Polarised Emission from Astrophysical Jets

Ierapetra June 12–16, 2017

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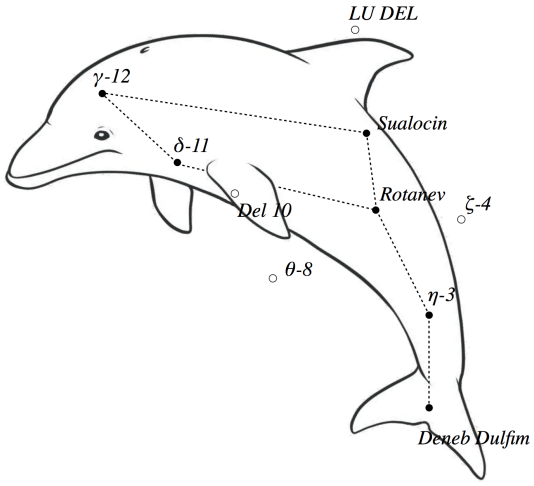
Abstracts Book



Max-Planck-Institut für Radioastronomie
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09:25 - 09:40	**Millas** Synthetic radiation maps from relativistic MHD jet simulations	09:25 - 09:40	**MacDonald** Faraday Conversion in Turbulent Blazar Jets	09:25 - 09:40	**Carrasco-Gonzalez** These guys can accelerate particles: synchrotron emission from protostellar jets	09:25 - 09:40	**Gabuzda** Determining the Jet Longitudinal Magnetic Field Directions and Black-Hole Rotation Directions in AGNs	09:25 - 09:40	**Damas Segovia** Rotation measure asymmetry reveals a precession of the AGN outflow in a Seyfert galaxy.
09:40 - 09:55	**Kylafis** The energy distribution of electrons in radio jets	09:40 - 09:55	**Nalewajko** A model of polarization angle swings in blazars based on kink instability of magnetized jets	09:40 - 09:55	**Baglio** Neutron star low mass X-ray binaries jets: a polarimetric view	09:40 - 09:55	**Knuettel** Evidence for toroidal B-field components in AGN jets on kiloparsec scales	09:40 - 09:55	**Cantwell** Low frequency Polarization observations of NGC 6251
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10:10 - 10:25	**Nishikawa** Recollimation, Reconnection and Associated Flares in Global Relativistic Jets Containing Helical Magnetic Fields with PIC Simulations	10:10 - 10:25	**Anantua** Towards multi-wavelength observations of relativistic jets from general relativistic magnetohydrodynamic simulations	10:10 - 10:25	**S. Potter** The extraordinary polarimetric nature of the white dwarf pulsar ARSCo.	10:10 - 10:25	**Lico** On the time variable rotation measure in the core region of Markarian 421	10:10 - 10:25	**Kierdorf** Probing the Magnetized Medium of AGNs using Wideband Polarimetry
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11:25 - 11:40	**Gómez** Probing the innermost regions of AGN jets and their magnetic fields with RadioAstron	11:25 - 11:40	**Meliani** Internal shocks in relativistic transverse stratified jets	11:25 - 11:40	**Trushkin** The jets of microquasars during giant radio flares and quiet state	11:25 - 11:40	**Pasetto** Exploring the environment of high Rotation Measure Active Galactic Nuclei with wideband radio spectropolarimetry observations	11:15 - 11:30	**Beaklini** OPTICAL POLARIMETRY AND RADIO OBSERVATIONS OF PKS1510-089 BETWEEN 2009 AND 2013
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12:10 - 12:25	**Janssen** High-resolution polarimetric study of Sgr A* with the GMVA	12:10 - 12:25	**Angelakis** Full-Stokes multi-band polarimetry	12:10 - 12:25	**Adebahr** Polarised structures in the restarted radio galaxy B2 0258+35 - Magnetic field compression or magnetic draping?	12:10 - 12:25	**Ma** Radio Polarisation Study of High Rotation Measure AGNs — How to Distinguish Intrinsic from External Sources of Rotation Measure?	12:00 - 12:15	**Briggs** LEAP – A LargE Area burst Polarimeter for the ISS
12:25 - 12:40	**Casadio** 3mm GMVA observations of total and polarised emission from blazar and radiogalaxy core regions	12:25 - 12:40	**Boettcher** SALT spectropolarimetry and self-consistent SED and spectropolarimetry modeling of blazars	12:25 - 12:40	**Partridge** Can CMB Surveys Help the AGN Community?	12:25 - 12:40	**Molina** Magnetic field studies in BL Lacertae throught Faraday rotation and a novel astrometric tecnique.	12:15 - 14:30	LUNCH
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	Chair: J. L. Gomez		Chair: M. Aller		Chair: M. Moscibrodzka		Chair: T. Hovatta	14:30 - 14:45	**Moody** Automated Polarimetry with Smaller Aperture Telescopes: The ROVOR Observatory
15:00 - 15:25	**Asada** ALMA and SMA polarimetric observation towards M87	15:00 - 15:25	**Jorstad** The VLBA-BU-BLAZAR program: Comparison of linear polarization in parsec scale jets with optical polarization of gamma-ray blazars	15:00 - 15:25	**Miller-Jones** Polarised radio emission from X-ray binary jets	15:00 - 15:25	**Aller** Centimeter-Band All-Stokes Observations of Blazar Variability	14:45 - 15:00	**Bernard** A Bethe-Heitler 5D polarized photon-to-e+e-pair conversion event generator
15:25 - 15:40	**Lu** The polarimetric structure of M87 with 3mm-VLBI	15:25 - 15:40	**Larionov** The blazar CTA 102 behaviour during two qiant outbursts.	15:25 - 15:40	**Lee** Detection of short-term flux density variability and intraday variability in polarized emission at millimeter-wavelength from S5 0716+714	15:25 - 15:40	**Barres de Almeida** Time-Evolving SED of MKN421: a long-term multi-band view and polarimetric signatures.	15:00 - 15:15	**Spencer** An Old Fogey's History of Jets
15:40 - 15:55	**Savolainen** Multifrequency polarization structure of the (sub-)parsec scale jet of 3C273 at mm-wavelengths	15:40 - 15:55	**Blinov** Connection between optical polarization plane rotations and gamma-ray flares in blazars	15:40 - 15:55	**Anderson** Beyond rotation measures: Leveraging broadband polarimetry and all-sky radio surveys to probe spatially-unresolved magneto-ionic structure in AGN jets	15:40 - 15:55	**Goyal** Multiwavelength variability study of the BL Lac objects PKS 0735+178 and OJ 287 on timescales ranging from decades to minutes	15:15 - 15:50	**Stawarz** Conference Summary
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18:00 - 19:30	**"The Minoans"** by Dr. J. A. MacGillivray (British School at Athens)	17:05 - 17:20	**Liodakis** Coherent changes in the polarization angle and broadband SED: the case of 3C454.3			17:05 - 17:20	**Cohen (remotely)** Double Rotations in EVPA in OJ287	18:00 - 19:30	**Guided Tour** (tbc)
		17:20 - 17:45	**Itoh** Polarimetric monitoring of jets with Kanata Telescope			17:20 - 17:35	**Biggs** Polarization monitoring of the lens system JVAS B0218+357		
20:00	**star-gazing (public)** by "Cretan Friends of Astronomy"			20:00	**Conference Dinner** - live cretan music (tbd)	17:35 - 18:00	**Kobayashi** Polarised Emission from Gamma-Ray Burst Jets	20:00	**Closing ceremony:** - astrophotography contest - Public talk

Monday June 12

The abstracts are ordered as they appear in the program.

Polarized emission from 3-D GRMHD simulations of black hole jets

Monika MOSCIBRODZKA (Radboud University)
(invited)

Recent advances in numerical modeling allow for realistic and detailed predictions of the observational signatures of accretion flows and jets near a black hole. In this talk, I will present the results from my recent study which couples general relativistic magnetohydrodynamics simulations of accretion flows onto supermassive black hole with polarized radiative transfer models. For the first time, we compare the modeled polarization degree and rotation measure to the existing non-VLBI millimeter data obtained for the vicinity of the supermassive black hole in the core of M87 galaxy. Our models successfully explain the origin of the observed low net polarization and rotation measure detected in this source. The models also allow us to constrain the mass accretion rate onto the black hole and provide independent constraints on the viewing angle of the accretion disk/jet system. The Event Horizon Telescope will soon acquire very first resolved images of the black holes at event horizon scales in the centers of the Milky Way and M87 galaxy. These observations will allow for further detail tests of the current MHD accretion theories.

Synthetic radiation maps from relativistic MHD jet simulations

Dimitrios MILLAS (DEPARTMENT OF MATHEMATICS, KU LEUVEN)
O. Porth, R. Keppens

Astrophysical jets originating from active galactic nuclei (AGN) have been continuously observed over the years with different instruments on many wavelengths, ranging from radio to X- and gamma rays. These observations provide valuable information on the structure of AGN jets, in terms of density, velocity and magnetic field configuration. For the latter, polarization maps and Faraday rotation measures (RM) are widely used to determine the magnetic field orientation and determine its helical nature. It is also believed that many AGN jets consist of two distinct components: the inner component is light in terms of density, with a Lorentz factor of the order of 10 and the outer is slower (but still relativistic) and of considerably higher density. Depending on the density, velocity and magnetic field profile, these jets can be susceptible to a number of instabilities, which in turn can potentially affect the emission from these objects. Based on 2.5D and 3D relativistic, magnetohydrodynamic simulations of such (un-)stable two-component jets, we present synthetic radiation and polarization maps, based on different AGN jet configurations, where we calculate the intensity and the polarization vector for the emitting regions.

The energy distribution of electrons in radio jets

Nikolaos KYLAFIS (University of Crete)
A. Tsouros

Black-hole and neutron-star X-ray binaries exhibit compact radio jets, when they are in the so called quiescent, hard, or hard intermediate states. The radio spectrum in these states is flat to slightly inverted, i.e., the spectral index alpha is typically in the range [0 – 0.5]. It is widely accepted that the energy distribution of the electrons, in the rest frame of the jet, is a power law with index p in the approximate range [3 – 5]. A power-law energy distribution of the electrons in the jet is sufficient to explain the flat to slightly inverted spectrum emitted by the jet from radio to near infrared wavelengths, but is it necessary? Contrary to what our thinking was decades ago, now we know that the jets originate in the hot inner flow around black holes and neutron stars. Thus, we have investigated the spectrum that is emitted by a thermal jet with kT in the range [100 – 250 keV]. Under the assumption of a parabolic jet and flux freezing, we have computed the emitted spectrum from radio to near infrared using either a thermal distribution of electrons or a power-law one. We have found that parabolic jets with a thermal distribution of electrons give inverted spectra with alpha in the range [0 – 0.4], while jets with a power-law distribution of electrons give inverted spectra with alpha in the range [0 – 0.2]. The rest of the parameters are kept the same in the two cases. The break frequency, which marks the transition from optically thick to optically thin synchrotron emission, is comparable for the two electron energy distributions. Our conclusion is that, contrary to common belief, it is not necessary to invoke a power-law energy distribution of the electrons in a jet to explain its flat to slightly inverted radio spectrum. A relativistic Maxwellian produces similar spectra. Thus, the widely invoked "corona" around black holes in X-ray binaries may actually be the jet!

Electric currents along astrophysical jets

Ioannis CONTOPOULOS (RCAAM, Academy of Athens)

Current observations of transverse Faraday RM gradients suggests that large scale ordered electric currents are present in about 10% of all extragalactic astrophysical jets. We will discuss the significance of this result for current MHD theories on the origin, acceleration and collimation of astrophysical jets, and for current theories on the origin of astrophysical magnetic fields.

Recollimation, Reconnection and Associated Flares in Global Relativistic Jets Containing Helical Magnetic Fields with PIC Simulations

Kenichi NISHIKAWA (University of Alabama in Huntsville)

Jose L. Gómez, Yosuke Mizuno, Charley White, Jacek Niemiec, Oleh Kobzar, Martin Pohl, Ioana Duan, Asaf Pe'er, Jacob Trier Frederiksen, Ake Nordlund, Athina Meli, Helene Sol, Philip E. Hardee and Dieter H. Hartma

In the study of relativistic jets one of the key open questions is their interaction with the environment on the microscopic level. Here, we study the initial evolution of both electron-proton and electron-positron relativistic jets containing helical magnetic fields, focusing on their interaction with an ambient plasma. We have performed simulations of "global" jets containing helical magnetic fields in order to examine how helical magnetic fields affect kinetic instabilities such as the Weibel instability, the kinetic Kelvin-Helmholtz instability (kKHI) and the Mushroom instability (MI). In our initial simulation study these kinetic instabilities are suppressed and new types of instabilities can grow. In the electron-proton jet simulation a recollimation-like instability occurs and jet electrons are strongly perturbed. In the electron-positron jet simulation a recollimation-like instability occurs at early times followed by a kinetic instability and the general structure is similar to a simulation with RMHD. The evolution of electron-ion jets will be investigated with different mass ratios. Simulations using much larger systems are required in order to thoroughly follow the evolution of global jets containing helical magnetic fields. We will investigate mechanisms of flares possibly due to reconnection.

