IAU Symposium 275: Jets at all Scales

Abstract book

Buenos Aires, Argentina, September 13-17, 2010

Program

Monday 13

08:00 Registration opens

08:45 - 09:00 Welcome

09:00 - 09:45 Invited review I: The jet/accretion disk coupling (F. Mirabel)

09:45 - 10:30 Invited review II: Accreting X-ray binaries and jets (R. Sunyaev)

10:30 - 11:00 *Coffee break*

Morning Session: Jets - basic issues and physical processes

11:00 - 11:30 Invited talk 1: Relativistic jets: physics and simulations (J. F. Hawley)

11:30 - 11:50 Contributed talk 1: Waves in Poynting-flux dominated jets (J. G. Kirk)

11:50 - 12:10 Contributed talk 2: Modelling magnetially dominated and radiatively cooling jets (M. Huarte-Espinosa)

12:10 - 12:30 Contributed talk 3: Transformation of the electromagnetic into the plasma energy in Poynting dominated jets (Y. Lyubarski)

12:30 - 15:00 *Lunch break*

Afternoon Session: Accretion processes and outflows

15:00 - 15:30 Invited talk 2: The stability of astrophysical jets (P. Hardee)

15:30 - 16:00 Invited talk 3: Accretion disk winds (D. Proga)

16:00 - 16:20 Contributed talk 4: Investigating the disk-jet coupling in accreting compact objects by studying the "radio quiet" sources (P. Soleri)

16:20 - 17:00 *Coffee break*

17:00 - 17:20 Contributed talk 5: Fitting along the Fundamental plane: New comparisons of jet physics across the black hole mass scale (S. Markoff)

17:20 - 17:40 Contributed talk 6: Jets at lowest mass accretion rates (D. Maitra)

17:40 - 18:00 Contributed talk 7: Radiatively efficient black holes in the hard state: the case of H1743-322 (M. Coriat)

19:00 *Welcome cocktail*

Tuesday 14

09:00 - 09:45 Invited review III: Relativistic jets at high energies (A. Levinson)

Morning Session: New observational results on jets at all scales

09:45 - 10:15 Invited talk 1: Broadband observations of jets on different scales (E. Gallo)

10:15 - 10:35 Contributed talk 1: The far-infrared view of the radio galaxy M 87 as seen by the Herschel Space Observatory (M. Baes)

10:35 - 11:15 *Coffee break*

11:15 - 11:35 Contributed talk 2: Unveiling the nature of extragalactic jets with Chandra observations (F. Massaro)

11:35 - 11:55 Contributed talk 3: The jet in M 87 from EVN observations (G. Giovannini)

11:55 - 12:15 Contributed talk 4: The picture of relativistic jet from Fermi-LAT and multi-band observations of blazar 3C 279 (M. Hayashida)

12:15 - 15:00 *Lunch break*

Afternoon Session: Galactic jets

15:00 - 15:30 Invited talk 2: The Galactic Center jet (H. Falcke)

15:30 - 16:00 Invited talk 3: A magnetohydrodynamical model for the formation of episodic jets (F. Yuan)

16:00 - 16:20 Contributed talk 5: High luminosty jets: Can the GRS 1915+105 plateau be compared to the canonical hard state? (P. Van Oers)

16:20 - 17:00 *Coffee break*

17:00 - 17:20 Contributed talk 6: The disk/jet connection in the enigmatic microquasar Cygnus X-3 (K. Koljonen)

17:20 - 17:40 Contributed talk 7: The role of jets in black-hole X-ray binaries (N. Kylafis)

17:40 - 18:00 Contributed talk 8: The physics of disk winds, jets, and X-ray variability in GRS 1915+105 (J. Neilsen)

Parallel Educational Program I (in Spanish)

19:30 A. J. Castro-Tirado: "GRBs, los fenómenos más energéticos del Universo, y su estudio con instrumentación robótica" (at the *Galileo Galilei* Planetarium of the City of Buenos Aires)

Wednesday 15

09:00 - 09:45 Invited review IV: High energy emission and broadband correlations in microquasars (S. Corbel)

Morning Session: Microquasars

09:45 - 10:15 Invited talk 1: Non-thermal processes in microquasars (V. Bosch-Ramon)

10:15 - 10:45 Invited talk 2: Investigating accretion disk - radio jet coupling across the stellar mass scale (J. Miller-Jones)

10:45 - 11:15 *Coffee break*

11:15 - 11:35 Contributed talk 1: X-ray radiation of the jets and the supercritical accretion disk in SS 433 (S. Fabrika)

11:35 - 12:05 Invited talk 3: Jets from neutron stars (S. Migliari)

12:05 - 12:25 Contributed talk 2: Long-term simulations of extragalactic jets: cavities and feedback (M. Perucho)

12:25 - 12:45 Contributed talk 3: GRS 1915+105 celebrates its majority (1992-2010) (A. Castro-Tirado)

12:45 - 15:00 *Lunch break*

Free afternoon for social activities.

Parallel Educational Program II (in Spanish)

19:30 I. F. Mirabel: "Agujeros negros y los albores del Universo" (at the *Galileo Galilei* Planetarium of the City of Buenos Aires)

Thursday 16

09:00 - 09:45 Invited review V: The formation of relativistic jets (D. Meier)

Morning Session: Jet formation mechanisms

09:45 - 10:15 Invited talk 1: General relativistic plasmas around black holes (S. Koide)

10:15 - 10:35 Contributed talk 1: Brown dwarfs jets: testing the universality of jet launching mechanisms at the lowest masses (E. Whelan)

10:35 - 11:15 *Coffee break*

11:15 - 11:45 Invited talk 2: Suzaku studies of microquasars (Y. Ueda)

11:45 - 12:05 Contributed talk 2: Particle acceleration and heating by magnetic reconnection in accretion disk / jet systems: Numerical simulations (E. M. de Gouveia Dal Pino)

12:05 - 12:25 Contributed talk 3: Connections between jet formation and multiwavelenght spectral evolution in black hole transients (E. Kalemci)

12:25 - 12:45 Contributed talk 4: Jet launching and field advection in disks (J. Ferreira)

12:45 - 15:00 *Lunch break*

Afternoon Session: Jets from protostars

15:00 - 15:30 Invited talk 3: Radio observations of jets from massive young stars (L. F. Rodríguez)

15:30 - 16:00 Invited talk 4: Jet-driven molecular outflows (S. Cabrit)

16:00 - 16:30 Invited talk 5: Formation of protostellar jets (C. Fendt)

16:30 - 17:00 *Coffee break*

17:00 - 17:20 Contributed talk 5: On the three-dimensional structure of HH jets (F. De Colle)

17:20 - 17:40 Contributed talk 6: Origin of jets from young stars: high-angular resolution observations (C. Dougados)

Conference Dinner

20:00 Conference Banquet with Tango Show (voucher required).

Friday 17

09:00 - 09:45 Invited review VI: Blazar jet physics in the age of Fermi (C. D. Dermer)

Morning Session: AGNs' jets

09:45 - 10.15 Invited talk 1: Hadronic jet models today (M. Sikora)

10:15 - 10:35 Contributed talk 1: Radiation from matter entrainment in astrophysical jets (A. Araudo)

10:35 - 11:15 *Coffee break*

11:15 - 11:35 Contributed talk 2: Variability studies in blazar jets with SF analysis: caveats and problems (D. Emmanoulopoulos)

11:35 - 11:55 Contributed talk 3: Jet-disk connection in OJ 287 (M. J. Valtonen)

11:55 - 12:15 Contributed talk 4: Time-dependent multi-zone radiation transfer modeling of fast blazar variability (G. Fossati)

12:15 - 12:35 Contributed talk 5: The influence of collimation on the appearance of relativistic jets (P. O. Petrucci)

12:35 - 15:00 *Lunch break*

Afternoon Session: GRBs' jets

15:00 - 15:30 Invited talk 3: GRBs: recent theoretical progress (T. Piran)

15:30 - 16:00 Invited talk 4: GRBs: phenomenology (G. Ghisellini)

16:00 - 16:20 Contributed talk 6: Afterglow light curves from magnetized GRB flows (P. Mimica)

16:20 - 17:00 *Coffee break*

17:00 - 17:20 Contributed talk 7: GRB spectral-energy correlations: facts and misconceptions (G. Ghirlanda)

17:20 - 17:40 Contributed talk 8: Instabilities in the GRB central engine. What makes the jet variable? (A. Janiuk)

17:40 - 18:00 Contributed talk 9: Simulation of relativistic shocks and associated radiation from turbulent magnetic fields (K -I. Nishikawa)

18:00 - 18:30 Summary (Sambruna / Paredes / Romero)

18:30 Farewell

Editors for the Proceedings

Gustavo E. Romero (Chief Editor)
Instituto Argentino de Radioastronomía (IAR)
C.C. No.5
1894 Villa Elisa
Buenos Aires
Argentina
romero@fcaglp.unlp.edu.ar

Co-Editors:
Rashid Sunyaev
Max-Planck-Institut für Astrophysik
Karl-Schwarzschild-Str. 1
D-85748 Garching
Germany
sunyaev@mpa-garching.mpg.de

Tomaso Belloni
INAF
Osservatorio Astronomico di Brera
Via E Bianchi 46
IT 23807 Merate (LC)
Italy
belloni@merate.mi.astro.it

Invited talks & reviews

1. **Non-thermal processes in microquasars**

Valentí Bosch-Ramon[1,2]
[1]*Dublin Institute for Advanced Studies, Ireland.*
[2]*Max-Planck-Institut fur Kernphysik, Germany.*

Microquasar jets can accelerate particles up to relativistic energies, produce non-thermal radiation from radio to TeV, and may make an important contribution to the galactic CRs in some energy ranges. The orbital motion and compactness of these systems allow the study of high-energy astrophysical phenomena in extreme conditions that change, periodically or stochastically, in accessible timescales. In this talk, I discuss the modeling of microquasar non-thermal emission, focusing mainly in the high and the very high energies, but touching also the radio band.

2. **Jet-driven molecular outflows**

S. Cabrit
LERMA, Observatoire de Paris, France.

(Abstract not available.)

3. **Jets from microquasars**

Stéphance Corbel
Université Paris 7 Denis Diderot and Service d'Astrophysique, France.

In the past decade, several considerable achievements have been reached in the field of Galactic microquasars, especially in light of the extreme variability of their relativistic jets. These jets are now known to exist in at least three different flavours: the self absorbed compact jets in the hard state, the transient and discrete ejection events associated with the state transitions, and the emission associated with the interaction of the jets with the interstellar medium (that may not be always separated from the core). Althought their phenomenology is now rather well established, their emission and contribution to the total energy budget of microquasars is still the subject of active debates. In this review, I will present the most relevant observations concerning our understanding of relativistic jets in accreting systems, discussing in particular some open issues.

4. **Blazar jet physics in the age of Fermi**

Charles D. Dermer
Code 7653, Space Science Division, US Naval Research Laboratory, USA.

Even without the Fermi Gamma ray Space Telescope, the study of blazar jets would be in a highly active state given the results from ground-based γ-ray Cherenkov telescopes. With Fermi, we have a new census of the high-energy sky and many unexpected puzzles. After posing an answer to the remarkably short 5 min variability from PKS 2155−304 found with HESS, we ponder the relevance of the multi-GeV cutoffs in 3C 454.3 and other FSRQs. Scattering scenarios for external Compton processes are considered. Gamma-ray opacity cutoffs are expected for emission deep within the broad line region, leaving as the probable explanation a cutoff or softening in the electron spectrum, the reasons for which are not well understood.

An advantage of blazar AGN over GRB research is that we are confident that we know which is the synchrotron and which is the Compton peak. With this knowledge, we can determine the bulk Lorentz factor Γ of the shocked emitting plasma, and compare with Doppler factors derived from $\gamma\gamma$ limits and high-resolution radio observations. The magnetic field can be compared with equipartition estimates, limited by absolute jet power. Constraints on the energy density of the external radiation field, the probable target photon energy, and the radiative properties of the jet are contingent on knowledge of B.

The source counts in the LAT Bright AGN Sample (LBAS) and the first LAT AGN Catalog (1LAC) are far better for statistical studies than the EG catalogs made of the unevenly exposed EGRET sky. Blazar demographics and genealogy are remarked upon, with relevance to the blazar sequence as viewed with first Fermi and Swift results in hand. We consider that statistics of radio galaxies and blazars detected at γ-ray energies seem to favor a structured jet rather than a one-zone blob model.

A crucial central question for high-energy cosmic physics is whether blazar AGNs accelerate the bulk of the UHECRs. This question is addressed in the context of the recent extraordinary SEDs and light curves measured with Fermi and an array of ground-based (e.g., optical blazar monitoring, radio, Cherenkov) and space-based (e.g., RXTE, Swift, Spitzer) telescopes from prototypical X-ray TeV sources Mrk 421 and Mrk 501, radio galaxies like Centaurus A, and flat spectrum quasars, including also PKS 1510−089 and 3C 279.

5. **The Galactic Center jet**

Heino Falcke
Radboud University Nijmegen/ASTRON, The Netherlands.

(Abstract not available.)

6. **Formation of protostellar jets**

Christian Fendt
Max Planck Institute for Astronomy, Germany.

I will present recent results of jet formation MHD simulations considering a variety of model setups.
In the first approach the interrelation between the disk magnetic flux profile or disk mass loss profile and the jet collimation degree is investigated. Our results suggest (and quantify) that outflows launched from a very concentrated region close to the inner disk radius tend to be weakly collimated.
In the second approach, jet formation is investigated from a magnetic field configuration consisting of a stellar dipole superposed by a strong disk field. We find that the central dipole is considerably de-collimated by the disk wind. In addition, reconnection flares are launched in the interaction region of disk and stellar magnetic field, and subsequently change the mass flux in the outflow by factors of two-four for a short time. The time interval between the flare ejection in our setup is about 1000 Keplerian periods which is surprisingly similar to the observed time lag between jet knots.
The third approach considers radiative pressure effects on jet collimation and propagation – an environment which is interesting mainly for outflows from massive young stars (but also for AGN jets).
Finally, I will discuss briefly the extension of the previous simulations into the relativistic regime – applicable to AGN and microquasars.

7. **Broadband observations of jets on different scales**

Elena Gallo
MIT Kavli Institute for Astrophysics and Space Research, USA.

(Abstract not available.)

8. **Gamma Ray Bursts: phenomenology**

Gabriele Ghisellini
INAF – Osservatorio Astronomico di Brera, Italy.

I will critically present the most relevant facts and ideas concerning our understanding of Gamma Ray Bursts, discussing in particular what I think are the issues that are still open.

9. **The stability of astrophysical jets**

Philip E. Hardee
Department of Physics & Astronomy, Gallalee Hall, The University of Alabama, USA.

Jets are produced by protostellar systems, by black hole binary star systems (**micro-quasars**), by active galactic nuclei (**AGN**), are associated with neutron stars and pulsar wind nebulae, and are thought responsible for the gamma-ray bursts (**GRBs**). An understanding of these outflows must include how they are launched and collimated into jets, and how they propagate to large distances. Jets be they Poynting flux and/or kinetic flux dominated are current driven (**CD**) and/or Kelvin-Helmholtz (**KH**) velocity shear driven unstable. Thus in astrophysical systems one might expect stability conditions to provide exceptional tools for selection between launching and propagation configurations satisfying the MHD equations governing jet flow. Here I present some of the work that is leading to a better understanding of the properties required for the observed relative stability of astrophysical jets.

10. **Relativistic jets: physics and simulations**

John F. Hawley
Department of Astronomy, University of Virginia, USA.

Jets are one of the more dramatic and visible manifestations of black hole accretion. It is becoming increasingly accepted that magnetic fields underlie the mechanism behind the launching of relativistic jets. At the same time it is now appreciated that the fundamental driving mechanism behind accretion is due to magnetohydrodynamical processes and the stresses they engender. Global disk simulations in full general relativity have begun to reveal the radial dependence of disk stresses and the intimate connections between accretion and jet-launching. This talk will review the issues involved, the recent progress that has been made, and the challenges that remain.

11. **General relativistic plasmas around black holes**

Shinji Koide
Faculty of Science, Kumamoto University, Japan.

It is believed that cosmic relativistic jets from active galactic nuclei and micro-quasars are launched by drastic phenomena around black holes at the central regions of these objects. However, the distinct mechanisms of the jet formation still remain mystery. Recently, models with magnetic fields become noticeable because they may explain both of acceleration and collimation of the jets. The magnetic models suggest that the relativistic jets are anchored to the vicinity of the black holes and then we have to understand the interaction of plasmas and magnetic field around the black holes. Recently, general relativistic MHD (GRMHD) numerical simulations have become popular and they confirmed the magnetic processes can eject the relativistic jets. On the other hand, a number of magnetic islands, which are caused by magnetic reconnection, appear in such numerical simulations. These magnetic islands are numerically artificial because all of recent GRMHD simulations assume zero resistivity (ideal GRMHD). Such numerical errors may influence the whole results of the jet formation. It is also noted that when

we employ the customarily used relativistic Ohm's law, causality may be broken. To fix these matters, we introduce the generalized GRMHD equations derived on the basis of the general relativistic two-fluid equations.
In my talk, I will summarize numerical simulations of ideal GRMHD and point out their problems. I show the generalized GRMHD equations and indicate several peculiar phenomena suggested by these equations.

12. **Relativistic jets at high energies**

Amir Levinson
Faculty of Exact Sciences, Tel Aviv University, Israel.

Recent high energy observations, in particular by Fermi and the various TeV experiments, and advances in numerical techniques have led to a progress in our understanding of relativistic jets: i) In M 87, combined VLBA and TeV data seem to indicate that the TeV emission is produced on horizon scales by either some magnetospheric process, or at the base of the VLBA jet. The observational constraints raise interesting questions about the structure of the BH magnetosphere and the jet formation mechanism, that appear to be relevant also to TeV blazars. ii) Fermi observations of blazars provide now a better than before probe of opacity sources on sub-parsec scales. The data reveal a relation between source power and spectral features that can be interpreted in terms of BLR properties. iii) Combined Fermi and TeV observations of VHE blazars may be used to probe inter galactic magnetic fields. Attempts to derive constrains on the IGMF have been published, and although inconclusive yet, the results demonstrate the potential in pursuing further these efforts. iv) Fermi LAT detections of several GRBs indicate very high Lorentz factors in outflows having opening angles larger than the causality scale. Those detections triggered recent theoretical studies and numerical simulations of magnetic outflows. The conclusion emerging from these studies is that processes beyond ideal MHD are crucial. Hydrodynamical outflows, perhaps driven by neutrino annihilation, may provide an alternative. The nature of the GeV emission in GRBs is yet an open issue. v) In several bursts a prominent, quasi-thermal spectral component has been detected, challenging the "standard model". It opens up the issue of dissipation and emission during the prompt phase. In particular, part of the emission is likely produced behind relativistic radiation mediated shocks.
In this talk I will give an overview of those recent developments and more.

13. **The formation of relativistic jets**

David L. Meier
Jet Propulsion Laboratory, California Institute of Technology, USA.

I review current ideas on the launching, acceleration, collimation and propagation of relativistic jets and the influence of strong magnetic fields in the process. Recently, several important elements of the entire jet "engine" structure have been shown to likely play key roles in the production of an astrophysical jet. Depending on the type of system, these include the spin of the central black hole, the thermal and/or magnetic state of the accretion flow, the presence of a re-collimation point in the jet outflow far away from the central object, and the behavior of MHD shocks and kink instabilities in the final jet. While these physical processes probably are at work in all types of relativistic jets (and many even in more benign stellar outflows), I shall concentrate on ones produced by lower luminosity black hole sources, both in active galactic nuclei and in X-ray binaries. I also will discuss the connection between the theoretical concepts and the large body of observational data now available on these systems. The progress made on low luminosity systems also may point the way toward models of the high luminosity ones and on what types of observations need to be made in such objects to understand all types of astrophysical jets.

14. **Jets from neutron stars**

Simone Migliari
European Space Astronomy Centre, Spain.

I will review our observational knowledge of jets and disk-jet coupling in neutron star X-ray binaries. I will compare the neutron star phenomenology to that observed in black hole systems with the aim of understanding the role of the compact object in jet formation. Is the jet formation mechanism in neutron star and black hole systems the same? Can we quantify the role of the spin in the production of jets? Can we quantify the role of the stellar magnetic field in the production of jets? I will show our current observational limits in trying to address these questions.

15. **Investigating accretion disk - radio jet coupling across the stellar mass scale**

James Miller-Jones[1], Greg Sivakoff[2], Diego Altamirano[3], Elmar Körding[4], Hans Krimm[5], Dipankar Maitra[6], Ron Remillard[7], Dave Russell[3], Valeriu Tudose[8], Vivek Dhawan[9], Rob Fender[10], Sebastian Heinz[11], Sera Markoff[3], Simone Migliari[12], Michael Rupen[9], Craig Sarazin[2]
[1]*Curtin Institute of Radio Astronomy, Australia.*
[2]*Department of Astronomy, University of Virginia, USA.*
[3]*Astronomical Institute 'Anton Pannekoek', University of Amsterdam, the Netherlands.*
[4]*Université Paris Diderot and Service d'Astrophysique, UMR AIM, CEA Saclay, France.*
[5]*NASA/Goddard Space Flight Center, USA.*
[6]*Department of Astronomy, University of Michigan, USA.*
[7]*MIT Kavli Institute for Astrophysics and Space Research, USA.*
[8]*Netherlands Institute for Radio Astronomy, the Netherlands.*

[9]*NRAO Domenici Science Operations Center, USA.*
[10]*School of Physics and Astronomy, University of Southampton, UK.*
[11]*Astronomy Department, University of Wisconsin-Madison, USA.*
[12]*European Space Astronomy Centre, Spain.*

Relationships between the X-ray and radio behavior of black hole X-ray binaries during outbursts have established a fundamental coupling between the accretion disks and radio jets in these systems. I will begin by reviewing the prevailing paradigm for this disk-jet coupling, also highlighting what we know about similarities and differences with neutron star and white dwarf binaries. Until recently, this paradigm had not been directly tested with dedicated high-angular resolution radio imaging over entire outbursts. Moreover, such high-resolution monitoring campaigns had not previously targetted outbursts in which the compact object was either a neutron star or a white dwarf. To address this issue, we have embarked on the Jet Acceleration and Collimation Probe Of Transient X-Ray Binaries (JACPOT XRB) project, which aims to use high angular resolution observations to compare disk-jet coupling across the stellar mass scale, with the goal of probing the importance of the depth of the gravitational potential well, the stellar surface and stellar magnetic field, on jet formation. Our team has recently concluded its first monitoring series, including (E)VLA, VLBA, X-ray, optical, and near-infrared observations of entire outbursts of the black hole candidate H1743-322, the neutron star system Aquila X-1, and the white dwarf system SS Cyg. I will present preliminary results from this work, largely confirming the current paradigm, but highlighting some intriguing new behavior, suggesting a possible difference in the jet formation process between neutron star and black hole systems, and potentially hinting at an additional role from the ergosphere.

