Oral contributions accepted for HEPRO IV

Barkov, Maxim

Rapid TeV and GeV Variability in AGNs as Result of Jet-Star Interaction.

We propose a new model for the description of ultra-short and short flares from TeV and GeV AGNs by compact magnetized condensations (blobs), produced when red giant stars or gas clouds cross the jet close to the central black hole. Our study includes as a simple dynamical model as 2D relativistic HD for the evolution of the envelope lost by the star in the jet, and its high energy nonthermal emission through different leptonic and hadronic radiation mechanisms. We show that the fragmented envelope of the star can be accelerated to Lorentz factors up to 100 and radiate effectively the available energy in gamma-rays predominantly through proton, electron synchrotron radiation or external inverse Compton scattering of electrons or proton-proton collisions. The model readily explains the day-long and variable on timescales of hours GeV gamma-ray flare observed from 3C454.3 on top of the weeks-long plateau observed during November 2010. The model also can explain the minute-scale TeV flares from the blazar PKS 2155-304 and day-scale TeV flares from M87.

Bednarek, Wlodek

Gamma-rays from millisecond pulsar population in the Galactic Center

It was proposed that the central dense stellar cluster in the Galactic Center has been formed as a result of a merging of several massive globular clusters. These globular clusters are expected to provide a large number of millisecond pulsars (MSPs) within the central parsec of the Galactic Center. We propose that these MSPs inject relativistic leptons into the dense infrared and optical radiation region present within the central parsec. We calculate the expected TeV γ-ray emission produced by these leptons by the Inverse Compton Scattering process in the soft radiation field. It is shown that this emission can be responsible for the multi-TeV γ-rays observed by the Cherenkov telescopes from the Galactic Center for reasonable densities of the soft radiation, diffusion models for the propagation of leptons, their injection parameters (fluxes and spectral proprieties). If the energy conversion efficiency from the pulsars to the relativistic leptons is of the order of 10%, then about a thousand of MSPs have to be present in the central cluster in the Galactic Center.

Bisnovatyi-Kogan, Gennady

Estimation of alpha-viscosity coefficient from observations of nonstationary disk accretion.

The optical behaviour of the Be star in the high mass X-ray transient A0535+26/HDE245770 shows that at the periastron typically there is an enhancement in the luminosity of order 0.05 to few tenths mag, and the X-ray outburst happens about 8 days after the periastron. We construct a quantitative model of this event, basing on a nonstationary accretion disk behavior, connected with a high ellipticity of the orbital motion. We explain the observed time delay between the peaks of the optical and X-ray outbursts in this system by the time of radial motion of a matter in the accretion disk, after increase of the mass flux in the vicinity of a periastral point in the binary. This time is determined by the turbulent viscosity, with the parameter $\alpha=0.1-0.3$, estimated from the comparison of the model with observational data.

Bosch-Ramon, Valenti

Gamma-ray binaries: the dynamics of shocked stellar-pulsar winds

Binary systems hosting a massive star and a powerful young pulsar are luminous sources of gamma rays. The interaction of the stellar and the pulsar wind in conjunction with the orbital motion gives rise to a very complex flow structure. In this talk, I will provide with a dynamical description of the shocked flow at different scales, from the two-winds interaction region up to pc scales, where the momentum and energy are deposited in the surrounding medium. I will also point out interesting regions of non-thermal phenomena in these systems.

Chen, Xuhui

Magnetic field amplification and blazar flares

Recent multiwavelength observation of PKS 0208-512 by SMARTS, Fermi, and Swift revealed that gamma-ray and optical light curves of this flat spectrum radio quasar (FSRQ) are highly correlated, but with an exception of one large optical flare having no corresponding gamma-ray activity or even detection (Chatterjee et al. 2012). On the other hand, recent advances in supernova remnant (SNR) observations and plasma simulations both reveal that magnetic field downstream of astrophysical shocks can be largely amplified beyond simple shock compression. These amplifications, along with their associated particle acceleration, can be expected to explain the blazar flares, including the peculiar flare of PKS 0208-512. Using our time dependent multizone blazar emission code, we evaluate several scenarios that may represent such phenomena. This code combines Monte Carlo method that tracks the radiative processes including inverse Compton scattering, and Fokker-Planck equation that follows the cooling and acceleration of particles. It is a comprehensive time dependent code that fully take into account the light travel time effects (LTTEs). In this study, changes of both magnetic field and acceleration efficiency are explored as the cause of blazar flares. Under these assumptions, synchrotron self-Compton (SSC) and external Compton (EC) models produce distinct features that favor the EC model. The optical flares with/without gamma-ray counterparts can be explained by different allocations of energy between the magnetization and particle acceleration, which in turn can be affected by the relative orientation between the magnetic field and the shock front. We will compare the details of the observation and simulation, and highlight what implications this study has on our understanding of relativistic jets.