Imaging Magnetic Fields at the Event Horizon of a Black Hole

Michael JOHNSON (Smithsonian Astrophysical Observatory)
(invited)

Magnetic fields play a central role in the accretion, emission, and outflow near black holes but have never been directly observed in this region. Yet, because linear polarization of the bright synchrotron emission from galactic cores traces these magnetic fields, polarimetric interferometry with the Event Horizon Telescope (EHT) is capable of imaging these near-horizon fields. I will present EHT observations of the Galactic Center supermassive black hole, Sgr A*. These observations, the first to resolve the polarized emission from Sgr A* at any wavelength, revealed ordered magnetic fields with vigorous activity near the event horizon. I will also discuss the emerging capabilities of the EHT to study turbulence driven by the magnetorotational instability, the role of magnetic fields in jet launching, and signatures of magnetically-dominant regions near supermassive black holes.

Probing the innermost regions of AGN jets and their magnetic fields with RadioAstron

Jose L. GOMEZ (Instituto de Astrofisica de Andalucia - CSIC)
Lobanov, A., Bruni, G., Kovalev, Y., on behalf of the RadioAstron Polarization KSP

RadioAstron provides the first true full-polarization capabilities for space VLBI observations on baselines longer than the Earth diameter. We present the results of more than four years of RadioAstron observations, obtained as part of our Key Science Program to study the innermost regions of AGN jets and their magnetic fields at the highest angular resolutions achieved to date.

Ultra-compact regions with very high polarization are found in quasars

Yuri KOVALEV (Astro Space Center of Lebedev Physical Institute)
RadioAstron AGN survey team

The Space-VLB interferometer RadioAstron has performed a survey of 248 radio-loud quasars at 18, 6, and 1.3 cm at projected spacings up to 350,000 km. Significant detections at space-ground baselines were achieved for 164 AGNs. While the survey was dedicated for total intensity measurements, we have serendipitously made the following discovery for several quasars. Linearly polarized correlated flux density was found to be about equal or higher than Stokes I correlated flux density at long SVLBI projected spacings. The most striking result was achieved for the quasar 3C279 at 18 cm. Modeling suggests that we observe very bright and compact, optically thin regions with highly ordered magnetic field, most probably within the core of those quasars.

Impact of Faraday effects on event horizon scale GRMHD images of Sgr A*

Alejandra JIMENEZ ROSALES (Max-Planck-Institut für extraterrestrische Physik)
Jimenez-Rosales, Alejandra Dexter, Jason

At the centre of our galaxy lies a supermassive black hole, Sagittarius A* (Sgr A*), with a spectral peak at sub-millimeter wavelengths. Millimeter VLBI observations made with the Event Horizon Telescope (EHT)

have spatially resolved a linear polarization fraction (LPF) which rises from ∼5-10% as seen by lower resolution interferometers to ∼20-40% on smaller spatial scales. These observations show that the emission on event horizon scales is somewhat depolarized on scales smaller than the size of the emission region. We post-process GRMHD simulations of magnetized accretion onto Sgr A* and perform a fully relativistic radiative transfer calculation of the emitted synchrotron radiation. We obtain polarized images and, by comparing the scrambled vs. the coherent, we characterize their degree of change, which we call the 'correlation length' of the image. We find that the toroidal magnetic fields in the accretion flow are well ordered and lead to coherent polarized images. However, Faraday rotation within the emission region can decrease the LPF and its spatial coherence. We show how EHT measurements of the polarized correlation length can constrain the strength of these effects, and, consequentially, plasma properties like the electron temperature and magnetic energy fraction. We compare these unresolved constraints to those given by the unresolved Rotation Measure and LPF of the images. These appear to be less robust than the correlation length approach.

High-resolution polarimetric study of Sgr A* with the GMVA

Michael JANSSEN (Radboud University Nijmegen)

C. Müller, C. D. Brinkerink, H. Falcke, T. P. Krichbaum, G. C. Bower, I. van Bemmel, M. Kettenis, D. Small, E. Castillo, A. Deller, S. Doeleman, R. Fraga-Encinas, C. Goddi, A. Hernández, D. Hughes, M. Kramer, J. Leon-Tavares, L. Loinard, A. Montana, M. Moscibrodzka, G. Ortiz-Leon, D. Sanchez-Arguelles, R. Tilanus, G. Wilson, J. A. Zensus

The supermassive black hole Sagittarius A* (Sgr A*) at the center of our galaxy is the closest active galactic nucleus and therefore the prime target for the investigation of accretion and jet physics on event horizon scales with millimeter VLBI techniques. Recently, Brinkerink et al. detected non-zero closure phases in Sgr A* at 3 mm - possibly indicating asymmetric source sub-structure. I will discuss results from a follow-up campaign with the GMVA in 2016, where an independent realization of the scattering screen allows for a robust disentanglement of intrinsic and scatter-induced structure. Moreover, in the light of potentially ordered magnetic fields, observed at 1.3mm by Johnson et al., the polarization properties of the millimeter core are investigated. For the data reduction, two paths are chosen in parallel - classic AIPS and CASA. For the latter, newly commissioned VLBI capabilities are tested for the first time. The long term goal is the development of a fully automatic CASA pipeline for the reduction of millimeter VLBI data. In my talk I will present the latest results from our combined 3mm campaigns and the status of the CASA VLBI pipeline.

3mm GMVA observations of total and polarised emission from blazar and radiogalaxy core regions

Carolina CASADIO (Max-Planck-Institut für Radioastronomie)

A. Marscher, T. Krichbaum, S. Jorstad, J. L. Gomez, Agudo I., J. Hodgson, M. Bremer, B. Rani, H. Rottmann, U. Bach, A. Bertarini, P. Devicente, J. Kallunki, M. Lindkvist

We present preliminary total and linearly polarised 3 mm GMVA images of a sample of blazars and radio galaxies from the VLBA-BU-BLAZAR 7 mm monitoring program aimed to probe the innermost regions of AGN jets and locate the sites of gamma-ray emission observed by Fermi-LAT. The reduced opacity at 3 mm and improved angular resolution, of the order of 50 microarcseconds, allow us to estimate the angular sizes and magnetic field structure of the most compact features, which can be compared with those observed at 7 mm with the VLBA for the determination of the jet's physical parameters.

ALMA and SMA polarimetric observation towards M87

Keiichi ASADA (ASIAA)
(invited)

Probing the mass accretion rate onto SMBH has been one of the fundamental quests to understand AGN. However, observational understanding of their accretion flows is very limited, as there is no direct imaging of the accretion flow so far. RM observations at mm/sub-mm wavelength are one of the most powerful methods to derive the mass accretion rate. We conducted ALMA and SMA observations to probe the mass accretion process onto SMBH of M87, which is one of the representavie of nearby low-luminosity AGN, and one of two primary targets to image the shadow of SMBH with mm/submm VLBI in near future. As the results, we successfully derived an RM to be order of 10^4 rad m^{-2} for the first time. By adopting a standard formulation between RM and mass accretion rate, we derirved that the mass accretion rate onto SMBH of M87 to be $\sim 10^{-5}\ M_{sun}$ yr^{-1}, which is in good agreement with the prediction with radiatively ineffecient accretion flow model. This small mass accretion rate would not be sufficient to support large kinematic power attributed with relativistic jet. We will also discuss the origin of the polarization flux with time variation of the polarization angles at mm wavelength.

The polarimetric structure of M87 with 3mm-VLBI

Rusen LU (Max Planck Institute for Radio Astronomy)

Understanding the magnetic field properties in the immediate vicinity of supermassive black holes is crucial in testing jet-launching scenarios. High angular resolution imaging of the polarized non-thermal emission from AGN jets provides a direct way to study their associated magnetic fields. The 50 micro-arcseconds resolution, achievable with the Global Millimeter VLBI Array (GMVA), probes a physical scale of <10 Schwarzschild radii in M87. In this presentation, we will show our results from recent GMVA studies of the magnetic field configuration at the jet base of M87.

Multifrequency polarization structure of the (sub-)parsec scale jet of 3C273 at mm-wavelengths

Tuomas SAVOLAINEN (Aalto University Metsähovi Radio Observatory)

3C273 is the nearest high power radio quasar (z=0.158) and due to its large black hole mass, 1 milliarcsecond angular resolution corresponds only to $\sim$4000 Schwarzschild radii linear resolution. This makes it excellent target for studying the jet formation in a cold mode accreting, high luminosity quasar. Earlier polarimetric VLBI studies of 3C273 have revealed a rotation measure gradient across the jet, suggesting an ordered toroidal magnetic field in the jet sheath (Asada et al. 2002), as well as indications of high RM values near the core (>10^4 rad/m^2; Attridge et al. 2005). We have carried out quasi-simultaneous polarimetric VLBI observations of 3C273 with the VLBA at 15, 24, 43 and 86 GHz with an aim to study the jet polarization structure down to sub-parsec scales and to test the existence of high RM values above 10^4 rad/m^2. We will present results of this experiment, including a fully calibrated 86 GHz polarization image, which shows transversely resolved structure inside the innermost 1 mas, i.e., <$10^4\ R_S$. Polarization is detected on a level up to ~ 20%, and preliminary multifrequency analysis shows RM above $2 \cdot 10^4$ rad/m^2 at about 1 mas from the core with a transverse gradient present as seen earlier by Attridge et al. (2005).

Probing the magnetic fields in 3C273 through Faraday rotation observations

Talvikki HOVATTA (Tuorla Observatory, University of Turku)

T. Savolainen, S. O'Sullivan, A. Tchekhovskoy, M. F. Aller, H. D. Aller, D. C. Homan, M. L. Lister, G. B. Taylor, R. T. Zavala

3C273 is one of the brightest quasars in the sky over the entire electromagnetic spectrum. It is relatively nearby with a redshift of z=0.158, and was the first radio source whose emission lines were noted to be at high redshift. Its parsec-scale jet is well resolved in Very Long Baseline Array (VLBA) observations, which allowed Asada et al. (2002) to detect the first Faraday rotation measure gradient transverse to the jet, indicative of a helical magnetic field around the parsec-scale jet. VLBA observations at 43 and 86 GHz have also revealed a very high rotation measure (RM) of 10^4 rad/m^2 between its two innermost jet components (Attridge et al. 2005), making 3C273 one of the most interesting objects for studying the magnetic fields at the base of the jet. We will present recent observations taken at 1mm wavelength with ALMA, where we aim to detect Faraday rotation across the band in order to look for the predicted extremely high rotation measures of $> 10^5$ rad/m^2. We model the Faraday rotation and frequency-dependent polarization behaviour to distinguish between Faraday rotation occurring internal or external to the emission region. Our numerical simulations show that if the jets are highly magnetized, the RM in the boundary layer of the jet will dominate over the RM within the jet, which allows us to probe the jet magnetization through the RM observations. In addition, we will present results on the long-term evolution of the parsec-scale Faraday rotation measure structure of 3C273 by combining observations taken over a timespan of 15 years at 8 to 15 GHz with the VLBA.

Accretion Flow Property of 3C 84: A View Through Faraday Rotation

Hiroshi NAGAI (NAOJ)

3C 84 (NGC 1275, Perseus A) offers a unique environment to study the jet formation and interaction with the ambient medium in the close vicinity of the super massive black hole. This source shows a steadily increasing emission from the re-started radio jet, which is now reaching historical records at all wavelengths. The re-started jet is forming mini hotspot and radio lobe in the central $\sim$1 pc (Nagai et al. 2014), suggesting a strong interaction with the circumnuclear gas. Recently, the polarization radio emission is identified on the hotspot by Very Long Baseline Array observation at 43 GHz. Faraday rotation is detected within an entire bandwidth of the 43-GHz band. The measured rotation measure is at most 6×10^5 rad m^{-2} and is slightly time variable on the timescale of month by a factor of few. Similar degree of rotation measure is also reported by Plambeck et al. (2014) by SMA and CARMA observations. Assuming that Faraday rotation is caused by the accretion flow of spherical power-law profle, we derive an accretion rate of $\sim 0.1\ M_{sun}$ yr^{-1} at 1 pc from the core. This accretion rate shows a good agreement with the one estimated from the bolometric luminosity with a black hole mass of $8 \times 10^8\ M_{sun}$ and a radiative efficiency of 10%.

Tuesday June 13

The abstracts are ordered as they appear in the program.

Modeling the Time-Dependent Polarization of Blazars

Alan MARSCHER (Boston University)
(invited)

Polarization is an extremely valuable observational tool to probe the dynamical physical conditions of blazar jets. The author will review recent progress toward understanding blazars that multi-waveband monitoring observations and theoretical modeling have advanced. Some patterns are seen in the data, suggestive of order that can be explained by the extremely well-collimated relativistic jets, shock waves, and helical magnetic field components. However, much disorder is apparent, which implies that turbulence plays a major role as well, especially in the fluctuations of flux and polarization and perhaps particle acceleration. The author will compare observational results with the expectation of theoretical models in an attempt to construct a comprehensive model of the relativistic jets of blazars. This research is funded in part by US National Science Foundation grant AST-1615796 and the NASA Fermi and Swift Guest Investigator programs.

Faraday Conversion in Turbulent Blazar Jets

Nicholas MACDONALD (Boston University)
Alan Marscher

Low ($< 3\%$) levels of circular polarization (CP) detected at radio frequencies in the relativistic jets of some blazars can provide insight into the underlying nature of the jet plasma. CP can be produced through linear birefringence, in which initially linearly polarized emission produced in one region of the jet is altered by Faraday rotation as it propagates through other regions of the jet with various magnetic field orientations. Marscher has recently begun a study of jets with such magnetic geometries with the Turbulent Extreme Multi-Zone (TEMZ) model, in which turbulent plasma crossing a standing shock in the jet is represented by a collection of thousands of individual plasma cells, each with distinct magnetic field orientation. Here we develop a radiative transfer scheme that allows the numerical TEMZ code to produce simulated images of the time-dependent linearly and circularly polarized intensity at different radio frequencies. In this initial study, we produce synthetic polarized emission maps that highlight the linear and circular polarization expected within the model.