16. **The jet/accretion disk coupling**

Felix Mirabel[1,2]
[1]*Conicet, Argentina.*
[2]*CEA, France.*

(Abstract not available.)

17. **GRBs: recent theoretical progress**

Tsvi Piran
Racah Institute of Physics, The Hebrew University, Jerusalem, Israel.

Jets constitute a key feature in all models of Gamma-Ray Bursts (GRBs). As transient jets they are different from most observed jets seen in other systems that are quasi stationary. While jets cannot be observed directly their predicted unique signature, an achromatic break in the light curve accompanied by a complicated pattern in the radio, has been observed many times. I review different models of GRB jets. I summarize our understanding of jets and their signatures and compare various aspects of the theory with observations.

18. **Accretion disk winds**

Daniel Proga
Department of Physics and Astronomy, University of Nevada, USA.

Thermal expansion, magnetic fields, and radiation pressure have been suggested as mechanisms that can drive outflows from stars and from disks. These three outflow mechanisms have been studied extensively using analytic as well as numerical methods. In most previous studies however, the focus was on only one of the mechanisms and the other were neglected. I will briefly review these studies. Then I will present results from disk wind simulations where both radiation and magnetic forces are included. I finish with a few remarks on possible connections between disk winds and jets.

19. **Radio observations of jets from massive young stars**

Luis F. Rodríguez
Centro de Radioastronomía y Astrofísica, UNAM, México.

The formation of low mass stars takes place with the assistance of an accretion disk that transports gas and dust from the envelope of the system to the star, and a jet that removes angular momentum and allows accretion to proceed. In the radio, these ionized jets can be studied very close to the star via the thermal (free-free) emission they produce and at larger scales by the molecular outflows that result from their interaction with the surrounding medium. Is the same disk-jet process responsible for the formation of massive stars? I will review recent evidence for the presence of collimated jets in association with forming massive stars and the search for the simultaneous presence of wide outflows in them. The jets in massive protostars have large velocities that could produce a synchrotron component and I discuss the evidence for the presence of this non-thermal process.

20. **Hadronic jet models today**

Marek Sikora
Copernicus Astronomical Center, Poland.

A matter content of relativistic jets in AGNs is dominated by a mixture of protons, electrons, and positrons. During dissipative events these particles tap a significant portion of internal and/or kinetic energy of the jet and convert it partially into the electromagnetic radiation. While leptons - even those with moderate relativistic energies - can do it very efficiently, protons need to be accelerated up to energies exceeding 10^{16-19} eV to produce such radiation via direct synchrotron emission and/or via pair cascades triggered by the photo-meson process. I review the constraints imposed on the role of these processes in shaping the high energy spectra of blazars. It will argue that protons, despite being efficiently accelerated and presumably playing dominant dynamical role in the dissipative processes and deposition of energy to electrons/positrons, are more likely to remain radiatively passive in AGN jets.

21. **Accreting X-ray binaries and jets**

R. A. Sunyaev[1,2]
[1]*MPI for Astrophysik, Germany.*
[2]*Space Research Institute, Russia.*

(Abstract not available.)

22. **Suzaku studies of microquasars**

Yoshihiro Ueda
Department of Astronomy, Kyoto University, Japan

We report our recent results from multiwavelengths studies of microquasars, particularly focusing on X-ray data of GRS 1915+105 and GX 339−4 obtained with Suzaku and other observatories. The broad band coverage and high energy resolution achieved with Suzaku (or by a combination of Chandra/HETGS and RXTE) enable us to perform the most reliable spectral analysis both on Fe-K features and continuum simultaneously, and thus to best constrain the accretion disk structure of microquasars at various mass accretion rates and its relation to the jet formation. Latest results from the Monitor of All-sky X-ray Image (MAXI) mission will be also presented.

23. **A magnetohydrodynamical model for the formation of episodic jets**

Feng Yuan[1], Jun Lin[2], Kinwah Wu[3], Luis Ho[4]
[1]*Shanghai Astronomical Observatory, Chinese Academy of Sciences, China.*
[2]*National Astronomical Observatories/Yunnan Observatory, Chinese Academy of Sciences, China.*
[3]*Mullard Space Science Laboratory, University College London, UK.*
[4]*The Observatories of the Carnegie Institution of Washington, USA.*

Episodic ejection of plasma blobs has been observed in many black hole systems. While steady, continuous jets are believed to be associated with large-scale open magnetic fields, what causes the episodic ejection of blobs remains unclear. Here by analogy with the coronal mass ejection on the Sun, we propose a magnetohydrodynamical model for episodic ejections from black holes associated with the closed magnetic fields in an accretion flow. Shear and turbulence of the accretion flow deform the field and result in the formation of a flux rope in the disc corona. Energy and helicity are accumulated and stored until a threshold is reached. The system then loses its equilibrium and the flux rope is thrust outward by the magnetic compression force in a catastrophic way. Our calculations show that for parameters appropriate for the black hole in our Galactic centre, the plasmoid can attain relativistic speeds in about 35 min.

Contributed talks

1. **Radiation from matter entrainment in astrophysical jets**

Anabella T. Araudo[1,2], Valentí Bosch-Ramon[3], Gustavo E. Romero[1,2]
[1]*Instituto Argentino de Radioastronomía (CONICET), Argentina.*
[2]*Facultad de Ciencias Astronómicas y Geofísicas, Universidad Nacional de La Plata, Argentina.*
[3]*Max Planck Institut für Kernphysik, Germany.*

Jets at different scales are found in a variety of astrophysical sources, from young stellar objects to active galactic nuclei (AGN). In all the cases the jet propagates with a supersonic velocity through the external medium, which can be inhomogeneous, and inhomogeneities could penetrate into the jet. The interaction of the jet material with an obstacle produces a bow shock in the jet in which particles can be accelerated up to relativistic energies and emit high-energy photons. In this work, we explore the generic scenario of medium clumps entering into the jet, focusing on the dynamical and radiative consequences of the interaction at different jet heights. We compute the emission produced by one interaction, and also for the case when many clumps interact with the jet. We illustrate this with the application of the model to high-mass microquasars and AGNs. In both scenarios, we find that the produced high-energy emission could be detectable by the current γ-ray telescopes. In general, the jet-clump interactions are a possible mechanism to produce (steady or flaring) high-energy emission in many astrophysical sources in which jets are present.

2. **The far-infrared view of the radio galaxy M 87 as seen by the Herschel Space Observatory**

Maarten Baes[1] and the HeViCS consortium[2]
[1]*Sterrenkundig Observatorium, Universiteit Gent, Belgium.*
[2]*Herschel Virgo Cluster Survey consortium,* `http://www.hevics.org`

The origin of the far-infrared emission from the nearby radio galaxy M 87 remains a matter of debate. Some studies find evidence of a far-infrared excess due to thermal dust emission, whereas others propose that the far-infrared emission can be explained by synchrotron emission without the need for an additional dust emission component. We observed M 87 with the PACS and SPIRE instruments onboard the Herschel Space Observatory and present new far-infrared maps at wavelengths between 100 and 500 μm. M 87 is clearly detected and spatially resolved at all wavelengths. We compare the new Herschel data with a synchrotron model based on ISOCAM, IRAS, Spitzer, SCUBA, GBT, WMAP and VLA data to investigate the origin of the far-infrared emission. We find that both the integrated SED and the Herschel surface brightness maps are adequately explained by synchrotron emission. At odds with previous claims, we find no evidence of a diffuse dust component in M 87, which is not unexpected in the harsh X-ray environment of this radio galaxy sitting at the core of the Virgo Cluster.

3. **GRS 1915+105 celebrates its majority (1992-2010)**

Alberto J. Castro-Tirado
Instituto de Astrofísica de Andalucía (IAA-CSIC), Spain.

GRS 1915+105 is the prototypical microquasar, a small group of low-mass X-ray binaries (LMXBs) which show sporadic ejection of matter at apparently superluminal velocities. In these binaries of stellar-mass, the three basic ingredients of quasars are found: a black hole, an accretion disc heated by viscous disspation, and collimated jets of high energy particles. But in microquasars the black hole is only a few solar masses instead of several milion of solar masses; the accretion disc has mean thermal temperatures of several milion degrees instead of several thousand degrees, and the particles ejected at relativistic speeds can travel up to distances of a few light years only, instead of several milion light years as in radio galaxies. I will review how our understanding of the underlying physics in this particular system has improved over the last 18 years, since the discovery of this puzzling source on 15 Aug 1992.

4. **Radiatively efficient accreting black holes in the hard state: the case study H 1743−322**

Mickael Coriat[1,2], L. Prat,[1,2] S. Corbel,[1,2] J. C. A. Miller-Jones,[3], D. Cseh[1,2], A. K. Tzioumis[4], C. Brocksopp[5], R. P. Fender[6], J. Rodriguez[1,2], G. R. Sivakoff[7]
[1]*Université Paris Diderot, France.*
[2]*Service d'Astrophysique, CEA Saclay, France.*
[3]*NRAO Headquarters, USA.*
[4]*Australia Telescope National Facility, Australia.*
[5]*Mullard Space Science Laboratory, University College London, UK.*
[6]*School of Physics and Astronomy, University of Southampton, UK.*
[7]*Department of Astronomy, University of Virgina, USA.*

In recent years, numerous efforts have been devoted to unravel the connection between accretion flow and jets in accreting compact objects. From the empirical relations discovered by comparing the simultaneous evolution of their emissions at all wavelengths, several hypotheses have been formulated on the nature of the accretion flow, the jet physics and the emission processes that dominate in these systems. Here I will report new constraints on these issues, through the long term study of the radio and X-ray behaviour of the Black Hole Candidate H1743−322. This source is known to be one of the "outliers" of the universal radio/X-ray correlation i.e. a group of stellar mass accreting black holes displaying fainter radio emission for a given X-ray luminosity, than expected from the correlation. In this work we find, at high X-ray luminosity in the hard state, a tight radio/X-ray correlation with an unusual steep slope of $b = 1.38 \pm 0.03$. This correlation then breaks below $\sim 5 \times 10^{-3} L_{\rm Edd}\,(M/10M_{\odot})^{-1}$ in X-ray and becomes shallower. When compared with radio/X-ray data from other Black Hole X-ray Binaries, we see that the deviant points of H1743−322 join the universal correlation and seem to follow it at low luminosity. Based on these results, I will present several hypotheses that could explain both the $b \sim 1.4$ slope and the transition toward the universal correlation. I will first show that if the standard relation, $L_{\rm radio} \propto \dot{M}^{1.4}$, between the jet radio emission and the accretion rate is valid, then our results require a radiatively efficient accretion flow

that dominate the X-ray emission in the hard state at high accretion rate. In addition, below a critical accretion rate, the flow has to become radiatively inefficient to account for the transition. I will finally investigate the possibility that our results arise from the outflow properties of the source rather than from the accretion flow. I will highlight in particular that, if we relax the assumption that the jet power is a fixed fraction of the accretion power and we consider this fraction linearly dependent on the accretion rate, we can obtain the required correlation with an inefficient accretion flow.

5. **On the three-dimensional structure of HH jets**

Fabio De Colle
Astronomy & Astrophysics Department, University of California, USA.

The physical parameters of Herbig-Haro jets are usually determined from emission line ratios, obtained from spectroscopy or narrow band imaging, assuming that the emitting region is homogeneous along the line of sight. Under the more general hypothesis of axisymmetry, we have applied tomographic reconstruction techniques to the analysis of Herbig-Haro jets. We use public data of the HH30 jet taken with the Hubble space telescope. Using a non-parametric Tikhonov regularization technique, we determine the volumetric emission line intensities of the [SII]$\lambda\lambda$6716,6731, [OI]λ6300 and [NII]λ6583 forbidden emission lines. From our tomographic analysis of the corresponding line ratios, we produce three-dimensional images of the physical parameters. The reconstructed density, temperature and ionization fraction present much steeper profiles than those inferred using the assumption of homogeneity. Our technique reveals that the reconstructed jet is much more collimated than the observed one close to the source (a width $\sim 5\,$AU vs. $\sim 20\,$AU at a distance of 10 AU from the star), while they have similar widths at larger distances. In addition, our results show a much more fragmented and irregu- lar jet structure than the classical analysis, suggesting that the the ejection history of the jet from the star-disk system has a shorter timescale component ($\sim$ some months) superimposed on a longer, previously observed timescale (of a few years). We also compare the results of the inversion technique with three-dimensional simulations of variable jets, constraining the jet mass flux and the ejection properties of the outflow.

6. **Particle acceleration and heating by magnetic reconnection in accretion disk/jet systems: numerical simulations**

Elisabete M. de Gouveia Dal Pino[1], Luiz H. S. Kadowaki[1], Grzegorz Kowal[1], Alex Lazarian[2]
[1]*Instituto de Astronomia, Geofísica e Ciências Atmosféricas, Universidade de São Paulo, Brazil.*
[2]*Dept. of Astronomy, University of Wisconsin - Madison, USA.*

In recent work we demonstrated that magnetic reconnection can have an important role on the heating and particle acceleration in jet/accretion disk systems, namely microquasars, active galactic nuclei (AGNs), and young stellar objects (YSOs). In the case of relativistic jets, violent reconnection events may heat the coronal/disk gas and accelerate the plasma to relativistic velocities through a diffusive first-order Fermi-like

process within the reconnection site which can produce relativistic ejections or plasmons. The resulting power-law electron distribution is compatible with the synchrotron radio spectrum observed during the outbursts of these sources. We have built a diagram of the magnetic energy rate released by violent reconnection as a function of the black hole (BH) mass spanning 10^9 orders of magnitude that shows that the estimated magnetic reconnection power is sufficient to explain the observed radio luminosities of the outbursts, from microquasars to low luminous AGNs. In this talk, we will show the results of numerical simulations that indicate that this acceleration mechanism within reconnection sheets can be very efficient.
In addition, the magnetic reconnection events cause the heating of the coronal gas which can be conducted back to the disk to enhance its thermal soft x-ray emission as observed during outbursts in microquasars. The decay of the hard x-ray emission after a radio flare could also be explained in this model due to the escape of relativistic electrons (which are believed to be responsible for the hard x-ray by inverse Compton scattering of soft x-rays) with the evolving jet outburst.
In the case of YSOs, a similar magnetic reconnection model could produce the observed x-ray flares and help heating the jet launching basis as observed in some sources.

7. **Origin of jets from young stars: high-angular resolution observations**

C. Dougados[1], V. Agra-Amboage[1], E. Whelan[1], S. Cabrit[2]
[1]*Laboratoire d'Astrophysique de Grenoble,CNRS/Université Joseph Fourier, France.*
[2]*LERMA, UMR 8112 du CNRS, Observatoire de Paris, France.*

Supersonic jets are one of the most spectacular manifestation of the formation of a young star. Jets are observed at all phases of stellar formation where active accretion occurs. Although their connection with magnetic processes is now well established, the exact origin of jets is still a major open issue in star formation. In addition to injecting mechanical energy at large scales, jets may play a crucial role in the regulation of the angular momentum and the final mass of the forming protostar. Moreover, jets from young stars, because of their proximity and the wealth of diagnostics offered by their rich emission line spectrum, offer a unique opportunity to investigate the accretion/ejection connection in general.
T Tauri stars are optically revealed pre-main sequence stars with ages of $\simeq 10^6$ yr that have already emerged from their native environment. They are however still actively accreting matter from circumstellar discs and driving small-scale jets. Although less powerful than the HH flows driven by the younger embedded protostars, T Tauri jets give direct observational access to the innermost collimation and acceleration regions ($z \leq 100$ AU).
I will present in this contribution constraints on jet launching models derived from high angular resolution observations of the inner regions of T Tauri jets on scales from 10 to 100 AUs. I will discuss in particular near-infrared spectro-imaging observations with SINFONI/VLT and OSIRIS/Keck which bring new insight into the mass-loss process in young stars. I will also discuss near-infrared interferometric programs aimed at directly probing the jet launching regions on AU scales.

8. **Variability studies in blazar jets with SF analysis: caveats and problems**
Dimitrios Emmanoulopoulos, Ian M. Hardy, Phil Uttley
School of Physics & Astronomy, University of Southampton, United Kingdom

Blazars are radio-loud active galactic nuclei (AGN) dominated by relativistic jets seen at small angles to the line of sight. They exhibit dramatic flux variations across the electromagnetic spectrum. The fastest variations are observed in the X-ray and γ-ray bands on time-scales of hours or even minutes. Currently a substantial part of the blazar literature has been based on the study of these temporal variations through the use of structure function (SF) analyses, the results of which are believed to put great constrains on the jet physics.
The SF is often invoked in the framework of shot-noise models to determine the temporal properties of individual shots within the jet as well as their geometrical sizes. We argue that for blazar variability studies the SF results are sometimes erroneously interpreted leading to misconceptions about the actual source properties. Based on extensive simulations we caution that spurious breaks will appear in the SFs of almost all light curves, even though these light curves may contain no intrinsic characteristic time-scale.
Finally, it is also commonly thought that SFs are immune to the sampling problems, such as data gaps, which affects the estimators of the underlying power spectra density function such as the periodogram. However, we show that SFs are also troubled by gaps which can induce artefacts.

9. **X-ray radiation of the jets and the supercritical accretion disk in SS 433**
Sergei Fabrika[1], Alexei Medvedev[2]
[1]*Special Astrophysical Observatory, Russia.*
[2]*Moscow State University, Russia.*

Observed X-ray luminosity of S 433 is $\sim 10^{36}$ erg/s, it is known that all the radiation is formed in the famous SS 433 jets. The bolometric luminosity of SS 433 is $\sim 10^{40}$ erg/s, and originally the luminosity must be realized in X-rays. The original radiation is probably thermalized in the supercritical accretion disk wind, however the missing of more than four orders of magnitude is surprising. We have analysed the XMM-Newton spectra of SS 433 using a model of adiabatically and radiatively cooling X-ray jets. The multi-temperature thermal jet model reproduces very well the strongest observed emission lines, but it can not reproduce the continuum radiation and some spectral features. We have found a notable contribution of ionized reflection to the spectrum in the energy range from ~ 3 to 12 keV. The reflected spectrum is an evidence of the supercritical disk funnel, where the illuminating radiation comes from deeper funnel regions, to be further reflected in the outer visible funnel walls ($r \geq 2 \cdot 10^{11}$ cm). The illuminating spectrum is similar to that observed in ULXs, its luminosity has to be no less than $\sim 10^{39}$ erg/s. A soft excess has been detected, that does not depend on the thermal jet model details. It may be represented as a BB ($T_{\rm bb} \approx 0.1$ keV and $L_{\rm bb} \sim 3 \cdot 10^{37}$ erg/s). The soft spectral component has about the same parameters as those found in ULXs.

10. **Jet launching and field advection in discs**

Jonathan Ferreira
Laboratoire d'Astrophysique de Grenoble, France.

Large scale magnetic fields are the fundamental key ingredient for both jet collimation and production. However, their presence is still a mystery: are they generated by a dynamo or simply advected? In a first part of this talk the physics of jet launching discs will be reviewed. It will be shown that the only available solutions of powerful jets require fields close to (but smaller than) equipartition. All these solutions rely on a crude phenomenological local description of turbulence (alpha prescription). However, despite this caveat, they seem to be consistent with several observational evidences derived from Young Stellar Objects, such as mass loss rates and jet kinematics (Ferreira et al 06b). In a second part, the interplay between turbulent diffusion and advection will be addressed by 2.5D simulations done with the MHD code PLUTO. Such a problem was analytically tackled by Lubow et al (94) and more recently by Rothstein & Lovelace (08). It will be shown that advection can indeed occur above a threshold on the disc magnetization. Our results shed a new light on the long term evolution of accretion discs, with a strong emphasis on the magnetic history of any particular object. This has potentially strong implications on the hysteresis cycles observed in black hole X ray binaries (Ferreira et al 06a, Petrucci et al 08).

11. **Time-dependent multi-zone radiation transfer modeling of fast blazar variability**

Giovanni Fossati, Xuhui Chen
Physics and Astronomy Department, Rice University, USA.

We present the first applications of a new time-dependent multi-zone jet radiation transfer code to the study the multiwavelength emission of the TeV Blazar Mrk 421. The code couples Fokker-Planck and Monte Carlo methods. For the first time all light travel time effects are fully considered, internal and external, as well as proper self-consistent treatment of Compton cooling, which depends on them. With this code we can play with (inhomogeneous and varying) physical conditions, internal and external to the active region, and simulate a broad range of scenarios for blazar variability.

Our first tests focus on the March 2001 observations of Mrk 421, still one of the best datasets available, for phenomenology and X-ray/TeV data coverage. We present several model cases based on a reasonable picture whereby a blob in the jet encounters a shock, studying scenarios characterized by different combinations of electron injection and acceleration "prescriptions", physical parameters (e.g. magnetic field) and active region geometry, with or without the addition of a pre-existing cospatial electron population contributing to the SED.

We are able to appreciate fully the impact of the spatial extent of the source both for internal effects and with respect to the observer's point of view, and we find that the predicted variability sometimes challenges the immediate intuition.

