood

E.J.A. Meurs, J. OReilly (DCU)

State-of-the-art stellar evolution models were employed for selecting likely supernova candidates among highly evolved massive stars in the (wider) solar neighbourhood. When exactly these stars will explode cannot however be predicted with any certainty.

3.25 AGN contributions to HDF galaxies

E.J.A. Meurs, C. Helly (DCU)

For a relevant colour versus spectral slope diagram, grids were calculated displaying redshift and an active nucleus component for several galactic models. A comparison of these grids with galaxies observed in the Hubble Deep Fields indicates that Active Galactic Nuclei likely contribute to the emission of most of these high-redshift galaxies.

3.26 X-ray observations of the 2007 PSR B1259-63 periastron passage

M.Chernyakova, A. Neronov (ISDC), F. Aharonian, Y. Uchiyama (SLAC), T. Takahashi (JAXA)

PSR B1259-63 is a 48 ms radio pulsar in a highly eccentric 3.4 year orbit with a Be star SS 2883. Unpulsed γ-ray, X-ray and radio emission components are observed from the binary system. It is likely that the collision of the pulsar wind with the anisotropic wind of the Be star plays a crucial role in the generation of the observed nonthermal emission. The 2007 periastron passage was observed in unprecedented details with *Suzaku*, *SWIFT*, *XMM-Newton* and *Chandra* missions. We have analyzed the data and compared the results with previous observations. Using the multi-mission data, we are able, for the first time, to study the details of the spectral evolution of the source over a ~ 2 months period of the passage of the pulsar close to the Be star. New data confirm the spectral hardening to the photon index smaller than $\Gamma = 1.5$ observed this time during a local minimum of the flux in the middle of a period of passage of the pulsar through the equatorial wind of the companion Be star. We discuss the implications of the observed spectral evolution . Unfortunately the lack of simultaneous data in the TeV energy band prevents us from defining the nature of the observed spectral hardening and thefore on the origin (Inverse Compton or synchrotron) of the X-ray emission.

3.27 Study of the longterm variability of gamma-ray loud binary LSI +61 303

M.Chernyakova, A. Neronov (ISDC)

The Be star binary LSI +61 303 is one of few currently known gamma-ray loud X-ray binaries. The spectrum of high-energy emission from the system extends up to TeV energies and the power output of the source is dominated by emission in the gamma-ray energy band. In this system the compact source is orbiting around the Be star along the elongated orbit with 26.496 days period.

The inhomogeneity of environment created by the stellar wind and radiation of the Be star leads to an "onion-like" structure of the system, so that emission in different energy bands is produced at different distance scales. The fraction of the total source power emitted in a given energy band depends on the time that high-energy particles spend in the corresponding "shell". This, in turn, depends on the speed of escape of the high-energy particles. High-resolution radio observations show that the radio synchrotron emission from ~ 10 MeV electrons is produced at large distances, outside the binary orbit. The same population of electrons, most probably, produces the X-ray emission via inverse Compton scattering at smaller distances. Finally, close to the Be star, emission is suppressed because of the dominance of the non-radiative Coulomb loss.

Since the compact object moves along an elliptical orbit, the rate of injection of the high-energy electrons in the X-ray and radio emitting shells depends on the orbital phase. This determines the orbital modulation of the signal in radio and X-ray energy bands. In the radio band it is known that the signal exhibits modulation not only on the orbital, but also on the super-orbital time scale, with a period $P_{\rm s} = 1667 \pm 8$ d ($\sim$4.6 yr).

Change of the properties of the disk on the super-orbital time scale leads to the change of the regime of escape of the 10 MeV electrons from the system. Since these electrons are responsible not only for the radio emission from the system, but also for the X-ray emission, the modulation of the escape regime should also lead to the super-orbital modulation of the orbit-folded lightcurve in the X-ray band.

Contrary to observations in the radio band, in which the source is regularly monitored on orbit-by-orbit basis, the X-ray observations of the system are sparse and the super-orbital modulaiton, similar to the one observed in the radio band was not reported before. Previous attempts to look for it were based on the RXTE/ASM data and were inconclusive due to the relative weakness of the source. In our work we collect all the available X-ray observations of the system on the time scale of more than a decade. We show that these observations provide an evidence to the fact that the shape of the orbit-folded X-ray lightcurve changes on the several years time scale. Moreover, the phase of the X-ray maximum seems to "drift" in the same direction as the phase of the maximum of the radio lightcurve. However, the sampling of the X-ray lightcurve is at the moment not sufficient to reveal the details of the super-orbital modulation of the X-ray flux.

3.28 Molecular clouds as tracers of cosmic ray acceleration

S Gabici

Theoretical studies of particle acceleration at non relativistic shocks were performed, with particular attention to expanding shocks of supernova remnants. Cosmic rays can escape the supernova remnants and interact with the surrounding gas. Within this framework, the radiative signatures that can be expected in the scenario in which a massive molecular cloud located close to the supernova remnant provides a thick target for cosmic ray interactions were studied. Gamma rays from such hadronic interactions are expected to dominate the total emission from the cloud, exceeding the energy output in other energy bands by an order of magnitude or even more. This suggests that molecular clouds illuminated by cosmic rays might explain at least some of the unidentified TeV sources detected by HESS, especially the "dark" sources which are bright at TeV energies but are characterized by the lack or the very low level of the emission at lower frequencies.

3.29 Particle Acceleration and Radiation at Sub Relativistic Shocks

S. Delaney, P. Dempsey, F. Aharonian and P. Duffy (UCD)

Diffusive shock acceleration in radiation dominated environments has previously been examined in non-relativistic flows by Vannoni, Aharonian & Gabici (2008). However most sources which are potentially radiation dominated, e.g. microquasars,are expected to contain mildly relativistic shocks. In this project we intend to extend the results of Vannoni, Aharonian & Gabici (2008) to mildly relativistic shocks. We are simultaneously developing a numerical code for particle acceleration at arbitrary velocity shocks. This will be tested against the mildly relativistic code mentioned above and an extremely fast non-relativistic code we have already developed, before applying it to the ultrarelativistic shocks we expect in gamma ray bursts.

3.30 Time Dependent Relativistic Shock Acceleration with Turbulence Transmission

P. Dempsey and J. Tammi (Metsähovi Radio Observatory, Finland)

Using a semi-analytical method, similar to that developed in Dempsey & Duffy (2008) for examining particle acceleration and radiation at relativistic shocks, we have been able to determine the acceleration timescale and the temporal evolution of the particle distribution at arbitrary velocity shocks. Our results are consistent with those previously published in the non-relativistic limit (see Drury (1983) for a review) and also takes into account the details of turbulence transmission across the shock (see Vainio, Virtanen & Schlickeiser (2003) and Tammi & Vainio (2006)).

3.31 Relativistic Shock Acceleration: A Hartree-Fock Approach

P. Dempsey and J. Kirk (MPIK Heidelberg)

Keshet & Waxman (2005) produced a simple formula for the power law index of particles accelerated at shocks of arbitrary velocity. While their formula fits previous values very well, their derivation contains several errors and their method fails to produce a pitch angle distribution that is consistent with previous numerical and semi-analytical work. By making certain analytical approximations we have produced power law indices that are close to those previously calculated, while simultaneously obtaining pitch angle distribution which agree with those found in early semi-analytic work.

3.32 Particle Acceleration by Multiple Parallel Shocks

J. Tammi (Metsähovi Radio Observatory, Finland) and P. Dempsey

Using both numerical and semi-analytical techniques we are examining particle acceleration in multiple parallel relativistic shocks. The non-relativistic results have been known for some time and by extending these results to the relativistic limit we hope to apply them to the internal shock models of gamma-ray bursts.

3.33 Shear Acceleration in Rotating Jets

P. Dempsey and F. Rieger (MPIK Heidelberg)

Internally rotating jets are expected to be present in a number of astrophysical sources including AGNs. We are considering the acceleration of energetic charged particles within such flows and examining the role of shear and centrifugal effects for efficient particle energization. We believe that shear acceleration could be particularly interesting in the context of hadronic models.