A model of polarization angle swings in blazars based on kink instability of magnetized jets

Krzysztof NALEWAJKO (Nicolaus Copernicus Astronomical Center)

I will present a new toy model of polarization angle swings in blazars. The basic idea is that large (>180

deg) uniform polarization angle rotations can be explained by a helical dissipation pattern resulting from saturation of current driven instability of the magnetized jet and its likely interaction with the external medium. I will also discuss the effect of relativistic aberration as function of the viewing angle on the observability of polarization swings.

Modeling polarization from relativistic outflows

Tania GARRIGOUX (Centre for Space Research)

M. Boettcher, Z. Wadiasingh, M. Zacharias

The X-ray and gamma-ray emissions from highly energetic astrophysical sources such as Gamma-Ray Bursts and Active Galactic Nuclei, are believed to be produced primarily by two mechanisms: synchrotron radiation (SR) and inverse Compton scattering (ICS). The study of the polarization of the emissions is an important tool in the analysis of these mechanisms. We investigate the polarization of photons produced by ICS of relativistic electrons on a thermal target photon field. We present polarization results over the whole energy spectrum, including the trans-relativistic regime, considering initially unpolarized photons and electrons in any spectral distribution.

Towards multi-wavelength observations of relativistic jets from general relativistic magnetohydrodynamic simulations

Richard ANANTUA (University of California, Berkeley)

Alexander Tchekhovskoy, Jonathan C. McKinney, and Roger D. Blandford

A methodology for reverse engineering current and anticipated intensity and polarization observations of relativistic jets using self-consistent, general relativistic magnetohydrodynamic (GRMHD) simulations is detailed from data-hosting and manipulation to mimicking instrument-specific properties such as point spread function convolution. This pipeline handles particle acceleration prescriptions, synchrotron and inverse Compton emission and absorption, Doppler boosting, time-dependent transfer of polarized radiation and light-travel time effects. Application of this pipeline to low-frequency radio observations is exemplified using the famous jet in the giant elliptical galaxy M87. High-frequency gamma-ray observations are represented by the powerful quasar 3C 279. Though the work presented here focuses on a single simulation of a magnetically arrested disk and a wind-collimated, approximately force-free jet, it can readily be adapted to simulations with different spatiotemporal resolutions and/or plasma initial conditions. Stationary, axisymmetric semi-analytic models are also developed, providing a quantitative understanding of the simulated jet flow and its electromagnetic properties. Using the 3D time-dependent "observing" routines for synchrotron models, predictions such as bilateral asymmetry of observed jet regions with helical magnetic field substructure for models where magnetic field enters emission and absorption via the cross product of magnetic field and observer direction are advanced. Using gamma ray prescriptions in the routines resulted in rapid variability. With the advent of the state-of-the-art gamma ray Cerenkov Telescope Array, the Event Horizon Telescope which promises to resolve Schwarzshild radius (rS) scale features at the Galactic Center and M87 and more sophisticated GRMHD simulations with similar resolution coupled with dynamical range 10^0rS-$10^5 rS$, direct comparison of simulation and observation in this work may facilitate the understanding and prediction of the physical nature of relativistic jets in the near future.

Multi-wavelength polarization signatures probe the blazar jet physics

Haocheng ZHANG (University of New Mexico)
(invited)

Radio and optical polarimetry has been used to constrain the magnetic field in blazar jets. Recent polarization monitoring has shown that the polarization signatures are highly variable. This opens a new window to constrain the blazar jet physics, in particular, the jet magnetization and particle acceleration. This talk will give an overview of current theories on the polarization variability, and how polarization signatures help to understand the jet physics. In addition, in view of several high-energy polarimeters that are under development, this talk will focus on the great potential of high-energy polarimetry in diagnosing and revealing new jet physics.

Internal shocks in relativistic transverse stratified jets

Zakaria MELIANI (LUTh, Observatoire de Paris)
Olivier Hervet

Using relativistic hydrodynamics large sample of AGN radio jets monitored in (VLBI) by the MOJAVE collaboration, we investigate association of the multiple knots with successive re-collimation shocks and the with and the transverse stratification of relativistic astrophysical jets. We succeed to link the different spectral classes of AGN with specific stratified jet characteristics, in good accordance with their VLBI radio properties and their accretion regimes. High frequency synchrotron peaked BL Lacs, associated to ADAF disks, are consistent with the simulations of a very weak outer jet (> 1% of the total energy), reproducing stationary equal-distance internal shocks, damped within a short distance from the central object. Flat spectrum radio quasars, associated to Standard (optically thick, geometrically thin) disks, have properties well reproduced by simulations of two jet components with similar energy fluxes, by presenting a very strong first internal shock. Finally, low- and intermediate frequency synchrotron peaked BL Lacs, associated to hybrid disks (ADAF in the center and standard outer), are characterized by simulations with a relatively powerful outer jet enhancing inner stationary shocks near the core with moving shocks at large distance, accompanied by an increase of the jet aperture angle.

Total and linearly polarized synchrotron emission from overpressured magnetized relativistic jets

Antonio FUENTES (Instituto de Astrofísica de Andalucía-CSIC)
J. L. Gómez, J. M. Martí, M. Perucho

We present numerical simulations of overpressured magnetized relativistic jets which are characterized by their dominant type of energy, namely internal, kinetic, or magnetic. Each model is threaded by a helical magnetic field with a pitch angle of 45 deg and features a series of recollimation shocks produced by the initial pressure mismatch, and whose strength and number varies as a function of the dominant type of energy. We perform a full-Stokes parameters study of the polarization signatures from these models by integrating the radiative transfer equations for synchrotron radiation using as inputs the RMHD solutions. These simulations show a top-down emission asymmetry produced by the helical magnetic field and a roughly bimodal distribution of the EVPAs due to the axial symmetry. Small variations of the order of 15 degrees are observed in the polarization of the stationary features associated with the recollimation shocks.

Radiative signature of large scale magnetized jets

Christian FROMM (ITP Goethe University Frankfurt)
O. Porth, Z. Younsi, Y. Mizuno and L. Rezzolla

Relativistic jets are launched from the direct vicinity of black holes and can propagate up to kpc-scales. During their path from the smallest to the largest scales they encounter different ambient configurations which can influence their shape and their dynamics. Using state-of-the art RMHD simulations and ray-tracing algorithms we can model the dynamics of the jets together with their radiation microphysics. We investigate the impact of different ambient medium and jet configurations (e.g., low vs. high magnetization) on the observed emission. During the post-processing we take the properties of the observing array (sparse u-v plane) and the imaging process into account which allows us a more direct comparison between simulations and recent/future ground and space-based VLBI observations.

Full-Stokes multi-band polarimetry

Emmanouil ANGELAKIS (MPIfR)
I. Myserlis, J. A. Zensus

Here we review our multi-band, high cadence linear and circular polarisation datasets which has been observed for a sample of Fermi blazars.

The VLBA-BU-BLAZAR program: Comparison of linear polarization in parsec scale jets with optical polarization of gamma-ray blazars

Svetlana JORSTAD (IAR, Boston University)
(invited)
A. Marscher, V. Larionov, I. Agudo, J-L. Gomez, P. Smith

Since 2008 June, the BU blazar group has been carrying out monthly monitoring with the Very Long Baseline Array at 43 GHz of a sample of gamma-ray blazars, alongside optical photometric and polarimetric observations at the Perkins telescope of Lowell Observatory (Flagstaff, AZ). I will present general results on polarization parameters at 43 GHz of the parsec scale jets and at optical wavelengths during both quiescent and active states, emphasizing similarities and differences in behavior at these two wavebands and for different objects. This research has been funded in part by NASA Fermi Guest Investigator grants NNX08AV65G, NNX11AQ03G, and NNX14AQ58G and National Science Foundation grant AST-1615796.

SALT spectropolarimetry and self-consistent SED and spectropolarimetry modeling of blazars

Markus BOETTCHER (North-West University)
Hester Schutte (NWU), Brian van Soelen, Richard Britto (UFS), David Buckley (SAAO)

We report on recent results from a target-of-opportunity programme to obtain spectropolarimetry observations with the Southern African Large Telescope (SALT) on flaring gamma-ray blazars. In tandem with this observational program, we develop a leptonic blazar model for the SEDs and SALT spectropolarimetry. Such modeling provides an accurate estimate of the degree of order of the magnetic field in the emission region as well as thermal contributions (from the host galaxy and the accretion disk) to the SED, thus putting strong

constraints on the physical parameters of the gamma-ray emitting regions.

The blazar CTA 102 behaviour during two qiant outbursts.

Valeri LARIONOV (Saint-Petersburg State University)

Valeri M.Larionov (St.Petersburg University, Russia), Svetlana G.Jorstad, Alan P.Marscher (Boston University, USA), Paul S.Smith (Steward Observatory, USA)

Blazar CTA 102 underwent two exceptional outbursts, in 2012 and 2016-2017, both in optical and high-energy ranges. We analyze its behaviour during these events, focusing on polarimetry as a tool that allows to trace changes of physical conditions and geometric configuration in close environs of central black hole of this blazar.

The RoboPol optopolarimetric blazar monitorng program

Vasiliki PAVLIDOU (Department of Physics, University of Crete)
(invited)

on behalf of The RoboPol Collaboration

Optical Synchrotron emission from blazars is significantly polarized and the polarization probes the magnetic field structure in the jet. Rotations of the polarization angle in blazars reveal important information about the evolution of disturbances responsible for blazar flares. The RoboPol program for the polarimetric monitoring of statistically complete samples of blazars was developed in 2013 to systematically study this class of events. RoboPol is a collaboration between the University of Crete, the Max-Planck Institute for Radio Astronomy, Caltech, the Inter-University Centre for Astronomy and Astrophysics in India, and the Nicolaus Copernicus University in Poland. Using a novel polarimeter operating at the 1.3m telescope of the Skinakas Observatory in Crete, it has succeeded in its 4 years of operation in taking optopolarimetric rotations of blazars from novelty status to a well-studied phenomenon that can be used to answer long-standing questions in our theoretical understanding of jets. I will review the RoboPol program and its most important results in the classification of the optopolarimetric properties of blazars, the statistical properties of polarization rotations, and their relation to gamma-ray activity in blazar jets.

Connection between optical polarization plane rotations and gamma-ray flares in blazars

Dmitry BLINOV (University of Crete)

on behalf of the RoboPol collaboration

We investigate the previously suggested connection between rotations of the polarization plane in the optical emission of blazars and their gamma-ray flares in the GeV band. The homogeneous set of polarization plane rotations detected in the frame of the RoboPol project is analysed together with the gamma-ray data provided by Fermi-LAT. We confirm that polarization plane rotations are indeed related to the closest gamma-ray flares in blazars and the time lags between these events are consistent with zero. Amplitudes of the rotations are anticorrelated with amplitudes of the gamma-ray flares. This is presumably caused by higher relativistic boosting in blazars that exhibit smaller amplitude polarization plane rotations. Moreover, the time scales of rotations and flares are marginally correlated.

Testing a stochastic variability model of optical EVPA rotations in blazars with RoboPol data

Sebastian KIEHLMANN (California Institute of Technology)
on behalf of the RoboPol collaboration

After three years of high-cadence optical linear polarization monitoring of an unbiased, flux-limited sample of 62 gamma-ray loud blazars the RoboPol program has largely increased the number of observed rotations of the polarization vector. RoboPol provides an unprecedented data set for systematic studies and model testing. In this study we test a simple stochastic variability model against the polarization data. We show that (i) a reduction of the polarization fraction during rotation events and (ii) an empirical relation between the amount of this reduction and the rotation rate, as found in the RoboPol data, are consistent with a stochastic process. In a statistical approach the model reproduces various characteristics of the rotation events. But it cannot reproduce the variability in the polarization fraction and angle consistently and, thus, challenges more sophisticated stochastic models.

Coherent changes in the polarization angle and broadband SED: the case of 3C454.3

Ioannis LIODAKIS (University of Crete, FORTH)
D. Blinov

Coherent changes in the Electric Vector Position Angle are often associated with a plethora of phenomena from flares seen throughout the electromagnetic spectrum, drastic changes in the polarization degree and ejection of radio components. Despite the wealth of accumulated information over years of studying these events, their origin and nature are still a mystery. We use data from the RoboPol optopolarimetric survey and the St Petersburg University blazar monitoring program to investigate changes in the optical spectrum during EVPA rotation events. The existence of these changes can prove immensely important in constraining models for the EVPA rotations as they suggest the presence of an additional polarized component in the jet. We observed a significant hardening in the optical spectrum of 3C454.3 during a highly energetic flare. This event is accompanied by a flare in gamma-rays, millimeter, optical polarization flux, as well as hardening of the gamma-ray spectrum. We use our findings to constrain the properties of the second component and discuss their impact on current models of EVPA rotations.

