High-Energy Phenomena in Relativistic Outflows V
(HEPRO V)

La Plata, Argentina, 5-8 October 2015

Book of Abstracts

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Radio Astronomy Group (GARRA)**

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Supported by

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Consejo Nacional de Investigaciones Científicas y Técnicas

Cámara de Senadores de la Provincia de Buenos Aires -Dirección de Cultura

The Abdus Salam International Centre for Theoretical Physics

Asociación Argentina de Astronomía

Facultad de Ciencias Astronómicas y Geofísicas - Universidad Nacional de La Plata

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Contents

Conference program

	Monday		Tuesday	Wednesday	Thursday
8:00 - 9:00	Registration				
9:00 - 9:20	Welcome	9:00 - 9:50	Pian	Khangulyan	De Colle
9:20 - 10:10	Bell	9:50 - 10:10	Böttcher	Moreno de la Cita	López-Cámara
10:10 - 10:30	Baring	10:10 - 10:30	Tavecchio	Kocharovsky	Fraija
10:30 - 11:00	Coffee break	10:30 - 11:00	Coffee break	Coffee break	Coffee break
11:00 - 11:20	Kadowaki	11:00 - 11:20	Berton	Pellizza	Penacchioni
11:20 - 11:40	Riquelme	11:20 - 11:40	Melioli	Pepe	Bisnovatyi-Kogan
11:40 - 12:10	Araudo	11:40 - 12:10	Mirabel	Bednarek	Timokhin
12:10 - 14:10	Lunch	12:10 - 14:10	Lunch	Lunch	Lunch
14:10- 15:00	Spitkovski	14:10- 15:00	Abraham	Giannios	Arons
15:00 - 15:20	Janiuk	15:00 - 15:20	Kapanadze	Sushch	Morlino
15:20 - 15:40	Chattopadhyay	15:20 - 15:40	Kurtanidze	Marcote	Ng
15:40 - 16:00	Singh	15:40 - 16:00	Paredes -Fortuny	Paredes	Kalapotharakos
16:00 - 16:30	Coffee break	16:00 - 16:30	Coffee break	Coffee break	Coffee break
16:30 - 17:20	Barkov	16:30 - 17:00	Bosch-Ramon	Altamirano	Porth
17:20 - 17:40	del Valle	17:00 - 17:20	Dong	Rodríguez-Kamenetzky	Farewell
	18:30 - 19:45 - Welcome cocktail		18:00 - 19:00 - Outreach talk at Planetario de la Ciudad de La Plata: "Radiación invisible en el Universo", by Dr. Josep Maria Paredes (in Spanish)	19:30 - 23:30 - Conference dinner	

Invited talk	Highlight talk	Contributed talk

Invited Talks

Invited Talk 1. Jet studies in Latin America

Zulema Abraham

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During the decade of 1970, astronomers were discussing the nature of the recently discovered quasars (Quasi Stellar Radiosources), specially their galactic or extragalactic nature. The existence of very small sources in the cores of these quasars was inferred by the first measurements made with VLBI, Very Long Baseline Interferometry, which provided mas resolution. Improvements in the imaging techniques led to the discovery of pc scale jets and components moving with, if extragalactic, superluminal velocities. It was only with the discovery of the galactic microquasars, some of them also presenting jets with superluminal velocity components, that the extragalactic nature of quasars and pc scale jets could not be contested any more. In this presentation I will review the role of Latin American research in the study and understanding of these jets, since the very beginning of its discovery. The studies were made with instruments in Latin America and abroad, especially at radio and optical wavelengths, followed by theoretical studies and numerical simulations.

Invited Talk 2. Current sheets in Pulsar Wind Nebulae

Jonathan Arons

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I discuss the role of electric current sheets and filaments in mass and magnetic flux transport, and in particle acceleration, in Pulsar Wind Nebulae.

Invited Talk 3. Numerical simulations of relativistic jets

Maxim Barkov

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We present numerical simulations of axisymmetric, magnetically driven relativistic jets on six decades in spatial scale. To eliminate the dissipative effects induced by a free boundary with an ambient medium we assume that the flow is confined by a rigid wall of a prescribed shape, which we take to be $z \sim r^a$ (in cylindrical coordinates, with a ranging from 1 to 3). We also prescribe, through the rotation profile at the inlet boundary, the injected poloidal current distribution: we explore cases where the return current flows either within the volume of the jet or on the outer boundary. The outflows are initially cold or hot, sub-Alfvénic and Poynting flux-dominated, with a total-to-rest-mass energy flux ratio up to $\mu \sim 15$. We find that in all cases they converge to a steady state characterized by a spatially extended acceleration region. The acceleration process is very efficient: on the outermost scale of the simulation as much as ~ 75 per cent of the Poynting flux has been converted into kinetic energy flux, and the terminal Lorentz factor approaches its maximum possible value ($\Gamma_\infty \sim \mu$).

Invited Talk 4. Particle acceleration in radio galaxies

Tony Bell

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Affiliation: University of Oxford (United Kingdom)

Whereas particle acceleration in supernova remnants is now reasonably well understood, the same cannot be said of particle acceleration in radio galaxies, partly because observation is more limited and partly because of the theoretical difficulties posed by relativistic or mildly relativistic shocks. Acceleration by relativistic shocks is heavily dependent on the strength and orientation of the magnetic field and on the structure of the turbulence that amplifies the magnetic field. Excellent progress has been made in understanding the early stages of acceleration using particle-in-cell codes, but the theory of acceleration to higher energies is very uncertain. Both theory and observation raise doubts about whether relativistic outflows are able to accelerate ultra-high energy (EeV) cosmic rays, and much more work is needed. I intend to review the various issues that make high velocity shocks more challenging than non-relativistic shocks.

Invited Talk 5. Gamma Ray Bursts: jet propagation

Fabio De Colle

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In this talk I will discuss our understanding of the gamma-ray burst (GRB) jet dynamics. Observations show that long GRBs are associated with the collapse of massive stars, which leads to the formation of ultra-relativistic jets moving with Lorentz factors up to $\sim$ 200-1000, often associated with an energetic supernova. As the jet propagates through the star, its interaction with the stellar material shapes the resulting supernova. Then, as the jet breaks out of the star and freely expands in the environment, dissipation of kinetic energy in internal shocks and/or at the jet photosphere produces the gamma-ray emission (the "prompt emission"). Finally, as the relativistic flow decelerates, it produces a multi-wavelength afterglow which can be observed in radio during several years. These different stages of evolution of the GRB jet will be described in detail in this talk, focusing in particular on how the interaction of the jet with the environment and the associated dissipation of kinetic energy leads to a powerful multi-wavelength emission extending from gamma to radio frequencies.

Invited Talk 6. Flares in relativistic jets from tidal disruption events

Dimitrios Giannios

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The tidal disruption event (TDE) of a star by a supermassive black hole provides us with a rare glimpse of these otherwise dormant supermassive black holes in galactic centers. It has long been predicted that the disruption will be accompanied by a thermal 'flare', powered by the accretion of bound stellar debris. A dozen of such TDE candidates have been discovered the past 15 years. The year 2011 marked a new era of TDE theory and observations when it became clear that a substantial fraction of the power released during the TDE can be channeled into an ultra-relativistic outflow. The X-ray transient Sw 1644 57 and its more distant twin, Swift J2058, provide strong support to the presence of powerful relativistic jets during tidal disruption events. I will discuss the rich behavior of Sw 1644 57 in the radio and X-rays and the valuable lessons it can teach us in terms of jet physics, super-Eddington accretion as well as for the circum-nuclear medium in quiescent nuclei.

Invited Talk 7. High-energy emission from relativistic jets

Dmitry Khangulyan

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Observations in gamma rays provide a very important window to study physical processes underlying the spectacular phenomenon of relativistic jets. Spectral properties and variability information obtained with spaceborne and ground-based gamma-ray detectors provide many constrains on the physical conditions in the gamma-ray bright region and on its location. These constrains however do not favor some specific scenario for non-thermal emission, but rather put further challenges for modelling. In this talk, I will review the recent progress in the field of modelling of the gamma-ray emission from various jetted sources.

Invited Talk 8. Relativistic jets: an overview of recent progress

Elena Pian

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Multi-wavelength observing campaigns in the last decade have revealed a great deal of detail about the behavior of extragalactic jets, and particularly of their most extreme manifestations, i.e. blazars and gamma-ray bursts. Variability in these sources offers an unequaled view on the powering mechanisms: patterns vary from source to source and from epoch to epoch and over a wide range of luminosities. Ultimately, the accurate mapping of jets through multi-wavelength monitoring will disclose the nature and working regimes of the inner engines. I will review some of the most revealing observations of relativistic jets of both blazars and gamma-ray bursts.

Invited Talk 9. Particle acceleration in relativistic outflows

Anatoly Spitkovsky

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Affiliation: Princeton University (United States)

I will review progress in kinetic modeling of particle acceleration in relativistic sources, concentrating on acceleration in collisionless shocks and magnetic reconnection. Particle-in-cell simulations enable ab-initio study of the injection, acceleration and magnetic field amplification in shocks. Dependence of acceleration efficiency on shock speed and magnetic inclination has now been explored for a range of parameters from non-relativistic to relativistic shocks. Magnetic reconnection can also contribute to the formation of energetic tails and to dissipation in Poynting-dominated outflows. Characteristic spectra and acceleration mechanisms of relativistic reconnection will also be discussed.