While it seems to be possible to fit adequately a set of observed SEDs, a closer analysis shows that there remain several open issues. The principal challenges remain: i) a systematic soft X-ray intraband lag. It seems to be very difficult to produce hard lags,

which have been observed in several cases, corroborated by spectral variations. ii) A delay of the gamma-ray flare with respect to the X-ray flare. iii) The simulated VHE spectrum is always softer than the observed one. iv) The correlation between the TeV gamma-ray and X-ray does not reproduce the (super)quadratic relationship observed in multiple occasions.
Clearly our first suite of models does not capture some of the crucial features of the flaring region/event in a blazar jet. We are exploring more complex scenarios with a higher degree of inhomogeneity (for instance much more localized energy "injection"). However, thanks to the uniqueness of the code we can for the first time begin to get robust insight on the geometry of the active region and on the relationships between all the physically relevant and geometry-related timescales.

12. **Gamma Ray Bursts spectral-energy correlations: facts and misconceptions**
G. Ghirlanda
INAF - Osservatorio Astronomico di Brera, Italy.

I will review the current status of the observational evidences of the spectral-energy correlations in GRBs given their twofold relevance for (i) the possible insights into the physics of the prompt emission and (ii) their use as cosmological probes. I will discuss some issues on these topics. I will present the recent study of the spectra of long Gamma Ray Bursts (GRBs) of known redshift detected by the Fermi satellite. Their fluxes and fluences are large enough to allow a time dependent study of their spectral characteristics in the 8 keV - 1 MeV energy range. We find that the peak energy Ep of their EL(E) spectrum correlates with the luminosity in a remarkable tight way within individual bursts. Our results indicate the presence of a similar physical mechanism, operating for the duration of different GRBs, linking tightly the burst luminosity with the peak energy of the spectrum emitted at different times. These results, while calling for a robust physical interpretation, strongly indicate that the Ep-Liso spectral energy correlation found considering the time integrated spectra of different bursts is real, and not the result of instrumental selection effects.

13. **The jet in M 87 from EVN observations**
Gabriele Giovannini, Marcello Giroletti
Istituto di Radioastronomia, Bologna, Italy.

One of the most intriguing open questions of today's astrophysics is the location and the mechanisms for the production of MeV, GeV, and TeV gamma-rays in AGN jets.
M 87 is a privileged laboratory for a detailed study of the properties of jets, owing to its proximity ($D = 16$ Mpc, 1 mas = 0.077 pc), its massive black hole (6×10^9 solar masses, corresponding to a scale of 1 mas = $280\,R_S$), and its conspicuous emission at radio wavelengths and above. MAGIC reported a detection of a flare at energy $E > 100$ GeV on Feb 10 (ATel#2341). We started on November 2009 a monitoring program with the e-EVN at 5 GHz. I will present here results of these multi-epoch observations. The inner jet and HST-1 are both detected and resolved in our datasets. One of these observations was obtained at the same day of the high energy flare. At present no flux density or

structure variabily has been found, however we note that the apparent velocity of HST-1 is increasing starting from 2005, and now the measured apparent velocity is 2.1c. I will discuss radio data and the correlation with high energy results.

14. **The picture of relativistic jet from Fermi-LAT and multi-band observations of blazar 3C 279**

Masaaki Hayashida (for the *Fermi*-LAT collaboration and members of 3C 279 multi-band campaign)
KIPAC/SLAC, Stanford, U.S.A.

Strong and variable radiation detected over all accessible energy bands in blazar arises from a relativistic, Doppler-boosted jet pointing close to our line of sight. Flat Spectrum Radio Quasar 3C 279 was one of the brightest γ-ray blazars in the sky at the time of the discovery with EGRET. Since the successful launch of the *Fermi* Gamma-ray Space telescope in 2008, we have organized extensive multi-band observational campaign of 3C 279 from radio to γ-ray bands, also including optical polarimetric observations. The uninterrupted monitoring in the γ-ray band by *Fermi*-LAT together with the multi-band data provide us with new insights of the relativistic jet of blazar. Here, we present the results of the multi-band campaign of 3C 279 for 2 years including the discovery of a γ-ray flare event associated with a dramatic change of the optical polarization - as well as a discovery of an "orphan" X-ray flare, unassociated with prominent outbursts in other bands. Based on those results, the implication on the structure of relativistic jets and broad-band emission models of radiation from the jet are discussed.

15. **Modelling magnetically dominated and radiatively cooling jets**

Martín Huarte-Espinosa[1,2,3], Adam Frank[1], Eric Blackman[1]
[1]*Department of Physics and Astronomy, University of Rochester, USA.*
[2]*Astrophysics Group, Cavendish Laboratory, UK.*
[3]*Kavli Institute for Cosmology Cambridge, UK.*

We will talk about recent 3DMHD Eulerian-grid numerical simulations of magnetically dominated and radiatively cooling jets. These magnetic towers are build up by the local injection of magnetic energy. Their propagation, structure, stability and emission will be discussed as a function of the rates of magnetic energy injection and cooling, and the details of the ambient thermal pressure too. Laboratory experiments suggest that variability in astrophysical jets may be caused by episodic magnetic towers. This idea will be explored with the simulations. Moreover, differences between magnetic towers and MHD centrifugally launched jets will be discussed.

16. **Instabilities in the Gamma Ray Burst central engine. What makes the jet variable?**

Agnieszka Janiuk[1], Ye-Fei Yuan[2], Rosalba Perna[3], Tiziana Di Matteo[4]
[1]*N. Copernicus Astronomical Center, Poland.*
[2]*Department of Astronomy, University of Science and Technology of China, Chinese Academy of Sciences, P.R. China.*
[3]*JILA and Department of Astrophysical and Planetary Sciences, University of Colorado, USA.*
[4]*Physics Department, Carnegie Mellon University, USA.*

Both types of long and short gamma ray bursts involve a stage of a hyper-Eddington accretion of hot and dense plasma torus onto a newly born black hole. The prompt gamma ray emission originates in jets at some distance from this 'central engine' and in most events is rapidly variable, having a form of sipkes and subpulses. This indicates at the variable nature of the engine itself, for which a plausible mechanism is an internal instability in the accreting flow. We solve numerically the structure and evolution of the neutrino-cooled torus. We take into account the detailed treatment of the microphysics in the nuclear equation of state that includes the neutrino trapping effect. The models are calculated for both Schwarzschild and Kerr black holes. We find that for sufficiently large accretion rates ($\gtrsim 10\,M_\odot$ s^{-1} for non-rotating black hole, and $\gtrsim 1M_\odot$ s^{-1} for rotating black hole, depending on its spin), the inner regions of the disk become opaque, while the helium nuclei are being photodissociated. The sudden change of pressure in this region leads the the development of a viscous and thermal instability, and the neutrino pressure acts similarly to the radiation pressure in sub-Eddingtoin disks. In the case of rapidly rotating black holes, the instability is enhanced and appears for much lower accretion rates. We also find the important and possibly further destabilizing role of the energy transfer from the rotating black hole to the torus via the magnetic coupling.

17. **Connections between jet formation and multiwavelength spectral evolution in black hole transients**

Emrah Kalemci[1], John A. Tomsick[2], Stephane Corbel[3], Philip Kaaret[4], Michelle Buxton[5], Tolga Dinçer[1], Yoon-Young Chun[1]
[1]*Sabanci University, Turkey.*
[2]*Space Sciences Laboratory, University of California, USA.*
[3]*Laboratoire Astrophysique des Interactions Multi-echelles Universite Paris Diderot, France.*
[4]*Department of Astronomy, Yale University, USA.*
[5]*Department of Physics and Astronomy, University of Iowa, USA.*

Multiwavelength observations are the key to understand conditions of jet formation in Galactic black hole transient systems. By studying radio and optical-infrared evolution of such systems during outburst decays, the compact jet formation can be traced. Comparing this with X-ray evolution we can obtain physical and geometrical conditions for jet formation, and study the contribution of jets to X-ray emission. In this presentation, first X-ray evolution - jet relation for XTE J1752-223 will be discussed. This source

had very good coverage in X-rays, optical, infrared and radio. A long exposure with INTEGRAL also allowed us to constrain the electron energy distribution after jet turns on. Then, deep hard state observations of GX 339-4 in the hard state with SUZAKU will be shown. The fits to iron line fluorescence emission shows that the inner disk radius increases by a factor of > 27 with respect to radii in bright states. This result, along with other disk radius measurements in the hard state will be discussed within the context of conditions for jet formation.

18. **Waves in Poynting-flux dominated jets**

John G. Kirk
Max-Planck-Institut für Kernphysik, Germany.

Energy extracted from a rotating black hole by the Blandford-Znajek mechanism is initially carried as Poynting flux in a force-free plasma, which expands to become a relativistic, supersonic, magnetised flow. When steady, such a flow can be collimated as it passes through shocks fronts. However, if rapid fluctuations are embedded in it, these can be reflected at the shocks and disrupt the upstream flow. In this contribution, the properties of nonlinear reflected waves are analysed, and the location at which disruption occurs is estimated and related to observations of rapidly varying emission in sub-parsec-scale jets.

19. **The disk/jet connection in the enigmatic microquasar Cygnus X-3**

Karri I. I. Koljonen[1], Diana C. Hannikainen[1], Michael L. McCollough[2], Guy G. Pooley[3], Sergei A. Trushkin[4], Marco Tavani[5], Robert Droulans[6]
[1]*Aalto University Metsähovi Radio Observatory, Finland.*
[2]*Smithsonian Astrophysical Observatory, USA.*
[3]*Astrophysics Group, Cavendish Laboratory, UK.*
[4]*Special Astrophysical Observarory RAS, Karachaevo-Cherkassian res, Russia.*
[5]*INAF-IASF, Italy.*
[6]*CESR/CNRS – Université de Toulouse, France.*

Simultaneous multiwavelength observations are crucial for understanding the physics of microquasars, especially the accretion disk/jet connection. The enigmatic microquasar Cygnus X-3 exhibits strong, up to 20 Jy in the radio, relativistic jet ejection events which are preceded by a very soft X-ray state with quenched emission in the radio and hard X-ray bands. Recently, during this hypersoft state, GeV flux was observed by the AGILE and Fermi γ-ray observatories. By using an extensive database of simultaneous multiwavelength observations gathered from Cygnus X-3 we can form a more unified picture of the source nature and show how the recent γ-ray observations fit into it.

20. **The role of jets in black-hole X-ray binaries**

Nick Kylafis
University of Crete and FORTH, Greece.

Black-hole X-ray binaries in the so-called low/hard spectral state exhibit many constraining observational characteristics (not all of them in the same source). These are:

(a) A characteristic energy spectrum for all of its components from radio to hard X-rays.
(b) A so-called reflection bump in the X-ray spectrum.
(c) A time-lag of the hard X-rays with respect to the soft ones. This time-lag is roughly inversely proportional to Fourier frequency.
(d) A time-lag of the infrared radiation with respect to the hard X-rays.
(e) Large rms variability.
(f) A correlation between radio and X-rays (both spectral index and total flux).
(g) A correlation between the X-ray spectral index and the average time-lag of the hard with respect to the soft X-rays.
(h) A correlation between the X-ray spectral index and the characteristic frequencies of variability.
(i) A narrowing of the autocorrelation function with increasing X-ray energy.

Since these characteristics appear when a radio jet is present in the source and not otherwise, it is quite likely that the jet is responsible for them. Using a single and simple jet model, I will demonstrate that all of the above characteristics can be naturally explained.

21. **Transformation of the electromagnetic into the plasma energy in Poynting dominated jets**

Yuri Lyubarsky
Physics Department, Ben-Gurion University, Israel.

It is widely agreed that the driving mechanism of relativistic jets is related to magnetic fields. The basic idea is that a strong magnetic field threading the rotating central object serves to convert the rotational energy into the outward directed Poynting flux. Due to low baryon contamination, the magnetically driven outflows could even be accelerated to relativistic velocities. In my talk, I am going to concentrate on the physical mechanisms responsible for the transformation of the Poynting flux into the plasma energy. I discuss and compare both gradual acceleration by magnetic stresses and dissipation via the reconnection processes. I will talk on the intimate connection between the collimation and acceleration as well as the on the role of the confining medium in collimating the outflow. These results strongly suggest that some sort of magnetic dissipation is necessary in order to utilize completely the electromagnetic energy. I examine instabilities that are able to trigger the magnetic reconnection and present a scenario for an efficient transformation of the electromagnetic into the plasma energy due to the Rayleigh-Taylor instability of current sheets within the jet.

22. **Jets at lowest mass accretion rates**

Dipankar Maitra[1], Andrew Cantrell[2], Sera Markoff[3], Jon Miller[1], Heino Falcke[4,5], Charles Bailyn[2]
[1]*Dept. of Astronomy, University of Michigan, USA.*
[2]*Dept. of Astronomy, Yale University, USA.*
[3]*Astronomical Institute "Anton Pannekoek", University of Amsterdam, The Netherlands.*
[4]*Dept. of Astronomy, Radboud University, The Netherlands.*
[5]*ASTRON, The Netherlands.*

I will present results of recent observations and theoretical modeling of data from black holes accreting at very low luminosities ($L/L_{\rm Edd} \lesssim 10^{-6}$). I will discuss our newly developed time-dependent model for episodic ejection of relativistic plasma within a jet framework, and a successful application of this model to describe the origin of radio flares seen in Sgr A*, the Galactic center black hole. Both the observed time lags and size-frequency relationships are reproduced well by the model. I will also present new results from our ongoing project to model the broadband spectral energy distributions of a sample of low-luminosity Seyfert-1 AGNs with $L/L_{\rm Edd} < 0.2$, in an effort to constrain disk–jet coupling in these systems. I will also discuss results from new Spitzer data of the stellar black hole X-ray binary system $A0620-00$. Complemented by long term SMARTS monitoring, these observations indicate that once the contribution from the accretion disk and the stellar contributions are properly accounted for, the residual mid-IR spectral energy distribution of $A0620-00$ is quite flat and consistent with a non-thermal origin. The results above suggest that a significant fraction of the observed spectral energy distribution originating near black holes accreting at low luminosities could result from a mildly relativistic outflow. The fact that these outflows are seen in both stellar-mass black holes as well as in supermassive black holes at the heart of AGNs strengthens our expectation that accretion and jet physics scales with mass.

23. **Fitting along the Fundamental Plane: New comparisons of jet physics across the black hole mass scale**

Sera Markoff[1], Michael A. Nowak[2], Dipankar Maitra[3], Jörn Wilms[4], Asaf Pe'er[5]
[1]*Astronomical Institute "Anton Pannekoek", University of Amsterdam, the Netherlands.*
[2]*Kavli Institute for Astrophysics and Space Research, USA.*
[3]*Department of Astronomy, University of Michigan, USA.*
[4]*Dr. Karl Remeis-Observatory & ECAP, University of Erlangen-Nuremberg, Germany.*
[5]*Space Telescope Science Institute, USA.*

Correlations between the radio and X-ray bands in the hard state of black hole X-ray binaries (BHBs) have led to the discovery of the Fundamental Plane of black hole accretion, linking accretion-driven radiative attributes to black hole mass. Although this discovery has led to new constraints on radiative efficiencies, there is still significant degeneracy in terms of understanding the governing physics. I present several new results exploring the processes driving the Fundamental Plane over the black hole mass range. These include the first ever homogeneous fits of sources at approximately the same Eddington luminosity but millions of times different in mass. Further I will discuss new constraints on pair and gamma-ray production relevant for outflow-dominated models of hard state BHBs, and time allowing also some results for neutron star X-ray binaries.

24. **Unveiling the nature of extragalactic jets with Chandra observations**

F. Massaro[1], C. C. Cheung[2], D. E. Harris[1]
[1]*Smithsonian Astrophysical Observatory, USA.*
[2]*NRL/NRC, USA.*

In 1974 Fanaroff & Riley divided the extended radio sources into two structural classes, on the basis of their radio morphology and power. For several years we have been collecting basic parameters for extragalactic jets in quasars and radio galaxies looking for an extension of the classification criterion, based on their X-rays and radio properties. The fact that different processes have been proposed to describe their X-ray radiation, (synchrotron vs inverse Compton emission) appeared as a good indication of a new classification scheme. However, comparing the radio-to-X-ray properties of the extragalactic jets, several aspects on their nature became unexpectedly unclear and will be discussed.

25. **Afterglow light curves from magnetized GRB flows**

Petar Mimica
Departamento de Astronomia y Astrofísica, Universidad de Valencia, Spain.

Using the RMHD code *MRGENESIS* and the radiative transfer code *SPEV* we compute multiwavelength afterglow light curves of magnetized ejecta of gamma-ray bursts interacting with a uniform circumburst medium. We are interested in the emission from the reverse shock when ejecta magnetization varies from $\sigma_0 = 0$ to $\sigma_0 = 1$. For typical parameters of the ejecta, the emission from the reverse shock peaks for magnetization $\sigma_0 \sim 0.01 - 0.1$, and is suppressed for higher σ_0. We fit the early afterglow light curves of GRB 990123 and 090102 and discuss the possible magnetization of the outflows of these bursts. Finally we discuss the amount energy left in the magnetic field which is available for dissipation at later afterglow stages.

26. **The physics of disk winds, jets, and X-ray variability in GRS 1915+105**

Joseph Neilsen[1,2], Julia C. Lee[1,2], Ron Remillard[3]
[1]*Harvard University Department of Astronomy, USA.*
[2]*Harvard-Smithsonian Center for Astrophysics, USA.*
[3]*MIT Kavli Institute for Astrophysics and Space Research, USA.*

We present new insights about accretion and ejection physics based on joint *RXTE*/ *Chandra* HETGS studies of rapid X-ray variability in GRS 1915+105. For the first time, with fast phase-resolved spectroscopy of the ρ state, we are able to show that changes in the broadband X-ray spectrum (*RXTE*) on timescales of seconds are associated with measurable changes in absorption lines (*Chandra* HETGS) from the accretion disk wind. Additionally, we make a direct detection of material evaporating from the radiation-pressure-dominated inner disk. Our X-ray data thus reveal the black hole as it ejects a portion of the inner accretion flow and then drives a wind from the outer disk, all in a bizarre cycle that repeats for days but lasts fewer than 60 seconds. We extend our discussion to the β state, which in our data appears to alternate between periods of jet formation and wind production on 15-minute timescales. Our results indicate that the accretion disk wind may play an integral role in GRS 1915+105, not only in quenching the jet on long and possibly short timescales, but also in producing or facilitating transitions between classes of X-ray variability.

27. **Simulation of relativistic shocks and associated radiation from turbulent magnetic fields**

K.-I. Nishikawa[1], J. Niemiec[2], M. Medvedev[3], B. Zhang[4], P. Hardee[5], Y. Mizuno[1], A. Nordlund[6], J. Frederiksen[6], H. Sol[7], M. Pohl[8], D. H. Hartmann[9], G. J. Fishman[10]
[1]*Center for Space Plasma and Aeronomic Research, Univ. Alabama in Huntsville, USA.*
[2]*Institute of Nuclear Physics PAN, Poland.*
[3]*Department of Physics and Astronomy, University of Kansas, USA.*
[4]*Department of Physics and Astronomy, University of Nevada, USA.*
[5]*Department of Physics and Astronomy, The University of Alabama, USA.*
[6]*Niels Bohr Institute, Denmark.*
[7]*LUTH, Observatore de Paris-Meudon, France.*
[8]*Institut für Physik und Astronomie, Universitaet Potsdam, Germany.*
[9]*Department of Physics and Astronomy, Clemson University, USA.*
[10]*NASA/MSFC, USA.*

Recent PIC simulations of relativistic electron- positron (electron- ion) jets injected into a stationary medium show that particle acceleration occurs at shocked regions. Simulations show that the Weibel instability is responsible for generating and amplifying highly nonuniform, small-scale magnetic fields and particle acceleration. These magnetic fields contribute to the electron's transverse deflection behind the shock. The "jitter" radiation from deflected electrons in turbulent magnetic fields has different properties than synchrotron radiation, which is calculated in a uniform magnetic field. This jitter radiation may be important for understanding the complex time evolution and/or spectral structure in gamma-ray bursts, relativistic jets in general, and supernova remnants. We will present detailed spectra for conditions relevant for various astrophysical sites of shock formation via the Weibel instability. In particular we will discuss the application to GRBs and SNRs.

28. **Long-term simulations of extragalactic jets: cavities and feedback**

Manel Perucho, Vicent Quilis, José María Martí
Departament d'Astronomia i Astrofísica, Universitat de València, Spain.

We present long-term numerical simulations of powerful extragalactic relativistic jets in two dimensions. The jets are injected at 1 kpc from the active nucleus, with leptonic composition and powers 10^{44}, 10^{45} and 10^{46} erg/s, during 50×10^6 years in the first two cases and 16×10^6 years in the latter. After this time, the jet injection is switched off. We follow the evolution of the jets and associated shocks from 1 kpc to several hundreds of kiloparsecs during several hundred million years, including a cooling function for bremmstrahlung radiation. Two more simulations were performed: the 10^{45} erg/s jet was simulated without cooling and changing the jet composition to baryonic. These simulations have been run with the code *Ratpenat* in supercomputers belonging to the Spanish Supercomputation Network (RES), with up to 128 processors. Our results show that, for powerful jets, the main heating mechanism is the driving shock-wave, which survives up to the end of the simulations at several hundred million years, typically reaching distances of 600 kpc. We derive pseudo-X-ray emission images and show how X-ray cavities naturally arise from the evolution of these jets. We discuss whether the energy injected by powerful Active Galactic Nuclei is enough to feedback the cooling flows in clusters.

29. **The influence of collimation on the appearance of relativistic jets**

Pierre-Olivier Petrucci, Timothe Boutelier, Gilles Henri
Laboratoire d'Astrophysique de GrenOble, Université Joseph Fourier, France.