Polarimetric monitoring of jets with Kanata Telescope

Ryosuke ITOH (Tokyo Institute of Technology)
(invited)
Makoto Uemura, Yasushi Fukazawa, Yasuyuki Tanaka, Koji Kawabata, Michitoshi Yoshida

The polarization of relativistic jet is of interest for understanding the origin, confinement, and propagation of jets. However, even though numerous measurements have been performed, the mechanisms behind jet variability, creation, and composition are still debated. We performed simultaneous gamma-ray and optical photopolarimetry observations of 45 blazars with Kanata telescope since Jul. 2008 to investigate the mechanisms of variability and search for a basic relation between the several subclasses of relativistic jets. Consequently, we found that a correlation between the gamma-ray and optical flux might be related to gamma-ray luminosity and the maximum polarization degree might be related to gamma-ray luminosity or the ratio of gamma-ray to optical flux. These results imply that low gamma-ray luminosity blazars emit from multiple regions.

Wednesday June 14

The abstracts are ordered as they appear in the program.

Probing magnetic fields in relativistic jets with real-time polarimetry

Carole MUNDELL (University of Bath)
(invited)

I will review current status of multi-wavelength polarisation studies of relativistic jets and present current state of the art observations in rapid, real-time observations of ultra-relativistic Gamma Ray Burst jets. I will discuss the observed polarization properties and implications for the jet magnetic field, place these observations in the context of shock models and introduce future prospects with ground and space-based facilities such as XIPE, ALMA and the SKA.

These guys can accelerate particles: synchrotron emission from protostellar jets

Carlos CARRASCO-GONZALEZ (Instituto de Radioastronomia y Astrofisica)
Adriana Rodriguez-Kamenetzky

Since the 90s, it has been proposed that protostellar jets, although not very energetic, are able to accelerate particles in some conditions. Some observations of spectral indices at radio wavelengths in a few protostellar jets seem to support this scenario. It was only in recent years that we were able to detect linearly polarized emission in a protostellar jet. This result confirmed the possibility of an acceleration mechanism taking place in these objects. Also, it allowed to study for the first time the magnetic field in the jet. I will present a summary of previous observations and new results in two protostellar jets (HH 80-81 and Serpens) in which, through high angular resolution, high sensitivity observations, we are studying the particle acceleration phenomena.

Neutron star low mass X-ray binaries jets: a polarimetric view

Maria Cristina BAGLIO (New York University of Abu Dhabi)
P. D'Avanzo, S. Campana, S. Covino, D. Russell

We present some results taken from a study aimed at detecting the emission of relativistic particles jets in NS-LMXBs using polarimetric optical observations. First, we focus on a polarimetric study performed on the persistent LMXB 4U 0614+091. For this source, we measured an intrinsic linear polarization in the r-band of $\sim$3% at a 3 sigma confidence level. This is in agreement with the findings of Migliari et al. 2010, who observed an infrared excess in the broad-band SED of the same source, which they linked to the optically thin synchrotron emission due to the presence of a jet. We then present an optical polarimetric study performed on the transitional MSP PSR J1023+0038 during quiescence. The source was in its accretion phase during our campaign. We measured a linear polarization of 1.09$\pm$0.27% and 0.90$\pm$0.17% in the V and R bands, respectively. The phase-resolved polarimetric curve of the source in the R-band reveals a hint of a sinusoidal modulation at the source 4.75 h orbital period, peaked at the same orbital phase as the light curve. The

measured optical polarization of PSR J1023+0038 could, in principle, be interpreted as Thomson scattering with free electrons, which can be found in the accretion disc of the system or even in the hot corona that sorrounds the disc itself, or as synchrotron emission from a jet of relativistic particles. However, the NIR-optical SED of the system built from our dataset did not suggest the presence of a jet. We conclude that the optical linear polarization observed for PSR J1023+0038 is possibly due to Thomson scattering with electrons in the disc, as is also suggested from the possible modulation of the R-band linear polarization at the system orbital period.

Polarimetric evidence of the first white dwarf pulsar

David BUCKLEY (South African Astronomical Observatory)
Pieter Meintjes, Stephen Potter, Tom Marsh, Boris Gansicke

This talk will discuss the recent discovery of a spinning white dwarf in the binary system AR Scorpii which shows all of the usual hallmarks of a pulsar. Initial observations established that it pulses at the 2 minute spin and beat periods, from the UV to radio wavelengths, and its luminosity is dominated by synchrotron emission, powered by the spin-down of the strongly magnetic white dwarf. More recent polarimetric observations undertaken at the SAAO have strengthened the arguments that the white dwarf in AR Sco is analogous to a pulsar, with optical polarization behaviour similar to that seen in the Crab pulsar and with pulsation and spectral energy distribution characteristics consistent with strong MHD interactions between the white dwarf magnetic dipole and the M-dwarf companion. These interactions include the penetration of the white dwarf's magnetic field into the M-star's photosphere, leading to a significant spin-down torque from Ohmic diffusion. In addition "pumping" of the M-star coronal loops and the generation of strong currents in the out-flowing relativistic wind, results in pulsed and polarized emission across a wide wavelength range. Further multi-wavelength observations have been undertaken of this fascinating system, and further are planned in the future.

The extraordinary polarimetric nature of the white dwarf pulsar ARSCo

Stephen POTTER (South African Astronomical Observatory)
David Buckley

We present new high speed photo-polarimetric observations of the recently identified white dwarf pulsar, covering multiple orbits or the binary. Furthermore we propose a model that describes the polarimetric variability.

Unravelling the complexities of the disk/corona/jet relationship

Sera MARKOFF (API, University of Amsterdam)
(invited)

The last decades have witnessed enormous progress in our understanding of X-ray binaries (XRBs), primarily due to coordinated, simultaneous multiwavelength campaigns. Correlations between different bands have revealed tight connections between the various components, and have created challenges for simpler scenarios that do not account for magnetic processes or time variability signatures. No one model can yet account for all the data, yet a picture is emerging of several regions that must be inter-related: a thin disk, a magnetised corona, winds, and jets. At the same time, progress in computational general relativistic magnetohydrodynamics (GRMHD) has led to an industry of jet launching in simulations, and while these are still in the 'early days' in the sense of being ideal and lacking full radiative processes, it is clear that earlier notions

of static, spherical coronae are not compatible with the presence of ordered magnetic fields. We are now trying to understand which region in simulations can "map" to the concepts we have developed from semi-analytical modeling: is the mass-loaded, magnetic wind seen coming off the accretion flow (whose existence is supported by observations of LLAGN) more part of the corona or the jet? When we observe compact, self-absorbed jets, are we seeing the boundary layer with this wind or actually probing the jet interior? What region is actually causing the reflection? In my talk I will discuss how these ideas are evolving, based on what we are learning both from new observations as well as new simulations, and how the scaling relationship between XRBs and AGN provides important hints. I will end by giving some examples of how polarisation will be a key diagnostic for distinguishing between the contributions from various regions, particularly when the X-ray band can be compared with polarization signatures from the radio and optical/IR bands.

The jets of microquasars during giant radio flares and quiet state

Sergei TRUSHKIN (Special Astrophysical Observatory RAS)
N.A. Nizhelskij, P.G. Tsybulev, G.V. Zhekanis

We report about the properties of the jets, determined from the intensive multi-frequency daily monitoring microquasars: V404 Cyg, SS433, Cyg X-3, GRS1915+105 and LSI+61d303 with the RATAN-600 radio telescope during 2010-2017. We have detected a lot of giant flares from SS433, the powerful flares from V404 Cyg in June 2015, and from Cyg X-3 in September 2016, and near 40 periodical flares from LSI+61d303. We will discuss the general properties of the intensive ejections based on the multi-band (radio, X-ray, gamma-ray) studies.

A search for polarised emission in jets from high-mass protostars

Katharine JOHNSTON (University of Leeds)
M. Hoare, L. Maud, S. Lumsden, S. Purser, J. Pittard

Although it is now clear that jets from low-mass stars are magnetically driven, the process which creates the jets observed towards massive stars is still in question. While commonly observed tracers such as thermal free-free emission and radio recombination lines can reveal information on the density and temperature of the jet, linearly polarised synchrotron emission is one of the only observational tracers which provides the magnetic field strength and direction across a large portion of the jet area (compared to polarised maser emission). To date, polarised synchrotron emission has only been observed in one jet from a young high-mass stellar object, HH80-81, but detection in more sources is essential to determine the importance of magnetic fields in massive star formation, find the strength and morphology of the magnetic field, and to constrain models of how material in the jet is accelerated to relativistic speeds. With e-MERLIN at 1.5 GHz, we have observed three nearby regions of high-mass star formation containing jet systems which show evidence for synchrotron emission to thereby test the hypothesis: are jets from high-mass stars magnetically driven? In this contribution, I will present our most recent results.

Polarized near-infrared emission from the Galactic center

Banafsheh SHAZAMANIAN (I. Physikalisches Institut, University of Cologne)
B. Shahzamanian, A. Eckart, M. Valencia-S., M. Zajacek

Near-infrared polarimetry observation is a powerful tool to study the central sources of the center of the Milky way. I will present our results on analyzing the polarized emission present in the central few light years

of the Galactic Ceneter region, in particular the non-thermal polarized emission of Sagittarius A* (Sgr A*), the electromagnetic manifestation of the super-massive black hole, and the polarized emission of an infrared-excess source in the literature referred to as DSO/G2 close to Sgr A* position. We obtain typical polarization degrees on the order of 20% and a preferred polarization angle of 13 degree. Since the emission is most likely due to optically thin synchrotron radiation, the preferred polarization angle we find is very likely coupled to the intrinsic orientation of the Sgr A* system, i.e. a disk or jet/wind scenario associated with the super-massive black hole. I also investigate an infrared-excess source called G2 or Dusty S-cluser Object (DSO) moving on a highly eccentric orbit around Sgr A*. I use for the first time the near-infrared polarimetric imaging data to determine the nature and properties of this source. I obtain the K-band identification of DSO in median polarimetry images of different years of observation. We find out that DSO is an intrinsically polarized source, based on the significance analysis of polarization parameters, with the degree of the polarization of $\sim$30% and an alternating polarization angle as it approaches the position of Sgr A*. Since the DSO exhibits a near-infrared excess of Ks-L > 3 and remains rather compact in emission-line maps, its main characteristics may be explained with the model of a pre-main-sequence star embedded in a non-spherical dusty envelope.

Polarised structures in the restarted radio galaxy B2 0258+35 - Magnetic field compression or magnetic draping?

Björn ADEBAHR (ASTRON)

B. Adebahr, M. Brienza, R. Morganti

Studying diffuse emission associated with compact radio galaxies is the best way to get a handle on the duty cycle of these sources and their influence on the surrounding environment including the interaction with other gas phases. The source B2 0258+35 is a Compact Steep Spectrum radio source associated with the galaxy NGC1167. The compact radio source shows a two-lobe morphology of $\sim$1 kpc size with an approximate age of 0.9 Myrs. On a large scale, two low surface brightness lobe structures have been detected (at 1.4 GHz using the WSRT and at 150 MHz using LOFAR), extending to a total size of 240 kpc. These large-scale lobes are interpreted as an evidence of a previous cycle of jet activity, although their radio spectra derived at high frequency doesn't show the typical steepening which is characteristic of remnant emission. Neutral hydrogen observations show a gas rich disk with a diameter of 160 kpc and regular rotation up to a radius of 65 kpc. In this talk we present the puzzling results obtained from the analysis of the polarisation in the outer lobes. The WSRT polarisation data at 1.4 GHz shows prominent polarised emission along only one edge of each radio lobe. These structures are 150 kpc long and less than 15 kpc wide. Interestingly, this emission is only visible beyond the extend of the neutral hydrogen disk, where it suddenly appears showing polarisation degrees of $\sim$20% reaching up to > 60% at the end of the lobes. This suggests a possible relation between the two gas phases and/or depolarisation due to emission propagating through the turbulent medium in the star-forming disk. To investigate the nature of the polarised structures we use complementary data from the JVLA full polarisation P-band and LOFAR 150 MHz band. We discuss scenarios for the origin of these polarised structures considering the possible interaction of still expanding radio lobes with a dense ISM producing magnetic field compression and/or magnetic draping.

Can CMB Surveys Help the AGN Community?

Bruce PARTRIDGE (Haverford College)

M. Lopez-Caniego, R. Datta, M. Gralla, D. Herranz, A. Lahteenmaki, T. Marriage, L. Mocanu, H. Prince, J. Vieira and N. Whitehorn

Contemporary projects to measure anisotropies in the cosmic microwave background (CMB) are now detecting hundreds to thousands of extragalactic radio sources, most of them blazars. As a group of CMB

scientists involved in the construction of catalogues of such sources, and their analysis, we wish to point out the potential value of CMB surveys to studies of AGN jets and their polarization. Current CMB projects:

- have adequate (and improving) sensitivity (<10 mJy for ACT and SPT)
- offer wide sky coverage (all-sky in the case of the Planck mission)
- are "blind" and generally of uniform sensitivity across the sky (hence useful statistically)
- now routinely provide polarization measurements
- make essentially simultaneous multi-frequency observations
- probe the highest frequencies accurately observed from the Earth's surface (e.g 70, 150, 220 GHz), and higher for Planck
- are at resolutions roughly comparable to ground-based single dish telescopes at cm wavelengths
- routinely offer repeated observations of sources with interesting cadence

Our aim is not to analyze in any depth the AGN science already derived from such projects, but to heighten awareness of their promise for the AGN community.