De Caneva, Gessica

The FSRQs 3C 279 and PKS 1510-089: MAGIC latest results and multiwavelength observations

3C 279 and PKS 1510-089 are two out of the three flat spectrum radio quasars (FSRQs) detected in the very high energy (VHE, >100 GeV) gamma-ray domain. FSRQs, a subclass of blazars, are characterized by broad emission lines in the optical spectrum, indicating the presence of a strong photon field. This low energy radiation can not only provide additional seed photons for the inverse Compton scattering process but also implies internal absorption of VHE gamma rays. Moreover, FSRQs have a steep gamma-ray spectrum, therefore their detection in VHE gamma rays is challenging. The MAGIC experiment, an array of two Cherenkov telescopes located on the Canary Island of La Palma, is a well suited instrument for observations of such objects due to the combination of low energy threshold and good sensitivity. Indeed, it detected all the FSRQs known to emit in VHE gamma rays; here we present MAGIC observations of 3C~279 and PKS 1510-089 together with simultaneous multiwavelength observation at lower energies.

The MAGIC telescopes observed 3C 279 (z=0.536) twice in 2011: first as regular monitoring, later as follow up observations after high activity states reported in the optical regime and high-energy gamma rays (HE, 100 MeV-100 GeV). None of the observation led to a significant detection, hence upper limits on the flux have been computed. The MAGIC observations of PKS 1510-089 (z=0.36) in 2012 were triggered by alerts of high activity states in high-energy gamma rays, both from the Fermi-LAT and the AGILE collaborations. The observation lead to a detection at >5 sigma significance level.

To outline a complete picture, MAGIC observations of 3C 279 and PKS 1510-089 are complemented with simultaneous multiwavelength observations in HE gamma rays, X-rays, optical and radio wavelengths and polarisation measurements. With the study of the spectral features and the variability observed from radio to VHE gamma rays, we aim at identifying the physical processes responsible for the behaviour of this class of sources. In particular, the combined study of the broad band spectral energy distribution and the light curves allow us to estimate the number and the location of emission regions and to determine the dominant radiative processes taking place in such objects.

Fendt, Christian

Formation and collimation of relativistic MHD jets - simulations and radio maps

We have performed special relativistic MHD simulations treating the formation of relativistic jets from disk winds and their propagation. Newtonian gravity was added in order to establish the physical boundary condition of an underlying accretion disk in centrifugal and pressure equilibrium. As a general result we obtain well collimated jets with a mass flux weighted half-opening angles of 3-7 degrees and mildly relativistic velocities depending on the launching conditions for the outflow. When we increase the outflow Poynting flux by injecting an additional disk toroidal field into the outflow, the asymptotic jet velocities increase to Lorentz factor of 8-10. Using the jet dynamics (eg. density, field strength, Doppler shift) obtained from our simulations, we can now produce emission maps, predicting VLBI radio or (sub-) mm observations of nearby AGN cores. For this we have developed a special relativistic synchrotron transport code fully taking into account self-absorption and internal Faraday rotation. We find that the strict bi-modality of the polarization direction suggested by other authors can be circumvented when the structure of a collimating jet is considered. Depending on the pitch angles of the emission region, also a spine-and-sheath polarization structure could be observed. The relativistic swing effect skews the polarization compared to the non-relativistic case. The frequency-dependent core shift in the radiation maps following our jet simulations is compliant with analytical estimates of conical jets in the literature. We will present mock observations of spectral index, polarization degree and rotation measure for various inclinations. Asymmetries in the spectral index and polarization degree can be observed most articulately at high inclinations. At about 30 degrees, the predominant polarization vector flips from perpendicular alignment for the blazar case to parallel alignment for the radio galaxy case at high inclinations.

Foschini, Luigi
The unification of relativistic jets
I report about the unification of relativistic jets from compact objects. The mass range is between 1.4 and 10 billion solar masses (i.e. from neutron stars to supermassive black holes in galaxies).

Fossati, Giovanni
On the relationship between jet, accretion disk and BLR variability in FSRQs
Studies of the relationship between variations in the jet continuum emission and those of broad emission lines (and disk emission) can provide new clues about the structure of the central regions of jetted AGNs and properties of the outflow, such as the location of the active region. Thanks to Fermi and the large multiwavelength coverage that it stimulated (and supported) there are now high quality data for several blazars and this type of investigation is becoming possible and slowly beginning to bear fruit. The interpretation of the correlated (or not) variability requires to look more in depth at the relationship between the various "radiative signals", some of which may be responsible for causing variations in other components, examples being BLR radiation seeding EC in the jet, disk emission increasing BLR power, or jet emission ionizing part of the BLR as recently discussed. Because the jet "blob" moves nearly at the same speed of the "signals", the actual relationships are somewhat at odds with the naive intuition. I will present results of our study of the observational implications/appearance of variations originating in different components and discuss the implications for the interpretation of recent novel observational work.

Gaibler, Volker
Powerful AGN jets in an inhomogeneous interstellar medium
Powerful jets from active galactic nuclei do not only interact with the circumgalactic gas at large distances, but can show plenty of interaction with the interstellar medium (ISM) of their host galaxy. Since the ISM of galaxies is known to be multi-phase and hence clumpy and highly inhomogeneous, these small-scale structures can have a decisive effect on the interaction of the jets with and their propagation through the host galaxy. In particular, for galaxies with a large gas reservoir as at high redshift or during and after mergers, the impact can be extreme. By means of high-resolution hydrodynamical simulations we have examined this interaction in detail and will present results on the asymmetry of the radio source, the gas budget of the galaxy and the star formation seen in the galaxy.