3.34 High-energy non-thermal astrophysics

Felix Aharonian

Activity in 2008 was related to several topics of High Energy Astrophysics with an emphasis on the phenomenological and theoretical studies of multi-wavelength properties of gamma-ray sources. As well as these topics being of certain interest in their own right, they are particularly motivated by the results obtained with the H.E.S.S. telescope array. Some studies have also been motivated within the framework of the two highest priority projects in Astroparticle Physics at present, namely CTA and KM3NeT. There is close collaboration also with the the Japanese Suzaku X-ray mission team (ISAS, Tokyo) and with the NANTEN team (Nagoya University) on CO observations of the interstellar medium, both wavelength intervals being of great importance in the identification and/or understanding of the nature of the very high energy gamma-ray sources. In the so called hadronic scenarios, gamma-radiation is accompanied by

the production of high energy neutrinos. For this reason F. Aharonian is also interested and involved in projects related to high energy neutrino astronomy. In particular a series of theoretical calculations of TeV neutrino fluxes from different types of hadronic sources have been made in the context of design studies of the cubic kilometer volume underwater neutrino detector in the Mediterranean Sea (KM3NeT). At present the main scientific interests of F. Aharonian are related to the following research areas:

- origin of galactic cosmic rays, in particular in the context of particle acceleration and related broad-band emission in supernova remnants, propagation of cosmic rays in the Galactic Disk and their interactions with molecular clouds leading to the production of extended gamma-ray emission and high energy neutrinos
- particle acceleration and interactions in radiation-dominated environments, in particular in the context of diffusive shock acceleration of electrons in SNRs and binary systems, as well as the acceleration of ultra-high energy protons in clusters of galaxies;
- binary pulsars and microquasars, in particular the magnetohydrodynamics of interactions of pulsar winds or black-hole jets with the stellar disk; time-dependent modeling of inverse Compton and synchrotron radiation of electrons accelerated in the relativistic outflows formed in binary systems
- gamma-radiation of AGN, in particular time-dependent modeling of electromagnetic and hadronic interactions in the inner jets of blazars with emphasis on formation of very hard intrinsic gamma-ray spectra, and modeling of broad band-emission from the large-scale jets of radiogalaxies
- acceleration and radiation processes in magnetosheres of underluminous supermassive black holes, in particular in Sgr A*, M87, and Centaurus A
- propagation of highest energy protons, nuclei and photons through intergalactic radiation and magnetic fields

3.35 The puzzling MILAGRO hot-spots

L Drury and F Aharonian

Early in the year the MILAGRO experiment produced a sky-map of the arrival direction of charged cosmic rays at energies around 10TeV showing two small “hot-spots” in the angular distribution. The very surprising aspect is the small angular extent of the spots, indicating a well-collimated if weak beam of hadrons which also appears to come from the direction of the local heliotail. A natural suspicion is albedo production of secondary neutrons in the heliotail, but analysis of this model has shown it to be incapable of producing a signal of the required strength. An alternative model based on loss-cone focussing and leakage of protons through a near-by magnetic mirror is suggested as the only plausible method of generating features on such a small angular scale.

3.36 The plasma temperatures in supernova remnants

L Drury, F Aharonian, D Malyshev and S Gabici

Many of the parameters (in particular the density and shock velocity) required in constructing models of specific supernova remnants are derived from X-ray observations, but there is considerable uncertainty as to the true electron and ion temperatures in the shock-heated gas filling these structures, and thus on the inferred parameters. We have attacked this problem from two different angles. On the one hand, we have asked the fundamental question; how cold can the post-shock gas be if the bulk of the energy dissipated in the shock goes into particle acceleration and not gas heating? In this extreme limit (strong acceleration and no wave dissipation in the precursor) we have shown that the post-shock gas temperature can be a rather small multiple of the upstream temperature so that "cold" SNRs appear possible. It is tempting to relate this to the observation that the strong TeV emitting shell remnants appear to be anomalously weak in thermal X-rays. The second approach we have adopted is a more formal study of minimal electron heating by Coulomb exchange using Chevalier's generalised self-similar models to describe the dynamics of the SNR.

3.37 Space Dosimetry

D O'Sullivan with Johnson Space Center, Houston

Following completion of measurement and analysis of the Matroshka-1 data, which was obtained by exposing a human phantom outside the International Space Station(ISS),attention was focussed on the Matroshka-2 project and work progressed steadily throughout the year.The Matroshka-2 project involved exposing the same phantom inside the Russian Zvezda module of the ISS from December 21, 2005 to December 22, 2006 (367 days).These two projects will result in a unique set of data for investigating the impact of cosmic radiation and solar energetic particles on human organs and provide important information for future long term missions such as those planned to Mars. With analysis nearing completion, initial results indicate that the ISS shielding decreases dose equivalent rates by approximately 56% inside the ISS and that the low and high linear energy transfer radiation contributions are 1/3 and 2/3 of the total, respectively. It is planned to use this information to help in shielding design for future space vehicles.

A proposal, (DOSIS), to map the radiation field inside the European Columbus Laboratory, which was launched to the ISS in Feb 2008, was successful and the DIAS/Houston detectors are collecting data in Earth orbit since that time. They are due to be returned early in 2009.

An extension of the DOBIES project, which is a collaboration between DIAS, the Belgian Nuclear Research Centre and the Czech Academy, was also included in the Columbus Laboratory on its first flight and the detectors were returned by the Russian Soyuz spacecraft in October 2008. Analysis will start in 2009.

4 International Collaborations

4.1 HESS, HESS-II

L Drury, F Aharonian, S Gabici, L Fallon The HESS experiment continued to have a very successful year of operations with many new detections and interesting results being published. Two highlights which stand out are the detection of TeV emission from the remnant of SN1006 and the detection of TeV emission from another non-blazar AGN, the strong near-by radio galaxy Cen A. Progress was made during the year with the construction of the steel frame for the HESS-II telescope (a single large dish) to be installed at the centre of the HESS-I array.

4.2 CTA

L Drury, F Aharonian, S Gabici

The Cherenkov Telescope Array project (CTA) a proposal to build on the great success of the second generation experiments HESS, Magic and Veritas with a facility that will be an order of magnitude more sensitive and operate as a true observatory. At the end of the year the CTA project was included in the the roadmap of the European Strategic Forum for Research Infrastructures (ESFRI).

S Gabicis is participating in the "Astrophysics and Astroparticle Physics" work package, whose aim within the CTA Design Study is to provide a summary of detailed physics goals to be investigated with CTA, and to define the required instrument performance. In particular he is Task Leader coordinating the activities of the work package for the topic: Cosmic Rays, Supernova Remnants and Molecular Clouds. L Drury contributed to the Observatory and Data working groups.

4.3 JETSET

T.P. Ray, JETSET Network Coordinator

The Jet Simulation, Experiment and Theory (JETSET) network operated very successfully throughout the year with some 50 collaborative publications between the various partners. Most of the contract positions for Early Stage Researchers (ESRs, i.e. PhD students) and Experienced Researchers (ERs, i.e. postdoctoral fellows) finished towards the end of 2008. In all cases the ESRs or ERs obtained host institution funded extensions, for example to finish their PhD, or new positions. The latter included some tenured posts for the ERs and offers of postdoctoral fellowships for ESRs.

Time was granted to the network on a number of world-class ground-based and space-based facilities including the VLT, Spitzer, Herschel (key programme status), HST and e-MERLIN (legacy programme status). Funding was also awarded to upgrade the MAGPIE laboratory jet

experiment facility at Imperial College London and for a number of new multi-lateral collaborative programs between partners.

In 2008, both a school (in Galway) on the theme "High Performance Computing in Astrophysics" and an international conference (held in Rhodes, Greece) entitled "Protostellar Jets in Context" were organised. Details of these events, which were managed by the section in collaboration with NUI Galway and the University of Athens respectively, are given in sections 12.1 and 12.3 .

4.4 KM3NeT

F. Aharonian and L. Drury

The section contributed extensively to the writing and the editing of the chapter "Physics, analysis and simulations", of the Conceptual Design Report, in particular the sections on supernova remnants, molecular clouds (where S Gabici made significant contributions), and diffuse emission from the inner galaxy. Moreover, the estimate of the diffuse neutrino flux from the inner Galaxy, included as preliminary results in the Conceptual Design Report, have been published as a separate paper in cooperation with the Km3NET Consortium.