Polarised radio emission from X-ray binary jets

James MILLER-JONES (ICRAR - Curtin University)
(invited)

X-ray binary systems are known to produce steady, compact radio jets in their hard and quiescent states, and bright, relativistically-moving transient ejecta at the peak of their sporadic outbursts. Linearly-polarised radio emission has been observed from both classes of jet, with linear polarisation fractions of order 1 per cent in the compact jets, and up to several tens of percent in the transient ejecta. A small subset of systems have also been observed to show highly-variable circular polarisation. In this talk, I will give an overview of radio polarimetric observations of X-ray binary jets, detailing what we have learned about the preferred magnetic field orientation in the jets and the depolarisation mechanisms at work. I will conclude by presenting some recent VLBI results showing how changing polarimetric signatures correspond to morphological changes in the jets.

Detection of short-term flux density variability and intraday variability in polarized emission at millimeter-wavelength from S5 0716+714

Jee Won LEE (Korea astronomy and space science institute, KASI)
B. W. Sohn, S. S. Lee, D. Y. Byun, S. C. Kang, J. A. Lee, S. S. Kim

We present results of flux density variability and intraday variability (IDV) of polarized emission from S5 0716+714 based on multi-frequency polarization observations using the Korean VLBI Network (KVN) radio telescopes. To search for existence of intraday variability in the flux density of S5 0716+714 at high radio frequencies for which the interstellar scintillation effect is not significant, we observed at 21.7 and 42.4 GHz with the KVN over 4 epochs. Over the whole set of observation epochs, the source showed significant inter-month variations in the flux density at both frequencies. In all epochs, no clear intraday variability was detected at either frequency. The source shows monotonic flux density increase in epochs 1 and 3 and monotonic flux density decrease in epochs 2 and 4. In the flux density increasing phases, the flux densities at 42.4 GHz

increase more rapidly. We find an inverted spectrum in epochs 1 and 3. On the other hand, we find relatively steep indices in epochs 2 and 4. We conclude that the frequency dependence of the variability and the change of the spectral index are caused by source-intrinsic effects rather than by any extrinsic scintillation effect. To detect the IDV in polarized emission, the observations were conducted at 22, 43, and 86 GHz in dual polarization using the KVN. We found significant variations in the degree of linear polarization at 86 GHz and in polarization angle at 43 and 86 GHz during 10 hour. The measured degree of the linear polarization ranges from 2.3% to 3.3% at 22 GHz from 0.9% to 2.2% at 43 GHz and from 0.4% to 4.0% at 86 GHz, yielding prominent variations at 86 GHz over 4-5 hours. The linear polarization angle is in the range of 4 deg to 12 deg at 22 GHz, -39 deg to 81 deg at 43 GHz, and 66 deg to 119 deg degree at 86 GHz with a maximum rotation of 110Âř at 43 GHz over 4 hour. We estimated the Faraday rotation measures (RM) ranging from -9200 to 6300 rad m^{-2} between 22 and 43 GHz, and from -71000 to 7300 rad m-2 between 43 and 86 GHz, respectively. The frequency dependency of RM was invested, yielding a mean power-law index, a, of 2.0. This implies that the polarized emission from S5 0716+714 at 22-86 GHz moves through a Faraday screen in or near the jet of the source.

Beyond rotation measures: Leveraging broadband polarimetry and all-sky radio surveys to probe spatially-unresolved magneto-ionic structure in AGN jets

Craig ANDERSON (Commonwealth Scientific and Industrial Research Organisation, CSIRO)

Radio observations of distant AGN can been used to probe magnetised plasmas throughout the cosmos, by studying the imprint left on linearly polarised emission by Faraday rotation. For many years, such analysis was conducted principally by calculating 'rotation measures' (RMs) - the gradient of a linear fit to the polarisation angle vs. the square of the observing wavelength - over comparatively narrow and / or sparsely-sampled frequency bands. However, modern broadband observations have revealed that many sources exhibit 'Faraday complexity' - complicated changes in frequency-dependent polarisation behaviour that encode information about spatially-unresolved magneto-ionic structure towards the emitting region. I will highlight the results of recent experiments designed to observe and characterise Faraday-complex polarisation behaviour in cosmic radio sources. I will show that Faraday-complexity is readily detected in a substantial proportion of radio sources, and that this complexity reveals the existence and intrinsic properties of magnetised structures in the jets of some AGN. I will go on to discuss how current and future wide-field, broadband radio telescopes such as the SKA and its precursors can exploit this information to provide a powerful and complementary new probe of magnetised structure in and around AGN.

Optical/infrared polarised emission in X-ray binaries

David RUSSELL (New York University Abu Dhabi)
(invited)

Recently, evidence for synchrotron emission in both black hole and neutron star X-ray binaries has been mounting, from optical/infrared spectral, polarimetric, and fast timing signatures. The synchrotron emission of jets can be highly linearly polarised, depending on the configuration of the magnetic field. Optical and infrared (OIR) polarimetric observations of X-ray binaries are presented. The OIR polarimetric signature of relativistic jets is detected at levels of $\sim$1-10%, similar to AGN cores. This reveals that the magnetic geometry in the compact jets may be similar for supermassive and stellar-mass BHs. The magnetic fields near the jet base in most of these systems appear to be turbulent, variable and on average, aligned with the jet axis, although there are some exceptions. These measurements probe the physical conditions in the accretion (out)flow and demonstrate a new way of connecting inflow and outflow, using both rapid timing and polarisation. Some examples are given, including the discovery of variable polarisation on timescales of minutes to seconds in both

black hole (GX 339-4 and V404 Cyg) and neutron star (Sco X-1 and Cyg X-2) X-ray binaries. The variations in polarisation could be due to rapid changes of the ordering of the magnetic field in the emitting region, or in one case, flares from individual ejections or collisions between ejecta. The spectral, polarimetric and rapid variability properties of the black hole system Swift J1357.2-0933 are consistent with synchrotron emission from weak compact jets. This represents the first detection of polarisation from a synchrotron jet in quiescence. While most systems have tangled, variable magnetic fields near the jet base, the exception of Cyg X-1 is discussed, in which the magnetic field appears to be highly ordered and perpendicular to the axis of the resolved radio jet. It is predicted that in some cases, variable levels of X-ray polarisation from synchrotron emission originating in jets will be detected from accreting Galactic black holes with upcoming spaceborne X-ray polarimeters.

Thursday June 15

The abstracts are ordered as they appear in the program.

Understanding jet launching through polarisation observations

John WARDLE (Brandeis University)
(invited)

This review will present an overview of new polarization results since the Granada and Malaga meetings. Particularly exciting is the thrust towards millimeter and sub-millimeter wavelengths with the GMVA and the EHT. With an Earth-sized array, resolution approaches a few gravitational radii on Sgr A* and M87, while for more distant blazars we can see the beginning of the jets at unprecedented resolution. The Magnetically Arrested Disk (MAD) model provides good reason to believe that jets are launched by strong magnetic fields at the central black hole/accretion disk system, so it follows that polarization observations are essential for elucidating the precise physics of this process. We will also review observations of variable rotation measures and variable rotation measure transverse gradients that have been observed at milliarcsecond resolution. These will include new observations of 3C273 and a new model for the magnetic field structure in its jet.

Determining the Jet Longitudinal Magnetic Field Directions and Black-Hole Rotation Directions in AGNs

Denise GABUZDA (University College Cork)

It is expected theoretically that AGN jets should carry helical magnetic (B) fields, which come about due to the rotation of the central black hole and accretion disk combined with the jet outflow. The direction of the azimuthal (toroidal) component of the helical B field is determined by the direction of the longitudinal (poloidal) component of the initial seed field that is "wound up" and the direction of rotation of the central black hole and accretion disk. The presence of the jet's helical B field can be manifest both through the presence of Faraday rotation gradients across the jet, and the presence of appreciable circular polarization, which comes about when linearly polarized emission from the far side of the jet is converted to circularly polarized emission as it passes through the magnetized plasma at the front side of the jet on its way towards the observer. When both of these properties are manifest, they can be used jointly with the jet linear polarization structure to uniquely determine both the direction of the longitudinal component of the helical B field and the direction of the central rotation. This technique, originally proposed by Gabuzda et al. (2008), has been applied to 12 AGNs. The results imply statistically equal numbers of outward and inward longitudinal B-field components and of clockwise (CW) and counter-clockwise (CCW) rotations of the central black holes on the sky. However, the directions of the longitudinal field and central rotation are coupled, with CW/CCW central rotation being preferentially associated with inward/outward longitudinal B field. This intriguing result is predicted by the Poynting–Robertson battery mechanism considered, for example, by Christodoulou et al. (2016), in which the direction of the longitudinal seed field is determined by currents in the accretion disk.

Evidence for toroidal B-field components in AGN jets on kiloparsec scales

Sebastian KNUETTEL (University College Cork)
Denise Gabuzda, Shane O'Sullivan

The collimation of jets, particularly in active galactic nuclei (AGN), is a long standing question in astrophysics. Collimation due to a toroidal or helical magnetic field is a viable mechanism to explain this. This B-field structure can be detected in images of the Faraday rotation measure (RM) of a jet. Faraday rotation is the change in polarisation angle of an electromagnetic wave as it passes through a magneto-ionic medium. This change is directly proportional to the wavelength squared; long centimetre wavelengths are therefore very sensitive to Faraday rotation. The Faraday rotation measure is also directly proportional to the line-of-sight magnetic field; therefore a monotonic gradient in the rotation measure transverse to the jet indicates a similar behaviour of the line-of-sight B-field component. This type of analysis has mostly been done on parsec scales using VLBI observations at centimetre wavelengths while relatively few studies have probed decaparsec to kiloparsec scales. The detection of RM gradients with significances of 3σ or more on such large scales can reliably show that a helical or toroidal field component persists to these distances from the centre of the AGN. We present the results of new Faraday rotation analyses for 4 AGN on kiloparsec scales based on multiwavelength VLA observations, with robust transverse RM gradients detected in 2 of these. Furthermore, the direction of the gradients on the sky gives evidence for a predominance of outward currents in the jets on kiloparsec scales.

VLBA polarimetry monitoring of 3C 111 as a tool to probe AGN jet physics on parsec scales

Tobias BEUCHERT (Dr. Remeis Observatory & Erlangen Centre for Astroparticle Physics)
M. Kadler, M. Perucho, C. Grossberger, R. Schulz, I. Agudo, C. Casadio, D. Gabuzda, J.L. Gomez, M. Gurwell, D. Homan, Y.Y. Kovalev, M.L. Lister, S. Markoff, S.N. Molina, A.B. Pushkarev, E. Ros, T. Savolainen, T. Steinbring, C. Thum, J. Wilms

We study the physics of the parsec-scale jet of 3C 111 including the dynamics of the magneto-hydrodynamical flow and the geometry of the intrinsic magnetic field. We base our results on long-term polarimetric observations with the VLBA as part of the MOJAVE program and complement these data with data from the IRAM 30-m telescope as well as the SMA. The high spatial resolution of the VLBA allows to observe a complex evolution of the polarized jet. The electric vector position angles (EVPAs) perform a large rotation of more than 180 degrees over a distance of about 20 pc. As opposed to this smooth swing, the EVPAs are strongly variable within the first parsecs of the jet. We find an overall tendency towards transverse EVPAs across the jet with a local anomaly of aligned vectors in between. The polarized flux density increases rapidly at that distance and eventually saturates towards the outermost observable regions. The feature size of moving components suddenly decreases coincident with a jump in brightness temperature around where we observe the EVPAs to turn into alignment. Also the gradients of the feature size and particle density with distance steepen significantly at that region. We interpret the propagating polarized features with shocks and the observed local anomalies with the interaction of these shocks with a localized recollimation shock of the underlying flow. Together with a sheared magnetic field, this shock-shock interaction could possibly explain the large rotation of the EVPA. The superimposed variability of the EVPAs close to the core is likely related to a clumpy Faraday screen, which also contributes significantly to the observed EVPA rotation in that region. Our observations therefore provide an ideal test-bed for future simulations of dynamical shock-shock interactions with full polarized radiative output.

On the time variable rotation measure in the core region of Markarian 421

Rocco LICO (Institute of Radioastronomy, IRA/INAF)
Jose Luis Gomez, Keiichi Asada, and Antonio Fuentes

In this talk we will discuss and interpret the time variable rotation measure (RM) observed for the first time in the core region of a blazar. These results are based on a one-year, multi-frequency (15, 24, and 43 GHz) Very Long Baseline Array (VLBA) monitoring of the TeV blazar Markarian 421. We explore the possible connection between the RM and the accretion rate and we investigate the Faraday screen properties and its location with respect to the jet emitting region. Among the various scenarios, the jet sheath is the most promising candidate for being the main source of Faraday rotation. We interpret the two RM sign reversals observed during the one-year monitoring within the context of the magnetic tower models. We invoke the presence of two nested helical magnetic fields in the relativistic jet with opposite helicities, whose relative contribution produce the observed RM values. Additional scenarios are considered to explain the observed RM time evolution.