Gelfand, Joseph
Modeling the Dynamical and Broadband Spectral Properties of a Pulsar Wind Nebula inside a Supernova Remnant
The properties of a pulsar wind nebula inside a supernova remnant are sensitive to the birth properties of the central neutron star, the energetics of the progenitor supernova, and the energy spectrum of particles in the pulsar wind. Currently, the best way of constraining these properties by fitting the observed properties of a pulsar wind nebula inside a supernova remnant with an evolutionary model. In this talk, I will describe such a model, and present what is learned by applying this model to various systems.

Gerard, Lucie
BL Lac population study at high energies
In the context of AGN unification, BL Lacs blazars and their associated parent population share the same intrinsic characteristics and the orientation of the relativistic jets of these objects explains the observational differences between the two populations. The growing number of BL Lacs detected at high energies (HE > 100 MeV) and very high energies (VHE >100GeV) offers new opportunities to test this association, somehow challenged if only the simplest jet models are considered. In this study, we performed extensive MC simulations of apparent luminosity distributions of HE BL Lacs with different structures of the jet and compared them with the population extracted from the 2nd Fermi catalog. We constrain the jet characteristics: the geometry, velocity and intrinsic luminosity. The association of those BL Lacs with their usual counterpart, the FRI type radio galaxies, is then discussed.

Giannios, Dimitrios
*The S2 star as a probe of the accretion disk of Sgr A**
How accretion proceeds around the massive black hole in the Galactic center and other highly sub-Eddington accretors remains poorly understood. The orbit of the S2 star in the Galactic center passes through the accretion disk of the massive black hole and any observational signature from such interaction may be used as an accretion probe. Because of its early stellar type, S2 is expected to posses a fairly powerful wind. We show here that the ram pressure of the accretion disk shocks the stellar wind fairly close to the star. The shocked fluid reaches a temperature of a few keV and cools efficiently through optically thin,

thermal bremsstrahlung emission. The radiation from the shocked wind peaks around the epoch of the pericenter passage of the star at a luminosity potentially comparable to the quiescent emission detected from Sgr A*. Detection of shocked wind radiation can constrain the plane of the accretion disk and the density of the disk at a distance of several thousands of gravitational radii from the black hole.

Ikhsanov, Nazar

Evidence for magnetic accretion in X-ray binaries and AGNs

Study of observed spin evolution of long-period X-ray pulsars challenges currently used quasi-spherical and Keplerian disk accretion models. It shows that the magnetospheric radius of these pulsars is substantially smaller than the Alfven radius and the spin-down torque applied to an accreting neutron star is significantly larger than that evaluated in the conventional accretion scenarios. These problems can be, however, avoided if the fossil magnetic field of the accretion flow itself is incorporated into the accretion scenario. The accretion structure in this case can be explained in terms of a dense non-Keplerian magnetic slab (or torus) in which the material is confined by its intrinsic magnetic field. We show that a necessary condition for the slab formation can be satisfied in both close X-ray binaries and AGNs. Modeling of accretion process in terms of this magnetic accretion scenario provides us with additional mechanisms of plasma ejection and collimation in the accretion-powered sources.

Inoue, Susumu

Synchrotron gamma radiation from ultrahigh energy cosmic ray nuclei in gamma-ray bursts

Gamma-ray bursts (GRBs) are promising candidates for the sources of ultrahigh energy cosmic rays (UHECRs), whose composition may contain a significant amount of heavy nuclei as indicated by data from the Pierre Auger Observatory. We show that under certain conditions, synchrotron radiation from UHE nuclei accelerated in GRBs may be observable as GeV-TeV gamma-rays and provide a crucial diagnostic. If the CR composition at the source is deficient in protons as suggested by the observed lack of associated anisotropy, synchrotron gamma rays from species such as O or Fe may be directly observable and distinguishable through the dependences of the spectral peak energy and cooling time on the mass and charge of the nuclei. If instead the composition is similar to Galactic CRs, the emission from heavy nuclei may be buried beneath the proton synchrotron component, but that due to He may still be discernible and offer important constraints on the pair dip model for the origin of the ankle in the UHECR spectrum. Future detection of such gamma rays will offer a unique probe of UHECR nuclei acceleration in GRBs.

Kalapotharakos, Constantinos

Gamma-ray pulsar emission. From theory to observations.

We present numerical models of dissipative 3D pulsar magnetospheres which are then used to explain the observations. Using a variety of prescriptions to relate the current density J to the fields E, B we produce families of solutions covering the entire spectrum between the vacuum retarded dipole and the force-free solutions. These solutions provide also the distribution of electric components, parallel to the magnetic field B, which accelerate the radiating particles. Using these detailed dissipative magnetospheric models we generate model gamma-ray light curves by calculating realistic trajectories of radiating particles and the corresponding Lorentz factors under the influence of both the accelerating electric fields E and radiation-reaction effects. Finally, we compare our results with the Fermi Large Area Telescope observations getting clear hints with respect to the models being able to explain the observations.