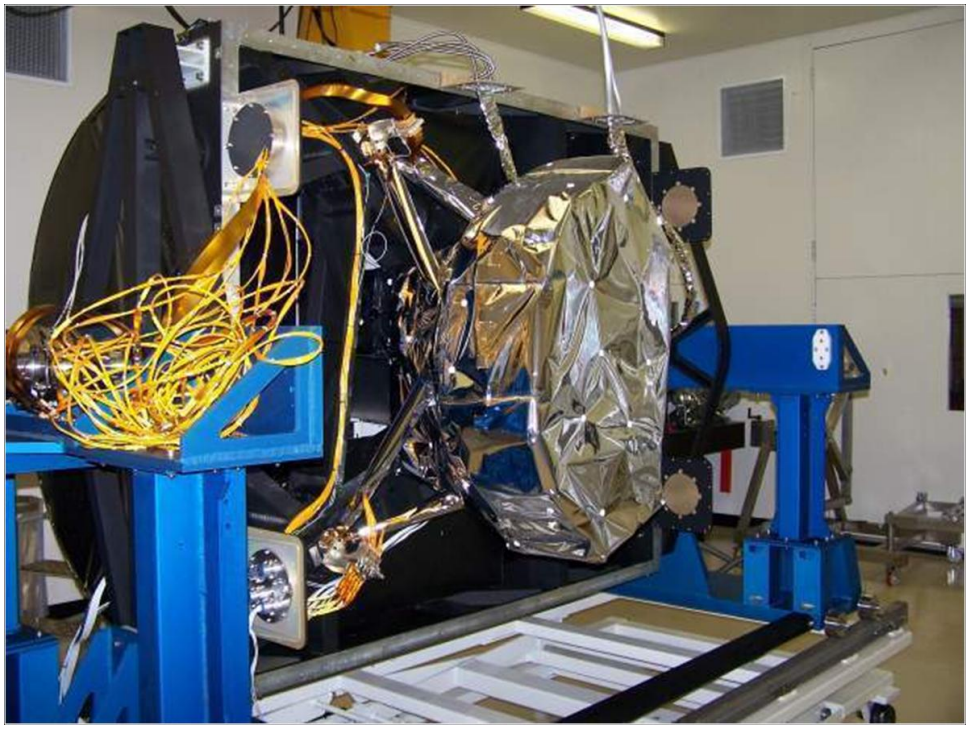
4.5 MIRI

T. P. Ray with B. Espey (TCD) and B. Frye (DCU)

MIRI is the mid-IR instrument for the James Webb Space Telescope (JWST), the successor to the very successful Hubble Space Telescope, and it is due for launch in 2013. It provides imaging, coronography and integral field spectroscopy over the 5-28μm wavelength range and it is the only instrument cooled to 7K by an on-board dedicated cryostat. This temperature is much lower than the passively cooled 40K of the rest of JWST and maintaining it introduces unique challenges.

The flight model (FM) design of the MIRI Optical System is now complete and the spectrometer and imaging elements are currently being assembled in the Astronomy Technology Centre (ATC) in Edinburgh and the Commissariat à l'énergie atomique (CEA) in France for final integration and testing in 2009 of the whole instrument at the Rutherford Appleton Laboratory (RAL). The Focal Plane Module containing the MIRI detectors is being manufactured by JPL.

Tesing of the Verification Model (VM) was completed in 2008 at RAL and B. Frye assisted with the testing campaign (see figure). First-light was readily achieved and results from both imaging and spectroscopic modes were excellent after minor alignment problems were solved. This has given the team confidence in building the FM. Some modifications to the Filter Wheel Assembly (FWA) carrying the DIAS supplied mid-infrared filters, are also being made.



MIRI Verification Model (VM) encased in a Mylar blanket prior to vacuum cryostat testing.

4.6 NAHUAL

C. del Burgo

Carlos del Burgo is the Project Scientist and co-PI of NAHUAL, a near-infrared (0.9-2.5μm) high-resolution spectrograph (R=65000) for the 10.4-m GRANTECAN telescope on the Observatorio Roque de Los Muchachos (La Palma, Spain). NAHUAL is developed in the framework of an international collaboration leaded by the Instituto de Astrofsica de Canarias (IAC, Spain) with the participation of research centres in Germany, Italy, Portugal and Ireland. CdB is the leader of a group of engineers that is working on the acquisition camera, the grating mounting, the atmospheric dispersion compensator, a slit-viewing camera and the overall optics of NAHUAL. NAHUAL will be a stable and highly repeatable cryogenic system, able to measuring radial velocities with a precision of 1 m/s in the wavelength range from 1 to 2.4 microns. The main goal is the search or rocky extrasolar planets around cool stars.

In the last three months of 2008, CdB has been coordinating the science working groups and the calibration group of NAHUAL. The document that describes the NAHUAL instrument concept has been presented to the scientific community and two external referees in the GTC/Exoplanet and V NAHUAL workshop (September 2008). The referees have reported positively about NAHUAL.

4.7 REM

E. Meurs

The Rapid Eye Mount (REM) Telescope is a robotic telescope with the principal aim to provide quick follow-up observations of Gamma Ray Bursts detected by satellite γ-ray observatories. The telescope has a 60 cm diameter mirror, is located at La Silla (Chile), and carries Near-InfraRed as well as optical cameras. The REM project is led by Brera Observatory in Milan-Merate (Italy), with Irish participation by DIAS and UCD.

5 Contributions to the national e-Infrastructure

5.1 e-INIS

The e-INIS project aims to develop an integrated national e-infrastructure building on the three existing service providers, HEAnet as the National Research and Education Network service, ICHEC the Irish Centre for High-End Computing as the national HPC service, and Grid-Ireland as the National Grid Infrastructure provider, together with specific centres of expertise in partner institutions. It is one of the national collaborations funded under PRTLI-4. A major milestone was the appointment of Dr Keith Rochford as project coordinator and outreach officer in June. The other major development was the completion of the first major capital project with the replacement of ICHEC's capacity cluster (Walton) with a new SGI system named Stokes. The new system was delivered in November and the Walton system decommissioned in December. HEAnet made progress with implementing the advanced optical network envisaged in the proposal, and plans for the national data store were well advanced by year end.

5.2 Blue Gene

The national capability computing system, commissioned by DIAS on behalf of the third level research community, completed its first full year of operations. The system was formally launched by the Tánaiste and Minister for Enterprise, Trade and Employment, Mary Coghlan TD in the presence of Larry Hirst, Chairman of IBM EMEA, at the Irish Centre for High-End Computing's annual seminar held in the Royal Irish Academy on 30th Oct (see Fig. 1).

The system consists of one rack of BlueGene/P (named Schroedinger) and one rack of BlueGene/L (named Lanczos) with a shared front end. It is hosted in the HEAnet national hosting centre and operated by the Irish Centre for High-End Computing as part of their portfolio of services. As expected take-up of the system was initially rather slow, but then increased steadily to the point that by year-end it was fully occupied and supporting some six distinct class-A projects. By September two user groups had advanced to the point where they could request access to larger scale IBM facilities in the US (as provided for in the contract).

Figure 1: L Drury (far right) explaining the importance of the BlueGene facility to an Tániste, Mary Coughlan TD at the official launch in the RIA. Also in the picture (from left), Michael Kelly, Chairman of the HEA; Dr Damien Thompson, Tyndall National Institute; Larry Hirst, chairman of IBM EMEA.

6 Publications

6.1 Refereed Publications

Note that all the publications listed as Aharonian et al (HESS collaboration) include F. Aharonian, L. Drury and S. Gabici as co-authors from DIAS. Almost all these publications are available online as a private library under the ADS using the following URL:

`http://adsabs.harvard.edu/cgi-bin/nph-abs_connect?library&libname=Ref2008&libid=4794ca7845`