The question of the collimation of relativistic jets is the subject of a lively debate in the community. We numerically compute the apparent velocity and the Doppler factor of a non homokinetic jet using different velocity profile, to study the effect of collimation on the appearance of relativistic jets (apparent velocity and Doppler factor). We argue that if the motion is relativistic, the high superluminal velocity are possible only if the geometrical collimation is smaller than the relativistic beaming angle. In the opposite case, the apparent image will be dominated by the part of the jet traveling directly towards the observer resulting in no apparent velocity. Furthermore, getting rid of the homokinetic hypothesis yields a complex relation between the observing angle and the Doppler factor, resulting in important consequences for the numerical computation of AGN population and unification scheme model.

30. **Investigating the disc-jet coupling in accreting compact objects by studying the "radio quiet" sources**

Paolo Soleri[1], Rob Fender[2]
[1]*Kapteyn Astronomical Institute, University of Groningen, The Netherlands.*
[2]*School of Physics and Astronomy, University of Southampton, United Kingdom.*

The coupling between accretion processes and ejection mechanisms in accreting black holes in binary systems can be investigated by means of empirical relations between the X-ray/radio and X- ray/optical-infrared luminosities. These correlations are valid over several orders of magnitude in luminosity and connect stellar-mass and supermassive black holes. Despite these relations were supposed to be universal, many sources have been found to produce jets that, given certain accretion-powered luminosities, are fainter than expected from the correlations. This shows that black holes with similar accretion flows can produce a broad range of outflows in power, suggesting that some other parameters or factors might be tuning the accretion/ejection coupling. We discuss whether typical parameters of the binary system, as well as the properties of the outburst, produce any effect on the energy output in the jet. No obvious dependence is found. We also define a jet-toy model in which the bulk Lorentz factor becomes larger than 1 above 0.1% of the Eddington luminosity. With this model we are able to describe qualitatively the scatter of the X-ray/radio correlation and the "radio quiet" population.

31. **Jet-disk connection in OJ 287**

Mauri J. Valtonen[1,2] , Tuomas Savolainen[3], Kaj Wiik[2]
[1]*Helsinki Institute of Physics, University of Helsinki, Finland.*
[2]*Dept. of Physics and Astronomy, Tuorla Observatory, University of Turku, Finland.*
[3]*Max-Planck-Institut für Radioastronomie, Germany.*

In the binary black hole system OJ 287 it is possible to study the structure of the accretion disk surrounding the primary and how it connects to the jet. We find that in this case the viscosity parameter $\alpha \sim 0.1$ (Valtonen et al. 2010a). The optical brightness

variations depend on the perturbations of jet mass flow as 1.4th power of the flow rate (Valtonen et al. 2006), in agreement with Heinz and Sunyaev (2003). The timing of the optical outbursts in relation to disk perturbations indicates that the jet is connected to the disk via magnetic field lines which extend at least to 10 Schwarzschild radii from the primary close to the disk plane (Turner et al. 1999). Due to the influence of the secondary black hole on the accretion disk, the jet obtains a nodding motion, as suggested by Katz (1997), with periods of 12 and 120 yr. Due to a small viewing angle, between 1 and 2 degrees, the projection of the jet rotates strongly in the sky. The observed rotation of the radio jet between 1980 and 2010 follows the model. Also the spin of the primary black hole rotates, but with a period of 2700 yr, which is too slow to be the cause of the rotation of the radio jet. Thus it is the accretion disk axis rather than the spin axis of the black hole that gives the direction to the jet; the two directions are different by about 8 degrees in OJ 287 (Valtonen et al. 2010b). There is evidence that the jet slows down between the optical emission region at 0.01 pc and the radio jet at 10 pc from the center, and that the reorientation of the jet due to the nodding does not happen simultaneously in both parts of the jet but with a 5 yr time difference.

32. **High luminosity jets: can the GRS 1915+105 plateau state be compared to the canonical hard state?**

Pieter van Oers[1], Sera Markoff, Dipankar Maitra, Michael Nowak, Jörn Wilms, Alberto J. Castro-Tirado, Farid Rahoui, Jerome Rodriguez, Vivek Dhawan, Emilios Harlaftis
[1]*University of Southampton, United Kingdom.*

GRS 1915+105 is a very peculiar black hole binary that exhibits accretion-related states that are not observed in any other stellar-mass black hole system. One of these states, however referred to as the plateau state may be related to the canonical hard state of black hole X-ray binaries. Both the plateau and hard state are associated with steady, relatively lower X-ray emission and flat/inverted radio emission, that is sometimes resolved into compact, self-absorbed jets. However, while generally black hole binaries quench their jets when the luminosity becomes too high, GRS 1915+105 seems to sustain them despite the fact that it accretes at near- or super-Eddington rates. In order to investigate the relationship between the plateau and the hard state, we fit two multi-wavelength observations using a steady-state outflow-dominated model, developed for hard state black hole binaries. The data sets consist of quasi-simultaneous observations in radio, near-infrared and X-ray bands. Interestingly, we find both significant differences between the two plateau states, as well as between the best-fit model parameters and those representative of the hard state. We discuss our interpretation of these results, and the possible implications for GRS 1915+105's relationship to canonical black hole candidates.

33. **Brown dwarf jets: testing the universality of jet launching mechanisms at the lowest masses**

Emma T. Whelan[1], Francesca Bacciotti[2], Tom P. Ray[3], Catherine Dougados[1]
[1]*Laboratoire d'Astrophysique de l'Observatoire de Grenoble, France.*
[2]*Osservatorio Astrofisico di Arcetri, Italy.*
[3]*Dublin Institute for Advanced Studies, Ireland.*

In the last number of years it has become apparent that proto-stellar -like outflow activity extends to the brown dwarf (BD) mass regime. Indeed 2MASS1207-3932 the lowest mass object known to drive a jet is only $\sim 24 M_{\rm JUP}$. While the presence of accretion appears to be the common ingredient in all objects known to drive jets (BDs to AGN), several fundamental questions remain unanswered. The more prominent being the exact mechanism by which jets are launched, and whether this mechanism remains universal among such a diversity of sources and scales. To address this question we have been investigating outflow activity in a sample of protostellar objects that differ considerably in mass and mass accretion rate. *Central to this is our study of brown dwarf jets.* To date Classical T Tauri (CTTS) jets have offered us the best touchstone for decoding the launching mechanism, thanks to their proximity (a few 100 pc), and to their rich line emission spectrum (allowing gas speed and physical conditions to be measured). The observed high ratio $\sim 10\%$ of outflow to accretion rate, and the small scales ~ 50 AU on which CTT jets become collimated both require the action of strong magnetic fields. Determining the launch mechanism of jets is thus essential also to constrain the ill-known magnetic flux distribution in protoplanetary disks. In this talk we will focus on the comparison between jets driven by objects with central mass $< 0.1 M_{\odot}$ and those driven by CTTSs. Since reporting the first BD jet in 2005 we have obtained a clearer picture of outflow activity in the BD mass regime by extending the wavelength range of our study and using state-of-the-art observational techniques. For example mass loss rates for our sample of BD outflows are found to be comparable to the mass accretion rates. In this talk, we shall review what is understood so far of BD jets. In addition we shall discuss current leading jet launching models and the important constraints our observations place on these models.

Poster contributions

1. **EVN monitoring observation of M 87 jet**

Keiichi Asada[1], Masanori Nakamura[2], Akihiro Doi[3], Hiroshi Nagai[4], Makoto Inoue[1]
[1]*Institute of Astronomy and Astrophysics, Academia Sinica, Taiwan, R.O.C.*
[2]*Department of Physics and Astronomy, The Johns Hopkins University, and Space Telescope Science Institute, USA.*
[3]*Institute of Space and Astronautial Science, Japan Aerospace Exploration Agency, Japan.*
[4]*National Astronomical Observatory of Japan, Tokyo, Japan.*

We report results of our Europian VLBI Network observations towards at 1.6 GHz M 87 jet in order to study the velocity field. We revealed continuous jet upto 500 mas from the core and HST-1 component. We have not detected any proper motion for the components within first 160 mas from the core and significant superluminal motions from 2.5 to 3.5 c for the HST-1 components. Thoes are in good agreement with previous observations. We derived proper motions for the components about 160 to 500 mas from the core. Interestingly, the measured proper motions are faster than that of the inner components and slower than that of HST-1 components. It may suggest the possible acceleration region for superluminal features of M 87 jet.

2. **Gamma-rays and neutrinos from accreating neutron stars**

Włodek Bednarek
Department of Astrophysics, University of Łódź, Poland.

Rotating neutron stars can accreate the matter from the companion star in different modes depending on their parameters and the accretion rate. We consider acceleration of particles in the turbulent transition region which appears at some distance from the neutron star surface as a result of balance between the pressure of accreating matter and the magnetic field of the neutron star. The expected high energy radiation (gamma-rays, neutrinos) produced by these relativistic particles is calculated in terms of different parameters describing such scenario (see Bednarek 2009).

3. **Relativistic Radiation Mediated Shocks and prompt GRB emission**

Omer Bromberg[1], Ziv Mikoulizky[2], Amir Levinson[2]
[1]*The Racah Institute of Physics, Hebrew University, Israel.*
[2]*Raymond and Beverly Sackler School of Physics & Astronomy, Tel Aviv Univ., Israel.*

In the past several years, there has been mounting evidence that shocks mediated by radiation have an important role in relativistic sources, such as gamma-ray bursts (GRBs) and microquasars. Such shocks are formed in regions where the Thomson optical depth exceeds unity and have properties which are vastly different than that of collisionless shocks. Indeed, recent Fermi observations suggest that in some GRBs large amount of energy is dissipated below the photosphere of the relativistic outflow. In this talk I will elucidate the conditions under which relativistic radiation mediated shocks (RRMS) form, and describe recent analysis of the structure and spectrum of such shocks. In particular it will be shown that a broad, nonthermal spectrum produced by Compton scattering inside the shock transition is an inherent signature of RRMS. I will also discuss the implication of the shock structure on particle acceleration mechanisms associated with collisionless shocks.

4. **Analysing VLBI images of astrophysical jets via cross-entropy global optimisation method**

Anderson Caproni[1], Hektor Monteiro[2], Zulema Abraham[3]
[1]*Núcleo de Astrofísica Teórica, Universidade Cruzeiro do Sul, Brazil.*
[2]*UNIFEI, Instituto de Ciências Exatas, Universidade Federal de Itajubá, Brazil.*
[3]*Instituto de Astronomia, Geofísica e Ciências Atmosféricas, Universidade de São Paulo, Brazil.*

Most of jets detected in AGN blazar sources exhibit a morphological structure usually composed by a spatially unresolved core and jet knots receding from it at relativistic velocities. In some cases, the trajectories of the jet components on the plane of the sky seem to be bent, indicating the existence of some kind of acceleration in the respective motion. However, such claims depend strongly on the correct determination of the structural parameters of the jet components, usually obtained from model fitting procedures performed either in the (u, v) or in the image planes. In this work we introduce a new model fitting technique to obtain structural parameters of knots present in VLBI jet images. Our method that is based on the cross-entropy technique minimises an objective function that depends on the sum of the squared residuals obtained from the comparison of an VLBI image and a model image, constructed by summing $N_{\rm s}$ elliptical Gaussian synthetic sources. The $6N_{\rm s}$ parameter problem is solved by finding the synthetic model image that better minimises the referred objective function. We present in this work the cross-entropy model fittings of two benchmark images that were built to simulate most of the conditions encountered in typical VLBI images of active galactic nuclei. Besides recovering the parameters of the jet components in all validation tests, our method is able to point out quantitatively the number of the sources present in the image. An additional application of our method to a real blazar observation is also shown and discussed in this work.

5. **Magnetospheric accretion and ejection of matter**

Miljenko Čemeljić
Academia Sinica, Institute of Astronomy and Astrophysics and Theoretical Institute for Advanced Research in Astrophysics, Taiwan

We simulate launching of outflows in the close vicinity of a young stellar object, with the disk and stelar surface layer included in the simulation. Using our version of the ZEUS-3D code, Zeus347, in the axisymmetry option, we solve the resistive MHD equations to investigate the effect of magnetic diffusivity in the magnetospheric accretion-ejection mechanism (MAEM). Four robust, not fine tuned stages for magnetospheric interaction are found, which should occur in every resistive simulation, for the cases of slow and fast stellar rotation. We check the Elsasser criterion for launching of resistive flows throughout the magnetosphere and indicate the outflow origin. The location of a disk inner radius is identified to be near the line of balance of disk ram pressure and magnetic pressure.

6. **Revealing the various contributions in microquasars SED**

Sylvain Chaty[1], Farid Rahoui[2], Juan Antonio Zurita Heras[1]
[1]*Laboratoire AIM, CEA/DSM - CNRS - Université Paris Diderot, IRFU/Service d'Astrophysique, France.*
[2]*Harvard-Smithonian Center for Astrophysics, USA.*

Modeling the Spectral Energy Distribution of microquasars is a difficult task, since all the contributions coming from the accretion disk, the jet and the companion star, are embedded in various domains of the electromagnetic spectrum. Here we present modeling of new observations aiming at disentangling the various contributions, including irradiation of the accretion disk, on the microquasars XTE J1650-500, XTE J1752-223, XTE J1818-245, and GRS 1915+105.

7. **Timing and spectral analysis of 2010 outburst of the black hole candidate GX 339-4**

Tao Chen
Unversity Paris Diderot, CEA DSM/IRFU/SAp, France

In this poster we investigate the quasi periodic oscillation (QPO) behavior of the black hole candidate GX339-4 during its 2010's outburst using RXTE/PCA data. We perform a full analysis (spectral and temporal) of the observations, where the QPO exists. We analyze the relationship between the centroid frequency of QPO with the spectral parameters. We find that the QPO frequency is possibly correlated with the photon index until a turn-off frequency. This is similar to other sources as shown by Vignarca et. al. (2003). In GX339-4 we find that the turn-off frequency is low comparing to other sources like XTE J1550-564, GRO J1655-40 or XTE J1744-288. But this frequency is close to that observed in GRS 1915+105. If this value is connected with the mass of black hole (Vignarca, 2003), then the mass of GX339-4 should be similar to the mass of GRS 1915+105. This would give us a new tool to estimate the mass of black hole.

8. **Radio structure and jet properties of 1803+784. Results of Space VLBI data processing**

Andrey A. Chuprikov, Igor A. Guirin
Astro Space Center, P. N. Lebedev Physical Institute, Russian Federation.

We present result of processing of data of ground-space VLBI experiment titled V053. These observations were made in 1997 October with 10 antennas of American interferometer VLBA and Japan satellite VSOP (VLBI Space Orbital Program). Data were transferred from NRAO (National Radio Astronomy Observatory, USA) archive and processed with the software titled "Astro Space Locator" (ASL for Windows). The main result of such processing is the image of the quasar titled 1803+784 with high resolution and high accuracy. Using this image, we make some conclusions about the radio structure of jet of this object. Our result is not in conflict with other results of processing of Space VLBI data for 1803+784 published earlier with other authors. We could add some new aspects into that results. The reconstructed images of 1803+784 for 6 centimeter wavelength range and values of some parameters of this source are presented.

9. **Radio structure of Cen A (J1325−4301) and its changes in time. Results of VLBI data processing**

Andrey A. Chuprikov, Igor A. Guirin
Astro Space Center, P. N. Lebedev Physical Institute, Russian Federation.

We present results of processing of data of some VLBA experiments have been made during last years. Data were transferred from NRAO (National Radio Astronomy Observatory, USA) archive and processed with the software titled "Astro Space Locator" (ASL for Windows). Object of our interest is well-known galaxy titled Cen A. Results of Space VLBI experiment titled W079 has been made during 1999 - 2000 are also presented in our report. Some new methods of SVLBI data processing have been developed by us are used. The reconstructed radio images of Cen A and values of some parameters of this source are presented.

10. **The Multi Wavelength Radio structure of 3C 84 and its changes in time. Results of VLBI data processing**

Andrey A. Chuprikov, Igor A. Guirin
Astro Space Center, P. N. Lebedev Physical Institute, Russian Federation.

We present results of processing of data of VLBA experiments have been made in 2008-2009. Data were transferred from NRAO (National Radio Astronomy Observatory, USA) archive and processed with the software titled "Astro Space Locator" (ASL for Windows). The main property of all the experiments is the simultaneous observation in many wavelength ranges. These are L-range (18-21 cm), C-range (6 cm), X-range (4 cm), K-range (1.35 cm), and Q-range (7 mm). Object of our interest is close ($z = 0.018$) galaxy titled 3C 84. The MFS method (Multi Frequency Synthesis) is used for all the data processing. The reconstructed radio images of 3C 84 are presented. All the methods and technologies used are valid for the future Space VLBI mission titled "RADIOASTRON" data processing.

11. **Multi-Epoch VLBI observations of the extreme scintillator J1819+3845**

Giuseppe Cimò, Leonid Gurvits
Joint Institute for VLBI in Europe, the Netherlands.

The quasar J1819+3845 has shown extreme variability with flux density variations in the radio regime up to 600% in less than one hour. In case of intrinsic high varibility, the short time scale sets a limit on the size of the emitting region and allows to estimate its brightness temperature. This would exceed 10^{21} K in the case of J1819+3845. Even an high relativistic jet beamed and doppler boosted in our line of sight cannot explain such an extreme violation of the Inverse Compton limit (10^{12} K). The variability of this source has been proven to be due to scattering in the Interstellar medium by a number of different experiments. Such an explanation requires a closeby scattering screen (few parsecs) and it results in a brightness temperature of about 10^{14} K. Many observing campaigns have been carried on to map the innermost jet structures of J1819+3845. Here we present the results of a number of VLBI observations, including space VLBI, to search for the 'missing' jet in this puzzling source.

12. **Gamma-ray activity from the microquasar Cygnus X-3 revealed by Fermi**

Stéphance Corbel (On behalf the Fermi LAT collaboration)
Université Paris 7 Denis Diderot and Service d'Astrophysique, France.

Cygnus X-3 is a high-mass X-ray binary with a Wolf-Rayet star companion and with a short orbital period. It occasionally becomes one of the brightest radio source among the Galactic binary systems, with major flares from its relativistic jets. In the 1970's and early 1980's, it was postulated to be a source of high and very high energy gamma rays, that generated considerable excitement in the field of gamma-ray astronomy. With its unprecedented sensitivity, the Large Area Telescope (LAT) aboard the Fermi Gamma-Ray Space Telescope continuously scans the entire sky every $\sim$ 3 hours and is ideally suited to probe the high energy emission of binary systems.
The Fermi Large Area Telescope has detected a variable high energy source coinciding with the position of the X-ray binary and microquasar Cygnus X-3. Its identification with Cygnus X-3 is secured by the detection of its orbital period in gamma rays, as well as the correlation of the LAT flux with radio emission from the relativistic jets of Cygnus X-3. The gamma-ray emission likely originates close to the binary system, opening new areas in which to study the formation of relativistic jets.
Here, we will report the results of more than two years of observations with the LAT of the very crowded Cygnus region, with specific focus on the high energy spectrum of Cygnus X-3, as well as its multi-wavelength behavior and the new recent active period in 2010.

13. **Large scale nebulae around Ultra Luminous X-ray Sources**

David Cseh[1], Stephane Corbel[1], Phil Kaaret[2], Fabien Grise[2], Cornelia Lang[2], Tasso Tzioumis[3]
[1]*Laboratoire Astrophysique des Interactions Multi-echelles, France.*
[2]*Department of Physics and Astronomy, University of Iowa, USA.*
[3]*Australia Telescope National Facility, Australia.*

We have conducted a new series of observations in order to further constrain the energy budget of this ULX and the properties of the associated nebula. New radio observations (5, 9 and 18 GHz) with the Australia Telescope Compact Array (ATCA) and CABB-upgrade indicate that we resolved the surrounding radio nebula, and we characterized its radio spectra. Furthermore, we obtained new high resolution and broadband optical spectra using the FORS2 spectrograph of ESO's Very Large Telescope (VLT). We will also provide the results CLOUDY simulations in order to constrain the motions within the nebula and the density of the nebula. This should allow us to estimate the kinematic power of the nebula. Along with optical, UV and X-ray measurements of Hubble Space Telescope (HST) and Chandra telescope we use the nebula as a calorimeter to provide the intrinsic power of this ULX source and compare it to eg. SS433 or S26.
Somewhat similarly, using the Very Large Array (VLA), we discuss further complementary observations of radio nebulae associated with other ULXs that are known to have optical nebular counterpart.

14. **Broad emission lines for a negatively spinning black hole**

T. Dauser[1], J. Wilms[1], C. S. Reynolds[2], L. W. Brenneman[3]
[1]*Dr. Karl Remeis-Observatory and Erlangen Centre for Astroparticle Physics, Germany.*
[2]*Department of Astronomy and Maryland Astronomy Center for Theory and Computation, University of Maryland, USA.*
[3]*Harvard-Smithsonian Center for Astrophysics, USA.*

We present an extended scheme for the calculation of the profiles of emission lines from accretion disks around rotating black holes. The scheme includes disks with angular momenta which are parallel and antiparallel with respect to the black hole's angular momentum, as both configurations are assumed to be stable (King 2005). We discuss line shapes for such disks and present a code for modeling observational data with this scheme in X-ray data analysis programs. Based on a Green's function approach, an arbitrary radius dependence of the disc emissivity and arbitrary limb darkening laws can be easily taken into account, while the amount of precomputed data is significantly reduced with respect to other available models. Moreover the observability of these lines in current and future X-ray missions is discussed.

15. **Non thermal emission from T Tauri stars**

María V. del Valle, Gustavo E. Romero
Instituto Argentino de Radiastronomía (IAR), Argentina.

T Tauri stars are young, low mass, pre-main sequence stars surrounded by an accretion disk. This objects present strong magnetic activity and powerful magnetic reconnection events.
Associated strong shocks are likely outcome of massive reconnection. Such shocks can accelerate particles up to relativistic energies.
We present a model for the non-thermal radiation produced by such particles in the environment of T Tauri stars.