Constraints on Particles and Fields from Full Stokes Observations of AGN

Daniel HOMAN (Denison University)
(invited)

Combined polarization imaging of AGN jets in circular and linear polarization, also known as full Stokes imaging, has the potential to constrain both the magnetic field structure and particle properties of jets. Although only a small fraction of the emission when detected, circular polarization directly probes the magnetic field and particles within the jet itself and is not expected to be modified by external screens. A key to using full Stokes observations to constrain jet properties is obtaining a better understanding of the emission of circular polarization, including its variability and spectrum. I will discuss what we have learned so far from parsec-scale monitoring observations in the MOJAVE program and from multi-frequency observations of select AGN.

Exploring the environment of high Rotation Measure Active Galactic Nuclei with wideband radio spectropolarimetry observations

Alice PASETTO (Instituto de Radioastronomia y Astrofisica, IRyA-UNAM)
C. Carrasco Gonzalez, S. O'Sullivan, G. Bruni, A. Basu, A. Kraus, K.-H. Mack

I present new high sensitivity wide-band full polarization observations of a sample of Active Galactic Nuclei observed with the JVLA. This sample contains objects with very high Rotation Measure (RM) values, sign of extreme environment of the AGN. Their radio spectra and their polarization properties have been studied in the well-sampled frequency range between 4 and 12 GHz. The polarization properties show a complex behaviour with the polarization angle and the fractional polarization that change within the wide-band. The strong depolarization experienced by the sources, have been studied through modeling of the Stokes parameters Q and U together with the fractional polarization and the polarization angle with wavelength by combining simple internal and external Faraday screens. This study suggests the presence of multiple Faraday screens within or in front of the observed emitting region each of them with extreme polarized conditions. This new approach of polarization study allows to spectrally resolve multiple polarized components of unresolved AGN with the result to trace some clumpy and dense region in or around them. This new spectropolarimetry approach can be adopted as a new way to trace clumpy and dense regions surrounding the AGN. Moreover, I will briefly show that this new spectropolarimetry study could be applied to a very specific class of objects: the Compact Symmetric Objects (CSOs), the nature of which is still matter of debate. Indeed, polarization study

could help to distinguish which scenario, youth or frustrated, is the most probable.

Linear Polarization Properties of Parsec-Scale AGN Jets

Alexander PUSHKAREV (Crimean Astrophysical Observatory)
Y. Kovalev, M. Aller, H. Aller, M. Hodge, M. Lister, T. Savolainen

We used 15 GHz multi-epoch VLBA polarization sensitive observations of more than 400 sources within a time interval 1996-2016 from the MOJAVE program, and also from the NRAO data archive. We have analyzed the linear polarization characteristics of regions downstream of the compact core feature, and their changes along and across the parsec-scale AGN jets. In particular, we have systematically detected significant increase of fractional polarization with distance from the core along the jet as well as towards the jet edges. We discuss orientation of the electric vector position angle with respect to the local jet direction for the sources of different optical classification. We also tested whether a regularity of the magnetic field associated with the outflow depends on its orientation, transverse or aligned with the jet ridge line.

Multi-frequency polarimetric analysis of the quasar 0850+581

Evgeniya KRAVCHENKO (Astro Space Center of Lebedev Physical Institute)
Y. Y. Kovalev

The quasar 0850+581 (redshift 1.3) displays one of the largest apparent core shift among all active galactic nuclei jets. We study physical conditions in the jet of this unique quasar through polarimetric observations carried out with VLBA simultaneously at 4.6, 5.0, 8.1, 8.4, 15.4, 23.8 and 43.2 GHz. Linear polarization and Faraday rotation of the jet in this quasar are reconstructed and investigated. In combination with the core shift results, this allows us to probe physical conditions in the inner and outer regions of the jet, i.e. properties of the jet medium, magnetic field strength, its spatial geometry and distribution along the jet, as well as the jet geometry.

Radio Polarisation Study of High Rotation Measure AGNs - How to Distinguish Intrinsic from External Sources of Rotation Measure?

Yik Ki (Jackie) MA (MPIfR)
Sui Ann Mao, Aritra Basu, Carl Heiles, Jennifer West

As polarised emission from astrophysical jets transverse through foreground magnetised plasma clouds, the line-of-sight physical conditions are encrypted in the form of Rotation Measure (RM). Such RMs could stem from the immediate vicinity of the emitting volumes, but can also come from foreground screens in the intergalactic media or in the Milky Way. The first scenario is interesting for the study of AGNs since it is a unique probe of the surroundings (e.g. narrow line regions, ICM, or even inside the jets themselves) of the objects. We performed broadband spectro-polarimetric observations of high |RM| (> 300 rad m-2) sources away from the Galactic plane (|b| > 10 deg) in the NVSS RM Catalogue (Taylor et al. 2009). The main goals are to verify the NVSS RM values, which could be susceptible to n*pi-ambiguity, as well as to distinguish the origin of the extreme RM values. Our results show that eight (40% of the whole sample) of the sources suffered from n*pi-ambiguity in the NVSS RM Catalogue, while for most of the other sources our RM values do not agree with the NVSS values within the uncertainties, implying possible variability over $\sim$20 years epoch. We also devised methods to discern the source of the extreme RM values, including multi-wavelength comparisons, QU-fitting, and using the estimated timescales of variabilities. In this talk, we will discuss the interpretation of

these results, as well as the implication on the NVSS RM Catalogue.

Magnetic field studies in BL Lacertae throught Faraday rotation and a novel astrometric tecnique.

Sol Natalia MOLINA (Instituto de Astrofisica de Andalucia)
Jose L. Gomez, Richard Dodson, Maria J. Rioja

It is thought that dynamically important helical magnetic fields twisted by the differential rotation of the black hole's accretion disk or ergosphere play an important role in the launching, acceleration, and collimation of AGN jets. We present multi-frequency centimeter and millimeter polarimetric VLBA images, as well as Faraday rotation analyses of the jet in BL Lacertae as part of a sample of AGN jets (including BL Lacs, FSRQs, and radio galaxies) aimed to probe the magnetic field structure at the innermost scales to test jet formation models. Registration of the images across frequencies is obtained using a novel astrometric technique that provides anÂăaccuracy of the order of few microarcseconds at millimeter wavelengths.

Centimeter-Band All-Stokes Observations of Blazar Variability

Margo ALLER (University of Michigan)
(invited)
M. F. Aller, H. D. Aller, and P. A. Hughes

The University of Michigan 26-m telescope (UMRAO) was dedicated to obtaining centimeter-band linear polarization and total flux density observations of hundreds of blazars from the mid-1960s until June 2012, with the primary goal of delineating the range of variations and identifying their physical origin. From the mid 1970s, the data were obtained at 14.5, 8, and 4.8 GHz, providing 3-frequency spectral, as well as temporal, information over more than 3 decades. Additionally, throughout the last 10 years of the program, the observations included circular polarization observations of a subsample of bright (S>5Jy), flaring AGN in order to investigate the amplitude range of the variations and the relation to linear polarization, Stokes V sign stability, and the emission mechanism. Statistical low values of fractional linear polarization obtained from time-averaged measurements for blazars in source samples, as well as the very low values of fractional linear polarization measured during relatively quiescent periods in individual sources, have provided strong evidence for turbulent magnetic fields in the underlying flows at parsec scales. The light curves during strong flares are well-represented by radiative transfer models incorporating propagating shocks which compress and order the underlying, turbulent magnetic field. We describe the main polarization properties identified by the longterm UMRAO data and illustrate how the linear polarization data are currently being used to determine intrinsic jet properties and their evolution with time. Recent work supports a picture in which shocks, turbulent magnetic fields, and weak ordered axial magnetic field components, including helical geometry, all play a role.

Time-Evolving SED of MKN421: a long-term multi-band view and polarimetric signatures.

Ulisses BARRES DE ALMEIDA (Centro Brasileiro de Pesquisas Físicas)
P. Giommi, B. Fraga, N. Sahakyan, S. Gasparyan and D. Paneque

Some of the most detailed blazar SED studies to date are performed within dense, simultaneous multi-band campaigns, conducted over relatively short-term periods. It is well known, though, that the multi-band emission from these sources present sizeable temporal lags in their correlated variability, spanning timescales

which vary by orders of magnitude in range, depending on source state. Despite that, studies concerned with a detailed SED modelling usually neglect these properties, likely due to the difficulty in collecting good-coverage long-term data throughout the spectrum. As a consequence, SED models and the study of the temporal evolution of source parameters are usually based on time-averaged SEDs (when data is scarce) or considering strictly simultaneous multi-band snapshots of the source, neglecting correlation lags. In this work, by making use of the resources and large database made available through online facilities such as the ASI Science Data Center (ASDC), we present a novel approach to the modelling of blazar emission whereby the multi-epoch SED for Mkn 421 is modelled considering, in a self-consistent way, the temporal lags between bands (both in short and long-timescales). These are obtained via a detailed cross-correlation analysis, spanning data from radio to VHE gamma-rays from 2008 to 2015. In addition to that, long-term optical polarisation data is used to aid and complement our physical interpretation of the state and evolution of the source. A video will also be shown which gathers all the data collected to visually present the real-time correlations between the SED spectral changes, light-curve flares and features in the polarisation data, such as EVPA rotations.

Multiwavelength variability study of the BL Lac objects PKS 0735+178 and OJ 287 on timescales ranging from decades to minutes

Arti GOYAL (Astronomical Observatory of the Jagiellonian University)

L. Stawarz, M. Ostrowski, V. Larionov, P. J. Witta, Gopal-Krishna, M. Soida, I. Agudo, S. Zola et al.

The power spectral densities (PSDs) of blazar light curves, $P(f) = Af^{-\beta}$, where A is the normalization and β is the slope, indicate that the variability is generated by the underlying *stochastic* processes (i.e., $\beta \simeq 1-3$, characteristic of flicker/red noise). We present the results of our power spectral analysis using the standard Fourier decomposition methods as well as modeling the light curve as continuous-time auto regressive moving average (CARMA) process, for the BL Lac objects PKS 0735+178 and OJ 287. We use the data from *Fermi*-LAT survey at high-energy γ-rays, *Swift*-XRT at X-rays, several ground-based optical telescopes as well as *Kepler* satellite, and single-dish radio telescopes operating at GHz frequencies. The novelty of our approach is that, by combining long-term and densely sampled intra-night light curves in the optical regime, we were able to construct for the first time the optical power spectrum of the blazar for a time domain extending from decades years down to minutes. Our analysis reveals that: (i) the optical variability is consistent with a pure red noise, for which the power spectral density can well be approximated by a single power-law throughout the entire time domain probed; (ii) the slope of power spectral density at high-energy γ-rays ($\sim$1), is significantly flatter than that found at radio and optical frequencies ($\sim$2) within the corresponding time variability range; (iii) for the derived power spectra we did not detect any low-frequency flattening, nor do we see any evidence for cut-offs at the highest frequencies down to the noise floor levels due to measurement uncertainties. We interpret our findings in terms of a model where the blazar variability is generated by the underlying single *stochastic* process (at radio and optical frequencies), or a linear superposition of such processes (in the γ-ray regime). Implications of these results are discussed in the context of blazar emission models.

Linear and Circular Polarization Variability Properties of AGN Jets at Short Millimeter Wavelengths

Ivan AGUDO (Instituto de Astrofisica de Andalucia-CSIC)
(invited)

The properties of relativistic jets in AGN have not been extensively explored in the short millimeter range, specially on which regards to their variability in linear and circular polarization. In 2006, a program at the IRAM 30m Telescope dubbed POLAMI (Polarimetric Monitoring of AGN with Millimetre Wavelengths) started

observing the 4 Stokes parameters of a set of 40 sources with a time sampling up to 3 weeks at 3.5 and 1.3 mm. More than ten years after, the program is still active. In this talk, I will present the results of the POLAMI program for the first 8 years of observations, as well as their implications on the general properties of the variability of millimeter polarized emission of AGN relativistic jets, and on current jet-model concepts.

OJ287 polarization

Ioannis MYSERLIS (Max-Planck-Institut fÃijr Radioastronomie)

I. Myserlis, E. Angelakis, S. Komossa

tba

Double Rotations in EVPA in OJ287

Marshall COHEN (Caltech)

M.H. Cohen, H.D. Aller, M.F Aller, T. Hovatta, and D.L. Meier

Data from the UMRAO at 4.8, 8.0, and 14.5 GHz, and from the MOJAVE program at 15.3 GHz, were combined to make one EVPA curve for OJ 287, from 1974 to 2016. The curve shows three major double-rotation events, in which the EVPA has a large CCW rotation followed closely by a similar but CW rotation. The amplitude of these swings is of order 200-300 degrees, and the duration of the double rotation is from 1 to 3 years. As a basic model to explain this phenomenon we use two flux outbursts seen in succession, with their EVPAs rotating 200-300 degrees, CCW in the first and CW in the second. The outbursts are superposed on a steady background flux. With the proper timing and intensity, this pair can make the double rotation. A simple way to obtain the counter-rotation is with oppositely-directed shocks following a helical magnetic field in a relativistic jet. In the frame of the host galaxy both shocks are moving downstream, and an observer close to the axis will see two flux bursts with opposite rotations. Nakamura et al (2010) and Nakamura & Meier (2014) have shown that circumstances similar to these can be produced by supermagnetosonic shocks in jets with a helical magnetic field, although more theoretical work is needed. Nakamura, M., Garofalo, D., & Meier, D.L. 2010, ApJ, 721, 1783 Nakamura, M., & Meier, D.L. 2014, ApJ, 785, 152

Polarization monitoring of the lens system JVAS B0218+357

Andy BIGGS (European Southern Observatory)

I. Browne

Monitoring of the lens system JVAS B0218+357 with the Fermi Gamma-ray Space Telescope measured a different time delay to that derived from radio observations. We have re-analysed three months of archival VLA data to produce variability curves with an average sampling of one epoch per day in total flux, polarized flux and polarization position angle (PPA) at 15, 8.4 and 5 GHz. The variability is particularly strong in polarized flux. Dense sampling and improved subtraction of the Einstein ring has allowed us to derive an improved radio time delay (11.5 days) which agrees well with the gamma-ray value. Both images of 0218+357 are subject to strong Faraday rotation and depolarization as a result of the radio waves passing through the interstellar medium of the spiral lens galaxy. Our data reveal frequency-dependent variations in the PPA that are different in each image and which must therefore result from variable Faraday rotation in the lens galaxy on timescales of a few days. Our analysis has revealed systematic errors in the polarization position angle measurements that strongly correlate with hour angle. Although we have been able to correct for these, we

caution that all VLA polarization observations are potentially affected.