1. Vergani, S. D., Malesani, D., & Molinari, E.: The Interplay of Prompt and Afterglow Emission in GRB 060418 *International Journal of Modern Physics D* (2008) **17** 1343-1349.
2. Vergani, S. D. & Guidorzi, C.: GRB 070311:. a Common Origin for the Prompt and Afterglow Emission *International Journal of Modern Physics D* (2008) **17** 1359-1362.
3. Vergani, S. D., et al.: Do all Short GRBs have AN Associated Host Galaxy? the Case of GRB 070707 *International Journal of Modern Physics D* (2008) **17** 1363-1369.
4. Del Burgo, C., Carter, D., & Sikkema, G.: Spatial distribution of dust in the shell elliptical NGC 5982 *Astronomy and Astrophysics* (2008) **477** 105-116.
5. Aharonian, F., et al.: HESS very-high-energy gamma-ray sources without identified counterparts *Astronomy and Astrophysics* (2008) **477** 353-363.
6. Aharonian, F., et al.: HESS observations and VLT spectroscopy of PG 1553+113 *Astronomy and Astrophysics* (2008) **477** 481-489.
7. Neronov, A. & Chernyakova, M.: A Rotating Hollow Cone Anisotropy of TeV Emission from Binary Systems *Astrophysical Journal* (2008) **672** L123-L126.
8. Khangulyan, D., Aharonian, F., & Bosch-Ramon, V.: On the formation of TeV radiation in LS 5039 *Monthly Notices of the Royal Astronomical Society* (2008) **383** 467-478.
9. Aharonian, F., et al.: Upper limits from HESS active galactic nuclei observations in 2005-2007 *Astronomy and Astrophysics* (2008) **478** 387-393.
10. Rieger, F. M. & Aharonian, F. A.: Variable VHE gamma-ray emission from non-blazar AGNs *Astronomy and Astrophysics* (2008) **479** L5-L8.
11. Aharonian, F., et al.: Observations of the Sagittarius dwarf galaxy by the HESS experiment and search for a dark matter signal *Astroparticle Physics* (2008) **29** 55-62.
12. Podio, L., et al.: Tracing the origins of permitted emission lines in RU Lupi down to AU scales *Astronomy and Astrophysics* (2008) **480** 421-430.
13. Dieckmann, M. E., Shukla, P. K., & Drury, L. O. C.: The Formation of a Relativistic Partially Electromagnetic Planar Plasma Shock *Astrophysical Journal* (2008) **675** 586-595.

14. Aharonian, F., et al.: Discovery of very high energy gamma-ray emission coincident with molecular clouds in the W 28 (G6.4-0.1) field *Astronomy and Astrophysics* (2008) **481** 401-410.

15. Aharonian, F., et al.: Discovery of VHE γ-rays from the high-frequency-peaked BL Lacertae object RGB J0152+017 *Astronomy and Astrophysics* (2008) **481** L103-L107.

16. Uchiyama, Yasunobu & Aharonian, Felix A.: Fast Variability of Nonthermal X-Ray Emission in Cassiopeia A: Probing Electron Acceleration in Reverse-Shocked Ejecta *Astrophysical Journal* (2008) **677** L105-L108.

17. Amato, Elena, Blasi, Pasquale, & Gabici, Stefano: Kinetic approaches to particle acceleration at cosmic ray modified shocks *Monthly Notices of the Royal Astronomical Society* (2008) **385** 1946-1958.

18. Bosch-Ramon, V., Khangulyan, D., & Aharonian, F. A.: Non-thermal emission from secondary pairs in close TeV binary systems *Astronomy and Astrophysics* (2008) **482** 397-402.

19. Chrysostomou, A., et al.: Investigating the transport of angular momentum from young stellar objects. Do H2 jets from class I YSOs rotate? *Astronomy and Astrophysics* (2008) **482** 575-583.

20. Melnikov, S., et al.: A HST study of the environment of the Herbig Ae/Be star LkHα 233 and its bipolar jet *Astronomy and Astrophysics* (2008) **483** 199-208.

21. Aharonian, F., et al.: Exploring a SNR/molecular cloud association within HESS J1745-303 *Astronomy and Astrophysics* (2008) **483** 509-517.

22. Aharonian, F., et al.: Discovery of very-high-energy γ-ray emission from the vicinity of PSR J1913+1011 with HESS *Astronomy and Astrophysics* (2008) **484** 435-440.

23. Raga, A. C., et al.: A Latitude-dependent Wind Model for Mira's Cometary Head *Astrophysical Journal* (2008) **680** L45-L48.

24. Bogovalov, S. V., et al.: Modelling interaction of relativistic and non-relativistic winds in binary system PSR B1259-63/SS2883 - I. Hydrodynamical limit *Monthly Notices of the Royal Astronomical Society* (2008) **387** 63-72.

25. de Colle, F., Del Burgo, C., & Raga, A. C.: Diagnostics of inhomogeneous stellar jets. Convolution effects and data reconstruction *Astronomy and Astrophysics* (2008) **485** 765-772.

26. Drury, L. O.'C. & Aharonian, F. A.: The puzzling MILAGRO hot spots *Astroparticle Physics* (2008) **29** 420-423.

27. Aharonian, Felix A., Khangulyan, D., & Costamante, L.: Formation of hard very high energy gamma-ray spectra of blazars due to internal photon-photon absorption *Monthly Notices of the Royal Astronomical Society* (2008) **387** 1206-1214.

28. Covino, S., et al.: The complex light curve of the afterglow of GRB071010A *Monthly Notices of the Royal Astronomical Society* (2008) **388** 347-356.

29. Soldi, S., et al.: The multiwavelength variability of 3C 273 *Astronomy and Astrophysics* (2008) **486** 411-425.

30. Aharonian, F., et al.: Chandra and HESS observations of the supernova remnant CTB 37B *Astronomy and Astrophysics* (2008) **486** 829-836.

31. Kelner, S. R. & Aharonian, F. A.: Energy spectra of gamma rays, electrons, and neutrinos produced at interactions of relativistic protons with low energy radiation *Physical Review D* (2008) **78** 034013

32. Garcia Lopez, R., et al.: IR diagnostics of embedded jets: velocity resolved observations of the HH34 and HH1 jets *Astronomy and Astrophysics* (2008) **487** 1019-1031.

33. Aharonian, F., et al.: HESS upper limits for Kepler's supernova remnant *Astronomy and Astrophysics* (2008) **488** 219-223.

34. Čemeljić, M., et al.: Resistive jet simulations extending radially self-similar magneto-hydrodynamic models *Monthly Notices of the Royal Astronomical Society* (2008) **389** 1022-1032.

35. Aharonian, F., et al.: High energy astrophysics with ground-based gamma ray detectors *Reports on Progress in Physics* (2008) **71** 096901

36. Bosch-Ramon, V., Khangulyan, D., & Aharonian, F. A.: The magnetic field and the location of the TeV emitter in Cygnus ;X-1 and LS ;5039 *Astronomy and Astrophysics* (2008) **489** L21-L24.

37. Tanaka, Takaaki, et al.: Study of Nonthermal Emission from SNR RX J1713.7-3946 with Suzaku *Astrophysical Journal* (2008) **685** 988-1004.

38. Covino, S., et al.: The Afterglow Onset for GRB 060418 and GRB 060607A *Chinese Journal of Astronomy and Astrophysics Supplement* (2008) **8** 356-360.

39. Aharonian, F., et al.: Limits on an Energy Dependence of the Speed of Light from a Flare of the Active Galaxy PKS 2155-304 *Physical Review Letters* (2008) **101** 170402

40. Aharonian, F., et al.: Discovery of a VHE gamma-ray source coincident with the supernova remnant CTB 37A *Astronomy and Astrophysics* (2008) **490** 685-693.

41. Piranomonte, S., et al.: The short GRB 070707 afterglow and its very faint host galaxy *Astronomy and Astrophysics* (2008) **491** 183-188.

42. Stute, M., et al.: Stability and structure of analytical MHD jet formation models with a finite outer disk radius *Astronomy and Astrophysics* (2008) **491** 339-351.

43. Gabici, Stefano, et al.: The diffuse neutrino flux from the inner Galaxy: Constraints from very high energy gamma-ray observations *Astroparticle Physics* (2008) **30** 180-185.

44. Piranomonte, S., et al.: Probing the complex environments of GRB host galaxies and intervening systems: high resolution spectroscopy of GRB050922C *Astronomy and Astrophysics* (2008) **492** 775-785.

45. Aharonian, F., et al.: Simultaneous HESS and Chandra observations of Sagitarius A* during an X-ray flare *Astronomy and Astrophysics* (2008) **492** L25-L28.

46. De Colle, Fabio, Gracia, José, & Murphy, Gareth: The Effect of a Stellar Magnetic Variation on the Jet Velocity *Astrophysical Journal* (2008) **688** 1137-1141.

47. De Colle, Fabio, Raga, Alejandro C., & Esquivel, Alejandro: The Dynamics of Internal Working Surfaces in Magnetohydrodynamic Jets *Astrophysical Journal* (2008) **689** 302-307.

48. Coffey, Deirdre, Bacciotti, Francesca, & Podio, Linda: T Tauri Jet Physics Resolved Near the Launching Region with the Hubble Space Telescope *Astrophysical Journal* (2008) **689** 1112-1126.