Kapanadze, Bidzina

Microvariability of 0.3-10 keV Flux in HBL Source PKS 2155-304

High energy peaked BL Lacertae object PKS 2155-304 has been observed 106-times by the X-ray Telescope onboard the Swift satellite through the 0.3-10 keV band since 2005 November 17. Among these observations, we have revealed 19 cases of the intraday flux variability at 99.9% confidence level with fractional rms amplitudes up to 30% and timescales ranging from 40 ks down to 0.4 ks. Flux changes were often accompanied by a spectral variability which showed a complex character in the presence of both clockwise and counter-clockwise evolution in a hardness ratio-flux plane. These events show rather curved spectra fitted well with the log-parabolic model. The curvature parameter ranged from 0.13 to 0.73 and showed different values for the spectra corresponding to the separate orbits of a single observation. The peak of spectral energy distribution ranged between 1.76 keV and 2.67 keV and generally was variable during the intraday flux changes. The soft and hard X-ray fluxes showed a strong correlation each to other. No correlation between the occurrence of intraday variations and source brightness state was seen - they are found as in flaring as well for intermediate and low states. The X-ray microvariability in PKS 2155-304 can be explained both with the shock-in-jet scenario and emergence of a "blob" of very energetic particles in the jet base.

Khangulyan, Dmitry

Binary Pulsar System PSR B1259-63 as a Gamma-Ray Emitter

Recent observations with HESS and Fermi/LAT discovered a few important features of the gamma-ray emission produce in the binary pulsar system psr B1259-63. These observational results, once properly interpreted, poses very serious challenges for modelling, and may strongly change the conventional view on the processes occurring in binary pulsar systems.

Krakau, Steffen

Plasma effects on extragalactic ultrahigh-energy cosmic ray hadron beams in cosmic voids

The interaction of an ultrarelativistic hadron beam ($\Gamma_b\approx 10^6$) with the intergalactic medium (IGM) is investigated. Especially the collective instabilities ($\Lambda_{l/T}=0$), both electrostatic and electromagnetic, are calculated analytically. This calculation is important for the ultrarelativistic cosmic rays ($E>10^{15}$eV), which are assumed to be extragalactic and consequently have to propagate through the IGM on their way to earth.

Lauer, Robert

Gamma-Ray Astronomy with the HAWC Observatory

The High Altitude Water Cherenkov (HAWC) Observatory is a wide-field gamma-ray detector sensitive to primary energies between 50 GeV and 100 TeV. The array is being built at an altitude of 4100 meters on the Sierra Negra volcano near Puebla, Mexico. With a duty cycle close to 100% and a daily coverage of ~6 sr of the sky above it, HAWC is ideally suited to detect bright transient events at TeV energies such as gamma-ray bursts or flares from active galactic nuclei. The array will provide an unbiased survey of the TeV sky, observing sources for up to ~6 hours each day. The sensitivity of the full detector will exceed that of its predecessor, the MILAGRO experiment, by an order of magnitude. With the ability to measure gamma-ray spectra of galactic sources between 1 and 100 TeV, HAWC observations can complement those of other instruments and probe astrophysical phenomena and the origins of photon emission at the highest energies. The modular design of HAWC made it possible to start data taking in October 2012 with a preliminary configuration of 30 water Cherenkov detectors. Operation continues while the number of detectors is growing, allowing a smooth transition to full scientific operation with 100 detectors in August 2013 and 300 detectors in the summer of 2014. In this contribution, I will give an overview of the status and performance of the HAWC observatory, discuss observation strategies for transient gamma-ray phenomena, and present results from the first analyses.

Mao, Jirong

Jitter Polarization for GRB Prompt Emission

The radiation of relativistic electrons in random and small-scale magnetic field is called jitter radiation. We apply jitter process to study the polarization feature of GRB prompt emission. A two-dimensional compressed slab which contains stochastic magnetic field is applied in our model. If jitter condition is satisfied, the high-degree polarization can be achieved when the angle between line-of-sight and slab plane is small. Moreover, micro-emitters with mini-jet structure and jet off-axis effect are considered.

Massaro, Francesco

Unidentified gamma-ray sources: new insights on the blazar phenomenon

One of the main scientific objectives of the recent Fermi mission is unveiling the nature of the unidentified gamma-ray sources (UGSs). Despite the large improvements of Fermi in the source localization with respect to the past gamma-ray missions, about 1/3 of the gamma-ray objects detected still do not have a low energy counterpart associated. Since many UGSs can be blazars, the largest known population of gamma-ray sources, we developed two association methods to search for gamma-ray blazar candidates based on their physical properties. The first method takes advantage of the discovery that blazars can be recognized and separated from other extragalactic sources dominated by thermal emission using their infrared colors, while the second procedure is based on the blazar spectral properties at low radio frequencies. Both methods are powerful new diagnostic tools that can be used to extract new blazar candidates, to identify those of uncertain type and also to search for the blazar-like counterparts of unidentified gamma-ray sources. The implications of our results in the contest of the blazars - radio galaxies connection to test the expectations of the unification scenario for radio-loud active galaxies will be also highlighted.