Highlight and Contributed Talks

Talk 1. Fireworks in the sky: the 2015 outburst of the black hole LMXB V404 Cyg (*highlight talk*)

Diego Altamirano

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V404 Cyg is a black hole binary which went into outburst in 1989 for a ~ 150 days, at which point it became the brightest X-ray source in the sky. In June 2015, just about 26 years later, V404 Cyg underwent a ~ 20 days outburst in which it became the brightest X-ray source in decades. Given the outburst characteristics, it was followed with an unprecedented multiwavelength campaign which caught impressive fast, high amplitude variability at all wavelengths. In this talk, I will describe details of the campaign, summarize the complex datasets available, share our first results and discuss how our optical/radio/X-ray observations has given us insights in the physics that govern the launching of relativistic jets and extremely fast X-ray disc winds.

Talk 2. Magnetic field amplification and particle acceleration in the hotspots of FR II radiogalaxies (*highlight talk*)

Anabella Araudo, Tony Bell, Katherine Blundell, Aidan Crilly

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It has been suggested that relativistic shocks in extragalactic sources may accelerate the most energetic cosmic rays. However, recent theoretical advances indicating that relativistic shocks are probably unable to accelerate particles to energies much larger than a PeV cast doubt on this. The maximum energy to which cosmic rays can be accelerated depends on the structure of turbulence near the shock. Weibel instabilities in relativistic plasmas generate magnetic fields on scale lengths of the order of the plasma skin depth, constraining the maximum energy of particles being accelerated. We explore the radiative signatures of relativistic shocks by modelling the multi-wavelength emission in the hotspots of four FR II radiogalaxies. Data with high spatial resolution show a rapid decay of the synchrotron radio emission behind the shock, which is interpreted as damping of the downstream magnetic field. In addition to that, the turnover of the synchrotron spectrum is between infrared and optical frequencies, indicating that the diffusion of particles across the shock is not in the Bohm regime. We conclude that the magnetic field at the shock is insufficient for acceleration to EeV energies, as expected for small scale turbulence. If our result is confirmed by analyses of other radiogalaxies, it provides firm observational evidence that relativistic shocks at the termination region of powerful jets in FR II radiogalaxies do not accelerate ultra high energy cosmic rays.

Talk 3. Probing turbulence and acceleration at relativistic shocks in blazar jets

Matthew G. Baring, Markus Boettcher and Errol J. Summerlin

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Acceleration at relativistic shocks is likely to be important in various astrophysical jet sources, including blazars and other radio-loud active galaxies. An important recent development for blazar science is the ability of Fermi-LAT data to pin down the power-law index of the high energy portion of emission in these sources, and therefore also the index of the underlying non-thermal particle population. This paper highlights how multiwavelength spectra including X-ray band and Fermi data can be used to probe diffusive acceleration in relativistic, oblique, MHD shocks in blazar jets. The spectral index of the non-thermal particle distributions resulting from Monte Carlo simulations of shock acceleration, and the fraction of thermal particles accelerated to non-thermal energies, depend sensitively on the particles' mean free path scale, and also on the mean magnetic field obliquity to the shock normal. We investigate the radiative synchrotron/Compton signatures of thermal and non-thermal particle distributions generated from the acceleration simulations. Important constraints on the frequency of particle scattering and the level of field turbulence are identified for the jet sources Mrk 501, AO 0235 164 and Bl Lacertae. Results suggest the interpretation that turbulence levels decline with remoteness from jet shocks, with a significant role for non-gyroresonant diffusion.

Talk 4. High energy radiation from globular clusters (*highlight talk*)

Wlodek Bednarek

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Large population of the millisecond pulsars (MSPs) is expected to inject relativisitic leptons into the environment of globular clusters. These particles propagate within the cluster and interact with the strong radiation field produced by huge number of evolved stars and the magnetic field. As a result, GCs are expected to emit TeV gamma rays and synchrotron radiation. Observation of such non-thermal emission should allow to put constraints on the high energy processes around MSPs and on their propagation. We discuss different scenarios for acceleration, propagation and radiation of leptons within GCs. They are confronted with the available observational constraints obtained mainly by Cherenkov telescopes.

Talk 5. Exploring the parent population of beamed NLS1s: from the black hole to the jet

Marco Berton, Luigi Foschini, Stefano Ciroi, et al.

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Affiliation: Università degli Studi di Padova (Italy)

Flat-spectrum radio-loud Narrow-Line Seyfert 1 galaxies (NLS1s) are a recently discovered class of γ-ray emitting Active Galactic Nuclei (AGN), that exhibit some blazar-like properties which are explained with the presence of a relativistic jet viewed at small angles. When blazars are observed at larger angles they appear as radio-galaxies, and we expect to observe an analogue parent population for beamed NLS1s. The aim of this study is to understand the nature of this population, by examining the physical properties three different samples of parent sources candidates: steep-spectrum radio-loud NLS1s, radio-quiet NLS1s and disk-hosted radio-galaxies. To test these hypotheses we first studied the optical spectra of the sources to calculate their black hole mass and Eddington ratio, later comparing their similarities by means of the K-S test. Then we focused on the [OIII] $\lambda\lambda$ 4959,5007 lines, to investigate the properties of their Narrow Line Region, the interactions between the relativistic jet and the interstellar medium, and the link with the γ-ray emission. Finally we built their radio luminosity function, that allowed us to compare their jet luminosity and to determine the evolutionary relations linking the samples.

Talk 6. Magnetorotational supernovae and jet formation

G. S. Bisnovatyi-Kogan, S. G. Moiseenko, N. V. Ardelyan

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Magnetorotational mechanism of explosion is working in core-collapse supernova. The main energy source is a rotational energy of the new born neutron star, and magnetic field induce a transformation of this energy into the energy of the expanding shock wave. The energy release is enough for explanation of observations. The time of such transformation depends very weakly on the initial magnetic field strength, because of development of the magnetorotational instability, connected with growth of the toroidal component due to differential rotation. Topology of the explosion depends on the form of the magnetic field. Jet is formed at a dipole-like magnetic field configuration. Recent results of 2-D calculations are presented, based on the advanced equation of state of a hot superdense matter, and improved neutrino transfer.

Talk 7. Recent results of H.E.S.S. observations of extragalactic jet sources

Markus Boettcher (on behalf of the H.E.S.S. Collaboration)

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The High Energy Stereoscopic System (H.E.S.S.) is an array of 5 Cherenkov telescopes (4 X 12 m, 1 X 28 m diameter), located in the Khomas Highland near Windhoek, Namibia. The addition of the fifth (28-m) telescope in 2012 extended the sensitivity of the array significantly towards lower energies, compared to the first phase of H.E.S.S. In this talk, I will present highlights of recent results from H.E.S.S. observations of extragalactic jet sources, including the well-known (e.g., Mrk 501, PKS 2155-304, PG 1553 113, 1ES 0229 200) and recently discovered (e.g., PKS 1440-389), and gravitationally lensed (PKS 1830-211) blazars, and radio galaxies (Centaurus A, PKS 0625-354). A brief update on the H.E.S.S. Gamma-Ray Burst follow-up program will also be presented.

Talk 8. The effects of non-thermal processes on the dynamics of colliding star-pulsar winds (*highlight talk*)

Valenti Bosch-Ramon

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Binary systems hosting a pulsar and a companion star are powerful gamma-ray emitters. However, our understanding of the physics behind the non-thermal radiation is limited. In particular, despite it is well accepted that the high-energy emission is originated close or within the binary, and is linked to shocked star and pulsar winds, it is yet unclear what are the details of the dynamics of the interaction structure, which should largely characterize the emission sites. Particularly, the non-thermal processes are expected to affect significantly the unshocked and the shocked pulsar wind, removing energy and even momentum from it, which should have a strong impact on the subsequent evolution of the interaction structure. In this talk, I will discuss the importance of this factor in shaping the high-energy emitting regions.

Talk 9. Evolution of aspect ratio of relativistic astrophysical jets

Indranil Chattopadhyay

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We present relativistic hydrodynamic simulation of evolution of jet size with the lateral size of the lobe of extragalactic FR-II type jets. We discuss the condition which controls the evolution of the lateral size of the lobe with respect to the jet length. We also show that this evolution is important in understanding the role played by the matter energy density in the lobe.

Talk 10. High-energy studies of cloud-disc collisions

M. V. del Valle, G. E. Romero & A. L. Muller

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Affiliation: IAR - CONICET (Argentina)

Interstellar clouds of atomic hydrogen, with velocities inconsistent with Galactic rotation (higher than those expected from Galactic rotation) are known as high-velocity clouds (HVCs). A significant fraction of these clouds are falling down towards the Galactic disc and are expected to impact it. These clouds have masses of the order of $10^4 M_\odot$ and can reach velocities of a few hundreds of km s^{-1}, therefore the collision of HVCs with the disc can release a great amount of energy into the interstellar medium. The collision might produce shocks propagating through both the cloud and the disc that, under adequate conditions, can accelerate particles up to relativistic energies. In this work we study the hydrodynamical interactions and the relevant radiative processes (thermal and non-thermal) associated with the cloud-disc collision.

Talk 11. The X-ray spectral evolution and radio–X-ray correlation in radiatively efficient black-hole sources

Ai-Jun Dong, Qingwen Wu

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We present the X-ray spectral evolution and radio–X-ray correlation and find that hard X-ray photon indices, Γ, are anti- and positively correlated to X-ray fluxes when the X-ray flux, $F_{3-9\mathrm{keV}}$, is below and above a critical flux, $F_{\mathrm{X,crit}}$, which is is similar to that of LLAGNs and bright RQ AGNs respectively. We further present a new fundamental plane for 'outliers' of XRBs and bright RQ AGNs in black-hole (BH) mass, radio and X-ray luminosity space: $\log L_{\mathrm{R}} = 1.59^{0.28}_{-0.22} \log L_{\mathrm{X}} - 0.22^{0.19}_{-0.20} \log M_{\mathrm{BH}} - 28.97^{0.45}_{-0.45}$ with a scatter of $\sigma_{\mathrm{R}} = 0.51$ dex. This fundamental plane is suitable for radiatively efficient BH sources.