49. Aharonian, F., et al.: Energy Spectrum of Cosmic-Ray Electrons at TeV Energies *Physical Review Letters* (2008) **101** 261104

50. Whelan, E. T., & Garcia, P.: Spectro-astrometry, the method its limitations and applications, *Lecture Notes in Physics* (2008) **742** 123.

51. F. Vanhavere, J.L. Genicot, D. OSullivan, D. Zhou, F. Spurny, I. Jadrnickova, G.O. Sawakuchi, E.G. Yukihara: Dosimetry of Biological Experiments in Space (DOBIES) with luminescence (OSL and TL) and track etch detectors *Radiation Measurements,* **43** (2008) 694-697.

52. D. Zhou, D. OSullivan, E. Semones, N. Zapp, S. Johnson, M. Weyland: Radiation dosimetry for high LET particles in low Earth orbit *Acta Astronautica,* **63** (2008) 855-864.

6.2 Non-refereed publications

These are available online at:

`http://adsabs.harvard.edu/cgi-bin/nph-abs_connect?library&libname=NonRef2008&libid=4794ca7845`

1. D'Avanzo, P., et al.: GRB 080130: REM NIR observations. *GRB Coordinates Network* (2008) **7244** 1

2. D'Avanzo, P., et al.: GRB 080207: REM NIR observations. *GRB Coordinates Network* (2008) **7269** 1

3. D'Avanzo, P., et al.: GRB 080212: REM NIR afterglow? *GRB Coordinates Network* (2008) **7302** 1

4. D'Avanzo, P., et al.: GRB 080212: REM refined analysis. *GRB Coordinates Network* (2008) **7310** 1

5. D'Avanzo, P., et al.: GRB 080212: VLT optical rapid decay. *GRB Coordinates Network* (2008) **7311** 1

6. Covino, S., et al.: GRB 080218B: REM NIR early upper limits. *GRB Coordinates Network* (2008) **7322** 1

7. D'Avanzo, P., et al.: GRB 080229: REM NIR observations. *GRB Coordinates Network* (2008) **7342** 1

8. D'Avanzo, P., et al.: GRB 080303: REM NIR afterglow candidate. *GRB Coordinates Network* (2008) **7350** 1

9. Covino, S., et al.: GRB 080310: REM observations. *GRB Coordinates Network* (2008) **7385** 1

10. Covino, S., et al.: GRB 080319B: REM observations. *GRB Coordinates Network* (2008) **7431** 1

11. Covino, S., et al.: GRB 080319A: REM observations. *GRB Coordinates Network* (2008) **7440** 1

12. Covino, S., et al.: GRB 080319B: REM early data. *GRB Coordinates Network* (2008) **7446** 1

13. D'Avanzo, P., et al.: GRB 080330: REM optical observations. *GRB Coordinates Network* (2008) **7554** 1

14. D'Avanzo, P., et al.: GRB 080309: REM optical/NIR observations. *GRB Coordinates Network* (2008) **7574** 1

15. Antonelli, L. A., et al.: GRB 080413A: REM detection of the NIR afterglow. *GRB Coordinates Network* (2008) **7597** 1

16. Antonelli, L. A., et al.: GRB080413B: REM NIR & optical observation. *GRB Coordinates Network* (2008) **7600** 1

17. Covino, S., et al.: GRB080514: REM NIR & optical observations. *GRB Coordinates Network* (2008) **7712** 1

18. D'Avanzo, P., et al.: GRB 080710: REM afterglow confirmation & brightening. *GRB Coordinates Network* (2008) **7960** 1

19. D'Avanzo, P., et al.: GRB 080725: REM prompt observations. *GRB Coordinates Network* (2008) **8016** 1

20. D'Avanzo, P., et al.: GRB 080727B: REM prompt observations. *GRB Coordinates Network* (2008) **8023** 1

21. D'Avanzo, P., et al.: GRB 080727B: REM NIR afterglow prompt detection. *GRB Coordinates Network* (2008) **8037** 1

22. D'Avanzo, P., et al.: GRB 080913: REM NIR early observations. *GRB Coordinates Network* (2008) **8220** 1

23. Covino, S., et al.: GRB 080915: REM NIR early observations. *GRB Coordinates Network* (2008) **8233** 1

24. Fugazza, D., et al.: GRB 080916: REM candidate afterglow. *GRB Coordinates Network* (2008) **8238** 1

25. Antonelli, L. A., et al.: GRB 080916: REM detection of the NIR afterglow. *GRB Coordinates Network* (2008) **8239** 1

26. Covino, S., et al.: GRB 080919: REM NIR observations. *GRB Coordinates Network* (2008) **8271** 1

27. Covino, S., et al.: GRB 081007: REM NIR and optical counterpart. *GRB Coordinates Network* (2008) **8331** 1

28. D'Avanzo, P., et al.: GRB 081017: REM early observations. *GRB Coordinates Network* (2008) **8389** 1

29. Covino, S., et al.: GRB 081029: REM observations. *GRB Coordinates Network* (2008) **8441** 1

30. D'Avanzo, P., et al.: GRB 081109: REM NIR afterglow detection. *GRB Coordinates Network* (2008) **8501** 1

31. Covino, S., et al.: GRB081222: REM candidate afterglow. *GRB Coordinates Network* (2008) **8692** 1

32. Covino, S., Vergani, S. D., & Malesani, D.: REM observations of the GRB afterglow onset *Relativistic Astrophysics* (2008) **966** 21-24.

33. Tanaka, Takaaki, et al.: Suzaku Observations of SNR RX J1713.7-3946 in the Energy Range from 0.4 Kev up to 40 Kev *AAS/High Energy Astrophysics Division* (2008) **10** 38.07

34. Ray, Tom: Generating Jets from Young Stars: An Observational Perspective *APS Meeting Abstracts* (2008) 1

35. Suzuki-Vidal, F., et al.: Formation of Magnetically Driven Radiatively Cooled Plasma Jets in the Laboratory *APS Meeting Abstracts* (2008) 19

36. Reimer, O., et al.: VHE gamma-rays from Westerlund 2 and implications for the inferred energetics *Clumping in Hot-Star Winds* (2008) 195

37. Guidorzi, C. & Vergani, S.: GRB 070311: a common origin for the prompt and afterglow emission *American Institute of Physics Conference Series* (2008) **1000** 417-420.

38. Polcaro, V. F., et al.: Some Considerations on the HMXRB LSI +61 303 *Mass Loss from Stars and the Evolution of Stellar Clusters* (2008) **388** 217

39. Drury, Luke O'c.: Cosmic Rays in Supernova Remnants and the Galaxy *American Institute of Physics Conference Series* (2008) **1039** 427-432.

40. Chernyakova, M., et al.: Latest X-ray observations of PSR B1259-63. *American Institute of Physics Conference Series* (2008) **1085** 215-218.

41. Bosch-Ramon, V., Khangulyan, D., & Aharonian, F. A.: Clues to unveil the emitter in LS 5039: powerful jets vs colliding winds *American Institute of Physics Conference Series* (2008) **1085** 223-225.

42. Gabici, Stefano, Casanova, Sabrina, & Aharonian, Felix A.: Non-thermal radiation from molecular clouds illuminated by cosmic rays from nearby supernova remnants. *American Institute of Physics Conference Series* (2008) **1085** 265-268.

43. Taylor, Andrew, et al.: A reinvestigation into the diffuse neutrino flux from the inner Galaxy in light of new very high energy γ-ray observations *American Institute of Physics Conference Series* (2008) **1085** 384-388.

44. Casanova, S., et al.: Probing the Galactic cosmic ray flux with submillimeter and gamma ray data *American Institute of Physics Conference Series* (2008) **1085** 389-392.

45. Dempsey, Paul & Kirk, John: Relativistic Shock Acceleration: A Hartree-Fock Approach *American Institute of Physics Conference Series* (2008) **1085** 594-596.

46. Brunetti, G., et al.: Gamma ray emission and stochastic particle acceleration in galaxy clusters *American Institute of Physics Conference Series* (2008) **1085** 628-631.

47. Rieger, Frank M. & Aharonian, Felix: On the Origin of VHE Gamma-Ray Emission in M87 *American Institute of Physics Conference Series* (2008) **1085** 640-643.

48. Costamante, Luigi, et al.: The new surprising behaviour of the two "prototype" blazars PKS 2155-304 and 3C 279 *American Institute of Physics Conference Series* (2008) **1085** 644-647.