Melzani, Mickael
Differences between PIC, real, and Vlasov-Maxwell plasmas
The widespread use of particle-in-cell (PIC) codes for studying plasmas out of equilibrium calls for a deep understanding of the PIC model, and of its relations with a real plasma and with the Vlasov-Maxwell description. The PIC model lies on two building blocks. The first stems from the capability of computers to handle only up to ~10^{10} particles, while real plasmas contain from 10^4 to 10^{20} particles per Debye sphere: a coarse-graining step must be used, whereby of the order of p~10^{10} real particles are represented by a single computer "superparticle". The second is field storage on a grid with its subsequent finite superparticle size. We introduce the notion of coarse-graining dependent quantities, i.e. physical quantities depending on the number p. They all derive from the plasma parameter \Lambda, that we show to be proportional to 1/p. Important applications include the PIC collision- and fluctuation-induced thermalization times, that scale with the number of superparticles per grid cell and are a factor p~10^{10} smaller than in real plasmas, and the level of electric field fluctuations, that scales 1/\Lambda=p. We show how large superparticle sizes of the order of the Debye length modify these scalings. We investigate the extent to which these unphysically large parameters alter the PIC plasma physics with two main examples: the rapid thermalization of plasmas with two different temperatures, and the blurring of the linear spectrum of the filamentation instability. In the latter case, the fastest growing modes do not dominate the total energy because of a high level of fluctuations, and effective growth rates measured on the total energy can differ by more than 50% from the linear cold predictions. We also stress that a PIC plasma bears differences with the Vlasov-Maxwell description, which models a phase-space fluid with \Lambda=+\infty and no correlations.

Moldon, Javier
VLBI monitoring of the gamma-ray binary PSR B1259-63
PSR B1259-63 is a 48 ms pulsar in a highly eccentric 3.4-year orbit around the young massive star LS 2883. During the periastron passage the system displays transient non-thermal unpulsed emission from radio to very high energy gamma rays. Very Long Baseline Interferometric (VLBI) radio observations of the source showed an extended structure up to projected distances of 120 AU. This was the first observational evidence that non-accreting pulsars orbiting massive stars can produce variable extended radio emission at AU scales. We conducted a multiepoch campaign with the Australian Long Baseline Array at 2.3 GHz during the 2010-2011 periastron passage. This monitoring provides high resolution radio images of the radio outflow, and shows the evolution of its structure up to 100 days after the periastron passage, including the orbital phases of the post-periastron GeV flare. The data allow us to identify the position of the pulsar within the extended radio nebula. These observations reveal physical properties of this gamma-ray binary, as well as information about the real orientation of the system in the sky.

Munar-Adrover, Pere
Searching for gamma ray emission in massive star-forming regions
Star-forming regions and massive protostars have been proposed to be sources of gamma-ray emission. Some of these sources have shown non-thermal radio emission associated with the jets, indicating relativistic particle acceleration. It is expected that strong shocks form at the jet-termination region leading to gamma-ray emission. We have studied IRAS 16547- 4247, an isolated protostar showing non-thermal radio emission; and Monoceros R2, a star forming region coincident with a source of the 2nd Fermi-LAT catalogue. In the case of IRAS 16547- 4247, a deep analysis of the archival X-ray data resulted in the detection of a hard source. We find that this X-ray emission can be produced through thermal Bremsstrahlung by a fast shock at the jet end, and in addition significant γ-ray emission is expected. In the case of Monoceros R2, our analysis of the 3.5 years of Fermi-LAT data confirms with 12 sigma the former source detection. Our results are compatible with the source being the result the combined effect of multiple young stellar objects in Monoceros R2.

Mochol, Iwona
Strong electromagnetic waves and the sigma problem in pulsar winds
Strong waves can mediate a shock transition between a pulsar wind and its surroundings, playing the role of an extended precursor to the termination shock. Such precursors can effectively transfer the energy from fields to non-thermal particles and, therefore, provide a viable solution to the sigma problem in pulsar winds. In this context, I will discuss their stability and its implications for the properties of shocks, located at large stand-off distances from the central star. Those with stable precursors can exist in the winds of most isolated pulsars, but the precursors may be unstable if the external pressure is high, as in Vela-like pulsars.

Niemiec, Jacek

Studies of nonrelativistic young supernova remnant shocks through kinetic simulations

The structure of SNR shocks and the injection of suprathermal particles into a Fermi-type acceleration at such shocks constitute important problems of high-energy astrophysics. We report on recent results of kinetic particle-in-cell studies of nonrelativistic plasma collisions with absent or parallel large-scale magnetic field, that use parameter values expected for young SNRs. We show that the electron dynamics play an important role in the development of the system. While nonrelativistic shocks in both unmagnetized and magnetized plasmas can be mediated by Weibel-type instabilities, the efficiency of shock formation processes is higher when a large-scale magnetic field is present. The electron distributions downstream of the forward and reverse shocks are generally isotropic, whereas that is not always the case for the ions. We do not see any significant evidence of pre-acceleration, neither in the electron population nor in the ion distribution. First results of plasma collisions with perpendicular magnetic field configurations will also be presented. These simulations are based on a new setup that is unusually clean and permits the magnetic field strength and configuration to be different in the two colliding plasma slabs. We will also report on new realistic studies of the non-linear evolution and saturation of cosmic-ray streaming instabilities leading to the magnetic-field amplification upstream of the shock.

Nishikawa, Kenichi

Radiation from accelerated particles in relativistic jets with shocks, shear-flow, and reconnection

We investigated particle acceleration and shock structure associated with an unmagnetized relativistic jet propagating into an unmagnetized plasma. Strong magnetic fields generated in the trailing shock contribute to the electron's transverse deflection and acceleration. Kinetic Kelvin-Helmholtz instability (KKHI) is also responsible to create strong DC magnetic fields. The velocity shears in core-sheath jets create strong magnetic field perpendicular to the jet. We examine how the Lorentz factors of jets affect the growth rates of KKHI. We have calculated, self-consistently, the radiation from electrons accelerated in these turbulent magnetic fields in the shocks. We found that the synthetic spectra depend on the bulk Lorentz factor of the jet, its temperature and strength of the generated magnetic fields. We will investigate synthetic spectra from accelerated electrons in strong magnetic fields generated by KKHI. The calculated properties of the emerging radiation provide our understanding of the complex time evolution and/or spectral structure in gamma-ray bursts, relativistic jets in general, and supernova remnants.