Talk 12. Evidence of magnetic field amplification in the neutron star merger in some GRBs

Nissim Fraija and William H. Lee

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Simulations have found that magnetic field can be amplified beyond magnetar field strength by Kelvin-Helmholtz instabilities during the merger of a binary neutron star system. This system has been proposed as central engines of short gamma-ray bursts (GRBs). One of the brightest, GRB 090510 was observed by all instruments aboard Fermi and Swift satellites. The multiwavelength observations of this burst presented a short-lasting peak at the end of the prompt phase and a temporally extended component lasting hundreds of seconds. In the framework of early afterglow, a leptonic scenario is proposed to revisit GRB 090510 and interpret the multiwavelength observations presented in this burst. The origin of the temporally extended LAT, X-ray and optical fluxes is explained as synchrotron radiation from the adiabatic forward shock. Synchrotron self-Compton emission from the reverse shock is consistent with the bright LAT peak provided that progenitor environment is entrained with strong magnetic fields. It could provide irrefutable evidence of magnetic field amplification in this neutron star merger. We investigate other short GRBs that could have similar features.

Talk 13. Non-linear variability in microquasars in relation with the winds from their accretion disks

Agnieszka Janiuk, Petra Sukova, Mikolaj Grzedzielski

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The microquasar IGR J17091, as the recently discovered analogue of the well known source GRS 1915 105, exhibits quasi-periodic outbursts, of the period 5-70 seconds, and regular amplitudes, frequently referred to as a 'heartbeat state'. We argue that these states are plausibly explained by the accretion disk instability, driven by the dominant radiation pressure. Using our GLobal Accretion DIsk Simulation hydrodynamical code, we model these outbursts quantitatively. We also find a correlation between the presence of massive outflows launched from the accretion disk and stabilization of the oscillations. We verify the theoretical predictions with the available timing and spectral observations. Furthermore, we postulate that the underlying non-linear differential equations that govern the evolution of an accretion disk, are responsible for the variability pattern of several other microquasars, including XTE J1550-564 and GX 339-4, observed in some states. This study is based on the signatures of deterministic chaos in the observed lightcurves of these sources, which we found using the recurrence analysis method and comparison to the surrogate data. We discuss these results in the frame of the accretion disk instability model.

Talk 14. The Role of Fast Magnetic Reconnection in Microquasars and AGNs

Luís H.S. Kadowaki, Elisabete M. de Gouveia dal Pino, Behrouz Khiali, Chandra B. Singh, Grzegorz Kowal

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The origin of the very high energy (VHE) emission of active galactic nuclei (AGN) and microquasars it is still uncertain since the current gamma-ray detectors have too poor resolution to determine whether this emission is produced in the inner jet or in the core of these sources. We computed the power released by fast reconnection events between the magnetic field lines that lift from the accretion disk and those of the black hole (BH) magnetosphere triggered by enhanced accretion, employing different accretion disk models. We found that this power is enough to explain both the observed (core) radio and the gamma-ray luminosities of these sources regardless of the accretion disk model thus ensuring that the details of the accretion physics are not relevant in the magnetic reconnection process occurring in the corona. Moreover, this calculated reconnection power has a dependence with the BH mass of the sources that matches very well with the observed correlation between the luminosity and mass of these sources sustained for over 10 orders of magnitude in mass (for a sample including more than 200 sources). This match suggests a core emission for the VHE in these sources. Besides, fast magnetic reconnection is able to accelerate relativistic particles through a first-order Fermi process within the reconnection site at very efficient rates in the surrounds of the BHs, as predicted by de Gouveia Dal Pino and Lazarian (2005) model and successfully tested numerically (Kowal et al. 2011, 2012). Employing this acceleration model in the core region, we also computed the spectral energy distribution (SED) of several radio galaxies (M87, CenA, PerA, IC310) and microquasars (Cyg X1, Cyg X3) and found that these SEDs also match quite well with the observations, therefore strengthening the conclusions above in favor of a core emission for the VHE emission of these sources. In this talk these recent results will be reviewed.

Talk 15. Modeling pulsar high energy emission in the Fermi era

Constantinos Kalapotharakos

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I will present our study on pulsar high-energy emission that provides meaningful constraints on the macroscopic parameters of the global pulsar magnetosphere solutions through the extensive comparison of dissipative model light curves and their spectra with those provided by multi-wavelength observations of real pulsars. More specifically, I will present patterns of gamma-ray emission due to curvature radiation in dissipative pulsar magnetospheres. These state-of-the-art solutions, by their nature, provide, besides the field geometry, also the necessary particle accelerating electric fields. Using these solutions, we generate model gamma-ray light curves by calculating the trajectories and the Lorentz factors of the radiating particles, under the influence of both the accelerating electric components and curvature radiation-reaction. I will show how this study leads to the construction of model magnetospheres that successfully reproduce the observed light-curve phenomenology as depicted in the radio-lag vs peak-separation diagram obtained by Fermi. These models employ a hybrid form of conductivity; specifically, infinite conductivity interior to the light-cylinder and high but finite conductivity on the outside. In these models the gamma-ray emission is produced in regions near the equatorial current sheet. The model allows the calculation of phase-averaged and phase-resolved spectra and the total gamma-ray luminosities as well. I will show that the corresponding photon cut-off energies and total gamma-ray luminosities are within the observed ranges for both standard and MS pulsars. A direct and detailed comparison with the Fermi data reveals the dependence of the macroscopic conductivity parameter on the spin down rate uncovering the physical mechanisms underlying the observed pulsar high-energy emission.

Talk 16. X-Ray spectral curvature in HBLs

Bidzina Kapanadze, Sergo Kapanadze, Patrizia Romano, Stefano Vercellone

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High-energy peaked BL Lacertae objects (HBLs) are one of the brightest objects on the high-energy sky, characterized by a strong X-ray flux and spectral variability at different timescales, and, therefore, they are "favorite" targets of different X-ray missions. They mostly show X-ray spectral curvature that provides an effective tool to study physical conditions and dominant nonstationary processes in HBL jets. This effect is related to the logparabolic distribution of emitting particles with energy that can develop via the energy-dependent acceleration probability process related to the first-order Fermi acceleration at the shock front moving through the jet, or it can be established by the stochastic acceleration (e.g. second-order Fermi process) developed in the turbulent areas near the shock front. In the framework of synchrotron emission from one dominant homogenous component, the correlation between the synchrotron SED peak location and height in the powerlaw form $E_p \sim E_p^{\alpha}$ gives an opportunity to draw a conclusion about the about the physical factor driving the observed spectral changes during the flare. Our intensive X-ray spectral study of bright HBLs (Mrk 421, Mrk 501, 1ES 1959 650, Mrk 180, 1ES 1727 502, etc.) confirms the suggestion of some authors that the electrons in the jets of TeV-detected BL Lacertae sources should undergo an effective stochastic acceleration yielding a lower curvature ($b \sim 0.3$) compared to the TeV-undetected ones ($b \sim 0.7$). Due to a low spectral curvature, we predict that some HBLs (1ES 0120 340, EXO 0556.4-3838, 1ES 0737 746, 1H 1515 660, etc.) will be included among the TeV-emitters. In the majority of well-observed X-ray flares, we did not detect a significant correlation between the E_p and S_p parameters, indicating the existence of more than one physical factor driving the observed spectral evolution or the assumption about one dominant homogenous component is not valid. The b parameter shows a variability at different timescales and often exhibits an anticorrelation with unabsorbed X-ray flux that also favours a stochastic acceleration of the electrons producing X-ray photons during the flares.

Talk 17. Analytical theory of self-consistent current sheets in multicomponent relativistic plasma with arbitrary energy distribution of particles

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We develop a method of invariants of particle motion in the current sheets (PRL 104, 215002, 2010) and carry out a systematical analysis of the self-consistent magnetostatic configurations in a collisionless plasma admitting essentially arbitrary energy distribution of particles. The theory takes into account a complicated motion of both trapped and non-trapped particles, as well as a spatial inhomogeneity of their anisotropic distribution functions. We find properties of all qualitatively different 1D current structures in a polynomial-exponential class of particle distribution functions, including relativistic case. These structures include periodic, monotonic, and symmetric profiles of the vector potential. For all of them we provide analytical examples and describe possible relations between their spatial scales, magnitudes of current and magnetic field, a degree of anisotropy of particle distributions and magnetic-to-particle energy ratio. Among these examples, there are multi-peak configurations of the current density and antisymmetric magnetic field profiles. We outline and compare the previously known planar analytical solutions which correspond to the special cases of the polynomial-exponential particle distribution functions, and all are covered by our universal theory. We apply the theory to the interpretation of recent detailed observations of the quasi-magnetostatic configurations in the laser and cosmic plasma experiments and in the numerical simulations. We discuss also various long-lived magnetic structures in the relativistic astrophysical plasmas (jets, winds, accretion disks, collisionless shocks), including the individual filaments in a quasi-magnetostatic turbulence. Finally, we analyze in detail possible anisotropic features of synchrotron radiation of the self-consistent current structures and give examples of an analytical description of the breaks and the hidden components in their power-law spectra (Physics of Plasmas, submitted).

Talk 18. Optical study of TeV blazars

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In the beginning of 1990 we compiled a list of very interesting astrophysical point of view 25 blazar and conducted systematic monitoring of their fluxes using Abastumani observatory 125-cm and 70-cm meniscus telescopes. From 2005 up to now we observed about 1500 full nights using CCD cameras SBIG ST10-XME and Ap6E. On the basis of these observations we estimated time-scales of variability. The main results of observational study of blazars and their connection to physical processes in BH are also presented.