Polarised Emission from Gamma-Ray Burst Jets

Shiho KOBAYASHI (Astrophysics Research Institute, Liverpool John Moores University)
(invited)

I will review the theory of ultra-relativistic jets and polarized emission in the context of gamma-ray bursts.

Friday June 16

The abstracts are ordered as they appear in the program.

Rotation measure asymmetry reveals a precession of the AGN outflow in a Seyfert galaxy.

Ancor DAMAS SEGOVIA (MPIfR)

R. Beck

Feedback on galactic-scales is an important question in studies of cosmic evolution of galaxies. It is believed that AGN driven jets and/or stellar winds plays an important role in driving materials away from galactic discs. Radio polarimetric observations of galaxies are crucial for the study of the magnetic field of galaxies. We demonstrate that polarization studies of galactic outflows can help to distinguish between various driving mechanisms. New broad band polarimetric observations of NGC 4388 with the EVLA showed extended features in the radio polarized intensity of this Virgo galaxy. In this talk I will show how a jet precession model can well explain the complexity of these nuclear outflows. The model consists of a ballistic ejection of a precessing nuclear outflow and allows us to infer physical parameters of this ejection like velocity, inclination, period and total time of ejection. For the first time, the direction of the outflow with respect to the line of sight is introduced into this model and compared to the observed rotation measures (RMs) of the nuclear outflow. We find good agreement between the modeled RMs and the polarization radio observations. Furthermore, I will show how this precession model, combined with polarimetric radio observations, could serve as a tool for studying the interaction of nuclear outflows with their environments.

Low frequency Polarization observations of NGC 6251

Therese CANTWELL (JBCA, University of Manchester)

J. Croston, A. M. M. Scaife

With the advent of modern wide band telescopes such as WSRT and the EVLA, Faraday rotation measure synthesis has become an increasingly valuable polarization technique. The construction of the Low FRequency ARray (LOFAR) has opened up the opportunity to apply this technique at low frequencies and at high precision in Faraday depth. At LOFAR HBA frequencies, the resolution in Faraday space is typically sub 1 rad m^{-2}, allowing very accurate measurements of different Faraday depths. However, at these frequencies, depolarization dramatically reduces the number of polarized sources, with some observations suggesting densities of 1 source per 1.7 sq. degrees at 150MHz and sub-mJy sensitivity. Consequently, targets for polarization studies with LOFAR must be careful chosen. One promising class of targets for such studies are giant radio galaxies (GRGs), whose low density environments and high degree of intrinsic polarization minimize the effects of depolarization. Such objects are very interesting targets for polarization studies as, due to their large physical extent, observations of the Faraday effect can probe the magnetic fields in the extremely low density environments of the outer IGM and WHIM. Here we present the first detections of polarization in the GRG NGC 6251 at low frequencies (150 MHz). We used the new polarization analysis techniques of RM synthesis and QU fitting to study the environment of northern jet and lobe of NGC 6251.

Evidence for Helical or Toroidal Magnetic Fields on in a Jet on kpc-scales

Melanie JOHNSTON-HOLLITT (Victoria University of Wellington)
S. Shakouri

We present wide-band (2 GHz) polarimetric observations of the jets of a southern radio galaxy using the Australia Telescope Compact Array. We investigate the spectral index, rotation measure (RM), and polarisation structure of the jets over the band finding evidence of helical or toroidal magnetic fields on kpc-scales. In particular, the observed polarisation and spectral index intensity profiles and the transverse RM gradient across the jets show the classically predicted profiles which are a signature of helical or toroidal fields, in multiple locations along the jets. The results are strikingly similar to the intensity, spectral index, polarisation and RM structures seen in pc-scale jets which exhibit toroidal or helical fields, the difference here is the scale which shows these signatures out to 200 kpc from the AGN core.

Probing the Magnetized Medium of AGNs using Wideband Polarimetry

Maja KIERDORF (MPIfR)

To study magnetic fields in the universe I will investigate polarized extragalactic radio sources (EGSs). One class of those objects form unresolved sources with polarization degrees >30%. These ultrahigh polarization radio sources (UPRSs) have polarization fractions much larger than typical radio-loud active galactic nuclei (AGN). Except for the high degree of polarization, UPRSs appear to have normal AGN properties. Therefore, those objects could represent a class of EGSs with very well ordered magnetic fields. In addition to probe the intrinsic magnetic field structures and polarization properties, EGSs can be used to research the magnetism of Galactic HII regions, in nearby galaxies and in galaxies with high redshift via Faraday rotation measure (RM). For this, I will conduct a deep, high resolution polarization survey of EGSs to understanding their origin. Characterizing the polarization properties of UPRSs opens a new window towards unterstanding the process that generates extremely well ordered magnetic fields.

AGN polarization at the highest radio-frequencies and resolutions

Ivan MARTI-VIDAL (Onsala Space Observatory)
(invited)

Polarization is a powerful tool to study the magnetic-field geometry and the magneto-ionic conditions in AGN jets. Observing polarization at the highest frequencies allows us to probe regions very close to (if not at) the base of the jet, where the poynting-dominated outflow (originated in the immediate neighborhood of the AGN's central engine) gets accelerated up to relativistic energies. Due to the instrumental limitations at the high frequencies (and high spatial resolutions) required in this kind of studies, very little observational information is available about the magnetic-field conditions in the jet bases of AGN, which is crucial to discriminate between the major jet-launching scenarios in the theoretical models. However, these limitations are now being overcome, thanks to the advent of new-generation instruments (in particular, the Atacama Large mm/submm Array, ALMA). In this talk, we will discuss on recent observational studies of polarized emission from AGN jets at the highest radio-frequencies and spatial resolutions, focusing on the case of ALMA (and mm-VLBI) observations of the gravitationally-lensed blazar PKS1830-211.

Modelling blazar flaring using a time-dependent fluid jet emission model - an explanation for orphan flares and radio lags

William John POTTER (University of Oxford)

Blazar jets are renowned for their rapid violent variability and multiwavelength flares, however, the physical processes responsible for these flares are not well understood. In this talk I will discuss the results of a new time-dependent inhomogeneous fluid jet emission model for blazars I have recently developed. We model optically thick radio flares for the first time and show that they are delayed with respect to the prompt optically thin emission by $\sim$months to decades, with a lag that increases with the jet power and observed wavelength. This lag is caused by a combination of the travel time of the flaring plasma to the optically thin radio emitting sections of the jet and the slow rise time of the flare. From this work we predict two types of flares: symmetric flares - with the same rise and decay time, which occur for flares whose duration is shorter than the radiative lifetime; extended flares - whose luminosity tracks the power of particle acceleration in the flare, which occur for flares with a duration longer than the radiative lifetime. Our model naturally produces orphan X-ray and gamma-ray flares. These are caused by flares which are only observable above the quiescent jet emission in a narrow band of frequencies. Our model is able to successfully fit to the observed multiwavelength flaring spectra and lightcurves of PKS1502+106 across all wavelengths, using a transient flaring front located within the broad-line region.

Optical polarimetry and radio observations of PKS1510-089 between 2009 and 2013

Pedro P. B. BEAKLINI (Universidade de Sao Paulo)
T.P. Dominici, Z. Abraham

We report 7 mm (43 GHz) radio and R band polarimetric observations of PKS1510-089. The radio observations were performed at the Itapetinga Radio Observatory, while the polarimetric data were obtained in the Pico dos Dias Observatory, both in Brazil. The 7 mm observations cover the period between 2011 and 2013, while the optical polarimetric observations were made between 2009 and 2012. At 7 mm, the covered time interval was enough to detect a correlation between radio and g-ray fares, with a delay of about 54 days between them with the higher frequency counterpart occurring first. We detect a large variation in polarization angle within two days associated with the beginning of a gamma-ray flare.Complementing our data with others obtained in the literature we showed that, what seem to be a smooth rotation in polarization angle lasting about 50 days in 2009, presented oscillations associated with the occurrence of gamma or optical flares when a better time sampling was used. Both radio and optical polarimetric data can be explained by a shock-in-jet model, in which a new component is formed in the compact core producing an optical and/or g-ray are, propagates along the jet and after some time becomes optically thin, being detected as are at radio frequencies. The variability in the polarimetric parameters can also be reproduced.

SPRITE: the Stokes Polarimetric Radio Interferometer for Time-domain Experiments

Anthony C. S. READHEAD (Caltech)

Intensive studies of relativistic jets over the last decade, taking advantage of the multi-frequency opportunities afforded by Fermi-GST, NuSTAR, the VHE experiments, of developments in 3+1 simulations, and of multi-wavelength monitoring, have brought about an unprecedented focus on active galaxies and relativistic jets. It is very clear that high-frequency and low-frequency phenomena are often linked, and that millimeter wavelengths provide a very strong link with the high-energy emission. We are proposing to combine five OVRO 10.4 m millimeterwave antennas into the Stokes Polarimetric Radio Interferometer for Time-domain

Experiments (SPRITE) to measure all Stokes parameters and monitor active galaxies at 25-45 GHz, 80-116 GHz and a similarly broad band around 234 GHz.

The Future of Soft X-ray Polarimetry

Herman MARSHALL (MIT Kavli Institute)

Since 1960, X-ray astronomy has made great advance with the observation of energy, timing, and imaging. On the other hand, the polarization observation has been hardly carried out except for the observation of the Crab Nebula by OSO-8 because of the difficulty for the development of the detector. However, the advance of the imaging technology for the emitted electron track due to photo-absorption in gas has made possible the development of X-ray polarimeter with high sensitivity. The Imaging X-ray Polarimetry Explorer (IXPE) is the polarimeter with imaging capability developed by the collaboration of NASA/MSFC and Italian groups and has been selected by NASA for an expected launch in 2020. It will observe several types of astrophysical sources such as supernova remnants, active galactic nuclei (AGN), and pulsars to obtain linear polarization measurements as a function of energy, time, and position on the sky. I will introduce the performance of IXPE and concentrate on possible observations of jets from AGN and X-ray binaries.

LEAP - A LargE Area burst Polarimeter for the ISS

Michael BRIGGS (University of Alabama in Huntsville)
the LEAP Collaboration

In models of Gamma Ray Bursts (GRBs), Poynting-flux dominated jets are expected to have more ordered magnetic field configurations and high levels of gamma-ray polarization. Matter-dominated jets are expected to have less ordered magnetic field configurations, with levels of gamma-ray polarization that are dependent on the viewing angle to the jet. The LargE Area burst Polarimeter (LEAP) is a mission concept for a Compton scatter polarimeter instrument that would be deployed on the International Space Station (ISS). It was proposed as a NASA astrophysics Mission of Opportunity (MoO) in late-2016. The design employs discrete scintillation detector elements to measure the polarization of the incident flux. The detection principle of the LEAP instrument utilizes both plastic and CsI scintillation detectors to identify Compton scatter events. The azimuthal distribution of Compton scattered photons provides a measure of the source polarization. As a wide-FoV, non-imaging instrument, it is well-suited for measuring the polarization of transient events, such as GRBs and solar flares. Operating in the energy range of 50-500 keV, it will provide coverage of GRB spectra over a range that includes most values of Epeak. LEAP will provide a total effective area for polarization (double scatter) events of 500 cm2 . With a total geometric scintillator area of 5000 cm2 , LEAP will not only provide high quality polarization measurements, but it will also provide high quality spectral data as well. Designed for a lifetime of two years, the LEAP mission will provide polarization results on more than 60 GRBs. These data promise to shed significant light on the role that magnetic fields play in GRB jets.

Automated Polarimetry with Smaller Aperture Telescopes: The ROVOR Observatory

J. Ward MOODY (Brigham Young University)
Jonathan Barnes, Lauren Hindmann, Parkes Whipple, Nick Van Alfen, Nick Ducharme, Cameron Pace, Eric Hintz

Polarimetric monitoring campaigns at sufficiently high cadence are essential to understanding the time variability of polarized emission from astrophysical jets. Such campaigns are best done with automated systems

that function night after night with minimal operator input. The Remote Observatory for Variable Object Research or ROVOR observatory has been conducting monitoring campaigns for 9 years and was outfitted to do polarimetry in the fall of 2016. ROVOR, is a 16" RCO telescope on a Paramount ME mount located in the dark west desert of Utah, that is operated remotely over the internet. Setting up a night's observing takes about 30 minutes. Data reduction is automated through Excel scripts. We describe the observatory and present the results of our first polarimetric monitoring of CTA 102.