Odaka, Hirokazu

X-ray and gamma-ray polarimetry with ASTRO-H

Polarization in the X-ray and gamma-ray bands is a promising probe of high-energy phenomena in the universe. In the sub-MeV energy band (100 keV--1 MeV), polarized emissions have been reported from the brightest sources such as Crab nebula and Cygnus X-1 though these measurements still have uncertainties. The Soft Gamma-ray Detector (SGD) onboard ASTRO-H, which is the next international X-ray observatory scheduled for launch in 2015, is designed for spectroscopy as well as high-precision polarimetry using Compton scattering, improving the sensitivity and precision of the polarization. This instrument covers an energy range from about 50 keV up to 600 keV. The Crab pulsar and nebula is the most feasible target of the soft gamma-ray polarimetry, providing us with information on the radiation mechanism and the structure of the magnetic field in the vicinity of the emission site through the fraction and angle of polarization. The polarization properties for different pulsation phases (peak phases and off-pulse phase) and different energy bands from 50 keV up to 1 MeV will distinguish the pulsar signals and emissions from the pulsar wind nebula. We also stress the importance of the ASTRO-H measurements of soft gamma-ray variability during the GeV gamma-ray flares. Relativistic jets in galactic microquasars and blazars constitute another important category of polarimetry targets since their nonthermal radiations can be highly polarized. The SGD will able to probe nonthermal emissions from bright galactic black hole binaries (e.g. Cygnus X-1 and GRS 1915+105) by using polarization, which probably makes a difference between the jet and other thermal or even nonthermal coronal emissions close to the accretion disks. In this talk, we will discuss plans and predictions of observations of relativistic outflows with ASTRO-H. Based on detailed instrumental simulations and astrophysical source models, in-orbit performances of the instrument for polarization measurements are accurately evaluated.

Pavan, Lucia

New results on the puzzling jet of IGR J11014-6103.

IGR J11014-6103 is a unique Galactic hard X-ray emitter discovered by INTEGRAL, which comprises three main structures: (1) a hyper-fast pulsar running through the interstellar medium, (2) an elongated wind nebula trailing behind it, and (3) a puzzling jet extending over an unprecedented length of about 10 pc in a direction perpendicular to the motion of the pulsar. Although the overall characteristics of this system resembles the structures observed in the Guitar nebula, the more extreme elongation of the jet (a factor of 10) in IGR J11014-6103 makes any previous interpretation challenging, and shed light on the properties of jet structures formed in non-accreting systems. I will present the preliminary results of our recent X-ray (Chandra) and radio (ATCA) high-resolution observations of IGR J11014-6103 and discuss two possible interpretations of its elongated jet in terms of emission from (i) high-energy particles escaping the pulsar bow-shock and trapped into the ambient magnetic field, or (ii) a pure ballistic pulsar's jet.

Pelletier, Guy

Collisionless Relativistic Shocks: current driven turbulence and particle acceleration

Between the regime of strong magnetization where a synchrotron maser emission takes place and the regime of very low magnetization where Weibel turbulence and Fermi acceleration develop, there is an interesting regime, over a wide range of magnetization, dominated by current driven turbulence. In a pair plasma, its behavior has some similarities with that of Weibel turbulence and we will briefly show its complete analytical description. In a proton plasma, its behavior is quite different, especially because of the dominance of surfing modes? that bring a solution to several issues, still pending in the other situations, namely: efficient 3D scattering and Fermi acceleration, transmission of magnetic turbulence in the downstream flow, possibility of a dynamo action.

Porth, Oliver

Solution to the sigma-problem of Pulsar wind nebulae

Pulsar wind nebulae (PWN) provide a unique test-bed for the study of highly relativistic processes right at our astronomical doorstep. In this presentation I will show results from the first 3D RMHD simulations of PWN. Of key interest to our study is the long standing "sigma-problem" that challenges MHD models of Pulsars and their nebulae now for 3 decades. Earlier 2D MHD models were very successful in reproducing the morphology of the inner Crab nebula showing a jet, torus, concentric wisps and a variable knot. However, these models are limited to a purely toroidal field geometry which leads to an exaggerated compression of the termination shock and polar jet - in contrast to the observations. In three dimensions, the toroidal field structure is susceptible to current driven instabilities; hence kink instability and magnetic dissipation govern the dynamics of the nebula flow. This leads to a resolution of the sigma-problem once also the pulsar's obliqueness (striped wind) is taken into account (see also: http://adsabs.harvard.edu/abs/2013MNRAS.431L..48P). In addition, I will present polarized synchrotron maps and animations constructed from the 3D simulations, showing a remarkable resemblance with the available observations of Crab nebula.