Talk 19. Three-dimensional simulations of variable GRB jets

Diego López-Cámara, Davide Lazzati, Brian Morsony

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No Gamma-Ray Burst (GRB) is the same as any other. Variability is commonly observed in GRBs, and a significant fraction of the long GRBs (approximately 85%) appear to be the result of several pulses. The pre- and post-bursting activity remain to be fully understood, thus is significant to study the effects that a pulsed central engine has on the prompt GRB emission variability with numerical simulations. In this study, for the first time ever, using 3D numerical simulations numerous models of a variable jet drilling through the progenitors stellar envelope and then through the ISM is followed. Since there is a correlation between the variability and the observed peak isotropic luminosity, we calculate the light curve for each model and discuss how the variability in the central engine affects the photospheric emission. Finally, we also deliberate how our results compare with observations from Swift and other instruments.

Talk 20. Physical properties of the gamma-ray binary LS 5039 through low and high frequency radio observations

B. Marcote, M. Ribó, J. M. Paredes, C. H. Ishwara-Chandra

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LS 5039 is a gamma-ray binary displaying at GHz radio frequencies synchrotron emission with a small variability and without signatures of being orbitally modulated. A detailed study in the 0.15-15 GHz range has been carried out by analyzing VLA, GMRT and WSRT observations, obtaining an average spectrum and two quasi-simultaneous spectra. We have observed a persistent radio emission on day, week and year timescales, with a variability below 25% and with no signatures of orbital modulation at all frequencies except at 150 MHz, where the source remains undetected. The spectra reveal a power-law emission at high frequencies and a low-frequency turnover at about 0.5 GHz. We explain these spectra with a simple model of one-zone synchrotron emitting region. Synchrotron self-absorption and Razin effect explain the absorption at low frequencies. With this model we have obtained an estimate of the physical properties of the radio emitting region of LS 5039, and derived a high mixing of the stellar wind within the relativistic plasma of the radio outflow.

Talk 21. AGN jets and their interplay with the host galaxy and the central black hole

C. Melioli & E. M. de Gouveia Dal Pino

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Accreting supermassive black holes (SMBHs) influence their host galaxies through kinetic/radiative feedback processes, but the details of the specific feedback mechanisms remain under debate. Particularly in Seyfert galaxies, where intense star formation (SF) coexists with the active galactic nucleus (AGN) both the AGN jet and SF driven wind may affect the dynamics of the gas outflows and the galaxy evolution. In order to better understand the interplay between the jet and the host galaxy and establish the relative importance of these two driving mechanisms we have performed high-resolution three-dimensional, hydrodynamical, radiative cooling simulations of a rotating spiral active galaxy considering star formation, supernova (type I and II) explosions, and a narrow AGN jet emerging from the core of the galaxy. We have computed the evolution of the system and the formation of structures and turbulence around the central region, separating the role of each of these injection energy mechanisms, i.e., the SF driven wind and the AGN jet, on the galaxy evolution. In this talk, we will discuss the results of these simulations performed for several models with different initial conditions. We found that in all cases the jet alone is unable to drive a massive gas outflow (which is generally dominated by the SF feedback), although it can sporadically drag and accelerate clumps of the underlying outflow to very high velocities, as lately detected in several AGN sources.

Talk 22. Jet-induced star formation (*highlight talk*)

I. F. Mirabel

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I will review star formation induced by high energy phenomena, and in particular, relativistic jet-triggered star formation at the dawn and present universe.

Talk 23. Coupling hydrodynamics and radiation calculations for star-jet interactions in AGN

V. M. de la Cita, V. Bosch-Ramon, X. Paredes-Fortuny, D. Khangulyan and M. Perucho

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Stellar populations can contribute to the non-thermal emission of radio-loud active galactic nuclei via the interaction with the relativistic jets. The shock produced between the stellar wind and the jet can accelerate particles and produce high energy emission. We have performed 2D axisymmetric hydrodynamical simulations of the jet-stellar wind interaction and and obtained the hydrodynamical properties of the emitting flow. With this information we study the evolution of the non-thermal particles accelerated in the collision and their IC and synchrotron radiation. We present here the results of these computations: detailed radiation maps and spectral energy distributions for different scenarios, depending on the position of the star in the jet, the magnetic field, and the viewing angle. We have studied two representative scenarios: the steady state of the jet-wind interaction; and the case in which a transient instability develops, enlarging the interaction region.

Talk 24. Mass-loading of bow shock Pulsar Wind Nebulae

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We investigate the dynamics of bow shock nebulae created by pulsars moving super-sonically through a partially ionized interstellar. A fraction of interstellar neutrals penetrating into the tail region of a pulsar wind will undergo photo-ionization due to the UV light emitted by the nebula, with the resulting mass loading dramatically changing the flow dynamics of the light leptonic pulsar wind. Using a quasi 1-D hydrodynamic model of both non-relativistic and relativistic flow, and focusing on scales much larger than the stand-off distance, we find that a relatively small density of neutrals, as low as $n_{\rm ISM} = 10^{-4}\ {\rm cm}^{-3}$, is sufficient to strongly affect the tail flow. Mass loading leads to the fast expansion of the pulsar wind tail, making the tail flow intrinsically non-stationary. The shapes predicted for the bow shock nebulae compare well with observations, both in Hα and X-rays.

Talk 25. Mapping the magnetic field structure of elongated Pulsar Wind Nebulae

C.-Y. Ng

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As a pulsar spins down, the majority of its rotational energy is carried away by relativistic particle outflow. The confinement of such pulsar wind results in a termination shock with a synchrotron bubble downstream known as a pulsar wind nebula (PWN). The magnetic field structure of a PWN offers important information for understanding the shock interaction and electrodynamics of pulsar winds. It is also a powerful diagnostic tool for probing the physical conditions and evolutionary history of PWN systems. I will present recent results of radio polarization observations of evolved PWNe taken with the Australia Telescope Compact Array. Their radio morphology and magnetic field structure will be discussed.
This work is supported by a ECS grant of the Hong Kong Government under HKU 709713P. The Australia Telescope is funded by the Commonwealth of Australia for operation as a National Facility managed by CSIRO.

Talk 26. Super-orbital variability of the gamma-ray binary LS I 61 303 studied with MAGIC

J. M. Paredes, A. López-Oramas, D. Hadasch, O. Blanch, D. F. Torres for the MAGIC Collaboration; J. Casares, A. Herrero

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The gamma-ray binary LS I 61 303 has been detected from radio up to very high energy (VHE; $E > 100$ GeV) gamma rays. Its emission is likely originated by the interaction of the stellar wind and a relativistic outflow. The broadband emission shows a periodicity of about 26.6 days, coincident with the orbital period. A long-term periodicity of 1667 ± 8 days was discovered in radio and confirmed in optical and HE gamma rays. Here we will present the results of a four-year campaign performed by MAGIC together with archival data. In this campaign, we search for a long-term signature in the VHE emission from LS I 61 303. We will focus on the search of super orbital modulation of the VHE emission, similarly to the one observed in other wavelengths, and on the search for anti-/correlation between TeV emission and the extension of the circumstellar disk, measured through optical data.

Talk 27. Numerical simulations of the collision of an inhomogeneous stellar wind and a relativistic pulsar wind in a binary system

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Binary systems containing a massive star and a non-accreting pulsar present strong interacting winds. The stellar wind can be clumpy, or highly anisotropic as in Be stars, resulting in an unstable two-wind interaction region, which can strongly influence the non-thermal emission of the binary system. We performed axisymmetric, relativistic hydrodynamical simulations of the interaction between a relativistic pulsar wind (Lorentz factors up to 6) and a stellar wind with different degrees of inhomogeneity. The inhomogeneities are characterized by an over-dense region or clump with different radius and density contrasts but with the same speed as the homogeneous stellar wind. The results of the simulation show that stellar inhomogeneities with density contrast of 10 and a radii of a few percent of the binary size can significantly reduce the two-wind interaction region size, pushing the two-wind interface to less than 40% of the initial distance to the pulsar, before expanding and being disrupted. Furthermore, regardless of the degree of inhomogeneity, the whole interaction region is quite unstable and presents a complex spatial and temporal pattern, with the shocked pulsar wind structure strongly changing under small perturbations. All of this can lead to strong variations in the non-thermal radiation from these binary systems.

Talk 28. PRINCE: gamma-ray production and transport in cosmic environments

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High-energy observatories are continuously enhancing our knowledge of the gamma-ray sky, both unveiling new sources and providing a more detailed comprehension of the known ones. Many kinds of astrophysical systems have been found to produce gamma-ray radiation (e.g. supernova remnants, pulsar wind nebulae, active galactic nuclei, etc.). Radiation at very high photon energies requires the existence of relativistic populations of particles, but the source and detailed acceleration mechanisms of these particles are still a matter of debate, and one of the present challenges of relativistic astrophysics. Many scenarios have been developed to explain the gamma-ray emission of different types of sources. As the datasets on gamma-ray sources grow larger, the proper comparison of these scenarios with observations relies in our ability of obtaining accurate predictions from them. The detailed computation of gamma-ray production and transport in astrophysical scenarios becomes then a key issue in the field. In this work we introduce PRINCE, a novel tool developed to describe the gamma-ray emission and propagation in cosmic environments. This tool relies in an ab-initio computation of elementary processes of emission, absorption and scattering of high-energy photons, allowing to compute the production of gamma rays in lepto-hadronic models, and their propagation in arbitrary matter, radiation, and magnetic fields. We show the application of PRINCE to some outstanding problems, such as gamma-ray emission from microquasars or the propagation of high-energy photons through intergalactic radiation and magnetic fields, and discuss the kind of predictions it can provide beyond those of other techniques.