16. **Exploring jet formation and quenching at the opposite extremes of black hole accretion**

Salomé Dibi[1], Sera Markoff[1], P. Chris Fragile[2], Samia Drappeau[1], Stéphane Corbel[3]
[1]*Astronomical Institute "Anton Pannekoek", University of Amsterdam, the Netherlands.*
[2]*Physics & Astronomy College of Charleston, USA.*
[3]*Université Paris 7 and CEA Saclay, France.*

The discovery of the fundamental plane of black hole accretion argues for some level of mass scaling in the accretion physics of black holes, the strongest evidence for which occurs at low accretion rates (i.e. hard state X-ray binaries, XRBs, and low luminosity Active Galactic Nuclei, LLAGN). Compact jets are associated with these objects, and while they seem to persist down to very low accretion rates, at high accretion rates the jets seem to be quenched or lose dominance to the thermal accretion disk (i.e., soft state XRBs and some high luminosity AGN classes such as Seyferts/Radio Quiet Quasars). Understanding the formation and subsequent dismantling of compact jets at the extreme ends of the accretion rate range is thus an important outstanding question. We present

the preliminary results from two very different approaches to this problem. On the lowest known end of the LLAGN lies Sgr A*, our Galactic center supermassive black hole. Its slightly inverted spectrum and polarization characteristics in the radio band are very typical for LLAGN, where jets are usually resolved, however Sgr A*'s extreme weakness makes such a detection very challenging behind our Galactic plane. There is thus some controversy as to whether fully fledged jets are responsible for the emission, or if the spectrum could be due to uncollimated disk winds. Using the general relativistic magnetohydrodynamical code COSMOS++, which has the option of including radiative cooling, we are exploring the conditions for the creation of weak jets using actual physical inputs appropriate to Sgr A*, which has very well constrained physical parameters and accretion rate. We will show the resulting outflow geometry together with the spectra generated from several simulations and discuss the likelihood of collimated jet formation at $< 10^{-9}\, L_{\rm Edd}$. In order to explore the quenching of jets at the extreme opposite end of the accretion rate range, we are also developing a time dependent model to study the transition from hard to soft state, with a particular focus on modeling the radio through infared data. During this transition, the infrared is seen to decrease before the radio, and we will present some initial results of our time-dependent approach to explore the cause of this evolution, applied to multiwavelength data from the outbursts of several Galactic XRBs.

17. **A holistic approach to hadronic models for microquasars: statistical fits to radio through GeV data for Cyg X-3**

Samia Drappeau, Sera Markoff
Sterrenkundig Instituut "A. Pannekoek", Universiteit van Amsterdam, the Netherlands.

Microquasars are X-ray binaries (XRBs) in an accretion state associated with the production of relativistic jets. These objects are becoming more interesting for high-energy facilities since the first solid identification of Cygnus X-3, a microquasar system with a Wolf-Rayet companion star, as a variable GeV emitter by the Fermi Large Area Telescope (LAT). Generally the approach to modelling the high-energy emission is to consider very energetic hadronic $p-p$ and $p-\gamma$ interactions between accelerated particles in the jet and the external medium. Most groups so far have created models with an aim towards reproducing GeV-TeV emission, and only use the available radio through X-ray spectral data as general constraints. We present the preliminary results of a new approach, which is based on a jet model for microquasars that has been successful at statistically fitting simultaneous radio through X-ray data sets for many Galactic sources. While the original model considered protons only as kinetic energy carriers, we have now included hadronic acceleration processes, and will compare our predictions to simultaneous, broadband data including the γ-rays for Cyg X-3. Our model includes a more direct linkage to the base of the jet and the accretion disk, and thus can help address questions about required energy budgets and acceleration conditions necessary at the launch point.

18. **LS 5039 and LS I +61 303 - More Puzzles Uncovered by Fermi**

R. Dubois (for the Fermi LAT Collaboration)
SLAC National Accelerator Laboratory, USA.

Results from the first two year of Fermi LAT (Large Area Telescope) observations of the bright sources LS I +61 303 and LS 5039, well observed binary systems at X-ray and TeV energies, have yielded new questions at GeV energies about their nature. These sources are proving to be surprising in terms of spectral behaviour and variability. The exponential cutoff seen in both sources is very reminiscent of the many pulsars Fermi has found, yet the orbital variability is not expected in that interpretation. In addition, LS I +61 303 has shown remarkable, abrupt changes in its flux levels and orbital modulation. In survey mode the LAT observes every point in the sky every 3 hours making it an ideal monitor for these systems.

19. **High time resolution optical/X-ray cross-correlations of X-ray binaries: anti-correlations and rapid variability**

Martin Durant[1,2], Tariq Shahbaz[1,3], Poshak Gandhi[5], Remon Cornelisse[1], Teodoro Muñoz-Darias[1,4], Jorge Casares[1,3], Vik Dhillon[7], Tom Marsh[8], Hendrik Spruit[6], Kieran O'Brien[9], Danny Steeghs[8], Rob Hynes[10]
[1]*Instituto de Astrofísica de Canarias, Spain.*
[2]*University of Florida, USA.*
[3]*Departamento de Astrofísica, Universidad de La Laguna (ULL), Spain.*
[4]*Osservatorio Astronomico di Brera, Milano, Italy.*
[5]*Institute of Space and Astronautical Science (ISAS), Japan Aerospace Exploration Agency, Japan.*
[6]*Max Planck Institute for Astrophysics, Germany.*
[7]*Dept. of Physics & Astronomy, Univ. of Sheffield, UK.*
[8]*Dept. of Physics, Univ. of Warwick, UK.*
[9]*Dept. of Physics, University of California, USA.*
[10]*Dept. of Physics and Astronomy, Louisiana, USA.*

Using simultaneous observations in X-rays and optical, we have performed a homogeneous analysis of the cross-correlation behaviours of four X-ray binaries: SWIFT J1753.5−0127, GX 339−4, Sco X-1, and Cyg X-2. With high time-resolution observations using ULTRACAM and RXTE, we concentrate on the *short time-scale*, $\delta t < 20$ s, variability in these sources. For the first time, we include a dynamical cross-correlation analysis, i.e., an investigation of how the cross-correlation function changes within an observation. We describe a number of trends which emerge. We include the full dataset of results, and pick a few striking relationships from among them for further discussion. We find, that the surprising form of X-ray/optical cross-correlation functions, a positive correlation signal preceded by an anti-correlation signal, is seen in all the sources at least some of the time. Such behaviour suggests that a mechanism other than reprocessing as being the dominant driver of the short-term variability in the optical emission.

20. **The FLAMINGOS-2 Galactic Center Survey: prospecting for microquasars**

Stephen S. Eikenberry (and the F2GCS Team)
Department of Astronomy, University of Florida, USA.

The FLAMINGOS-2 wide-field near-infrared imager and multi-object spectrograph for the Gemini South 8-meter telescope, built by our team at the University of Florida, had first light in September 2009 and was accepted by the observatory in January 2010. One of the key science projects for FLAMINGOS-2 will be the FLAMINGOS-2 Galactic Center Survey (F2GCS). We will use the unique power of FLAMINGOS-2 to obtain near-infrared spectra of several thousand candidate IR counterparts to the *Chandra* X-ray sources in the Galactic Center region, to search for accretion disk emission line features that identify actual counterparts. Based on our preliminary work, we expect to discover $\sim 200 - 300$ new X-ray binary sources —including many new relativistic jet sources— over the next 2 years. I will present the details of the survey, results from our pre-imaging survey with the CTIO 4-meter telescope, and preliminary spectroscopic results.

21. **Precessing AGN jets, bubbles and cooling flows**

D. Falceta-Gonçalves[1,2], A. Caproni[2], Z. Abraham[3], E. M. de Gouveia Dal Pino[3], D. M. Teixeira[3]
[1]*Escola de Artes, Ciências e Humanidades, Universidade de São Paulo, Brazil.*
[2]*Núcleo de Astrofísica Teórica, Universidade Cruzeiro do Sul, Brazil.*
[3]*Inst. de Astronomia, Geofísica e Ciências Atmosféricas, Univ. de São Paulo, Brazil.*

Several galaxy clusters are known to present multiple and misaligned pairs of cavities seen in X-rays, as well as twisted kiloparsec-scale jets at radio wavelengths. It suggests that the AGN precessing jets play a role in the formation of the misaligned bubbles. Also, X-ray spectra reveal that typically these systems are also able to supress cooling flows, predicted theoretically. The absence of cooling flows in galaxy clusters has been a mistery for many years since numerical simulations and analytical studies suggest that AGN jets are highly energetic, but are unable to redistribute it at all directions. We performed 3D hydrodynamical simulations of the interaction between a precessing AGN jet and the warm intracluster medium plasma, which dynamics is coupled to a NFW dark matter gravitational potential. Radiative cooling has been taken into account and the cooling flow problem was studied. We found that precession is responsible for multiple pairs of bubbles, as observed. The misaligned bubbles rise up to scales of tens of kiloparsecs, where the thermal energy released by the jets are redistributed. After $\sim 150\,\mathrm{Myrs}$, the temperature of the gas within the cavities is kept of order of $\sim 10^7\,\mathrm{K}$, while the denser plasma of the intracluster medium at the central regions reaches $T \sim 10^5\,\mathrm{K}$. The existence of multiple bubbles, at diferent directions, result in an integrated temperature along the line of sight much larger than the simulations of non-precessing jets. This result is in agreement with the observations. The simulations reveal that the cooling flows ceased $\sim 50 - 70\,\mathrm{Myr}$ after the AGN jets are started.

22. **Spectral index and beaming effect for extragalactic radio sources**

J. H. Fan, J. Pan, Y. Liu, et al.
Center for Astrophysics, Guangzhou University, China.
Astronomy Science and Technology Research Laboratory of Department of Education of Guangdong Province, China.

In this work, we present a correlation between the spectral index and the core-dominance parameter for a sample of radio sources, the correlation can be explained by using a relativistic beaming effect.

23. **Relativistic jets in narrow-line Seyfert 1**

Luigi Foschini
INAF - Osservatorio Astronomico di Brera, Italy.

Narrow-Line Seyfert 1 (NLS1) is a class of active galactic nuclei (AGN) generally radio-quiet, but a small percent of them are radio-loud. The recent discovery by Fermi/LAT of high-energy γ-ray emission from four NLS1s convincingly proved the existence of relativistic jets in this type of AGN. This has great impacts on the unified model of AGNs with relativistic jets for several reasons: we are now sampling jets formed in systems with relatively small masses, very high accretion rates, and hosted by spiral galaxies (while blazars and radio galaxies are hosted by ellipticals). I will review the status of the researches in this field, with particular attention to the issues concerning the unified model and the theories on relativistic jets formation.

24. **Radio flare in the jet of CTA 102**

C. M. Fromm[1], E. Ros[1,2], T. Savolainen[1], A. P. Lobanov[1], M. Perucho[2], J. A. Zensus[1]
[1]*Max Planck Institute for Radio Astronomy, Germany.*
[2]*Universitat de Valencia, Departament d'Astronomia i Astrofisica, Spain.*

The blazar CTA 102 ($z = 1.037$) underwent an historical radio outburst in April 2006. This offers a unique chance to study the physical properties of the jet (e.g., the shock-in-jet model by Marscher & Gear 1985) during this event. We use single dish together with multi-frequency VLBI observations to analyze the spectral behaviour of this source, complemented by relativistic magneto-hydrodynamic (RMHD) simulations to understand the ongoing processes. After removal of the quiescent jet emission, we analyzed the turnover frequency - turnover flux density ($\nu_m - S_m$) plane, which show the Compton, synchrotron and adiabatic phases, with minor discrepancies from the model. Additionally, a pixel-to-pixel spectral analysis on the VLBI images, together with MOJAVE-derived kinematics of the jet lead to the picture of an over-pressured jet with respect to the ambient medium. We will present our findings on the interaction of a moving shock wave with a standing one. The results from the different observational approaches will be tested in contrast with RMHD simulations.

25. **Magnetic field decay in accreting young neutron stars**

Federico García[1], Deborah N. Aguilera[2], Gustavo E. Romero[1]
[1]*Instituto Argentino de Radioastronomía, Argentina.*
[2]*Ohio University, USA & Laboratorio Tandar, CNEA, Argentina.*

Neutron stars are compact objects usually born with strong surface magnetic fields ($B \approx 10^{12}$ G). It is thought that accreting neutron stars can produce jets only if they are weakly magnetized ($B \approx 10^{8}$ G). In this work, we study the possibility of jet formation in a binary system formed by a neutron star and a massive donor star. We make estimates of the magnetic field decay induced by the accretion of clumps from the stellar companion and we discuss the possibility of jet launching in relatively young systems like some recently detected Super-fast X-ray transients.

26. **Searching for Radio relics and Halos in an X-ray selected sample of clusters of galaxies: Their role in the formation and acceleration of extragalactic cosmic rays.**

Nectaria A. B. Gizani
School of Natural Sciences and Technology, Hellenic Open University, Greece.

We search for extended regions of radio emission, known as 'relics' and 'halos', in an X-ray selected sample of galaxy clusters, using radio data. Most clusters of galaxies with cool cores have active galactic nuclei at their centres. These AGN can produce bubbles of non-thermal radio-emitting particles. One explanation for the formation of 'radio relics and halos' could be the confinement of cosmic rays by these bubbles. We also investigate the correlation between cluster X-ray luminosity and radio power of halos. We report on the work in progress and future plans.

27. **The role of AGN jets and intracluster magnetic fields in the formation and acceleration of cosmic rays.**

Nectaria A. B. Gizani
School of Natural Sciences and Technology, Hellenic Open University, Greece.

Using radio and X-ray data of two powerful radiogalaxies we attempt to find out the role that radio jets (in terms of composition and power) as well as intracluster magnetic fields play in the formation and acceleration of cosmic rays. Both radio sources, namely Hercules A and 3C 388, lie at the center of galaxy clusters in a dense environment. X-ray observations together with Faraday rotation measurements of background and cluster radio sources, provide the main evidence of large-scale intra-cluster magnetic fields and of significant densities and acceleration mechanisms of relativistic electrons. We have made total intensity and polarization multifrequency, multiconfiguration observations of Hercules A using the VLA. We combine these with ROSAT PSPC+HRI data on the source to find the magnetic field in the intracluster medium. We derive an estimate of the same quantity for 3C388, using Inverse Compton Radiation. Hercules A has two unique and very different jets, which we have traced in pc-scales (EVN observations). The western one leads to a series of ring-like features in the corresponding radio lobe. The eastern one seems to have a helical appearance, and is the brightest known (in

terms of flux density), capable of accelerating cosmic rays. 3C 388 on the other hand presents a bright western jet and a possible counter jet. Minimum pressure estimates imply a severe underestimate of the energy content of the jets of both sources. Radio spectral observations also indicate the ageing of the emitting particles. We report on the progress of the work and future plans.

28. **What is shaping the planetary nebula K3-35?**

Yolanda Gómez
Centro de Radiostronomía y Astrofísica, UNAM, México.

K 3-35 is a very young planetary nebula (PN) with a characteristic S-shaped radio emission morphology. It is the first PN where water vapor maser was detected, the emission is located in a torus-like structure with a radius of 100 AU and also at the surprisingly large distance of 5000 AU from the star, in the tips of the bipolar lobes. Several mechanism have been proposed to explain the bipolar morphology of PNe, and in the case of K 3-35 we believe we may be observing several of them at the same time: i) a disk-like structure traced by the H_2O masers, ii) a precessing bipolar jet probably due to the presence of a binary companion and iii) circular polarization in the OH 1665 MHz masers, which suggests the presence of a magnetic field. Additional observations and modeling are needed to establish what mechanisms are shaping K 3-35.

29. **Radiation-hydrodynamics effects in stellar jets-ISM interaction**

Matthias González, Edouard Audit
Laboratoire AIM, CEA-Université Paris Diderot-CNRS, France.

The stellar jets simulations often use a cooling function approximation to treat the radiative transfer. However, in the case where the jet is still embedded in the optically thick molecular cloud, the photons may have a short mean free path needing a detailed radiative transfer treatment. We emphasize here the differences obtained in this latter case, carrying out radiation-hydrodynamics simulations performed with the 3D HERACLES code. We present simulations of the propagation of a jet in an interstellar medium at rest. The results show that the jet is collimated due to purely radiative effects and that a secundary jet can be created.

30. **The pc-scale radio structure of radio-loud NLS1s**

Minfeng Gu[1,2], Yongjun Chen[1]
[1]*Shanghai Astronomical Observatory, Chinese Academy of Sciences, China.*
[2]*Department of Physics, University of California, USA.*

We present the compact radio structure of three radio-loud narrow line Seyfert 1 galaxies from VLBA archive data at 2.3, 5 and 8.4 GHz. In RXS J16290+4007, the radio structure is mostly unresolved. The combination of compact radio structure, high brightness temperature and inverted spectrum between simultaneous 2.3 and 8.4 GHz, strongly favors jet relativistic beaming. Combining with the VLBI data at 1.6 and 8.4 GHz from

literatures, we argued that RXS J16333+4718 may also harbor a relativistic jet, with resolved core-jet structure in 5 GHz. B3 1702+457 is clearly resolved with well defined jet component. The overall radio steep spectrum indicates that B3 1702+457 is likely a source optically defined as NLS1 with radio definition of compact steep spectrum sources. From these three sources, we found that radio loud NLS1s can be either intrinsically radio loud (e.g. B3 1702+457), or apparently radio loud due to jet beaming effect (e.g. RXS J16290+4007 and RXS J16333+4718).

31. **Does AGN feedback feed back? The impact of radio-jet driven outflows on the molecular gas**

P. Guillard[1], P. M. Ogle[1], P. N. Appleton[2], B. Emonts[3], F. Boulanger[4], G. Pineau des Forêts[4]
[1]*Spitzer Science Center, Caltech, USA.*
[2]*NASA Herschel Science Center, Caltech, USA.*
[3]*Australia Telescope National Facility, CSIRO, Australia.*
[4]*Institut d'Astrophysique Spatiale, Université Paris-Sud 11, France.*

Although observations of ionized and neutral gas outflows in radio-galaxies (RG) suggest that AGN feedback has a galaxy-scale impact on the host ISM, it is still unclear how AGN feedback affects the molecular gas. Studying the physical conditions of the molecular gas in powerful RG is therefore critical, if we want to understand how radio sources may regulate the star formation in their host galaxies. Recently, Spitzer IRS observations have revealed that 30% of a sample of 55 nearby 3C RG have bright mid-IR line emission from warm (100-1000 K) molecular hydrogen (H_2), with weak tracers of star formation (e.g. PAHs). Following these results, we obtained deep IRS high-resolution spectroscopy of 8 nearby RG that show fast HI outflows, on which I focus on. Strikingly, all of these HI-outflow RG are H_2-luminous. This strongly suggests that the radio jet, which drives the HI outflow, is also responsible for the shock-excitation of the warm H_2 gas. I will review the peculiar properties of these H_2-luminous galaxies, and propose an interpretation based on our recent analysis of the warm and cold multiphase gas content of the 'prototypical' H_2 luminous RG 3C326N. We explain these observations through a common physical framework where a fraction of the mechanical energy of the radio jet is being dissipated on small scales within the molecular gas, which powers the observed H_2 emission. This is an extension of the classical 'cocoon' model, explicitly taking into account the multiphase character of the ISM, with an emphasis on the molecular gas. Some of these H_2-luminous RG have low star-formation efficiencies, which suggests that these processes may indeed have a significant impact on star formation. Dissipation times suggest that this effect may be long-lasting, and perhaps even exceed the jet lifetime. I will discuss the possible implications of these processes for the evolution of RG in particular, and massive galaxies in general.

32. **The long-term polarimetric monitoring program of blazars at San Pedro Mártir**

Jochen Heidt[1], Erika Benítez[2], David Hiriart[2]
[1]*ZAH, Landessternwarte, Heidelberg, Germany.*
[2]*Instituto de Astronomía, UNAM, México.*

Numerous multiwavelength campaigns have considerably improved our understanding of Blazars in the last decade. In particular, a wealth of optical monitoring data have been provided in total flux. However, largely neglected has been the potential of determining the properties of the sources in polarized light. This is a powerful tool, to e.g. determine strength and orientation of magnetic fields in their relativistic jets giving rise to the variable synchrotron radiation and/or as a further test for the various Blazar jet models. Most importantly, since multiwavelength campaigns typically concentrate on sources during highly active states, the characteristic polarimetric properties of Blazars in quiescence wrt to the ones in active state are poorly known.
The long-term polarimetric monitoring program of Blazars at San Pedro Martir aims to investigate this. About 35 sources are monitored for about 80 nights per year using the 84 cm telescope at San Pedro Martir since 2008. In this contribution, the current status of the program will be described, a summary of the results obtained so far be given and some highlights be discussed.

33. **Structure and evolution of magnetic fields in Fanaroff-Riley II objects**

Martín Huarte-Espinosa[1,2,3], Martin Krause[4], Paul Alexander[2,3]
[1]*Department of Physics and Astronomy, University of Rochester, USA.*
[2]*Astrophysics Group, Cavendish Laboratory, UK.*
[3]*Kavli Institute for Cosmology Cambridge, UK.*
[4]*Max-Planck-Institut für Extraterrestrische Physik, Germany.*

A combination of 3DMHD numerical simulations and synthetic observations will be presented in order to discuss the structure and evolution of magnetic fields in Fanaroff-Riley Class II objects. The power of the jets, in terms of their velocity and density, and the observational viewing angle are investigated. Our polarization maps agree with the observations and show that the magnetic structure inside radio sources is shaped by the backflow of the jets. The polarimetry statistics correlates with time, with the viewing angle and with the jet-to-ambient density contrast too. As sources expand, the linear polarization fraction decreases and the magnetic structure inside the sources with large ellipticities, such as the ones formed by modestly light jets, seems more uniform than that inside the more spherical cocoons, such as the ones formed by very light jets. Moreover, in proportion to their velocity, jets increase the magnetic energy inside their host cocoon, and both, filaments in the synthetic synchrotron emissivity maps and magnetic power spectra in Fourier space, suggest that turbulence develops in evolved sources.

34. **Long term X-ray observations of blazars with MAXI**

Naoki Isobe (the MAXI team)
Department of Astronomy, Kyoto University, Japan.