49. Aharonian, Felix A., Hofmann, Werner, & Rieger, Frank: VERITAS Blazar Observations-Recent Results *American Institute of Physics Conference Series* (2008) **1085**

50. Aharonian, Felix A., Hofmann, Werner, & Rieger, Frank: VERITAS Blazar Observations-Recent Results *American Institute of Physics Conference Series* (2008) **1085**

6.3 Preprints

These are available online at:

`http://adsabs.harvard.edu/cgi-bin/nph-abs_connect?library&libname=Preprint2008&libid=4794ca7845`

1. Zdziarski, A. A., Neronov, A., & Chernyakova, M.: A compact pulsar wind nebula model of the gamma-ray loud binary LS I +61 303 *ArXiv e-prints* (2008) arXiv:0802.1174

2. Vannoni, G., Gabici, S., & Aharonian, F. A.: Diffusive Shock Acceleration in Radiation Dominated Environments *ArXiv e-prints* (2008) arXiv:0803.1138

3. D'Elia, V., et al.: The prompt, high resolution spectroscopic view of the "naked-eye" GRB080319B *ArXiv e-prints* (2008) arXiv:0804.2141

4. Dieckmann, M. E., Meli, A., Shukla, P. K., Drury, L. O. C., & Mastichiadis, A.: Two-dimensional PIC simulations of ion-beam instabilities in Supernova-driven plasma flows *ArXiv e-prints* (2008) arXiv:0804.2677

5. Bosch-Ramon, V., Khangulyan, D., & Aharonian, F. A.: On the X-ray/TeV connection in Galactic jet sources *ArXiv e-prints* (2008) arXiv:0805.1700

6. Rieger, F. M. & Aharonian, F. A.: Particle acceleration close to the supermassive black hole horizon: the case of M87 *ArXiv e-prints* (2008) arXiv:0805.4075

7. Gabici, S., Taylor, A. M., White, R. J., Casanova, S., & Aharonian, F. A.: The diffuse neutrino flux from the inner Galaxy: constraints from very high energy gamma-ray observations *ArXiv e-prints* (2008) arXiv:0806.2459

8. Coffey, Deirdre, Bacciotti, Francesca, & Podio, Linda: T Tauri Jet Physics Resolved Near The Launching Region with the Hubble Space Telescope *ArXiv e-prints* (2008) arXiv:0808.0617

9. De Colle, Fabio, Gracia, Jose, & Murphy, Gareth: The effect of a stellar magnetic variation on the jet velocity *ArXiv e-prints* (2008) arXiv:0808.1949

10. De Colle, Fabio, Raga, Alejandro, & Esquivel, Alejandro: The dynamics of internal working surfaces in MHD jets *ArXiv e-prints* (2008) arXiv:0808.2346

11. Hinton, J. A., Skilton, J. L., Funk, S., Brucker, J., Aharonian, F. A., Dubus, G., Fiasson, A., Gallant, Y., Hofmann, W., Marcowith, A., & Reimer, O.: HESS J0632+057 : A new gamma-ray binary? *ArXiv e-prints* (2008) arXiv:0809.0584

12. Stute, Matthias, Tsinganos, Kanaris, Vlahakis, Nektarios, Matsakos, Titos, & Gracia, Jose: Stability and structure of analytical MHD jet formation models with a finite outer disk radius *ArXiv e-prints* (2008) arXiv:0809.1652

13. Dempsey, Paul & Kirk, John G.: Relativistic Shock Acceleration: A Hartree-Fock Approach *ArXiv e-prints* (2008) arXiv:0809.2657

14. Khangulyan, D. V., Aharonian, F. A., Bogovalov, S. V., Koldoba, A. V., & Ustyugova, G. V.: Hydrodynamics of interaction of pulsar and stellar winds and its impact on the high energy radiation of binary pulsar systems *ArXiv e-prints* (2008) arXiv:0809.5197

15. Gabici, Stefano, Casanova, Sabrina, & Aharonian, Felix A.: Non-thermal radiation from molecular clouds illuminated by cosmic rays from nearby supernova remnants *ArXiv e-prints* (2008) arXiv:0810.0035

16. Henney, William J., Arthur, S. Jane, De Colle, Fabio, & Mellema, Garrelt: Radiation-magnetohydrodynamic simulations of the photoionisation of magnetised globules *ArXiv e-prints* (2008) arXiv:0810.1531

17. Dionatos, O., Nisini, B., Garcia Lopez, R., Giannini, T., Davis, C. J., Smith, M. D., Ray, T. P., & De Luca, M.: Atomic jets from class 0 sources detected by Spitzer: the case of L1448-C *ArXiv e-prints* (2008) arXiv:0810.1651

18. Casanova, S., Gabici, S., Aharonian, F. A., Torii, K., Fukui, Y., Onishi, T., Yamamoto, H., & Kawamura, A.: Probing the Galactic cosmic ray flux with submillimeter and gamma ray data *ArXiv e-prints* (2008) arXiv:0810.4297

19. Bosch-Ramon, Valenti, Khangulyan, Dmitry, & Aharonian, Felix: The TeV emitter structure in LS 5039 *ArXiv e-prints* (2008) arXiv:0810.4494

20. Taylor, Andrew M. & Aharonian, Felix A.: The Spectral Shape and Photon Fraction as Signatures of the GZK-Cutoff *ArXiv e-prints* (2008) arXiv:0811.0396

21. O'C. Drury, L., Aharonian, F. A., Malyshev, D., & Gabici, S.: On the plasma temperature in supernova remnants with cosmic-ray modified shocks *ArXiv e-prints* (2008) arXiv:0811.3566

22. Takahashi, T., Kishishita, T., Uchiyama, Y., Tanaka, T., Yamaoka, K., Khangulyan, D., Aharonian, F. A., Bosch-Ramon, V., & Hinton, J. A.: Study of the Spectral and Temporal Characteristics of X-Ray Emission of the Gamma-Ray Binary LS 5039 with Suzaku *ArXiv e-prints* (2008) arXiv:0812.3358

6.4 Books and Conference Proceedings

1. Bacciotti, F., Whelan, E. T. & Testi, L. (eds): 2008, Lecture Notes in Physics, Berlin. Springer Verlag, 742.

2. Aharonian, F. A. & Rieger, F.: "High Energy Phenomena in Relativistic Outflows", World Scientific, in press

3. Aharonian, F.A., Hofmann, W. & Rieger, F.: "High Energy Gamma-ray Astronomy", AIP conference proceedings, New York, in press

6.5 Theses

Four students successfully defended their PhD theses during the year:

1. Colin Melody *Production mechanisms of run-away stars* (supervisor E Meurs)

2. Paul Ward, *Spectroscopy of gamma-ray bursts* (supervisor E Meurs)

3. Susanna Vergani *REM studies of gamma-ray bursts* (supervisor E Meurs)

4. Anthony Moraghan (Lindsey Scholar, jointly with Armagh Observatory) *Numerical studies of protostellar jets* (supervisors, M Smyth and T Ray)

In addition Stephane Dudzinski completed his part-time MSc by research with a thesis entitled *An Extension to Grid Security Monitoring to incorporate Host-based Intrusion Detection*.