Talk 29. Estimating GRB detection rate with MIRAX

A. V. Penacchioni, J. R. Sacahui, J. Braga, M. A. Castro, F. D'Amico

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MIRAX (Monitor e Imageador de Raios X) is a satellite mission designed to monitor the hard X-ray and soft gamma-ray part of the sky (5 - 200 keV). Its principal instrument is an X-ray camera that makes use of a coded mask and solid-state (CZT) detectors. With its wide field of view (20×20 degrees) MIRAX will study variable sources such as accreting neutron stars, black holes, active galactic nuclei and both short and long gamma-ray bursts (GRBs). In this work we present an estimation on how many GRBs MIRAX will be able to detect during its low-earth near equatorial orbit (90 min). We perform Monte Carlo simulations with GEANT4 to reproduce the interaction of the cosmic diffuse background with the detector material, and image reconstructions for different known GRB sources at different positions in the field of view. We also compute MIRAX sensitivity curve over the energy detection range, and estimate the redshift range for which a GRB will be detectable by MIRAX as a function of the flux. Finally, we show how some known GRB light curves would look like if they were detected by MIRAX.

Talk 30. Spectral energy distribution, polarization and synthetic radio maps of Cygnus X-1: a lepto-hadronic jet model

Carolina Pepe, Gabriela S. Vila and Gustavo E. Romero

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Cygnus X-1 is the best candidate for an X-ray binary hosting a black hole. Over a decade ago, the detection of steady radio jets made the object to be classified as a microquasar. Several radiative models that attempt to explain the broadband emission of Cygnus X-1 are available. For the jet emission in particular, only leptonic models have been considered despite the observational evidence of the presence of hadrons in other microquasars. In this work, we present an inhomogeneous, lepto-hadronic jet model for the broadband emission of Cygnus X-1. We calculate the contribution to the SED of both non-thermal (primary and secondary) electrons and protons, taking into account their interaction with the magnetic field, matter and internal jet radiation, as well as interactions with the wind and the photons from the companion star. We obtain best-fit models for the SED that account for the existing broadband observations from radio to gamma rays, including the MeV tail whose origin is still disputed. We also produce synthetic radio maps of the jet and compare them to actual interferometric observations of the source. Finally, we present preliminary results of calculations of the degree and angle of polarization of the synchrotron radiation in the jet.

Talk 31. Termination shock emission and particle transport in PWNe (*highlight talk*)

Oliver Porth, Serguei Komissarov, Maxim Lyutikov, Michael Vorster and Eugene Engelbrecht

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Crab nebula continues to be one of the prime drivers of high energy astrophysical research. In the search for the elusive γ-ray flaring region, recent multi-frequency observations by Rudy et al. (2015) have provided with excellent data of the variable 'inner Knot'. For the first time, correlations between the knot emission and its position on the sky are observed which affirms that the emission region is attached to the termination shock (e.g. Komissarov & Lyubarsky, 2004). At the same time, other aspects like the aspect ratio of the knot, distance to the pulsar and a high polarization degree of 60% (Moran et al., 2013) appear to challenge this model. We re-visit the shock emission model and show how each of these challenges is overcome. In this, some of our conclusions differ from the complementary study of Yuan & Blandford (2015). However, we agree that the magnetization in the knot region must be low, which can be used to set constraints on the obliqueness of the pulsar. With affirmed low knot magnetization, chances for the gamma-ray emission to originate at the knot location are slim. In the second part of my talk, I will present results of 3D MHD test particle simulations that constrain the diffusive transport coefficients of high energy leptons. As particles are transported via large-scale turbulent motion, the diffusion coefficients of the relevant particles do not depend on energy. Instead, a simple scaling with the size of the termination shock is proposed. Using averaged values from the 3D models, we then fit the spectral index profiles for three young PWN and compare with a standard laminar flow model.

Talk 32. Electron heating and heat transport in collisionless accretion disks

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Accretion disks are called collisionless when the collision time between particles is much larger than the accretion time of the disk. These disks are characterized by a extremely low luminosity, with the disk around Sgr A* being, perhaps, the most important example of this kind of systems. Because of the lack of collisions, in these environments ions and electrons are expected to be out of thermal equilibrium, with the electrons being much colder than the ions. We will present the results of our numerical study of electron heating and heat transport in these systems using particle-in-cell (PIC) plasma simulations. Especial attention will be paid to the nonlinear evolution of a series of kinetic plasma instabilities (on electron and ion scales), and the role they play in regulating electrons heating and heat transport in these systems.

Talk 33. High energy processes in protostellar jets

A. Rodríguez-Kamenetzky, C. Carrasco-González, A. T. Araudo, J. M. Torrelles, G. Anglada, J. Martí, L. F. Rodríguez, C. Valotto

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Synchrotron emission from jets of young stellar objects (YSO) is a phenomenon that has been detected only very recently. Non-thermal emission in some protostellar jets has only been detected through negative spectral indices, with the exception of HH 80-81 (one of the most powerful and bright jets known) for which, also, linearly polarized radio emission was detected. It was proposed that synchrotron emission is produced by particles accelerated up to relativistic velocities in strong shocks of the jet with the dense envelope surrounding the protostar. Particle acceleration has been studied in several astrophysical systems (AGN, microquasars, SN, massive binaries, etc.), nevertheless, in YSO is a fairly new phenomenon. At present there exist several YSO candidates to present synchrotron emission. In this work we present the first results of a observational campaign with the JVLA to study synchrotron emission from a sample of protostellar jets. Here, we present the analysis of high sensitivity continuum and linearly polarized images at several frequencies of two of the most characteristics non-thermal protostellar jets (HH 80-81 and the Triple Source in Serpens).

Talk 34. Spatial growth of current driven instability in rotating relativistic jets

C. B. Singh, Y. Mizuno and E. M. de Gouveia Dal Pino

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Using three-dimensional relativistic magnetohydrodynamic code RAISHIN, we investigated the influence of radial density profile on the spatial development of current-driven kink instability along magnetized rotating, relativistic jets. For purpose of our study, we use a non-periodic computational box. We studied light as well as heavy jet with respect to the environment depending on density profile, besides different sets of angular velocity amplitude parameters are also provided. Results show the propagation of helically kinked structure along jet propagation and relatively stable configuration for jets lighter in terms of density. The jets do appear to be collimated by magnetic field lines and the magnetic acceleration is seen due to conversion of electromagnetic energy into kinetic energy of the jet. We discuss the implications of our findings for Poynting-dominated jets in connection with magnetic reconnection process.

Talk 35. Role of the disk environment in the observed TeV light curve from the binary system PSR B1259-63/LS 2883

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PSR B1259-63/LS 2883 is a very high energy (VHE; $E > 100$ GeV) gamma-ray emitting binary consisting of a 48 ms pulsar orbiting around a Be star with a period of 3.4 years. The Be star features a circumstellar disk which is inclined with respect to the orbit in such a way that the pulsar crosses it twice every orbit. The circumstellar disk provides an additional field of target photons which may contribute to inverse Compton scattering and gamma-gamma absorption, leaving a characteristic imprint in the observed spectrum and light curve of the high energy emission. We study the possible impact of the gamma-gamma absorption in the disk on the observed TeV light curve. We show that the cumulative absorption of VHE gamma-rays in stellar and disk photon fields might be a reason of the modulation of the flux at the periastron passage.

Talk 36. Extreme BL Lacs: probes for cosmology and UHECR source candidates

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High-energy observations of extreme BL Lac objects, such as 1ES 0229 200 or 1ES 0347-121, recently focused interest both for blazar and jet physics and for the implication on the extragalactic background light and intergalactic magnetic field estimate. Moreover, their enigmatic properties have been interpreted in a scenario in which their primary high-energy output is through a beam of high or ultra-high energy hadrons. However, despite their possible important role in all these topics, the number of these extreme highly peaked BL Lac objects (EHBL) is still rather small. Aiming at increase their number, we selected a group of EHBL candidates considering those undetected (or only barely detected) by the LAT onboard Fermi and characterized by a high X-ray versus radio flux ratio. We assembled the multiwavelength spectral energy distribution of the resulting 9 sources, using available archival data of Swift, GALEX, and Fermi satellites, confirming their nature. Through a simple one-zone synchrotron self-Compton model we estimate the expected very high energy flux, finding that in the majority of cases it is within the reach of present generation of Cherenkov arrays or of the forthcoming Cherenkov Telescope Array.

Talk 37. Generation of electron-positron plasma in pulsar magnetosphere (*highlight talk*)

Andrey Timokhin

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Pulsar activity is intimately connected to the copious generation of electron-positron pairs. It is widely agreed upon than a rapidly rotating neutron star is active as a radio pulsar as long as pairs are being produced in its magnetosphere and that the relativistic outflow from pulsar - pulsar wind - is composed of relativistic pair plasma. In this talk I will briefly overview the progress in theoretical studies of pulsar magnetospheres in the last few years and report on results of recent modeling of pair production by pulsars based on modern self-consistent numerical models of particle acceleration in their magnetospheres. I will discuss implication of these results for understanding of physics of pulsars and Pulsar Wind Nebulae.

Posters

Poster 1. Ultra high energy cosmic rays and signature of black strings

R. C. Anjos and C. H. Coimbra-Araújo

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This contribution provides a better understanding of the effects of luminosities from shower, AGN mechanisms and braneworld AGN corrections and provides a background model for the consideration of UHECR luminosity. We investigate the bolometric luminosity that comes from the accretion mechanism. It will be argued that the jet contribution comes as a quantity that is proportional to the bolometric luminosity, i.e., a fraction of such luminosity, assuming that any geometrically thick or hot inner region of an accretion flow can advance magnetic field fluctuations to produce power jets. We calculate cosmic ray luminosities from some AGN and radio galaxies and compare them with: i) the possible theoretical bolometric luminosity, based on a simple model of accretion disk around a SMBH; ii) the theoretical bolometric luminosity with corrections due to the presence of an AdS_5 extradimension (RS bulk). Comparisons to results obtained using these approaches are also shown and discussed.