X-ray monitoring observations of blazars with MAXI are reported. One of the most important properties of blazars is their rapid intensity variation, which should provide us a useful probe for the high energy phenomena related to their jets, including the particle acceleration. MAXI is the ideal observatory for studies of the long term variation of blazars, thanks to its unprecedentedly high sensitivity as an all-sky X-ray monitor. Actually, since it started its operation in 2009 August, MAXI has successfully detected several strong X-ray flares from the high-energy peaked BL Lac object Mrk 421, with the X-ray flux at highest level among those ever recorded from the object. Using the MAXI data, long term X-ray variability of blazars, in particular in a time scale significantly longer than a day, are investigated.

35. **Probing the accretion disk - jet connection via instabilities in the inner accretion flow. From microquasars to quasars**

Agnieszka Janiuk[1], Bożena Czerny[1], Monika Mościbrodzka[2], Aneta Siemiginowska[6]
[1]*N. Copernicus Astronomical Center, Poland.*
[2]*Department of Physics, University of Illinois, USA.*
[3]*Harvard Smithsonian Center for Astrophysics, USA.*

We present the various instability mechanisms in the accreting black hole systems which might indicate at the connection between the accretion disk and jet. First, the jets observed in the microquasars can have a peristent or blobby morphology. Correlated with the accretion luminosity, this might provide a link to the cyclic outbursts of the disk. Such duty-cycle type of behaviour on short timescales results from the thermal instability caused by the radiation pressure domination. Second, the same type of instability may explain the cyclic activity of the supermassive black hole systems, the ages and morphology of radiosources. Third, the somewhat longer timescales of active and quiescent periods of the accretion disk are characteristic for the instability caused by the partial hydrogen ionization. Also, when operating in the SMBH disks, this may provide an AGN reactivation mechanism and feedback with the surrounding environment. Finally, the distortions of the jet direction and complex morphology of the sources can be caused by the precession of the disk-jet axis.

36. **MAXI observations of transient X-ray sources: black hole candidates and AGN**

Nobuyuki Kawai[1,2] (on behalf of the MAXI Team)
[1]*Department of Physics, Tokyo Institute of Technology, Japan.*
[2]*Coordinated Space Observation and Experiment Research Group, RIKEN, Japan.*

MAXI is an all-sky monitor on the ISS that scan the entire sky every 92 minutes in the 0.5-30 keV band. Since August 2010, MAXI has been monitoring the variable X-ray sources distributed over the entire sky. MAXI has obtained light curves and energy spectra of black hole candidates, binary X-ray pulsars, low-mass X-ray binaries, and

AGN. MAXI has also detected short transient events such as gamma-ray bursts and stellar flares. I will present highlights of the MAXI observations in its first year in orbit. For example, the light curve and the energy spectrum of XTE J1752-223, a black hole candidate newly discovered in 2009, was observed almost continuously over seven months from its outburst onset in a low-hard state to a high-soft state and back to a low-soft state. Another example is a detection of record-high X-ray flares from a BL Lac object Mrk 421 coincident with TeV gamma-ray activity.

37. **Magnetic braking-driven outflows and disk formation during accretion**

Ruben Krasnopolsky[1,2], Zhi-Yun Li[2,3], Hsien Shang[1,2]
[1]*Academia Sinica, Institute of Astronomy and Astrophysics, Taiwan.*
[2]*Academia Sinica, Theoretical Institute for Advanced Research in Astrophysics, Taiwan.*
[3]*University of Virginia, Astronomy Department, USA.*

Here we present MHD calculations of the collapse of rotating, magnetized dense cores which form low-mass stars. We find that early outflows are produced immediately after the formation of the central point mass, due to magnetic braking. Magnetic fields strongly interact with the rotating and collapsing material, leading to the suppression of disk formation, with the removed angular momentum ejected by a transient outflow. We explore how the process of disk suppression and outflow formation depends on various non-ideal MHD effects, including Ohmic resistivity, the Hall effect and ambipolar diffusion. The inclusion of all of these realistic non-ideal MHD effects in our calculations of accretion and outflows in star formation is the first of its kind.
Early outflows and disk formation are two sides of the same coin. The main effects of non-ideal MHD appear in modulating magnetic braking and angular momentum transport, and in controlling the magnetic flux distribution.

38. **The astrophysical jets**

Wolfgang Kundt
Argelander-Institut für Astronomie der Universität Bonn, Germany.

Models for the various astrophysical jet sources can be grouped according to their choices of the following six alternative assumptions:
(1) Their central engines (CEs) are: BHs / (non-aligned) rotating magnets, (2) The jet substance is: (at least partially) hadronic / pair plasma, (3) The jet substance gets energized: in situ / by the CE, (4) Confinement and Focussing happen by: magnetic fields / inertia, (5) Propagation losses are: compensated by post acceleration / negligible, (6) Beamed radiation is due to: large Lorentz factors / focussed tangents.
In my talk, I shall update my 2004 analytical model [J.A.A.25,115-127] with Gopal Krishna, whose assumptions are always those of the second entries.

39. **Intermittent activity of radio sources. Accretion instabilities and jet precession**

M. Kunert-Bajraszewska[1], A. Janiuk[2], A. Siemiginowska[3], M. Gawronski[1]
[1]*Toruń Centre for Astronomy, N. Copernicus University, Poland.*
[2]*N. Copernicus Astronomical Center, Poland.*
[3]*Harvard Smithsonian Center for Astrophysics, USA.*

We consider the radiation pressure instability operating on short timescales ($10^3 - 10^6$ years) in the accretion disk around a supermassive black hole as the origin of the intermittent activity of radio sources. We test whether this instability can be responsible for short ages ($< 10^4$ years) of Compact Steep Spectrum sources measured by hot spots propagation velocities in VLBI observations and statistical overabundance of Gigahertz Peaked Spectrum sources. The implied timescales are consistent with the observed ages of the sources. We also discuss possible implications of the intermittent activity on the complex morphology of radio sources, such as the quasar 1045+352, dominated by a knotty jet showing several bends. It is possible that we are witnessing an ongoing jet precession in this source due to internal instabilities within the jet flow.

40. **A catalogue of radio loud AGN in the XMM-Newton archive, and their properties**

Alvaro Labiano[1], Matteo Guainazzi[1], Stefano Bianchi[2], Giovanni Miniutti[3]
[1]*European Space Astronomy Centre, European Space Agency, Spain.*
[2]*LAEFF, Centro de Astrobiología (CSIC-INTA), Spain.*
[3]*Dipartimento di Fisica, Universitá degli Studi Roma Tre, Italy.*

We have cross-correlated the Veron 2010 (Quasars and Active Galactic Nuclei, 13th Ed.) with the XMM-Newton Serendipitous Source Catalogue, 2XMMi-DR3 (XMM-SSC,2010) to carry out a multiwavelength study of all radio loud AGN observed with XMM-Newton. In this talk I present the first results of our study.

41. **Magnetic field structure in the outflows of NGC 1333 IRAS4A protostellar core**

Shih-Ping Lai[1], Tao-Chung Ching[1], Josep Miquel Girart[2], Ramprasad Rao[3]
[1]*Institute of Astronomy, National Tsing Hua University, Taiwan.*
[2]*Institut de Ciències de l'Espai (IEEC-CSIC), Spain.*
[3]*Submillimeter Array, Inst. of Astronomy and Astrophysics, Academia Sinica, Taiwan.*

It is widely believed that magneto-centrifugal force is responsible for the launch of the protostellar outflows, however observation data on the magnetic fields are very rare for confirming the theories. We present the first SMA detection of CO polarizations from J=3-2 transition in protostellar outflows of NGC 1333 IRAS4A, providing the magnetic field structure close to the protostar. The polarization from molecular line emission is either parallel or perpendicular to the magnetic field direction, depending on the exact geometry (The Goldreich-Kylafis effect: Goldreich & Kylafis 1981). This ambiguity may be resolved by comparing the line polarization to the dust polarization, since the polarization from dust emission is always perpendicular to the magnetic field direction. We found that within the IRAS 4A dust envelope, the CO polarization directions are

mostly perpendicular to the dust polarization, suggesting that the CO polarization is parallel to the magnetic field. The directions of the CO polarization appear to vary smoothly from the dust continuum to the red-shifted lobe of the outflows without any abrupt changes, implying that the CO polarization remains parallel to the magnetic field direction in the outflows. Our inferred magnetic field directions suggest that a helical field may be wrapping around the outflows, which is consistent with the theoretical expectations for outflows associated with a rotating disk.

42. **The image jets modeling of gravitationally lensed sources**

Tatiana I. Larchenkova
Astro Space Center of P. N. Lebedev Physical Institute, Russia.

The image jets modeling of gravitationally lensed sources for different surface density distribution have performed. We considered several basic models of the gravitational lens mass distribution, in particular, the ellipsoidal density model, the model of exponential disk, the density profile of FNW. The expected image parameters are compared with results of observations. The possibility to observe the geometrical properties of lensed jets with cosmic and ground based interferometers are discussed.

43. **Side-entrainment in a jet embedded in a sidewind**

Diego Lopez-camara Ramirez
Instituto de Ciencias Nucleares, Universidad Nacional Autonoma de Mexico, Mexico.

Numerical simulations of HH jets never show side-entrainment of environmental material into the jet beam. This is because the bow shock associated with the jet head pushes the surrounding environment into a dense shell, which is never in direct contact with the sides of the jet beam. We present 3D simulations in which a side-streaming motion (representing the motion of the outflow source through the surrounding medium) pushes the post-bow shock shell into direct contact with the jet beam. This is a possible mechanism for modelling well collimated "molecular jets" as an atomic/ionic flow which entrains molecules initially present only in the surrounding environment.

44. **Spectral evolution of the galactic microquasars XTE J1550-564 and GRO J1655-40 during outbursts**

Alexander A. Lutovinov
Space Research Institute, Russia.

We present results of a broadband spectroscopy of the Galactic microquasars and black hole candidates XTE J1550-564 and GRO J1655-40, performed in a wide energy band ($3 - 200\,\mathrm{keV}$) with the INTEGRAL and RXTE observatories during strong outbursts. The spectra of both sources can be well described by the comptonization model, including a reflection component. The spectral parameters evolution was traced and studied during brightening and fading phases of each outburst to search a possible hysteresis and transitions from state to state. We estimated a size and optical depth of different regions around microquasars, like a hot plasma zone and optically thick accretion disk. Obtained results are discussed in terms of models for broadband emission and accretion flows in stellar-mass black holes.

45. **Multiwavelenth observations of 3C sources: jets, thermal emission or scattered light**

F. Duccio Macchetto
Space Telescope Science Institute, USA.

We have used a variety of space based (CHANDRA, HST) and ground based observatories to carry out extensive, X-ray, ultraviolet, optical and infrared observations of the 3CR sources in order to acquire a complete and quantitative inventory of the structure, contents and evolution of these important objects. We discovered new optical jets, new dust lanes, found face-on disks where there are optical jets, and revealed an almost ubiquitous population of point-like nuclei, whose properties support FR-I/BL Lac unified schemes, and shed new light on the central properties of powerful FR-IIs. The HST/NICMOS infrared images of some of the 3CR sources have helped us to "de-shroud" dusty galaxies, study the underlying host galaxy free from the distorting effects of dust, locate hidden regions of star formation and establish the physical characteristics of the dust itself. We have shown that optical cores are present in most of the FR-Is galaxies. Their optical luminosity shows a striking correlation with the radio core, arguing for a common non-thermal synchrotron origin and indicating that we have a clear view of the central regions. The high detection rate (85%) in a randomly oriented sample implies that geometrically thick pc-scale tori are generally not present. FR-II nuclei are more complex, with both thermal components and FR-I-like nuclei present. However, these results can be seriously influenced by dust extinction. Nuclear dust disk are ubiquitous with a 96% detection rate. I will show that the analysis of the properties of the infrared nuclear sources of 3CR radio-galaxies broadly confirms the results derived from the study of the optical nuclei. In particular, it confirms the presence of two classes of radio-loud AGN. FR-I radio-galaxies as well as the sub-population of sources with FR-II morphology characterized by a low excitation optical spectrum belong to the first class. In these sources the mechanism of emission related to the presence of non-thermal plasma in their radio-jets dominates over the contribution from thermal radiation related to the accretion process.

46. **Over a decade of evolving Faraday rotation in the jet of 1803+784**

Mehreen Mahmud[1], Denise Gabuzda[2]
[1]*JIVE, the Netherlands.*
[2]*Dept. of Physics, University College Cork, Ireland.*

Faraday Rotation gradients have been observed in the jet of 1803+784 at several epochs between 1997 and 2008. Faraday Rotation gradients across the parsec-scale jets of a number of Active Galactic Nuclei, have been interpreted as evidence for helical magnetic (**B**) fields — the gradients were taken to be due to the systematic variation of the line-of-sight B field across the jet. We have observed an interesting feature (so far, unique to this source): a reversal in the direction of this gradient over time in the jet, which occurred sometime between June 2000 and August 2002 (Mahmud, Gabuzda & Bezrukovs 2009). This provides supporting evidence for "magnetic-tower" type models in which field lines emerging from the central region of the accretion disk and closing in the outer region of the accretion disk are both "wound up" by the differential rotation of the disk. The net

observed RM gradient will essentially be the sum effect of two regions of helical field, one nested inside the other. The direction of the net RM gradient will be determined by whether the inner or outer helix dominates the RM integrated through the jet, and RM gradient reversals will be observed if the inner and outer helical fields dominate in different regions of the jet. New observations in 2008 follow the monitoring of the evolving Faraday Rotation gradient in this source.

47. **On the nature of the X-ray corona of black hole binaries in the hard state**

Julien Malzac, Renaud Belmont
CESR, CNRS (UMR 5187), Université de Toulouse (UPS), France.

We discuss the nature of the X-ray emitting plasma of black hole binaries and its connection with the steady jet observed in the hard state. It is well known that the temperature and optical depth of the Comptonising electrons of the X-ray corona of black hole binaries can be measured using spectroscopy in the 1 keV-1 MeV energy band. We emphasize recent developments in the modeling of high energy radiation processes which allow us to constrain other important physical parameters of the corona, such as the strength of magnetic field, or the temperature of the ions. The results appear to challenge current accretion models. In particular, standard advection dominated accretion flow do not match the observed properties of bright hard state X-ray binaries such as Cygnus X-1 or GX 339-4. We also show that in Cygnus X-1 current estimates of the jet power suggests that the bulk of the X-ray emission is not produced in the jet. On the other hand we find that all the data would be consistent with a multi-zone magnetically dominated hot accretion flow model.

48. **Application of a hadronic model to the high energy emission of Cen A**

M. Clementina Medina
IRFU (ex-DAPNIA), Service de Physique des Particules, France.

We present the lepto-hadronic model output for the VHE emission from the radiogalaxy Cen A. We assume that this emission is produced inside the inner relativistic jet where protons and electrons are accelerated in a compact region near its base. Afterwards they cool emitting multi-wavelength radiation as they propagate along the jet. The Spectral Energy Distribution is calculated taken into account all the matter-radiation interactions. The possibility of ultra high energy cosmic rays production and the accompanying neutrino output are discussed together with the possibility of detection with KM3NET and IceCube.

49. **Cosmology and the subclasses of the gamma-ray bursts**

Attila Mészáros[1], Jakub Řípa[1], Zsolt Bagoly[2], Lajos G. Balázs[3], István Horváth[4], Péter Veres[2,4]

[1]*Charles University, Faculty of Mathematics and Physics, Czech Republic.*

[2]*Dept. of Physics of Complex Systems, Eötvös University, Hungary.*

[3]*Konkoly Observatory, Hungary.*

[4]*Dept. of Physics, Bolyai Military University, Hungary.*

Several statistical studies —done also by the authors of this contribution— show that there are three subclasses of the gamma-ray bursts. They can be called as short, intermediate and long ones, because they can be separated with respect to their durations. The short and intermediate bursts are distributed anisotropically on the sky. This behavior is highly remarkable, and can have a cardinal impact on the cosmology. The subject of this contribution is a survey of this topic.

50. **Astrophysical jets driven by high-power lasers**

C. Michaut, N. Globus, V. Cayatte, C. Sauty

LUTH, Observatoire de Paris, CNRS, Université Paris-Diderot, France.

We use a meridional self-similar model to derive solutions of MHD equations to describe astrophysical jets, both in the newtonian or the general relativistic case, in order to modelize jets from YSO to those around rotating black holes.

We show that stellar jets even with a relatively low mass loading are capable of braking T-Tauri stars in a reasonable time scale of one million year. This also explain the possible dichotomy between WTTS and CTTS. Jets in WTTS would be purely of stellar origin and weak while CTTS would have a two component jet including a powerful disk wind. We apply the model to the specific case of RYTau jet.

We extend the same model in the general relativistic case using the 3+1 split of spacetime in Schwarzschild or Kerr geometry under the assumption of small opening angles. We describe only the spine of the jet that corresponds to the leptonic part in AGN jets. We discuss the effect of the metric on the collimation process and show that the rotation of the black hole induces a more efficient magnetic collimation.

51. **Astrophysical jets driven by high-power lasers**

C. Michaut[1], M. Koenig[2], C. D. Gregory[2], B. Loupias[3], A. Ravasio[2], A. Dizière[2], E. Falize[3], S. Bouquet[1,3]

[1] *LUTH, Observatoire de Paris, CNRS, Université Paris-Diderot, France.*

[2] *LULI, CNRS, CEA, UniversitParis 6, Ecole Polytechnique, France.*

[3] *CEA-DIF, France.*

Within the framework of laboratory astrophysics, we form a qualified group with astrophysicists, experimentalists and theoreticians in radiative hydrodynamics. For nine years, we have been performing laboratory experiments as radiative shocks and plasma jets in connection to astrophysical phenomena. Such laboratory experiments provide a unique opportunity to validate models and numerical schemes introduced in radiative

hydrodynamics codes such as HADES 2D establishing the link between laboratory with astrophysics.
In this presentation, we will summarize our experimental researches related to laboratory astrophysics using intense lasers. Laboratory experiments have been performed at the LULI (France) and GEKKO XII (Japan) installations. The goal of these experiments is to investigate some of the complex features of Young Stellar Objects (YSO), and in particular the plasma jet interaction with the interstellar medium (ISM).
To this aim, we developed a target design (a foam filled cone ended with a "nozzle") in order to generate a plasma jet (Loupias et al. 2007, PRL 99, 265001). A jet-like structure was observed and its time evolution studied by varying the foam density. Interaction with ambient medium was performed showing a complex interaction area where growing instabilities appear for low density gas (Loupias et al. 2009, Ap&SS, 322, 25).
Several visible diagnostics have been also implemented to infer the dimensionless parameters necessary to verify the similarity of the experiment with YSO jets. But the radiation escaping from the jet seemed to be lower compared with its astrophysical counterpart. Therefore, in order to investigate the effects of radiative cooling in the propagation of jets, we have investigated another type of target (Gregory et al. 2008, Plasma Phys. Control. Fusion, 50, 124039; Gregory et al. 2009, Ap&SS, 322, 37). Jets are created through laser irradiation of thin ($\sim 5\,\mu$m) conical shells of either gold, copper or aluminum. In choosing targets of differing atomic number, the significance of radiative losses for the jet evolution has been examined. The flows of interest are generated from the rear-face of the target, isolating the jet propagation region from the laser and allowing the introduction of an ambient medium. The experiment is diagnosed with a series of time-resolved optical diagnostics, allowing the evolution of the jet to be followed for extended periods in a single laser shot.

52. **Exploring the association of Fermi sources with Young Stellar Objects**

Pere Munar-Adrover[1], Josep Maria Paredes[1], Gustavo E. Romero[2]
[1]*Dept. d'Astronomia i Meteorologia, Universitat de Barcelona, Spain.*
[2]*Inst. Argentino de Radioastronomía and Universidad de La Plata, Argentina.*

Massive protostars have associated bipolar outflows which can produce strong shocks when interact with the surrounding medium. Some theoretical models predict that, under some conditions, particle acceleration at relativistic velocities can occur leading to gamma ray emission. In order to identify young stellar objects (YSO) that might emit gamma rays, we have crossed the Fermi First Year Catalog with catalogs of known YSOs, obtaining a set of candidates by spatial correlation. We have conducted Montecarlo simulations to find the probability of chance coincidence. Our results indicate that 72% of the candidates should be gamma-ray sources with a confidence above 5σ.

53. **Probing AGN-jet magnetic-field configurations using transverse profiles**

Eoin G. Murphy, Denise C. Gabuzda
Physics Department, University College Cork, Ireland.

Both the emission properties and evolution of Active Galactic Nuclei (AGN) radio jets are dependent on the magnetic fields that thread them. A better understanding of these magnetic fields is crucial for our understanding of the launching and propagation of AGN jets. Several observations of jets have suggested that, on parsec scales, the magnetic field threading the jet may have a significant helical component. Using a model first proposed by Laing (1981) and developed by Papageorgiou and Cawthorne (Papageorgiou 2005), the variety of magnetic field structures observed in AGN jets can essentially be reproduced by varying the pitch angle of the helical magnetic field and the angle to the line of sight. In order to reduce the total polarization intensity to agree with observed values, a tangled magnetic field component is also introduced to the model. The model distributions of intensity, linear polarization and Faraday rotation can be convolved with Gaussians, mimicking the effects of finite image resolution.By comparing data from observations of AGN jets with a databank of theoretical profiles generated using this model, the pitch angle of the helical field, angle of the jet to the line of sight and degree of entanglement of the field can be estimated. Preliminary results using this method will be presented.