Pozanenko, Alexei

Testing a two-jet model of short Gamma-ray Bursts

We suggest observational tests which could verify the two-jet model of short duration Gamma-Ray Bursts with an Extended Emission (EE). Among the tests there are investigations of decay part of the EE, afterglow behavior and number density of the ratio of the peak flux of EE and the peak flux of Initial Pulse Complex (IPC). Based on the parameters investigated we can restrict parameters of the two-jet model. We also discuss a possible dichotomy in a population of short GRB.

Prokoph, Heike

VERITAS observations of relativistic outflows in low- and intermediate-frequency-peaked BL Lac objects

The majority of blazars detected at very-high-energies (VHE; E>100GeV) are high-frequency-peaked BL Lac objects (HBLs). Low- and intermediate-frequency-peaked BL Lacs (LBLs/IBLs with synchrotron-peak frequenices in the infrared and optical regime) are generally more powerful, more luminous, and have a richer jet environment than HBLs. However, only a handful of them have been detected by ground-based gamma-ray telescopes; typically during flaring states. The study of IBLs and LBLs, especially in different VHE flux states, thus completes the picture of blazar emission processes that we get from the much more numerous population of HBLs. It enables us to test our knowledge of the processes that explain gamma-ray emission under different environment conditions and in a different accretion regime which is typically proposed as main driver of these differences. The VERITAS array is monitoring five known VHE LBLs/IBLs since 2009: 3C 66A, W Comae, PKS 1424+240, S5 0716+714 and BL Lacertae, with typical exposures of 5-10 hours/year. The results of these long-term observations will be presented, including a bright, sub-hour scale VHE flare of BL Lacertae in June 2011, the first low-state detections of 3C 66A and W Comae, and the detection and characterization of the IBL B2 1215+30. We will discuss these new observational results in the context of characterizing the emission from blazars with powerful jets and the role of photons external to the jet in the production of gamma-ray emission.

Romero, Gustavo E.
Supermassive black hole binaries at high energies
Some Active Galactic Nuclei are supposed to harbor binary systems of supermassive black holes. They are an attractive target for gravitational wave experiments. The identification of these systems is mostly based on the detection of periodic features in the optical or radio light-curves. Such identifications, however, are far from being conclusive. In this work we study the perturbations caused in the accretion disk of the primary black hole by the orbital motion of the secondary. Then, we proceed to determine, for a number of cases, the kind of spectral energy distribution expected at gamma-ray energies from the inverse Compton up-scattering of disk photons. Gamma-ray observations with instruments such as the future Cherenkov Telescope Array can lead to a definitive identification of high-energy supermassive binary black hole systems.

Sahakyan, Narek
On the gamma-ray emission from the core and radio lobes of the radio galaxy Centaurus A
Centaurus A (Cen A) is the closest active galaxy to Earth and is one of the best-studied extragalactic objects over a wide range of frequencies. Cen A has a complex and extended radio morphology, with two giant outer lobes extending over 10 degree and oriented primarily in the north-south direction. I will present the recent results from analysis of Fermi LAT data from observations of the core and the radio lobes of Cen A. In the case of radio lobes the comparison between gamma-ray emitting region and WMAP radio image will be presented, and the origin of gamma-rays will be discussed within both leptonic and hadronic scenarios. For the core, spectral and temporal analysis of the gamma-ray data will be presented. Different possible scenarios and sites of gamma-ray production will be discussed based on the comparison of MeV/GeV and TeV spectra.

Takamoto, Makoto
Evolution of Plasmoid-Chain in Poynting-Dominated Plasma
In this presentation, we present our recent results of the evolution of the plasmoid-chain in a Poynting dominated plasma. We model the relativistic current sheet with cold background plasma using the relativistic resistive magnetohydrodynamic approximation, and solve its temporal evolution numerically. Numerical results show that the initially induced plasmoid triggers a secondary tearing instability. We find the plasmoid-chain greatly enhances the reconnection rate, which becomes independent of the Lundquist number, when this exceeds a critical value. Since magnetic reconnection is expected to play an important role in various high energy astrophysical phenomena, our results can be used for explaining the physical mechanism of them.

Tam, Pak-Hin Thomas
Discovery of an extra hard spectral component at >10 GeV in the afterglow of GRB 130427A
We report on the Fermi Large Area Telescope (LAT) observations of the >100 MeV emission from the very bright and nearby GRB 130427A. By performing time-resolved spectral fits of GRB 130427A, we found a strong evidence of an extra hard spectral component that exists in the extended high-energy emission of this GRB. We argue that this hard component may arise from the afterglow inverse Compton emission. Implications of the existence of such a component at >10 GeV to future VHE observations are discussed.

Taylor, Andrew
The Need for Local Hard Spectra Sources of Ultra-High Energy Cosmic Ray Nuclei
Using recent Auger energy spectrum and composition analysis results, an investigation is carried out into the requirements placed on the UHECR sources. The the spatial distribution of these sources is investigated along with the energy distribution of UHECR they output. These investigations reveal the need for local UHECR sources which output a hard spectrum of intermediate/heavy UHECR. These results demand that local ($<$80~Mpc) UHECR sources exist,placing exciting and difficult requirements on the local extragalactic candidate sources. None negligible ($>$0.01~nG) extragalactic magnetic fields are noted to further strengthen these results.