7 Invited talks

- Luke Drury
    1. "Theory of Galactic sources and acceleration of cosmic rays", 400th Heraeus Seminar, Physik Zentrum, Bad Honnef, Germany

    2. "The National Capability Computing System", IDC conference, Croke Park, Dublin

3. “Particle Acceleration in the Galaxy”, 7th International IGGP/SSL conference, Hawaii
4. Two lectures on Particle Acceleration theory at the 2008 Stanford Summer Institute, Stanford, California
5. “What can we learn from XLA about particle acceleration and SNR dynamics”, ESF topical workshop on Extreme Laboratory Astrophysics: Advances and Opportunities in High-Energy Density Experiments, Paris
6. “From Cosmochemistry to Astrophysics”, 50th Anniversary Festcolloquium of the MPI für kernphysik, Heidelberg

- Felix Aharonian
  1. “Theory: general remarks”, introductory talk at the workshop ”Non-Thermal Hadronic Processes in Galactic Sources”, Heidelberg, Germany, January 2008
  2. “Supernovae and SNR”, conference on “Challenges in Particle Astrophysics”, Chateau de Blois, France, May 2008
  3. “Theoretical aspects of Very High Energy Gamma Ray Astronomy”, APP UK 2008 Conference, Oxford, UK, June 2008
  4. “Very High Energy Gamma Ray Astronomy”, review talk at the International Seminar ”Origin, Mass Composition and Acceleration Mechanisms of UHECRs”, Malfa, Salina Island, Italy, September 2008
  5. “Status of Gamma Ray Astronomy”, 2008 TeV Particle Astrophysics international workshop, Beijing, China, September 2008
  6. “Potential of Ground Based Gamma Ray Astronomy”, workshop ” Science with the New Generation of High Energy Gamma-Ray Experiments”, Padova, Italy, October 2008
  7. “TEV astrophysics - highlights”, Conference on ”High Energy Astrophysics - today and tomorrow”, Moscow, Russia, December 2008
  8. “High Energy Gamma Ray and Neutrino connections”, National Institute for Nuclear and High Energy Physics, Amsterdam, NL, April 11, 2008 (NIKEF colloquium)
  9. “The TeV domain of cosmic electromagnetic spectrum”, Columbia University, New York, USA, May 5, 2008 (Columbia Physics colloquium)
  10. “Very High Energy Gamma-Ray Sources”, Princeton Institute for Advanced Study, Princeton, USA, May 6, 2008 (Princeton Astrophysics Seminar)
  11. “Cosmology with High Energy Gamma Rays”, New York University, New York, USA, May 9 (Astrophysics and Relativity Seminar)
  12. Lectures on high-energy processes in relativistic outflows, first La Plata International School on Astronomy, La Plata, Argentina, March

13. Lectures on selected topics in X- and Gamma-ray Astronomy, Pescara International School on Relativistic Astrophysics, December

- Tom Ray

    1. ”Getting to Grips with the Unknown: How Important are Magnetic Fields in Outflows from Young Stars?” and Conference Summary, Magnetic Fields in the Universe, Conzumel, Mexico, 1st February.
    2. ”Generating Jets from Young Stars: An Observational Perspective”, High Energy Density Laboratory Astrophysics Meeting, American Physical Society, St Louis, 11th April
    3. ”The James Webb Space Telescope”, British Astronomical Association, UCD, Dublin, 6th September
    4. ”Simulating Jets from Young Stars: What Numbers to Use?”, ESF Workshop on High Energy Laboratory Astrophysics, Paris Observatory, Meudon, 22 September
    5. ”Solving the Stellar Angular Momentum Problem: Do Jets Have a Role?”, ETH, Zurich 9th October

- Masha Chernyakova

    1. “Gamma-ray loud binary systems”, High Energy Astrophysics VIRGO.UA Workshop (1-3 September 2008, Kiev, Ukraine).

- Stefano Gabici

    1. “Gamma ray signatures of Ultra High Energy Cosmic Ray sources”, The impact of high-energy-astrophysics experiments on cosmological physics, Chicago, October 2008
    2. “Gamma ray astronomy”, invited review talk, XXI European Cosmic Ray Symposium, Kosice, September 2008
    3. “Molecular clouds with CTA”, CTA meeting, Barcelona, January 2008
    4. “Molecular clouds/supernova remnants interactions”, Nonthermal hadronic mechanisms in galactic sources, Heidelberg, January 2008

- Denis O’Sullivan

    1. “Radiation experienced by astronauts determined with CR-39 dosimeters using a human phantom on ISS” 59th IAC, Glasgow, UK, Oct. 2008

8 Current Grants

- Luke Drury

    1. PRTLI-4 e-INIS, Project Coordinator
    2. EU Marie Curie fellowship

3. SFI RFP award one postdoc (awaiting sanction to appoint)

- Evert Meurs
  1. SFI RFP one postgrad
- Felix Aharonian
  1. EU FP6 Design Study KM3NeT, 40K, Preparatory Phase 30K
  2. SFI RFP, two postgrads
  3. IRCSET, one postdoc
- Tom Ray
  1. EU JETSET, two postdocs and an administrator
  2. PRODEX MIRI
  3. SFI RFP, one postdoc and one postgrad
  4. IRCSET, one postdoc
- Carlos del Burgo
  1. co-I on proposal of PI Eduardo Martin, project: AYA2007-67458, "DETECCION DE EXOPLANETAS TELURICOS CON ESPECTROGRAFOS DE MUY ALTA RESOLUCION ESPECTRAL EN TELESCOPIOS DE GRAN DIAMETRO" (which means "Detection of exoplanets using high spectral resolution spectrographs in big telescopes") 500K over three years.
- Denis O'Sullivan (emeritus)
  1. DOBIES - from Enterprise Ireland under PRODEX, 24k over 2 years

9 Proposals submitted

- Luke Drury
  1. Joint PI proposal with John Morrison (UCC) and Andy Shearer (NUIG) to SFI for Data-Centric Computing
- Felix Aharonian
  1. EU FP7 Preparatory Phase KM3NeT, 30K
- Tom Ray
  1. FP7 MC training Network proposal, JETset-II
  2. PRODEX funding for MIRI software development team

10 Community Service etc

- Luke Drury:
  1. Member of the ICHEC oversight board;
  2. Chairman of the interview panel for the NUI travelling studentships;
  3. Member of the H.E.S.S. Collaboration Board;
  4. Member of the KM3NeT consortium;
  5. Member of the RIA Astronomy and Space Science Committee;
- Felix Aharonian:
  1. co-PI of the ROTSE project;
  2. member of the H.E.S.S. Collaboration Board;
  3. member of the Consortium of the KM3NeT;
  4. member of the working group "Science with NeXT" (Japanese next generation X-ray mission);
  5. member ("Principal Scientist/Professor") of the Heidelberg Graduate School of Fundamental Physics at the University of Heidelberg;
  6. Adjunct Professor of the International Center for Relativistic Astrophysics Network, Pescara/Rome
  7. Course of lectures on radiation process in high energy astrophysics, TCD, February
  8. external scientific member of the MPIK in the High Energy Astrophysics Group
  9. co-director of LEA - European Associated Laboratory on High Energy Astrophysics (jointly supported by CNRS and MPG);
  10. member of the European Astronet Infrastructure Roadmap Panel A: "High energy, astro-particle astrophysics and gravitational waves";
  11. member of the International Review Panel of the Helmholtz Association: "Astroparticle Physics"
  12. an Editor of the International Journal of Modern Physics D.
- Evert Meurs:
  1. member of the REM consortium;
  2. member of the RIA Astronomy and Space Science Committee in which capacity he finalised the National Plan for Astronomy in Ireland (2009–2019), which underlines the case for Irish membership of the European Southern Observatory (ESO);
  3. member of the Space Strategy Working Group (Space Industry Skillnet);

4. member of the Joint Management Committee, Armagh Observatory and Planetarium.

- Tom Ray
  1. Co-PI of the MIRI project;
  2. Chairman of the e-MERLIN Steering Committee (Steering committee for national radio astronomy facilities in the UK);
  3. Adjunct Professorship Trinity College Dublin (from October 2008);
  4. External Expert EU Framework 7 Programme;
  5. Member of the Herschel Observatory Time Allocation Committee;
  6. Member of the Physical and Chemical Sciences Committee, Royal Irish Academy
- Carlos del Burgo
  1. co-PI of the Nahual project
- Dennis O'Sullivan
  1. Presented with the Walker medal at the International SSNTD conference in Bologna
  2. Elected to membership of the Royal Irish Academy

11 Public Outreach

E.J.A. Meurs gave a talk on The Universe a laboratory of extremes to Hartstown Community School (Dublin 15) fifth and sixth form classes (23 January).

The normal programme of Open Nights concluded in March and recommenced in October. In a welcome development it was supplemented by a growing number of special events for specific interest groups (see Fig 2). In addition the Irish Astronomical Society were facilitated by being allowed the use of Dunsink for their meetings. The total number of visitors to Dunsink continues to rise and is now close to 2000 a year (see Fig 3). The final event of the year was Christmas themed with the presenters and some of the audience wearing santa hats (see Fig 4)!