54. **Exhaust inspection of the ultimate jet engine: the case of M 87**

Masanori Nakamura[1], Colin A. Norman[1], Keiich Asada[2], David L. Meier[3], David A. Garofalo[3]
[1]*Department of Physics & Astronomy, Johns Hopkins University, U.S.A.*
[2]*Academia Sinica Institute Astronomy & Astrophysics, R.O.C.*
[3]*Jet Propulsion Laboratory, California Institute of Technology, U.S.A.*

Some of the unanswered fundamental questions about extragalactic jets contain the location where the flow becomes relativistic and where acceleration and collimation terminate, as well as the specifics of how the flow interacts with the ISM. A nearby giant elliptical galaxy M 87 sitting at the center of the X-ray-luminous Virgo cluster is the first extragalactic jet discovered in 1918. Because of its proximity, the M 87 jet is one of the best candidates to explore relativistic outflows in extragalactic systems. However, its dynamical behavior has remained puzzling; no self-consistent view to understand observations; bulk acceleration and collimation, origin and trails of superluminal knots, and flow filamentary structures including magnetic field orientations. In this talk, we argue that the strongly magnetized jet is powered by large-amplitude torsional Alfvén waves, under a realistic ISM distributions. We introduce a self-consistent view of the M 87 jet that is grounded in the dynamics of relativistic magnetohydrodynamics (MHD). Our science goals include the foundation of the MHD paradigm in extragalactic jets.

55. **An additional component of broad-line region in 3c390.3-disk or jet?**

L. S. Nazarova[1], N. G. Bochkarev[2]
[1]*EAAS, Universitetskij Pr. 13, Russia.*
[2]*SAI, Universitetskij Pr. 13, Russia.*

Analysis of UV and optical spectra of the radio galaxy 3C 390.3 shows that the observed line ratios for the broad components of lines CIV/Lα, Lα/Hβ and Hα/Hβ can be explained best by two system of clouds (two components to the BLR). One BLR component has an electron density $10^{10-12}\,\mathrm{cm}^{-3}$ and is located in the equatorial plane at the distance ≈20 days from the center. This disk-like region emits predominantly low-ionization lines (including Hβ and Hα). The second BLR corresponds to the region with somewhat lower ($10^{8-9}\,\mathrm{cm}^{-3}$), located out of the equatorial plane in the direction of radio-jet. Gas in this region could extend out to a distance of ≈ 40-80 days from the center. This region emits the high-ionization CIV line, a significant part (≈ 60%) of Lα and far wings of the Balmer lines.

56. **Gamma-ray reprocessing in relativistic jets**

M. Orellana[1], L. J. Pellizza[2], G. E. Romero[1]
[1]*Instituto Argentino de Radiastronomía (IAR), Argentina.*
[2]*Instituto de Astronomía y Física del Espacio (IAFE), Argentina.*

Systems of two very different sizescales are known to produce very high-energy (VHE) radiation in their jets: AGNs and microquasars. The produced VHE photons can be absorbed by the intense environmental soft photon fields, coming from the companion star (in high mass binaries) or from the accreting material (disk+corona in AGNs). Energetic pairs are created by the photon-photon annihilation, and, depending on how efficient are the competing cooling channels, the absorption can lead to a reprocessing by Inverse Compton pair-cascade development.
A self-consistent modeling of these systems as gamma-ray sources should then include, along with the emission and absorption processes, a thorough treatment of the pair cascades. We discuss here on this issue, focusing on our results of numerical simulations.

57. **A 300 pc diameter bubble blown by a powerful microquasar jet**

Manfred W. Pakull[1], Roberto Soria[2], Christian Motch[1]
[1]*Observatoire Astronomique, University of Strasbourg, France.*
[2]*MSSL University College London, UK.*

Black hole accretion states near or above the limiting Eddington luminosity are still poorly known because of the rarity of such sources in today's Universe. Ultraluminous X-ray sources are the most luminous class of non-nuclear black holes ($L_\mathrm{X} \sim 10^{40}$ erg/s, and are often associated with large shock-ionized nebulae but with no evidence of collimated jets. Microquasars with steady jets are much less luminous. Here we report that the 300 pc diameter large nebula S26 in the nearby galaxy NGC 7793 is powered by a black hole with a pair of collimated jets (Pakull et al. 2010, Nature, in press). S26 is similar to the radio nebula W50 around the famous Galactic source SS433, but twice as large and many times more powerful. We determine a mechanical power $\sim 5\times10^{40}$ erg/s from

the size of the cocoon, the optical line flux and the high expansion velocity (275 km/s). The jets appear much more energetic than the X-ray emission from the core. S26 has the textbook structure of an FR II-type active galaxy: X-ray and optical core; X-ray hot spots; radio lobes and X-ray/radio cocoon. It is a microquasar where most of the jet power is dissipated in the form of thermal particles rather than relativistic electrons. We will discuss the implications for our understanding of microquasar physics and the interaction of stellar relativistic jets with the interstellar medium.

58. **Is there a mildly relativistic jet in SN2007gr?**

Zsolt Paragi[1,2] et al.
[1]*Joint Institute for VLBI in Europe, the Netherlands.*
[2]*MTA Research Group for Physical Geodesy and Geodynamics, Hungary.*

Supernovae (SNe) Ic have drawn increasing attention since 1998 owing to their sparse association with long duration Gamma-Ray Bursts (GRBs). Although both phenomena originate from the core collapse of a massive star, the former release most of their energy at optical wavelengths, while the latter mostly in soft gamma-rays or hard X-rays. Moreover, the GRB central engine generates ultra-relativistic jets, which beam the early emission into a small narrow cone; no relativistic outflows have yet been found in SNe Ib/c explosions. We show results from joint very long baseline interferometry (VLBI) and Westerbork Synthesis Array (WSRT) observations of SN2007gr, which indicated resolved emission on milliarcsecond scales, suggesting mildly-relativistic expansion in the source. We also present here new late-time WSRT observations taken to address the recent suggestion that the discrepancy between our VLBI peak brightness and the WSRT total flux density is due to underlying extended emission.

59. **A model for emission from microquasar jets: consequences of a single acceleration episode**

Asaf Pe'er[1], Piergiorgio Casella[2]
[1]*Space Telescope Science Institute, USA.*
[2]*School of Physics and Astronomy, University of Southampton, UK.*

We present a new model of emission from jets in Microqasars, which implements elements from the study of jets in gamma-ray bursts to these objects. By assuming that electrons are accelerated once at the base of the jet to a power law distribution above a low energy Maxwellian, and are cooled by synchrotron emission and possible adiabatic energy losses along the jet, a wealth of spectra can be obtained. We will show our theoretical results which can explain some of the key observations. In particular, we will show that: (I) a flat radio spectrum, as is frequently seen, is a natural outcome of the model; (II) Strong magnetic field results in a flux decay in the optical/UV band as $F_\nu \sim \nu^{-1/2}$, irrespective of many of the uncertainties of the model. (III) An increase of the magnetic field above a critical value of $\sim 10^5$ G leads to a sharp decrease in the flux at the radio band, while the flux at higher frequencies saturates to a constant value. We conclude that scatter in the values of the magnetic field may provide a natural explanation to the observed scatter in the radio/X ray luminosity correlation seen in these objects.

60. **The pertinence of Jet Emitting Discs in microquasars. Theory and comparison to observations**

Pierre-Olivier Petrucci[1], Jonathan Ferreira[1], Gilles Henri[1], Cedric Foellmi[1], J. Malzac[2]
[1]*Laboratoire d'Astrophysique de GrenOble, Université Joseph Fourier, France.*
[2]*Centre d'Etude Spatial des Rayonnement, France.*

Very broad band observations of microquasars, from radio to X-rays, have revealed the strong connection between accretion and ejection processes in these objects. Not only their radiative outputs are a complex combination of accreting and expelling components but jets appear to play also a crucial role in the dynamics and the energetics of these systems.
Based on the complete calculation of the full accretion-ejection set of equations, we developped since a few years a model that aims at explaining the spectral states of BH binaries as well as their spectral evolution during outbursts. In our view, the accretion flow is pervaded by a large scale magnetic field of bipolar topology. In the hard state, the field is large enough for a new class of accretion flow to set in where most of the released accretion power feeds self-collimated jets. Such a Jet Emitting Disc (JED) has dynamical properties quite different from both the standard and advection dominated discs. It also exhibits three different thermal equilibrium branches at a given radius: two stable (cold and hot) and one intermediate unstable. The hot solution has all the characteristics of the so-called "hot corona" generally invoked in XrB sytems in the Low/Hard states.
We will detail the energetics and radiative expectations of our model and show their good agreement with those observed in Cygnus X-1 in terms of jet power, jet velocity and spectral emission. The presentation of the corresponding SEDs, the comparisons to the "jet-dominated" part of the Hardness-Intensity diagram as well as the application of the model to the hysteresis behavior of X-ray binaries will also be presented.

61. **Testing the blazar sequence with a large sample of BL Lac objects**

Richard M. Plotkin[1], Sera Markoff[1], Scott F. Anderson[2], Brandon C. Kelly[3], Elmar Körding[4], Scott C. Trager[5]
[1]*Sterrenkundig Instituut "Anton Pannekoek", Univ. of Amsterdam, the Netherlands.*
[2]*Dept. of Astronomy, University of Washington, USA.*
[3]*Harvard-Smithsonian Center for Astrophysics, USA.*
[4]*Université Paris Diderot/CEA Saclay, France.*
[5]*Kapteyn Astronomical Institute, University of Groningen, the Netherlands.*

Jets observed from accreting black holes appear remarkably similar over eight orders of magnitude in black hole mass, with more massive black holes launching more powerful jets. For example, there is an observed correlation, termed the fundamental plane of black hole accretion, between black hole mass, radio luminosity, and X-ray luminosity. Here, we probe the high-mass tail ($10^8 - 10^9 M_\odot$) of the accreting black hole distribution with BL Lac objects —a rare class of radio-loud AGN viewed nearly along the axis of a relativistic jet. Because their jets are relativistically boosted, jet emission often dominates the entire spectral energy distributions (SEDs) of BL Lac objects, from the radio to the gamma-ray. This makes BL Lacs excellent probes of relativistic jet physics. We start with the largest uniform sample of BL Lacs yet assembled (700 objects from

the SDSS), and we build their SEDs using data from large multiwavelength surveys (i.e., FIRST/NVSS, SDSS, GALEX, RASS, etc.). We then use these SEDs to test the blazar sequence —a proposed anti-correlation between jet power and SED peak frequency— which might depend on black hole mass and accretion rate. This study utilizes the largest sample yet for a blazar sequence investigation, and it is the first one to include ultraviolet (UV) data (which is a powerful waveband at moderate frequencies because, unlike in the optical and near-infrared, contamination from the host galaxy is usually negligible in the UV). Finally, we place our BL Lac objects on the fundamental plane, and we discuss if their scatter around the plane is a function of their location in the blazar sequence, which can be interpreted as deviations as a function of accretion rate and/or Doppler boosting.

62. **New semi-analytical solution for relativistic, magnetohydrodynamical jets**

Peter Polko[1], David L. Meier[2], Sera Markoff[1]
[1]*Astronomical Institute "Anton Pannekoek", University of Amsterdam, the Netherlands.*
[2]*Jet Propulsion Laboratory, California Institute of Technology, USA.*

Jets can contribute to the spectra of X-ray binaries (XRBs) and active galactic nuclei (AGN) from the radio through the γ-ray bands; thus understanding their physics is key for interpreting the data. It is clear from observations that jets accelerate particles into power-law distributions; however, the nature and physical location of this acceleration is still an open question. Recent VLBI observations in particular suggest that the particle acceleration begins at a point offset from the black hole by $\sim 10^4\, r_{\rm g}$, possibly via a collimation shock. At the same time, spectral fitting of simultaneous, broadband data from both XRBs and AGN in jet-dominated states also supports the premise that this acceleration does not begin at the base of the jets. From a magnetohydrodynamical (MHD) point of view, it is natural to associate the onset of particle acceleration with the final MHD critical point in the flow, the modified fast point (MFP), where causal contact with the upstream flow is broken. In this way a standing disruption like a shock can form, and this location might vary with jet physical parameters such as total power or size of the launch region. In order to study this issue, we have used the self-similar formalism of Vlahakis & Königl (2003) to simplify the MHD equations and to derive solutions that cross the critical points. We have found a new parameter space of solutions that cross the MFP at a finite height above the disc *and* are relativistic, spanning a range of Lorentz factors $\Gamma \leq 10$. We present these results, as well as preliminary work connecting the self-similar formalism to the non-self-similar conditions with gravity near the base of the jets. These results will be incorporated into a radiative model to test against broadband astrophysical data.

63. **Mid-infrared observations of Cygnus X−1: a first spectroscopic detection of compact jets**

Farid Rahoui[1], Julia C. Lee[1], Sebastian Heinz[2], Dean C. Hines[3], Jörn Wilms[4]
[1]*Harvard University, Department of Astronomy & Harvard-Smithonian CfA, USA.*
[2]*Astronomy Department, University of Wisconsin-Madison, USA.*
[3]*Space Science Institute, USA.*
[4]*Dr. Karl Remeis-Observatory & ECAP, University of Erlangen-Nuremberg, Germany.*

We report the first spectroscopic measurement of the mid-infrared jet break frequency in microquasars, based on a multi-wavelength (radio, mid-infrared, X-ray) observational campaign of Cygnus X−1. Over the three epochs of our observations, we quantify the changes in the mid-infrared (Spitzer/IRS: 5−35 micron) spectroscopic properties as related to the contribution from the Cygnus X−1 compact jets, and surroundings. We will discuss these findings in the context of what this implies for the relationship between its jet, accretion, and focused stellar wind. For example, observed changes in the break frequency over our three observations will be considered in the framework of state transitions. Moreover, there are tantalizing hints from observed blue and red-shifted emission lines which point to interaction between discrete ejections and the stellar wind of the companion during one epoch in contrast to the other two.

64. **Studying magnetic fields in several parsec-scale AGN jets using Faraday rotation**

Andrea Reichstein, Denise Gabuzda
University College Cork, Ireland

We will present multi-frequency radio observations from the Very Long Baseline Array (VLBA) of selected AGN, that seem to have a B-field structure with a central "spine" of B-field orthogonal to the jet and a longitudinal B-field near one or both edges of the jet. Two explanations for this structure have been discussed in the literature: shocks making the central orthogonal field combined with a jet-medium interaction causing the longitudinal "sheath", or both components produced by a helical jet magnetic field. One way to investigate this phenomenon is to look for gradients in the Faraday Rotation across the jet. We will discuss results providing evidence for the latter picture.

65. **Observations of gamma-ray blazars with *Fermi* and VERITAS**

Luis C. Reyes[1] (for the *Fermi*-LAT and VERITAS Collaborations)
[1]*Kavli Institute for Cosmological Physics, University of Chicago, USA.*

Among the different gamma-ray sources observed by *Fermi* and VERITAS, blazars stand out as the dominant class of extragalactic objects. In this contribution we will present highlights from the joint observations carried out with both instruments and illustrate how the complementary capabilities of space and ground-based instruments are leading us to a better understanding of gamma-ray blazars as high-energy sources, as a population, and as a cosmological tool to probe the background radiation known as extragalactic background light (EBL).

66. **A lepto-hadronic model for the high energy emission from the jets of FR I radiogalaxies**

Matias M. Reynoso[1], Maria C. Medina[2], Gustavo E. Romero[3]
[1]*Universidad de Mar del Plata & IFIMAR, Argentina.*
[2]*IRFU (ex-DAPNIA), Service de Physique des Particules, France.*
[3]*Instituto Argentino de Radioastronomía (CONICET), Argentina.*

We present a lepto-hadronic model for the VHE emission from the relativistic jets in FR I radiogalaxies. We assume that protons and electrons are accelerated in a compact region near the base of the jet, and they cool emitting multiwavelength radiation as they propagate along the jet. The particle distributions are obtained using an inhomogeneous steady-state transport equation that accounts for the cooling processes as well as the convection of particles along the jet. The dominant processes of the spectral energy distribution are electron and proton syncrotron, inverse Compton interactions, proton-photon, and proton-proton collisions. The accompanying neutrino output is obtained the possibility of detection with KM3NET and IceCube is discussed for the cases of Cen A and M 87.

67. **The relation between the radio jet and the near-IR line emission in Seyfert galaxies**

Rogemar A. Riffel[1], Thaisa Storchi-Bergmann[2]
[1]*Universidade Federal de Santa Maria, Departamento de Física, Brazil.*
[2]*Universidade Federal do Rio Grande do Sul, Instituto de Física, Brazil.*

We present near-infrared integral field spectroscopy for the central few hundreds of parsecs of three nearby Seyfert galaxies (ESO428-G14, Mrk 1066 and Mrk 1157) obtained with the Gemini Near Infra-Red Spectrograph Integral Field Unit (GNIRS IFU) and Gemini's Near-Infrared Integral Field Spectrograph (NIFS) at spatial resolutions of a few tens of parsecs. From measurements of the emission-line profiles we have constructed two-dimensional maps for the flux distributions, radial velocities and gas velocity dispersions for the $H_2\,\lambda 2.1218\,\mu$m, Paβ and [Fe II] $\lambda 1.2570\,\mu$m emitting gas. These maps are compared with previous published radio continuum images in order to investigate what is the role of the radio jet on the excitation and kinematics of the Narrow-Line Region emitting gas. We conclude that the molecular and ionized gas present distinct flux distributions and kinematics, with the former more restricted to the plane of the galaxies and the latter extending to high latitudes, being associated with the radio emission. We found a tight relation between the radio structure and the ionized gas emission-line flux distributions and kinematics, revealing that the radio jet plays a fundamental role not only in shaping the narrow-line region but also in the imprint of its kinematics.

68. **Isolating the jet in broadband spectra of XBs**

David M. Russell
Astronomical Institute 'Anton Pannekoek', University of Amsterdam, the Netherlands.

Most accretion-powered relativistic jet sources in our Galaxy are transient X-ray binaries. Efforts to coordinate multiwavelength observations of these objects have improved dramatically over the last decade. Now the challenge is to interpret broadband spectra of X-ray binaries that are well sampled in both wavelength and time. Here I focus on the evolution of the jet in their broadband spectra. Various methods can be employed to attempt to isolate the jet component, and I emphasise the importance of measuring the jet flux and spectrum in the infrared, where the break to optically thin emission likely resides. I present some of the most densely sampled broadband SEDs of both black hole (e.g. GX 339−4) and neutron star (IGR J00291+5934) XBs which include radio, mid-IR, near-IR, optical, UV and X-ray data. In one intriguing case, the synchrotron emission from the jet likely dominates the X-ray power law of XTE J1550-564 at low luminosities during the hard state outburst decline.

69. **The X-ray burster 4U 1608–522 as seen by INTEGRAL**

Celia Sanchez-Fernandez, Erik Kuulkers
INTEGRAL Science Operations Center, ISOC, the Netherlands.

We present here a long term study of the X-ray burster 4U 1608−522 based on INTEGRAL data. We have studied the accretion history of the source over six years, and searched for X-ray bursts in the same time period. In this work we describe the bursting behaviour of the system as a function of the accretion rate onto the compact object.

70. **Evolution of the parsec-scale jet in 3C 345**

Frank K. Schinzel, Andrei P. Lobanov, J. Anton Zensus
Max-Planck-Institut für Radioastronomie, Germany.

The $16^{\rm m}$ quasar 3C 345 is one of the best examples of an active galactic nucleus (AGN) showing structural and flux variability on parsec scales around a compact unresolved radio core. It has been observed from radio to γ-ray wavebands with a special focus on Very Long Baseline Interferometry (VLBI) observations in the range 1-100 GHz that cover a period of over 30 years. The complex parsec-scale jet of 3C 345 exemplifies an archetypical "superluminal" jet with helical substructure. Existing VLBI observations of 3C 345 form an unprecedented database enabling a unique insight into the long-term evolution of the parsec-scale radio emission. We will present the latest results from our ongoing long-term VLBI monitoring of 3C 345, focusing on the morphological, kinematic, and spectral evolution of the parsec-scale jet. Special attention will be given to the recent onset of a new period of high activity in the source that has been manifesting itself since 2008 from radio through γ-rays. We combine recent VLBI and high energy observations to study the relation between the radio emission and the production of high energy photons in 3C 345.

71. **Suzaku observations of the radio galaxy Fornax A west lobe**

Hiromi Seta[1], Makoto S. Tashiro[1], Naoki Isobe[2]
[1]*Depertment of Physics, Saitama University, Japan.*
[2]*Department of Astronomy, Kyoto University, Japan.*

Suzaku observations of the Fornax A west radio lobe are reported. The cosmic microwave background boosted inverse-Comptonized (IC) X-ray from the radio lobe has been observed for decades, and authors have estimated the magnetic field and electron energy density assuming a single component of the relativistic electrons generating both the IC X-rays and the synchrotron radio emission. However the observed $1-10\,\mathrm{keV}$ X-rays are produced by electrons, whose Lorentz factor $\gamma = 1000 - 3000$, are not identical of those emitting synchrotron radiation ($\gamma > 10000$), and slight discrepancy of spatial distributions of these two emissions are suggested (Tashiro et al. 1998, 2001). In order to examine the basic assumptions for the electron energy and spatial distribution, we performed long mapping observations on the west lobe of Fornax A. We succeeded to detect hard X-rays up to 20 keV from the west lobe of Fornax A, and to show that the obtained $0.7-20\,\mathrm{keV}$ spectrum is well described with a single power-low model with the same spectral slope as that of synchrotron radio emissions. The observed IC X-ray flux density of $0.12 \pm 0.01\,\mathrm{nJy}$ at $1\,\mathrm{keV}$ which implies the magnetic field of $1.3 \pm 0.4\,\mu\mathrm{G}$. We also showed that the Lorentz factor of the electrons range at least $300 - 90000$ with a single power-law energy distribution (Tashiro et al. 2009). This paper also shows the results from the mapping observations with Suzaku XIS covering the whole west lobe.

72. **Measuring the spin of microquasar XTE J1550–564 using constraints from X-ray jets**

James F. Steiner, Jeffrey E. McClintock, Ramesh Narayan
Harvard-Smithsonian Center for Astrophysics, USA.