Poster 2. Optically thick inhomogeneous SSC model for the steady gamma-ray emission from BL Lacs

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The TeV gamma-ray emission from high-frequency peaked BL Lacs (HBL) is expected to be produced in relativistic jets. The gamma rays have to propagate in the jet radiation suffering significant absorption. We investigate the inhomogeneous model for the blazar's jet in a steady state in which absorption effects are important. We consider how such absorption process can influence the gamma-ray spectra for different parameters describing the model. The results of numerical calculations are compared with observations of some BL Lac objects.

Poster 3. Modeling blazar flares with polarization angle swings

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Multiwavelength flaring activities with large ($>$ 180 deg.) polarization angle rotations are occasionally observed in several blazars. We suggest that such phenomena can be interpreted as arising from light travel time effects within an underlying axisymmetric emission region, without the need of any bending jets or asymmetric pattern motions. We present simultaneous fittings of the SEDs, multi-wavelength light curves, and time-dependent polarization features of a multiwavelength flaring event with a polarization angle swing of the prominent blazar 3C279. Such a combination in one coherent physical model places stringent constraints on the particle acceleration and magnetic field evolution in the blazar emission environment, strongly favoring a scenario in which magnetic energy dissipation is the primary driver of the flare event.

Poster 4. Covariant hyperbolization of force-free electrodynamics

Federico Carrasco, Oscar Reula

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Force-Free Electrodynamics (FFE) is a non-linear system of equations for the electromagnetic field. It describes magnetically dominated relativistic plasma, that is, a tenuous plasma whose only function is to render the ambient to be highly conductive. Such a plasma is to play a key role in the physics of pulsars and active galactic nuclei (AGN). In spite of the fact that the FFE equations have been around for several years, its causal structure has only been recently started to be uncover. We now know that this system is not only strongly hyperbolic, but also symmetric hyperbolic, since a suitable formulation has been found by Pfeiffer (2013) in a particular (3 1) decomposition. In this talk we want to fully analyze this system in a covariant fashion, and, following the lines of Geroch, find its hiperbolizations and constraints. Our interest is not only mathematical, but rather practical, for in many instances in numerical implementations such knowledge is needed.

Poster 5. Optical polarimety of blazars detected at TeV gamma rays

S. A. Cellone, M. S. Sosa, I. Andruchow, J. Combi, C. von Essen, J. Gonzalez Pérez

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We present results from an optical polarimetric study of four blazars, looking for short time-scale fluctuations (i.e., microvariability) either/both in their polarisation percent or position angle in the B and R bands. The observations were obtained with the CAFOS instrument at the 2.2-m telescope of CAHA (Calar Alto, Spain), attaining a temporal resolution of ~ 45 min along 3 to 6 (quasi-)consecutive nights. Low-amplitude ($> 1\%$) variations were detected at inter-night time-scales, while intra-night variations remained below approx. 1%. On the other hand, for each blazar the value of the electric vector position angle (EVPA) remained nearly constant during our observations, except for one object which showed a mild (10 deg) EVPA rotation. This study is part of an effort to characterise the photo-polarimetric variability behaviour of gamma-ray emitting blazars. Most TeV-detected blazars are relatively nearby objects, because gamma photons are efficiently absorbed by the extragalactic background light. Thus, their host galaxies are relatively bright and resolved, introducing a depolarising effect, and, at the same time, leading to systematic errors in the photo-polarimetric light-curves when seeing conditions vary with time. We study this effect in detail, quantitatively evaluating host-galaxy effects, and systematic errors introduced by uncertainties in their structural parameters.

Poster 6. Connecting AGN jet luminosities and ultra high energy cosmic ray luminosities

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We investigate the production of magnetic flux from rotating black holes in active galactic nuclei (AGNs) and compare it with the upper limit of ultra high energy cosmic ray (UHECR) luminosities, calculated from observed integral flux of GeV-TeV gamma rays for nine UHECR AGN sources. We find that, for the expected range of black hole rotations ($0.44 < a < 0.80$), the corresponding bounds of theoretical magnetic luminosities from AGNs coincides with the calculated UHECR luminosity. We argue that such result possibly can contribute to constrain AGN magnetic and dynamic properties as phenomenological tools to explain the requisite conditions to proper accelerate the highest energy cosmic rays.

Poster 7. Relativistic particle content in the most massive colliding-wind binary in the Galaxy

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The wind collision region (WCR) of the system HD93129A was recently resolved by the first time using Very Large Baseline Interferometry (VLBI). This system is the most massive known binary in our Galaxy. We present a model to compute the energy distribution of relativistic particles accelerated in the WCR and the associated emission. The model takes into account different energy losses while the particles stream along the fluid lines in the shocked region. The particle energy distribution is then used to estimate the broadband emission of the most important radiative processes. We reproduce the available radio data and calculate the broadband spectrum of the source. We also predict the evolution of the cosmic-rays energy distribution and the radiative output for future epochs, when the stars come closer.
A free parameter in our model is the proton-to-electron ratio in the population of relativistic particles. Contrasting our predictions to future observations at higher energies (hard-X and γ-rays) it will be possible to determine whether the relativistic particle content is hadron- or lepton-dominated.

Poster 8. Leptonic and hadronic modeling of the gamma-ray flare of 3C454.3

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In this study, we use a one-zone leptonic and a lepto-hadronic model to investigate the multi-wavelength emission and a prominent flare for the flat spectrum radio quasar 3C 454.3. We perform a parameter study with both models to obtain broadband fits to the spectral energy distribution of 3C 454.3. We then investigate different flaring scenarios to both models to explain an extreme outburst and spectral hardening that occurred in Nov 2010. We observe that the one-zone lepto-hadronic model can successfully explain the broadband multi-wavelength emission and the light curves in the Swift UBV, XRT and Fermi bandpasses for the Nov. 2010 flare. We also find that the one-zone leptonic model also can explain the broadband emission but fails to explain the Nov 2010 flare with the different flaring scenarios investigated.

Poster 9. On the heating and ionization produced by HMXB outflows

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Previous works have shown that high mass X-ray binaries (HMXBs) provide radiative and kinetic feedback on the surrounding interstellar medium (ISM), and suggest that their effect on galaxy evolution and star formation history could not be neglected. It has also been proposed that these systems could have partially contributed to the process of heating and reionization of the intergalactic medium (IGM) in the early Universe. With the aim of studying the kinetic feedback of HMXBs due to energetic outflows of particles (jets), we simulated by means of a Monte Carlo code the propagation of low energy electrons injected by these sources into the surrounding medium and estimated the heating and the amount of ionizations produced by these flows. Using a simple model for the propagation of ionization fronts, we estimated the recombination rate and hence, the volume of the ionized bubble for different sets of parameters of the medium and the source. In this work, we present our preliminary results and discuss their astrophysical and cosmological implications on galaxy evolution and the Reionization era, as well as the future prospects of our research.

Poster 10. Multiwavelength survey of a sample of flat-spectrum radio-loud NLS1s

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We report about a multiwavelength survey of a sample of 42 flat-spectrum radio-loud Narrow-Line Seyfert 1 Galaxies (RLNLS1s). This is the largest sample of this type of AGN known to date. We found 17% of sources detected at high-energy gamma rays (E>100 MeV), and 90% at X-rays (0.3-10 keV). The masses of the central black holes are in the range $\sim 10^{6-8} M_{\odot}$, smaller than blazars. The disk luminosities are about 1-49% of the Eddington value, with one outlier at 0.3%, comparable with FSRQs. The jet power is about $\sim 10^{42-46}$, comparable with BL Lac Objects and smaller than FSRQs. However, once renormalized by the mass of the central black hole, the powers of RLNLS1s, BL Lacs, and FSRQs are consistent each others, indicating the scalability of the jet. We found episodes of extreme (hour timescales) variability at high energies. In some cases, a dramatic spectral and flux changes is interpreted as the interplay between the relativistic jet and the accretion disk. We concluded that, despite the observational properties, the central engine of RLNLS1s is similar to that of blazars. [See more in: Foschini et al., 2015, A&A, 575, A13]

Poster 11. Neutrino, cosmic ray and γ-ray fluxes from the core emission of the radio Galaxies

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The nearby active radio galaxy Cen A, M87 and NGC 1275, has widely been detected from radio to TeV γ-rays. Their spectral energy distributions show a double-peak feature, which are well explained by synchrotron self-Compton model. However, recent TeV detections by HESS, MAGIC, and VERITAS suggest that very-high-energy γ-rays (E$\geq$100 GeV) might not have a leptonic origin. We test a lepto-hadronic model to describe the whole SED: radio to MeV-GeV photons as SSC emission and TeV photons as the neutral pion decay resulting from pγ interactions. For the pγ interactions, we assume that the seed photons are around at second SSC peak. We show that this hadronic model describes successfully the TeV spectra of these radio galaxies. Additionally we compute the number of neutrinos and ultra-high-energy cosmic rays expected in IceCube and Pierre Auger/Telescope Arrays observatories.

Poster 12. On the origin of the SNR G306.3-0.9: a detailed X-ray study

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We present here a detailed study of the morphological and spectral X-ray properties of supernova remnant (SNR) G306.3-0.9 based on two deep observations performed with Chandra and XMM-Newton satellites. By means of combined images, equivalent-width emission line maps and spatially-resolved spectra from different sets of regions of the SNR, together with Spitzer infrared observations and MOST radio data, we perform a thorough study in order to put constraints on the ionization stage of the remnant, its age and progenitor type. Our preliminary results indicate that the remnant is propagating in a non-uniform environment, where the shock front is encountering a high density medium in the south-west region. The X-ray spectra are well represented by an absorbed non-equilibrium ionization (VNEI) thermal plasma model, with variable abundances all through the remnant. Moreover, in the central part of the remnant, Fe Kα line becomes very bright, showing the presence of ejecta material. The SNR is also very bright at 24 μm and radio continuum maps, showing a strong morphological correlation at different wavelengths. The relatively low ionization timescales, abundance ratios, and the presence of ejecta as suggested by the very strong Fe Kα emission suggest that SNR G306.3-0.9 is a young SNR originated in a Type-Ia explosion. Its X-ray morphology suggests that the SNR is expanding in a non-uniform media, with a density gradient which grows in the south-east direction.