Vila, Gabriela
Proton loading of relativistic jets
We study the injection of neutrons in the corona of an accreting black hole through the interaction of locally accelerated protons with matter and radiation. A fraction of these neutrons may escape and penetrate the base of the jet, later decaying into protons. This is a possible mechanism for baryon loading of Poynting-dominated outflows. We characterize the spatial and energy distribution of neutrons in the corona and that of the protons injected in the jet by their decay. We assess the contribution of these protons to the radiative

spectrum of the jet. We also investigate the fate of the neutrons that escape the corona into the external medium.

Vincent, Stephane

Very-high energy processes in black hole magnetosphere: the case of M87

Recent, highly sensitive, observations have shown the nearby radio galaxy M87 to be a rapidly (time scales of days) variable TeV emitting source. Due to its very low bolometric luminosity, the nucleus of M87 may already be transparent to TeV gamma-rays. We analyze the magnetospheric model acceleration of charged particles in the vicinity of the central black hole. It is shown that electrons may be a accelerated to very high Lorentz factors, allowing inverse Compton upscattering of ambient photons into to the very high energy domain. The results are compared to the observed fluxes from the nucleus of M87 for both low and high gamma-ray activities. It is shown that the intermittence of the accretion rate - responsible for the formation of gaps - would give rise to the variability of the TeV emission.

Weidinger, Matthias

The Modeling of Gamma-Rays From Blazars

The typical blazar spectrum consists of two distinct humps. While synchrotron radiation of electrons within the jet being responsible for the first, the mechanism underlying the second one is still under debate and so is the main driver of the inter-band, high-amplitude variability. A self consistent hybrid model, allowing leptons and hadrons to be non-thermal emitters within the jet is applied to various blazars, from High Frequency Peaked BL Lac objects to Flat Spectrum Radio Quasars. Mainly depending on the variability patterns the gamma-rays can be identified as inverse Compton up scattered photons or proton synchrotron radiation accompanied by photo-hadronic cascades. Using a numerical model even the non-linearities due to the cascading can be handled time-dependently, the principle will be explained on the blazar 1 ES 1011+496 as an example. The overall picture of a systematic blazar-modeling is drawn in the light of the recently appearing envelope structure of the blazar sequence.

Wu, Qingwen

A Physical Link Between Jet Formation and Hot Plasma in Active Galactic Nuclei

Recent observations suggest that in black hole X-ray binaries jet/outflow formation is related to the hot plasma in the vicinity of the black hole, either in the form of an advection-dominated accretion flow at low accretion rates or in a disk corona at high accretion rates. We test the viability of this scenario for supermassive black holes using two samples of active galactic nuclei distinguished by the presence (radio strong) and absence (radio-weak) of well-collimated, relativistic jets. Each is centered on a narrow range of black hole mass but spans a very broad range of Eddington ratios, effectively simulating, in a statistical manner, the behavior of a single black hole evolving across a wide spread in accretion states. Unlike the relationship between the radio and optical luminosity, which shows an abruptly break between high- and low-luminosity sources at an Eddington ratio of $\sim 1\%$, the radio emission---a measure of the jet power---varies continuously with the hard X-ray (2--10 keV) luminosity, roughly as $L_R \propto L_X^{0.6-0.75}$. This relation, which holds for both radio-weak and radio-strong active galaxies, is similar to the one seen in X-ray binaries. Jet/outflow formation appears to be closely linked to the conditions that give rise to the hot, optically thin coronal emission associated with accretion flows, both in the regime of low and high accretion rates.

Zacharias, Michael

Time-dependent SSC cooling effects on blazar emission

Recent observations of very rapid flaring events in blazars have challenged conventional emission models. Several scenarios have been invoked, which usually need a compact emission zone within the jet. Here we present a model, which incorporates the time-dependent nature of the synchrotron-self Compton (SSC) process being applicable especially for compact sources. Since under such circumstanced the electron and synchrotron photon densities are quite high, the SSC process is very efficient. Solving analytically the time-dependent kinetic equation for the electrons, we show that dominating SSC cooling leads to a much faster cooling of the electrons compared to the usual linear approaches, such as synchrotron or external Compton cooling. The emerging spectral energy distribution (SED), which is derived from the time integrated intensity spectrum, exhibits under such circumstances a dominant SSC component, which can be much more luminous than the synchrotron or the external Compton component. Additionally, the light curves also exhibit shorter variability time scales, which is more pronounced in compact sources, where the light crossing time scale is short. Thus, we argue for a wide utilization of the time-dependent treatment, when discussing rapid flares in blazars.

Zaw, Ingyin

Testing the alpha-disk Accretion Model in the Inner-Most Parsec of AGN with Water Masers

Water maser emission, the only known tracer of structure in the inner-most parsec of AGN which can be resolved in position and velocity, is a unique probe of accretion physics. In particular, this maser emission requires the narrow temperature range of ~400-1000 K, providing a stringent test of disk heating mechanisms. The Shakura-Sunyaev (1973) alpha-disk model has firm predictions for the temperature of the accretion disk. While the temperature depends on many parameters, e.g. black hole mass and accretion rate, which are often uncertain, in a given disk, these parameters are the same and the temperature gradient depends solely on the radius. If the accretion disks are flat alpha disks, the ratio of the radii of the outer-most to inner-most maser emission should be proportional to the ratio of minimal to maximal temperature. This can be tested by both VLBI maps of the maser emission and single dish spectra. A preliminary analysis of the maser radius ratios, from maps and spectra, will be presented and the implications for the alpha disk model will be discussed.