The microquasar XTE J1550−564 produced the very first X-ray jets to be observed from a black hole X-ray binary. *Chandra* imaging data obtained for these jets during 2000-2003 offer a near-unique opportunity to test whether the black hole's spin axis is tilted or aligned with the plane of the binary orbit. To this end, we apply a kinematic relativistic blast wave model to the jet positions and compare the derived orientation of the jet to the optically measured binary inclination angle. We measure the spin of XTE J1550−564's black hole by applying a fully relativistic model of the thermal X-ray continuum radiation produced by a geometrically thin and optically thick accretion disk. Our spin measurement is derived from a comprehensive analysis of the soft *RXTE* PCA spectra taken during XTE J1550−564's primary outburst in 1998.

73. **A detailed study of Spitzer IRAC emission associated with Herbig-Haro objects**

Michihiro Takami[1], Jennifer Karr[1], Haegon Koh[2], How-Huan Chen[1,3], Hsu-Tai Lee[1]
[1]*ASIAA, Taiwan.*
[2]*Sejong University, Korea.*
[3]*National Tsing-Hua University, Taiwan.*

The Infrared Array Camera (IRAC) on the Spitzer Space Telescope has been extensively used for observing jets and outflows associated with young stellar objects. A detailed understanding of extended emission observed at four bands (3.6, 4.5, 5.8 and 8.0 μm) would allow us to investigate their detailed physical conditions (density, temperature, dissociation rate) and understanding how the unseen components of the outflow interacts with the ambient gas.
We have made a detailed analysis of Spitzer-IRAC images obtained toward six Herbig-Haro objects (HH 54/211/212, L 1157/1448, BHR 71). Our analysis includes: (1) comparisons of the morphology between the four IRAC bands and H_2 1-0 S(1) at 2.12 μm; (2) measurements of the spectral energy distributions (SEDs) at selected positions; and (3) comparisons of these results with calculations of thermal H_2 emission at LTE (207 lines in four bands) and non-LTE (32–45 lines). We show that the observed similarities and differences in morphology are well explained by thermal H_2 emission. The majority of the observed SEDs are explained with H_2 emission, in particular with simple shock models with a power-law cooling function ($\Lambda \propto T^s$). The SEDs of bright knots suggest the presence of contaminating emission at 4.5 μm presumably due to vibrational CO transitions. We also show that analysis with flux ratios is useful for identifying Mach disks, and in searching for shocked emission in scattered continuum near the base of the driving source.

74. **The exceptional gamma-ray flares of 3C454.3: constraining the location of the emission region and the jet power**

F. Tavecchio, G. Ghisellini, G. Bonnoli, L. Foschini, G. Ghirlanda
INAF - Osservatorio Astronomico di Brera, Italy.

In December 2009 and April 2010, the blazar 3C 454.3 became the brightest high energy source in the sky, exceeding the level of 10^{-5} ph cm^{-2} s^{-1} above 100 MeV. This high flux level allowed us to find evidence of variability on timescales of few hours, challenging the scenario recently advanced in which the bulk of the gamma-ray luminosity is produced in regions of the jet at large distances (tens of parsec) from the black hole. For the flare of december 2009 we constructed really simultaneous spectral energy distributions (SED) using optical, X-ray and γ-ray data taken before, during, and after the luminosity peak. Our main findings are: i) the optical and X-ray fluxes correlate more than linearly with the γ-ray flux; ii) a simple one-zone synchrotron inverse Compton model can account for all the considered SED and the variability; iii) the power that the jet spent to produce the peak gamma-ray luminosity is of the same order, or larger, than the accretion disk luminosity.

75. **The Bardeen-Petterson effect as the precession mechanism for the radio galaxy 3C 84 (NGC 1275)**

Danilo M. Teixeira[1], Zulema Abraham[1], Anderson Caproni[2], Diego Falceta-Gonçalves[2]
[1]*Instituto de Astronomia, Geofísica e Ciências Atmosféricas, Universidade de São Paulo, Brazil.*
[2]*Núcleo de Astrofísica Teórica, CETEC, Universidade Cruzeiro do Sul, Brazil.*

The radio galaxy 3C 84, also known as NGC 1275, is located at a distance of 75 Mpc in the center of Perseus Cluster. Its optical morphology and the existence two systems of hydrogen lines seem to suggest that this galaxy is the result of an ongoing merge of two galaxies. X-ray emission has been observed in the nuclear region as well as in the halo. Bubble-like structures with different position angles with respect to the center of the cluster are seen in the X-ray maps; it has been suggested that these bubbles are inflated by a precessing jet. Recently, 3D numerical simulations (Falceta-Gonçalves et al. 2010, ApJ, 213, L74) showed that, under certain conditions, a precessing jet can inflate multiple pair of bubbles. Assuming that the Bardeen-Petterson effect can be the responsible for the jet precession in NGC 1275, they found that a precession period of $T_{\rm prec} = 5 \times 10^7$ years and a ratio between the angular momenta of the accretion disc and of the black hole of 1.1 could reproduce the observed X-ray maps. In fact, the combination of the Lense-Thirring effect and the viscosity of the accretion disc lead to the alignment or counter-alignment of the angular momenta of the Kerr black hole and of the accretion disc, which is known as the Bardeen-Petteson effect. Using the parameters of the numerical simulations, we studied the accretion disk and black hole physics of NGC 1275 and confirmed that the Bardeen-Petterson effect can be a possible mechanism for the jet precession and we were able to put limits on the spin of the Kerr black hole, having a lower limit of 0.23 and an upper limit of 0.4 and an accretion disk with column surface density in the form of a power law with exponent $-1.5 < s < -1.0$.

76. **Radiative MHD simulations of the jets from RW Aurigae**

Ovidiu Teşileanu[1], Andrea Mignone[2], Silvano Massaglia[2], Matthias Stute[2]
[1]*RCAPA, University of Bucharest, Romania.*
[2]*Dipartimento di Fisica Generale, University of Turin, Italy.*

The MHD simulations of stellar jets recently included complex models of radiative emission computation, allowing for better predictions in terms of emission line ratios. Employing also Adaptive Mesh Refinement with the PLUTO code, the large-scale propagation of jets could be followed. The simulation of multiple shockwaves originating in perturbations close to the jet origin and travelling along the jet beam allows for the construction of synthetic emission maps at various wavelengths, to be directly compared to observations. We apply this procedure for the jets originating from RW Aurigae.

77. **X-ray evidence for accretion disk winds in radio-quiet and radio-loud AGN**

F. Tombesi[1,2], R. M. Sambruna[1], M. Cappi[3], J. N. Reeves[4], V. Braito[5]
[1]*Laboratory for High Energy Astrophysics, NASA/Goddard Space Flight Center, USA.*
[2]*Dept. of Astronomy, University of Maryland, USA.*
[3]*INAF-IASF Bologna, Italy.*
[4]*Astrophysics Group, School of Physical and Geographical Sciences, Keele Univ., UK.*
[5]*Dept. of Physics and Astronomy, University of Leicester, UK.*

We present the results of our uniform and systematic search for accretion disk winds/outflows in a large sample of 42 radio-quiet and 5 radio-loud AGN observed with XMM-Newton and Suzaku. The most important diagnostic tool for their observation is the detection of highly ionized blue-shifted Fe K-shell absorption lines in the X-ray spectra at energies higher than 7 keV. We found a significant incidence of $\sim 35\%$ in radio-quiet AGN and $\sim 60\%$ in the smaller radio-loud AGN sample. This directly suggests a large covering factor for the absorbers, thereby implying large opening angles. The detection of variability even on time scales as short as a few days also indicate somewhat compact absorbers. The associated blue-shifted velocities are often quiet large, up to mildly relativistic values of $\sim 0.2-0.3c$. We call these new extreme X-ray absorbers with velocities higher than 10^4 km/s Ultra-fast Outflows (UFOs). We estimate a location close to the super-massive black hole, at distances of less than $\sim 0.01-0.1$ pc. From detailed photo-ionization modeling we derive extreme ionization parameters, in the range $\log \xi \sim 3-6\,\mathrm{erg\,s^{-1}\,cm}$, and large column densities, in the range $N_{\rm H} \sim 10^{22}-10^{24}\,\mathrm{cm^{-2}}$. The kinetic energy carried by UFOs can be of the order of the source bolometric luminosity and of the jet power in radio-loud objects. Moreover, their mass outflow rate can be comparable to the accretion rate. This suggests that UFOs might have a strong impact on the environment surrounding the AGN and may play an important role, even more than jets, in the expected cosmological feedback. The most likely association of UFOs with accretion disk winds/outflows and their detection in both radio-quiet and radio-loud AGN give us further important clues on the disk-jet connection and on the AGN accretion/ejection physics in general.

78. **Super-outburst of V455 And. Do cataclysmic variables produce jets after all?**

Gagik H. Tovmassian[1], Boris T. Gänsicke[2], Sergey V. Zharikov[1], Abdiel Ramirez[1]
[1]*Observatorio Astrónomico Nacional SPM, Instituto de Astronomía, Universidad Nacional Autónoma de México, México.*
[2]*Department of Physics, University of Warwick, UK.*

It is believed that cataclysmic variables do not produce jets unlike other, more massive interactive binaries. Here we present spectrophotometric observations of the super-outburst of V455 And. This enigmatic object has demonstrated not only all possible CV features, but far more. We will show that strong wind perpendicular the the accretion disc at the maximum of the super-otburst, i.e a jet, can probably explain observed spectroscopic behavior of this system.

79. **An outburst of SS 433 observed on VLBI scales**

Valeriu Tudose[1,2,3], Zsolt Paragi[4], Rob Fender[5,6], Mike Garrett[1,7,8], James Miller-Jones[9], Sergei Trushkin[10], Anthony Rushton[11], Ralph Spencer[12], George Heald[1], Paolo Soleri[13]
[1]*Netherlands Institute for Radio Astronomy, the Netherlands.*
[2]*Astronomical Institute of the Romanian Academy, Romania.*
[3]*Research Center for Atomic Physics and Astrophysics, Romania.*
[4]*Joint Institute for VLBI in Europe,*
Postbus 2, 7990 AA Dwingeloo, the Netherlands
[5]*School of Physics and Astronomy, University of Southampton, UK.*
[6]*Astronomical Institute "Anton Pannekoek", University of Amsterdam, the Netherlands.*
[7]*Leiden Observatory, University of Leiden, the Netherlands.*
[8]*Centre for Astrophysics and Supercomputing, Swinburne University of Technology, Australia.*
[9]*National Radio Astronomy Observatory, USA.*
[10]*Special Astrophysical Observatory, Russian Academy of Science, Russia.*
[11]*European Southern Observatory, Germany.*
[12]*Jodrell Bank Centre for Astrophysics, University of Manchester, UK.*
[13]*Kapteyn Astronomical Institute, University of Groningen, the Netherlands.*

e-VLBI (electronic very long baseline interferometry) is a relatively new implementation of the VLBI technique consisting in transferring the data from the radio telescopes to the correlator over the internet and correlating them in near real-time. Time-wise this is a major improvement over the traditional method. e-VLBI is thus offering new opportunities for radio transient studies. Its capability of rapid response enables a more efficient decision making process with respect to potential follow-up observations. The rapid feedback time also permits to quickly modify the observing strategy to best track the development of the transient phenomena. SS 433 is a high-mass X-ray binary system (XRB) and one of the most persistent sources of relativistic jets in the Milky Way. The object has been intensively studied in radio at arcsec scales, however the high-resolution observations (i.e. VLBI) are relatively scarce. In 2008 November the system was in outburst. Using the e-VLBI capabilities of the European VLBI Network (EVN) we observed SS 433 for three epochs during the active phase. The data offered an unprecedented view of the system's behaviour in outburst at mas scales. We used the so called "kinematic model" (which predicts the ejection date and position angle of any ejected knot) to investigate the dynamic parameters of SS 433 and we examined the polarization properties of the ejected material conducting one of the very few studies at this high resolution. Here we present a summary of our results.

80. **VLT / NACO detection of a candidate externally irradiated circumstellar disk/jet in Trumpler 14**

Sílvia Vicente[1], João Alves[2], Isamu Matsuyama[3], Hervé Bouy[4], Joana Ascenso[5], Filipe D. Santos[6,7], Timo Prusti[1]
[1]*ESA (ESTEC), Research and Scientific Support Department, The Netherlands.*
[2]*Institut für Astronomie, Universität Wien, Austria.*
[3]*Department of Earth and Planetary Science, University of California Berkeley, USA.*
[4]*LAEFF/INTA, Spain.*
[5]*CAUP, Portugal.*
[6]*Departamento de Física da Faculdade de Ciências da Univ. de Lisboa, Portugal.*

Externally illuminated circumstellar disks or *proplyds* are a special class of low-mass young stellar objects (YSOs) found embedded within or near a HII region. They are usually identified as comet-shaped photoionized envelopes with bright ionization fronts facing the source of external UV radiation and extended tails pointing away from it which are most visible in hydrogen recombination lines, in the optical and near-IR, and other optical ionized species like [OIII], [SII] and [NII]. These objects can also appear as cusps and round heads without tails and other irregular forms, some of them probably associated with supersonic jets.
In this work, we report the discovery and present the results of a first analysis of the observed morphology of an extended globule that might be a photoevaporating circumstellar disk/microjet system similar to the bright proplyds found in the Orion Nebula Cluster (ONC). The proplyd/jet candidate was discovered during a VLT/NAOS-CONICA (NACO) $JHKsL'$Brα survey of the core of Trumpler 14, a young cluster ($<$ 1 Myr; 2.8 kpc) located in the Carina Nebula (NGC 3372). Archival HST/ACS/HRC images in the optical, together with the adaptive optics near-IR images and existing photoevaporating theories, were used to discuss the possible scenarios for the nature, origin and expected lifetime of this object that can be confirmed or rejected by future high-resolution multi-wavelength observations.

81. **Transient high-energy flares from accreting black holes**

Florencia L. Vieyro[1,2], Gustavo E. Romero[1,2]
[1]*Instituto Argentino de Radioastronomía, Argentina.*
[2]*Fac. de Ciencias Astronómicas y Geofísicas, Univ. Nacional de La Plata, Argentina.*

We present a model for high-energy flares in accreting black holes based on the injection in a magnetized corona of a non-thermal population of relativistic particles. Coupled transport equations are solved for all species of particles and the electromagnetic and neutrino output is predicted for the case of Galactic black holes.

82. **A leptonic/hadronic jet model for the broadband spectrum of the low-mass microquasar XTE J1118+480**

Gabriela S. Vila[1], Gustavo E. Romero[1,2]
[1]*Instituto Argentino de Radioastronomía, Argentina.*
[2]*Fac. de Ciencias Astronómicas y Geofísicas, Univ. Nacional de La Plata, Argentina.*

The low-mass black hole binary XTE J1118+480 is an extensively studied transient X-ray source. Although no jets have been directly imaged yet in this system, the characteristics of its radio emission strongly indicates the presence of outflows.
In this work we present a one–zone jet model that fits the data from simultaneous broadband radio-to-X-rays observations of XTE J1118+480. We calculate the radiative contribution to the non-thermal spectrum of both relativistic electrons and protons, as well as that from secondary muons, charged pions and electro-positron pairs produced at high-energy hadronic interactions. The distribution in energy of all the species are obtained taking into account particle energy losses, injection, decay and escape from the emission region. We also asses absortion effects on the emission spectrum due to photon-photon annihilation. Finally, we discuss the detectability of XTE J1118+480 at high energies energies with the present instruments according to the predictions of our model for the gamma-ray band.

83. **Interpreting the multi-waveband spectra of 3C 273 jet knots with a modified synchrotron spectrum model**

Chuncheng Wang
Department of Astronomy, University of Science and Technology of China, P.R. China.

The X-ray emission mechanism in powerful FR II/quasar jets is under hot debate. The spectral energy distribution (SED) of the jet knots found in many of those objects reveals double-humped shape. It is generally believed that the X-ray emissions which locate at the high-energy hump may origin from inverse-Comptonization of cosmic microwave background photons by jet electrons (IC/CMB) or from synchrotron radiation of an electron population. Latest observational results seem to favor the second scenario. The X-ray spectra of the jet knots, however, cannot be directly connected to extrapolation of the radio spectra, and researchers have to resort to the second population of relativistic electrons to give X-ray synchrotron emissions. We find, however, if the magnetic field lines in the emission region are curved with random curvature radius, the resulting synchrotron spectra of one electron population with power-law distribution can naturally account for the double-humped SED. We apply this modified synchrotron spectrum model (named as 'synchro-curvature mechanism') to 3C 273 quasar jet and fit well the radio-to-X-ray continua of the successive knots down the jet. This work provides an alternative simple interpretation of the observed broad-band spectra as well as good support to synchrotron origin of the X-ray emissions detected in powerful quasar jets.

84. **A decelerating jet in the X-ray transient XTE J1752−223**

J. Yang[1], Z. Paragi[1,2], C. Brocksopp[3], S. Corbel[4], R. Fender[5], A. K. Tzioumis[6]
[1]*Joint Institute for VLBI in Europe, The Netherlands.*
[2]*MTA Research Group for Physical Geodesy and Geodynamics, Hungary.*
[3]*Mullard Space Science Laboratory, University College London, UK.*
[4]*Université Paris 7 Denis Diderot and Service d'Astrophysique, France.*
[5]*School of Physics and Astronomy, University of Southampton, UK.*
[6]*Australia Telescope National Facility, Australia.*

We detected a deceleration rate of 0.34 ± 0.02 mas day^{-2} in an approaching jet component of the new X-ray transient XTE J1752−223 during its first known outburst with the EVN (European VLBI Network) and the follow-up VLBA (Very Long Baseline Array) observations at 5 GHz. The corresponding receding component was also detected at the last epoch as a further support for the jet deceleration. Besides the proper motion, the approaching ejecta shows a minimum expansion speed of 0.89 ± 0.06 mas day^{-1}. According to a linear expansion model, the earliest birth date of the ejecta was on 2010 February 2, right at the beginning of the associated radio flare by the ATCA (Australia Telescope Compact Array) observations. The lower limit of the average separation speed of the approaching and receding components is 20.4 mas day^{-1}. As the separation speed is much higher than the measured average proper motion (6.9 mas day^{-1}) of the approaching component, the jet deceleration was inferred to start within a radius of 200 mas before our VLBI observations.

85. **Jet and kHz QPO-accreting pulsar and bottom magnetic field**

C. M. Zhang
National Astronomical Observatories, Chinese Academy of Sciences, China.

The bottom magnetic fields of neutron stars (NSs) in LMXBs are found to be proportionally related to their accretion rate, i.e. Z (Atoll) source with Eddington (less Eddington) rate is associated with a stronger value of about $B \sim 10^9$ G ($B \sim 10^8$ G). We discuss the relation between the jet formation of NS and its bottom magnetic field strength, and pointed out that the accretion powered millisecond pulsar will not exclude the jet production, furthermore the appearance of kHz QPOs may be also coexistence with the jets. The observer's viewing angle to the NS rotating axis may be a significant factor for observing the jet, pulsar or kHz QPO.

86. **Large scale cavities surrounding microquasars inferred from evolution of their relativistic jets**

Shuang-Nan Zhang
Institute of High Energy Physics, China

The black hole X-ray transient XTE J1550-564 has undergone a strong outburst in 1998 and two relativistic X-ray jets have been detected years later with the Chandra X-ray observatory; the eastern jet was found previously to have decelerated after its first detection. Here we report a full analysis of the evolution of the western jet; significant deceleration is also detected in the western side. Our analysis indicates that there is a

cavity outside the central source and the jets first traveled with constant velocity and then were slowed down by the interactions between the jets and the interstellar medium (ISM). The best fitted radius of the cavity is 0.31 pc on the eastern side and 0.44 pc on the western side, and the densities also show asymmetry, of $0.034\,\mathrm{cm}^{-3}$ on the east to $0.12\,\mathrm{cm}^{-3}$ on the west. The best fitted magnetic fields on both sides are 0.5 mG. Similar analysis is also applied to another microquasar system, H 1743-322, and a large scale low density region is also found. Based on these results and the comparison with other microquasar systems, we suggest a generic scenario for microquasar jets, classifying the observed jets into three main categories, with different jet morphologies (and sizes) corresponding to different scales of vacuous environments surrounding them. We also suggest that either continuous jets or accretion disk winds, or both may be responsible for creating these cavities. Therefore X-ray jets from microquasars provide us with a promising method of probing the environment of accreting black holes. This work has been published in ApJ, 702, 1648-1661 (2009).

87. **On the apparent lack of Be X-ray binaries with black holes in the Galaxy and in the Magellanic Clouds**

Janusz Ziółkowski
Copernicus Astronomical Center, Poland.

In the Galaxy there are 64 Be X-ray binaries known to-date. Out of those, 42 host a neutron star, and for the reminder the nature of a companion is not known. None, so far, is known to host a black hole. There seems to be no apparent mechanism that would prevent formation or detection of Be stars with black holes. This disparity is referred to as a missing Be – black hole X-ray binary problem. The stellar population synthesis calculations following the formation of Be X-ray binaries (Belczyński & Ziółkowski 2009) predict that the ratio of the binaries with neutron stars to the ones with black holes is rather high $F_{\mathrm{NStoBH}} \sim 30-50$. A comparison of this ratio with the number of confirmed Be – neutron star X-ray binaries (42) indicates that the expected number of Be – black hole X-ray binaries is of the order of only $\sim 0-2$. This is entirely consistent with the observed Galactic sample. Therefore, there is no problem of the missing Be+BH X-Ray Binaries for the Galaxy.

In the Magellanic Clouds there are 92 Be X-ray binaries known to-date. Out of those, 59 host a neutron star. Again, none hosts a black hole. The stellar population synthesis calculations carried out specifically for the Magellanic Clouds (Ziółkowski & Belczyński 2010) predict that the ratio of the Be X-ray binaries with neutron stars to the ones with black holes is only $F_{\mathrm{NStoBH}} \sim 10$. This value is rather too low, as it implies the expected number of Be+BH X-ray binaries of the order of ~ 6, while none is observed. We found, that to remove the discrepancy, one has to take into account a different history of the star formation rate in the Magellanic Clouds, with the respect to the Galaxy. New stellar population synthesis calculations are currently carried out.

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