Poster 13. Observational properties of magnetized accretion disks and cosmic censorship

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Observations of X-ray binary systems provide strong evidences of the existence of compact objects too massive to be explained by theoretical models of neutron stars. When these systems are in the thermal (*high/soft*) state, their observed spectra in the $0.1 - 5$ keV range can be modeled by thermal radiation originated in fully relativistic accretion disks formed around super-compact objects. Furthermore, the profile of the fluorescent iron line present in their X-ray spectra is useful to get insight related with the nature of the compact object. In this work we present thermal spectra and 6.4 keV fluorescent iron line profiles obtained using a magnetized Page-Thorne accretion disk model formed around Kerr black holes and naked singularities (Ranea-Sandoval & García, 2015, Astronomy & Astrophysics, 574, A40). Using the same model we present preliminary results related with the emission originated in an hypothetical co-rotating hot-spot. We incorporated two different magnetic field configurations: uniform and dipolar, using a perturbative scheme in the coupling constant between matter and magnetic field strength.
We show that the presence of an external magnetic field produces potentially observable modifications that might be useful to test the nature of the central object. This could be used to analyze the validity of Penrose's cosmic censorship conjecture.

Poster 14. Heartbeat oscillations and wind outflow in IGR J17091-3624

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During the bright outburst in 2011, the black hole candidate IGR J17091-3624 exhibited, in some states, the strong quasi-periodic flare-like events (on timescales of tens of seconds), so-called heartbeat state.
As the observations show, the source can exhibit strong wind outflow during the soft state, and its presence is anti-correlated with the heartbeat oscillations. This wind may therefore help to partially or even completely stabilize the heartbeat.
We found that this source's outbursts are of appropriate timescales and amplitudes as a result of the accretion disk instability, driven by the dominant radiation pressure, if part of the energy dissipated in the disk is deposited in the wind. Our model requires a substantial wind component to explain the proper variability pattern, and even complete suppression of flares in some states. The wind mass-loss rate extracted from the data agrees quantitatively with our scenario.

Poster 15. Numerical Simulations of GRB afterglow variability

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Gamma Ray Bursts (GRBs) are one of the most exciting high-energy phenomena in the universe. The variability present in their afterglow light curve is revised and studied in the present work via hydrodynamical simulations within the frame of 'refreshed shocks' in which the external blast wave of the GRB, described by a Blandford-McKee solution, is hit from behind by a faster relativistic cold shell.

Poster 16. Optical spectroscopic and photometric observations of unclassified Active Galactic Nuclei in the *Fermi*-2LAC catalogue

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Blazars, which are separated into BL Lacs and Flat Spectrum Radio Quasars (FSRQs), exhibit strong and rapid multi-frequency variability, as well as radio and optical polarization. Approximately 18% of the sources included in the *Fermi*-2LAC catalogue were classified as Active Galactic Nuclei of Unknown type (AGU). We aim to classify a selection of these AGU which are observable from South African observatories. To achieve our aim we are undertaking a multi-wavelength campaign to establish the distance, type, variability and Spectral Energy Distributions (SEDs) of these sources. Broad wavelength optical spectroscopic observations have been performed with the Southern African Large Telescope (SALT) and the SAAO 1.9-m telescope, while short and long term photometric variability of the sources was studied using the SAAO 1.9-m and Watcher Robotic Telescope respectively, as well as archival data. The results for 5 candidates are discussed. The spectra are mainly featureless as expected for BL Lacs, however potential spectral features are present for some sources allowing for redshift estimates. Similarly, photometric monitoring shows potential variability for certain sources. Additional data are, however, needed to elaborate on these findings.

Poster 17. A tight $L_{\mathrm{p,iso}} - E'_{\mathrm{p}} - \Gamma_0$ correlation of gamma-ray bursts

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We select a sample of 34 gamma-ray bursts (GRBs) whose Γ_0 values are derived with the onset peak observed in the afterglow lightcurves (except for GRB 060218 whose Γ_0 is estimated with its radio data), and investigate the correlations among Γ_0, the isotropic peak luminosity ($L_{\mathrm{p,iso}}$), and the peak energy of the νf_ν spectrum in the cosmological rest frame (E'_{p}). An analysis of pair correlations among these observables well confirms the results reported by previous papers. In addition, a tight correlation among $L_{\mathrm{p,iso}}$, E'_p, and Γ_0 is found from a multiple regression analysis, which takes the form of $L_{\mathrm{p,iso}} \propto {E'_{\mathrm{p}}}^{1.34\pm0.14}\Gamma_0^{1.32\pm0.19}$ or $E'_{\mathrm{p}} \propto L_{\mathrm{p,iso}}^{0.55\pm0.06}\Gamma_0^{-0.50\pm0.17}$. Nine other GRBs whose Γ_0 are derived via the pair production opacity constraint also follow such a correlation. We argue that this tighter $L_{\mathrm{p,iso}} - E'_p - \Gamma_0$ correlation may be more physical than the $L_{\mathrm{p,iso}} - E'_{\mathrm{p}}$ correlation, since the relationship between the observed $L_{\mathrm{p,iso}}$ and E'_{p} not only depends on radiation physics, but also depends on the bulk motion of the jet. We explore possible origins of this correlation and discuss its physical implications for understanding GRB jet composition and radiation mechanism.

Poster 18. Scalar-tensor-vector gravity effects on relativistic blobs ejected by AGNs

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We investigate the effects predicted by an alternative model of gravity on the shape and trajectory of plasma blobs ejected by Active Galactic Nuclei. Specifically, we calculate the outcome of Lorentz-like forces arisen in the the context Moffatt's scalar-tensor-vector gravity, produced by a supermassive black hole.

Poster 19. Looking for blazars in a sample of unidentified high-energy emitting Fermi sources: preliminary results

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As blazars are known to be high energy emitters, it is expected that a large portion of the unidentified sources detected at gamma rays are AGN of the blazar subtype. Through cross-correlation between the unidentified objects belonging to the 1FHL Fermi catalogue of gamma-ray sources and the ROSAT, XMM Slew and Swift/XRT catalogues of X-ray objects, a sample of 38 associations was found with a high level of positional accuracy (less than 10 arcsec); one third of them have been recently classified as blazars. The remainder, though believed to belong to the blazar class, have not yet been identified. Therefore, we aim to study the optical spectra of the counterparts of these unidentified sources in order to find their redshifts and to analyze their nature and main spectral characteristics. We present here our preliminary results of optical spectroscopic observations from Telescopio Nazionale Galileo.

Poster 20. Orbital and superorbital variability of LS I 61 303 at low radio frequencies with GMRT and LOFAR

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LS I 61 303 is a gamma-ray binary that exhibits an outburst at GHz frequencies each orbital cycle of 26.5 d and a superorbital modulation with a period of 4.6 yr. We have performed a detailed study of the low-frequency radio emission of LS I 61 303 by analysing all the archival GMRT data at 150, 235 and 610 MHz, and conducting regular LOFAR observations within the Radio Sky Monitor (RSM) at 150 MHz. We have detected the source for the first time at 150 MHz, which is also the first detection of a gamma-ray binary at such a low frequency. We have obtained the light-curves of the source at 150, 235 and 610 MHz, all of them showing orbital modulation. The light-curves at 235 and 610 MHz also show the existence of superorbital variability. A comparison with contemporaneous 15-GHz data shows remarkable differences with these light-curves. At 15 GHz we see clear outbursts, whereas at low frequencies we see variability with wide maxima. The light-curve at 235 MHz seems to be anticorrelated with the one at 610 MHz, implying a shift of $\sim$0.5 orbital phases in the maxima. We model the shifts between the maxima at different frequencies as due to changes in the physical parameters of the emitting region assuming either free-free absorption or synchrotron self-absorption, obtaining expansion velocities for this region close to the stellar wind velocity with both mechanisms.

Poster 21. HAWC and its capabilities to study TeV astrophysics

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The High altitude water Cherenkov (HAWC) is a gamma-Ray experiment which has the capability of observing events among 100 GeV and 100 TeV from the cosmic-ray background. HAWC's instantaneous field of view is 2 sr and during a day its coverage amounts to 2/3 of the celestial sphere. We will present a general review of HAWC and describe some of its scientific expectations among we can find: detection of new TeV sources, measurement of the spectrum of Galactic sources at high energy, detection of GRBs at high energies, detection of transient sources and prompt notification to other experiments, study of the diffuse Galactic emission, cosmic-ray anisotropy, constraints on the existence of the nearby dark matter, evaporation of primary black holes, test of Lorentz invariance, search for exotic signals like SUSY Q-balls. Finally we will present some of the first results of HAWC.

Poster 22. Low galactic HE gamma-ray blazars in the VVV survey.

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Blazars are one of the most intriguing and interesting sources, presenting some peculiar observational characteristics, like fast and large variability at all wavelengths, radio loudness and flat spectrum in the radio band, changes in the degree of polarization, and no emission/absorption lines (or very weak ones) in the optical band. Close to the Galactic plane there is a significant lack of detected blazars due to the diffuse radio emission and confusion with local sources, thus, identifying new blazars is an important challenge for the scientific community. Our goal is to search for photometric characteristics of blazars in the near IR (Z, Y, J, H, Ks passbands) with the Vista Variables in the Vía Láctea (VVV survey, Minniti et al. 2010) with which to find a method to associate blazars to unidentified gamma-ray sources. We show preliminary results on the photometric properties of high-energy gamma-ray blazars detected by Fermi-LAT using the color-magnitude and color-color diagrams of the VVV. We also compare these results with a different method based on mid-IR observations acquired with WISE (Massaro et al. 2011).