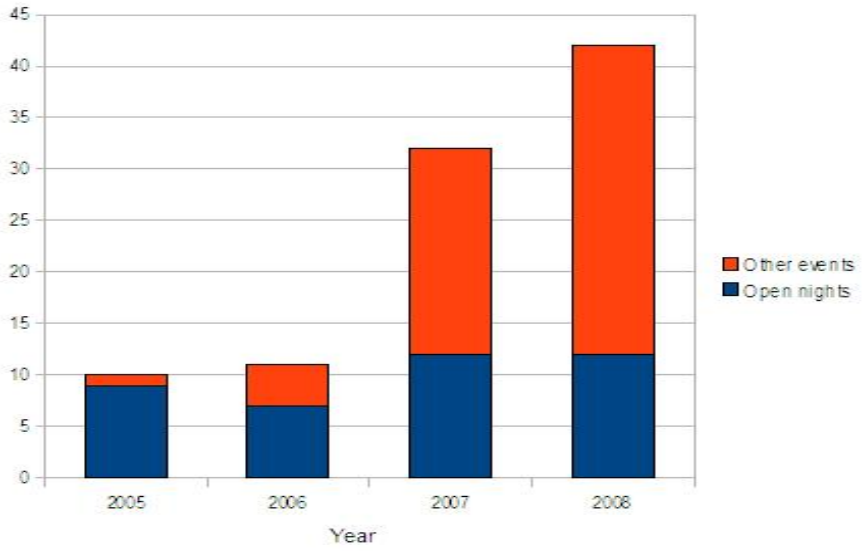


Figure 2: **Number of events held in Dunsink by Year**

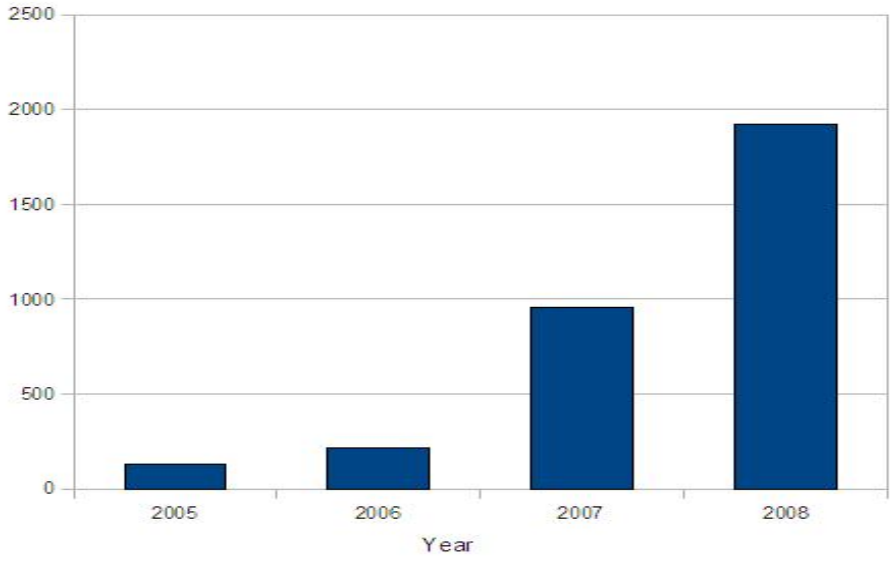


Figure 3: **Total number of visitors to Dunsink by year**

Date	Event	Time	Principal Speaker
9 Jan	Open Night	19:30	Ian Elliott
21 Jan	IAS meeting	19:30	A McCrea
23 Jan	Open Night	19:30	L Krista (TCD)
30 Jan	Special Event	19:00	W Nahm (DIAS)
5 Feb	University Evening	19:30	M Shadmehri (DCU)
6 Feb	Open Night	19:30	F McGroarty (QUB)
18 Feb	IAS meeting	19:30	M Shadmehri (DCU)
20 Feb	Open night	19:30	A Fitzsimmons (QUB)
27 Feb	University Mature Students	19:30	P Duffy (UCD)
2 Mar	West of Ireland School evening	19:30	M Shamdehri (DCU)
5 Mar	St Columba's Junior School	11:00	E Whelan (DIAS)
5 Mar	Special Event	19:00	D Kelleghan (IAS)
12 Mar	Open night	19:30	T Ray (DIAS)
21 Apr	IAS meeting	19:30	T Hanlon
19 Jun	Noncommutative Geometry conference	14:00	STP
5 Sep	BAA out of town meeting	19:00	E Ansbro
8 Sep	Science & Mathematics Education conference	16:00	M O'Reilly (DCU)
15 Sep	German visitors	19:00	V Witt (MPIA, Heidelberg)
1 Oct	Open night	19:30	T Ray (DIAS)
7 Oct	Danish group	19:30	C del Burgo & C Melody (DIAS)
15 Oct	Open night	19:30	D Kelleghan (IAS)
16 Oct	Hamilton Walk	13:00	NUIM
20 Oct	IAS meeting	19:30	L Drury (DIAS)
23 Oct	Tempelogue special event	19:30	F McGroarty
5 Nov	Open night	19:30	D Malone (NUIM)
Science week 2008			
10 Nov	South Dublin after-school group	16:00	IAS
	Dominican convent	19:00	E Whelan
11 Nov	St Peter's Jr School	13:30	S Delaney et al
	Our Lady's Tempelogue	19:00	P Dempsey
12 Nov	Deansgrange Jr school	11:00	D Kelleghan
	St Paul's Walkinstown	19:00	C Raftery
13 Nov	Educate together	11:00	D Malishev et al
	Loreto Bray	19:00	T Ray
17 Nov	IAS event	19:30	B Harvey
19 Nov	Open night	19:30	C Raftery (TCD)
26 Nov	University evening	19:00	NUIM+TCD
1 Dec	IAS event	19:30	J O'Neill
3 Dec	Open Night	19:30	M Shadmehri (NUIM)
17 Dec	Christmas Event	19:30	E Whelan (DIAS)

The following assisted regularly in running the above events: Nicola Meenan, Orna Nicholl (TCD students); Denys Malishev, Paul Dawson, Luke Drury, Ann Grace, Eileen Flood, Hilary O'Donnell, Mike Smyth (DIAS); Deirdre Kelleghan, Robin Moore, Val Dunne (IAS).

Figure 4: Christmas in the South dome! Note the red LED lighting of the floor (installed during the year by M Smyth) which has greatly improved safety without affecting night vision.

12 Conferences Organised

12.1 JETSET School on "High Performance Computing in Astrophysics"

This JETSET school (the last in the current series) was held from 8th - 13th January in the Astronomy Centre, NUI, Galway and consisted of a series of lectures on computational techniques with applications to astrophysical problems where possible. The school also contained a course on MPI, an introduction to grid technology, lectures on adaptive mesh refinement techniques and sessions on virtual observatories and analysis of large datasets.

Shorter presentations addressed applications of HPC to astrophysical problems such as 3D radiative transfer, large-scale jet simulations and jet stability. During the school, the participants had access to a computer lab to facilitate hands-on exercises. There were also a limited number of contributed oral presentations from the approximately 80 participants.

12.2 PIC simulations of Relativistic Shocks

This workshop, supported by the Astrosim programme of the ESF, brought together 33 scientists working on the application of modern computing techniques and resources to "particle in cell" simulations of the basic physics of relativistic collisionless shocks. The format was deliberately designed to emphasis the workshop, rather than mini-conference, nature of the meeting

with working groups and practical sessions being given as much if not more prominence than standard talks. The support of the Irish Centre for High-End Computing, of Grid-Ireland, and of the computer science department in TCD was essential for this aspect of the programme. All participants shared a common lunch each day (paid for from the ESF grant) which facilitated interaction and informal discussion and prevented the group breaking up and dispersing. Feedback from the meeting has been uniformly positive and a number of joint publications are promised.

The active engagement and hard work of the local organising committee, in particular Hilary O'Donnell (logistics and catering) and Paul Dempsey (web site and coordination) contributed greatly to the smooth running of the meeting.

Group photograph of the participants in the PIC Workshop

12.3 JETSET International Conference "Protostellar Jets in Context"

This conference was held from 7-12 July in Rhodes, Greece. The main goal of this meeting was to review the recent contributions of theoretical and computational modelling, high-resolution observations, and laboratory experiments to our understanding of jets and outflows from young stars. The connection with accretion disks and the similarities with outflow phenomena in other astrophysical contexts was also explored. The conference brought together some 140 scientists working in these various fields to stimulate cross-disciplinary exchange. It contained both invited and contributed talks (many by JETSET postdoctoral fellows), as well as poster sessions. The proceedings will be published by Springer-Verlag and edited by Profs. Kanaris Tsinganos and Tom Ray.

Group photograph of the Rhodes Conference