A Bethe-Heitler 5D polarized photon-to-e^+e^--pair conversion event generator

Denis BERNARD (LLR, CNRS/IN2P3)

Current pair conversion event generators (e.g. geant4 and EGS5 physics models) don't sample the five-dimensional differential cross section (5D DCS), but instead a product of 1D DCSs. In addition, most of them use high-energy and/or small angle approximations. Also the electron and positron polar angles are often generated independently so that energy-momentum is not conserved. Few of them can simulate the conversion of linearly polarized photons, and only at high energy [arXiv:1612.06239, to appear in Astropart. Phys.]. I have written an event generator that is sampling exactly the 5D Bethe-Heitler DCS, including for photons with a non-zero linear polarization fraction [NIM A 729 (2013) 765]. This event generator is using the BASES/SPRING instantiation of the VEGAS method: at a given energy, for a given target nucleus (nuclear conversion) or atom (triplet conversion), after a 5D grid has been optimized for DCS integration precision that is for event generator efficiency, the DCS is tabulated and stored, something that needs several seconds of computation. Then zillions of gamma conversions can be generated quickly at that energy and for that target. The polarization asymmetry properties of the Bethe-Heitler DCS were examined with that tool in Astropart. Phys. 88 (2017) 30, especially at low energy where most of the statistics is for cosmic sources. I am now developing a VEGAS-free version of that code, that will allow the fast generation of the conversion of a photon of a given energy on a given target, with the same other properties as for the VEGAS-based generator, i.e., 5D, exact, polarized and strictly energy-momentum conserving.

An Old Fogey's History of Jets

Ralph SPENCER (JBCA University of Manchester)

I will present some of the history of the discovery of radio jets in extragalactic and galactic objects. It will be from a personal point of view. It will no doubt be biased but there will be anecdotes, hopefully amusing.

Conference Summary

Lukasz STAWARZ (Astronomical Observatory of the Jagiellonian University in Cracow, Poland)

tba.

Posters

In each session the abstracts are ordered alphabetically.

tba

Hugh ALLER (University of Michigan)

tba

Gamma-ray astronomy with magnetic-field-free active targets: Optimal measurement of charged particle momentum from multiple scattering with a Bayesian analysis of filtering innovations.

Denis BERNARD (LLR, CNRS/IN2P3)
Mikael Frosini

Novel gamma-ray telescope schemes are under development so as to bridge the 0.1-100 MeV sensitivity gap of gamma-ray astronomy (Compton, pair creation), (silicon wafer stacks, emulsions, gas detectors). The lower average density with respect, e.g. to the tungsten/silicon active target of the Fermi-LAT makes square-meter effective area telescopes voluminous objects, for which the photon energy measurement by conventional means (calorimeter, magnetic spectrometer, transition radiation detector) is a challenge for the mass budget. We present an optimal measurement of track momentum by the multiple measurement of the angular deflections induced by multiple scattering in the active target itself, using a Bayesian analysis of the filtering innovations of a series of Kalman filters applied to the track.

High angular-resolution high sensitivity gamma-ray astronomy and linear polarimetry with low density (gas) detectors in the MeV-GeV energy range.

Denis BERNARD (CNRS / IN2P3)

A number of groups are developing pair-conversion detector technologies alternative to the tungsten-converter / thin-sensitive-layer stacks of the COS-B / EGRET / Fermi-LAT series, to improve the single-photon angular resolution. Presently observers are almost blind in the 1-100 MeV energy range, mainly due to the degradation of the angular resolution of e+e- pair telescopes at low energies: to a large extent, the sensitivity-gap problem is an angular-resolution issue. I will show that gas detectors such as TPCs (time projection chambers) can enable an improvement of up to one order of magnitude in the single-photon angular resolution (0.5 deg at 100 MeV) with respect to the Fermi-LAT (5 deg at 100 MeV), a factor of three better than what can be expected for Silicon detectors (1.0-1.5 deg at 100 MeV). With such a good angular resolution, and despite a lower sensitive mass, a TPC can close the sensitivity gap at the level of 10^{-6} MeV/(cm^2 s) between 3 and 300 MeV. In addition, the single-track angular resolution is so good that the linear polarisation fraction and angle of the incoming radiation can be measured. I will describe the fast-gas (low pile-up), cool-gas (low-diffusion), high pressure (0.5-4 bar) HARPO detector prototype and the results of its high-statistics characterisation in

the 1.7-74 MeV fully-polarised or non-polarised gamma-ray beam provided by the BL01 line at NewSUBARU. The excellent value of the polarisation asymmetry dilution factor that we measured paves the way to the opening of the polarimetry window in the MeV-GeV energy range. I will end this talk with the presentation of the balloon-flight prototype ST3G (Self-triggered TPC for Space gamma-ray Telescope, pronounced STEG) the design of which is in progress, and of its expected performance. The ion-recoil and optimal-tracking multiple-scattering contributions to the single photon angular resolution, the sensitivity calculations and the energy resolution studies are from [NIM A 701 (2013) 225]. The e+e- pair conversion event generator used is documented in [NIM A 729 (2013) 765] together with polarisation-asymmetry dilution studies in homogeneous detectors with optimal-tracking. See also [Astropart. Phys. 88 (2017) 30], focused on optimal methods in polarimetry and [Astropart. Phys. 88 (2017) 60], the characterization of several photon-conversion event generators. The HARPO prototype is described in [SPIE 9144 (2014) 91441M], the dedicated hybrid gas amplification system in [PoS(TIPP2014)133], the long-term gas quality assessment tests in [MPGD2015(EPJ Web of Conferences)], the beam-specific trigger system in [RT2016 (2016) IEEE-NPSS], the beam data taking in [PoS (ICRC2015) 1016] and the analysis software in [SPIE 9905 (2016) 99052R].

tba

Ian BROWNE (University of Manchester)

tba

X-ray properties of radio loud Sy1 AGN 3C111: detailed case-study

Elena FEDOROVA (Astronomical Observatory of NAtional Taras Shevchenko University of Kyiv)

E. Fedorova, B.I. Hnatyk, V.I. Zhdanov, A. Vasylenko

3C111 is broad line radio galaxy with signatures of FSRQ and Seyfert type disk corona in X-ray spectrum. We use all X-ray data publicly accessible in INTEGRAL, XMM-Newton, SWIFT and Suzaku database to recover contributions of thermal disk corona emission and nonthermal SSC quasar jet emission to the total X ray spectrum of 3C111. We show that each of these components is time-variable, that results in variability of equivalent width (EW) of Fe-Kα line (6.4 keV). Using all observational data available up-to-date, we have estimated the EWs of Fe-Kα line and total spectral fluxes of continuum emission near 6.4 keV for different observational periods. This allowed us to recover parameters of disk corona and jet spectra. Future investigations of polarization of 3C111 in IR-optical band, where synchrotron emission of jet dominates, are mandatory to better constrain parameters of SSC emission in 3C111 and to improve the disk corona model, including the spin of a central BH.

tba

Katie HESTERLY (The University of Manchester)

tba

Hydrodynamical Jet Simulations with Passive Magnetic Fields

Christopher KAYE (University of Central Lancashire)

The low fractional polarization in astrophysical jets suggests a largely disordered magnetic field. We are therefore developing numerical simulations of a hydrodynamic flow in which the jet polarization is generated entirely by the manipulation of an initially disordered 'frozen in' magnetic field as it is stretched and sheared by the flow. Here we present a progress report on this work.

What can we learn from radio jet polarisations of AGN

Xiang LIU (Xinjiang Astronomical Observatory, CAS)

Jun Liu, Xiaolong Yang, M. F. Aller, H.D. Aller

Radio jet polarisation properties of AGN are investigated from interferometry and flux monitoring observations.

The Jet Collimation Profile of 3C273

Colin LONSDALE (MIT Haystack Observatory)

Kazunori Akiyama, Vincent Fish (MIT Haystack Observatory), Keiichi Asada, Masa Nakamura (ASIAA), Hiroshi Nagai, Kazuhiro Hada (NAOJ)

The process of jet collimation in radio galaxies and quasars has been a topic of theoretical and observational study for decades, and the narrow opening angles of such jets frequently seen on large scales place severe constraints on mechanisms. Recent work has indicated that the Bondi radius at around $10^5 R_{\rm s}$ may be an important transition region beyond which active collimation gives way to a conical flow geometry consistent with an unconfined high Mach number flow. In this paper we discuss high resolution multi-wavelength VLBI imagery of the powerful quasar 3C273, yielding collimation profile data over ~ 2.5 decades of distance from the core, from $10^{4.5}$ to $10^7 R_{\rm s}$. The results are compared to similar data for the low-power radio galaxy M87, and are discussed in the context of different models for active collimation inside the Bondi radius.

From Supernovae, to Hypernovae to Binary Driven Hypernovae

REMO RUFFINI (ICRANET)

Our concept of Induced Gravitational Collapse (IGC paradigm) from an incipient Supernova into a companion Neutron Star, has unlocked the understanding of seven different families of GRBs, indicating the path for the formation of Black Holes in the Universe. An authentic laboratory of relativistic astrophysics has been unveiled in which new paradigms have been introduced in order to advance in the knowledge of the most energetic, distant and complex systems of our Universe. A novel paradigm of the Cosmic Matrix has been introduced which parallel, in a relativistic cosmic level, the concepts of an S Matrix introduced by Feynmann, Wheeler and Heisenberg in the quantum world of microphysics. Here the "in" states are represented by a Neutron Star and a Supernova, the "out" states, generated, in less then a second, by a new Neutron Star and a Black Hole. This novel field of research needs very powerful technological observations in all wavelength ranging from Radio, to Optical, to X and Gamma radiation all the way to ultra-high-energy cosmic rays.

The giant flares of the microquasar Cygnus X-3: X-rays states and jets

Sergei TRUSHKIN (Special Astrophysical Observatory RAS)

M. McCollough, N. Nizhelskij, P. Tsybulev

We report about the giant radio flares of X-ray binary Cyg X-3, consisted of a WR-star and probably a black hole. The recent flare occurred on 13 September 2016 after 2000 days from a previous giant flare in February 2011 as the RATAN-600 radio telescope daily monitoring showed. The flares are characterized by the increase of the fluxes in almost 2000 times ($\sim$from 10 to 20000 mJy) during 2-7 days, indicating relativistic bulk motions from the central regions of the accretion disk around a black hole. The flaring light curves and spectral evolution of the synchrotron radiation indicate a typical behaviour of the microquasars - formation of two relativistic collimated jets from the binaries. The flare from Cyg X-3 occurs only after a transition to 'hyper-soft' X-ray state, when the hard X-ray fluxes (Swift/BAT 15-50 keV data) fallen down to zero, the soft X-ray fluxes (MAXI 2-10 keV data) stayed high, and when later the binary comes back to a hard X-ray state. Just now (10-23 March 2017) Cyg X-3 entered in a 'hyper-soft' X-ray state and radio fluxes at 4-8 GHz are lower 30 mJy and we predict that a new flare will occur very soon. We discuss the properties of recent and probably new flares in March-April 2017) and the processes of jets formation in Cyg X-3 and in other microquasars.

Polarisation and spectral energy distribution in OJ 287 during the 2016 outbursts

Staszek ZOLA (Astronomical Observatory, Jagiellonian University)

Authors: M. Valtonen, S. Zola, S. Ciprini, H. Jermak, A. Gopakumar, L. Dey & Monitoring Team

After the General Relativity Centenary flare, which began on November 25, 2015, OJ 287 has stayed at 30 year record levels in optical brightness divided into two episodes in 2016. Here we report optical photometry and polarimetry showing its 2016 - 2017 behaviour. While the Centenary flare was limited only to the optical/UV region, and had a low level of polarization, the follow-up flares in 2016 had high polarization, and the outburst energy extends to X-rays with almost constant optical/X-ray spectral index of 2.7+/-0.1. This type of separation in the properties of the outbursts was predicted within the coalescing binary black hole model of OJ287. While the Centenary flare arises directly as the result of the impact of the secondary black hole onto the accretion disk of the primary, the follow-up flares occur in the jet of the primary. They are induced by transport of perturbations from the site of impact to the center of the accretion disk. The new observations allow the determination of the propagation speed. We also present the predictionÂă of the blazar brightness in the coming years.

OGLE Blazars behind the Large and Small Magellanic Clouds

Natalia ZYWUCKA-HEJZNER (Astronomical Observatory of Jagiellonian University)

Arti Goyal, Marek Jamrozy, Lukasz Stawarz, Michal Ostrowski, Szymon Kozlowski, Andrzej Udalski

We report blazar candidates behind the Large and Small Magellanic Clouds. Both Flat Spectrum Radio Quasar and BL Lacreate objects are selected based on long-term, multi-colour OGLE-III and OGLE-IV data. We cross-correlate the MQS optical catalogue (Kozlowski et al. 2013) with radio data at 6 frequencies from 0.8 to 20 GHz. We also analyze the radio polarimetric data obtained by ATCA array to check their fractional linear polarization and polarization angle, i.e. to make an additional assumption that the selected sources are blazars. Among the 1654 objects visible in optical range, we identify a sample of 44 blazar candidates, i.e. 27 flat spectrum radio quasars and 17 BL Lacertae. We examine selected objects with the respect to their radio, optical, and mid-infrared properties. Most of the selected sources are newly detected FSRQ and BL Lac blazar candidates.

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