Poster 23. Neutrino production in Cen A jets through proton re-acceleration

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In this work we study the production of neutrinos and gamma rays in the jets of Cen A as a consequence of proton re-acceleration in the jets. The jet is assumed to be rich in protons that can be accelerated at the jet base and then propagate downstream. We focus on the possible re-acceleration of protons at different distances along the jet, for instance, due to interactions of the jet with a star or a molecular cloud. These protons will produce gamma rays and neutrinos by *pp* interactions, and could also escape as cosmic rays. We compute the corresponding fluxes that could be produced within the proposed scenario.

Poster 24. Long-term optical photopolarimetric variability of 3C 454.3

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In this poster preliminary results of an R-band photopolarimetric variability study of the TeV blazar 3C454.3 are shown. Data were taken with the 0.84 m telescope at the Observatorio Astronómico Nacional at San Pedro Mártir, BC Mexico, with the instrument POLIMA from 2007 October 19 to 2014 November 17. Data were acquired during several runs assigned each month. The blazar clearly exhibits flux and polarization variations in the R-band during the seven years of observations. We found periods of increased activity and a clear low state was detected in late 2012. From our light curves we find that the maximum brightness occurred in 2010 November 1, with R=13.57±0.02 and a high polarization degree of P(%)=30.9±0.47. We will discuss possible rotations of the EVPA associated with flux and percentage degree variations and also the origin of the variations displayed by this TeV blazar.

Poster 25. Probing the Intergalactic Magnetic Field with the next generation Cherenkov telescopes

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Very high energy ($>$ 100 GeV) gamma rays coming from blazars can produce pairs when interacting with the Extragalactic Background Light (EBL) and the Cosmic Microwave Background, generating an electromagnetic cascade. Depending on the Intergalactic Magnetic Field (IGMF) intensity, this cascade may result in an extended isotropic emission of photons around the source (halo), or in a broadening of the emission beam. The detection of these effects might lead to important constrains both on the IGMF intensity and the EBL density, quantities of great relevance in cosmological models. Using a Monte Carlo program, we simulate electromagnetic cascades for different values of the IGMF intensities, considering a realist input spectrum for a blazar at redshift $z = 0.14$. In this work we study the possible response of a generic future Cherenkov telescope using a simplified model for the sensitivity, effective area and angular resolution. Finally, combining these instrument properties, we calculate the angular distribution of photons and develop a method to test the statistical feasibility of detecting the effect of a non null IGMF on this distribution.

Poster 26. BATSE data support multicomponent model for Gamma Ray Bursts prompt emission

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The spectra of Gamma Ray Bursts prompt emission in the keV-MeV energy range are usually considered as adequately fitted with the empirical Band function. Several observations of Gamma Ray Bursts prompt emission from both BATSE/CGRO and *Fermi* missions reveal deviations from the Band function to describe their spectra in the keV-MeV energy range. Recent data analysis from the *Fermi* Gamma Ray telescope conclude that GRBs prompt emission could be a combination of three main emission components simultaneously present: a thermal–like component interpreted as the jet photosphere, a non-thermal component interpreted as synchrotron radiation from particles within the jet and an additional non-thermal power-law (PL) function extending from low to high energies in gamma rays, interpreted most likely as Inverse Compton emission. In this work we present new analysis of three BATSE Bursts, namely GRBs 941017, 970111 and 990123. We show that the BATSE data are fully consistent with the model derived from *Fermi* data and that these three BATSE bursts also exhibit the three different components as reported from *Fermi*, noticing that they present similar spectral behavior. It become mainly relevant that the PL function may be present from the beginning of the bursts and it become dominant at lower energies, which is not well understood theoretically. Finally within this three component model the new relation between the time-resolved energy flux of the non-thermal component with its corresponding νF_ν spectral peak energy when fitted with a power law presents a similar index as the one obtained with the *Fermi* data, which points toward a possible universal relation between the luminosity of the non-thermal component and its corresponding νF_ν spectral peak energy in the rest frame.

Poster 27. Optical polarimetric variability of 3C279

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Preliminary results of optical variability analysis of the blazar 3C279 from 2008 February 26 to 2013 May 16, by mean of experimental variograms, are presented. The time series analyzed consist of flux, polarization degree and position angle of polarization data over time.

Poster 28. Studying the full dynamic of accretion-ejection structure through 3D MHD simulations

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We investigate the dynamics of the 3D bipolar jet launching from magnetically diffusive accretion disks. Our main goal is not to investigate the stability of the established jet flow - as this was subject to previous studies in the literature - but the evolution of the launching region itself under 3D perturbations. In our simulations the gravitational potential of the jet launching star-disk system is perturbed by a binary companion. This leads to a warping of the disk structure and, subsequently, to an asymmetric ejection of the disk outflow - that means a non-axisymmetric jet structure and also to a bipolar asymmetry.

Poster 29. Revealing traces of deterministic chaos in the accreting black holes lightcurves

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The high energy radiation emitted by black hole X-ray binaries originates in an accretion disk. Most of the sources undergo fast and complicated variability patterns on different timescales. The variations that are purely stochastic in their nature, are expected since the viscosity of the accretion disk is connected with its turbulent behaviour induced by magnetic instabilities. The variability of the disk that reflects its global evolution governed by the nonlinear differential equations of hydrodynamics may not be only purely stochastic. Instead, if the global conditions in the accretion flow are such that the system finds itself in an unstable configuration, the large amplitude fluctuations around the fixed point solution will be induced. The observed behaviour of the disk will then be characterized by the deterministic chaos. The recent hydrodynamical simulations of the global accretion disk evolution confirm that the quasi-periodic flare-like events observed in couple sources are in a good quantitative agreement with the radiation pressure instability model of the disc coupled with strong outflows in form of a wind. At least eight of the known BH X-ray binaries should have their Eddington accretion rates large enough for the radiation pressure instability to develop. In the current work, we aim to tackle the problem of stochastic versus deterministic nature of the black hole accretion disk variability from the analytic and observational point of view.

Poster 30. On the ensemble fluctuations of the cosmic ray energy spectrum

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Despite a big progress made on the observational side in the last few years, the sources of the ultra high energy cosmic rays are not identified yet. Moreover, the observations made at the highest energies allowed to obtain only a lower limit to the spatial density of sources. Different configurations of the spatial position of the sources, corresponding to a given value of the density of sources, lead to different energy spectra and composition profiles at Earth. These ensemble fluctuations are larger at the highest energies because of the interactions undergone by cosmic rays when propagate through the intergalactic medium. In this work we study different aspects of the ensemble fluctuations with a special emphasis on the influence of the intergalactic magnetic field on this phenomenon. In particular, it is found that the intergalactic magnetic field can increase the ensemble fluctuations for the case in which the cosmic rays are composed by heavy nuclei at the highest energies, as suggested by the data of the Pierre Auger Observatory.

Poster 31. Ongoing optical photometric monitoring of AGN TeV targets with the Watcher Robotic Telescope

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Active Galactic Nuclei (AGN) show variability on various time scales and present complex correlations between these variation at different wavelengths. Simultaneous multi-wavelength observations can therefore be used to place constraints on the different emission models. We have commenced in May 2015 with optical photometric monitoring of a subset of the known TeV emitting AGN using the Watcher Robotic Telescopes (Boyden Observatory, South Africa) to obtain long term photometric monitoring of these sources. Currently 17 targets are included in this monitoring campaign, selected based on optical brightness. The sources are observed once per night in the V, R & i' bands, depending on observability and weather. We present the initial results from this monitoring campaign as well as the proposed expansion and development.

Poster 32. Optical spectroscopic monitoring of the variation in the circumstellar disc in PSR B1259-63/LS 2883 during the 2014 periastron passage

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The gamma-ray binary system PSR B1259-63/LS 2883 went through periastron in May of 2014 and was the focus of intensive multi-wavelength campaigns. During the previous periastron, a large flare was detected at GeV energies 30days after the 2010 periastron passage by Fermi-LAT. This event was re-detected during 2014 at a similar orbital phase. The observed multi-wavelength light curve is complicated by the variation in the shock front as the pulsar passes through the circumstellar disc surrounding LS 2883. In order to place better constraints on the behaviour of the circumstellar disc around periastron, we performed optical spectroscopy of the H-alpha and He-I (6678) lines with the Southern African Large Telescope (SALT). PSR B1259-63 was observed at 25 epochs from 33 days before until 78 days after the 2014 periastron with the Robert Stobie Spectrograph (RSS) with a wavelength coverage of 661.7-698.3 nm ($R = 11021$). The H-alpha line remains single peaked through all observations, but with a noted asymmetry and variation in shape. The He-I line (6678) remains double peak and shows a variation in the relative peak heights. Both lines show an increase in the equivalent width which peaks after periastron. The line strengths before periastron are, however, weaker than were detected before the 2010 periastron, although they are comparable after periastron. The observations demonstrate the change in the circumstellar disc around periastron as well as the variation from periastron to periastron, which we attribute to the variability of the Be star.

Poster 33. A mechanism for fast radio bursts

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Fast radio bursts are transient sources of unknown origin. Since they are likely located at cosmological distances, and present extremely fast variability, the estimated brightness temperatures are well above the self-absorption limit of incoherent synchrotron radiation, suggesting a coherent nature.
We propose a radiation mechanism for fast radio bursts where coherent emission arises from electron acceleration in intense electrostatic soliton-like regions (cavitons). The cavitons are produced in the interaction of a relativistic electron beam with a denser plasma. We show that the proposed mechanism can account for the main features observed in fast radio bursts.

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