Bonn-Dwingeloo Neighbourhood VLBI Meeting

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MPIfR

Book of Abstracts

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RoboPol: The optical polarization of gamma-loud and gamma-quiet blazars

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After a review of the robopol project and its main findings in the angle domain, we will present average R-band optopolarimetric data, as well as variability parameters, from the first and second RoboPol observing season. We investigate whether gamma-ray-loud and gamma-ray-quiet blazars exhibit systematic differences in their optical polarization proper- ties. We find that gamma-ray-loud blazars have a systematically higher polarization fraction (0.092) than gamma-ray-quiet blazars (0.031), with the hypothesis of the two samples being drawn from the same distribution of polarization fractions being rejected at the 3σ level. We have not found any evidence that this discrepancy is related to differences in the redshift distribution, rest-frame R-band luminosity density, or the source classification. The median polarization fraction versus synchrotron-peak-frequency plot shows an envelope implying that high-synchrotron-peaked sources have a smaller range of median polarization fractions con- centrated around lower values. Our gamma-ray-quiet sources show similar median polarization fractions although they are all low-synchrotron-peaked. We also find that the randomness of the polarization angle depends on the synchrotron peak frequency. For high-synchrotron-peaked sources, it tends to concentrate around preferred directions while for low-synchrotron-peaked sources, it is more variable and less likely to have a preferred direction. We propose a sce- nario which mediates efficient particle acceleration in shocks and increases the helical B-field component immediately downstream of the shock.

Session I / 13

VLBI and gamma-ray studies of radio galaxies

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The γ-ray sky is strongly dominated by blazars, i.e. AGN with relativistic jets oriented closely with our line of sight. Radio galaxies are their misaligned counterpart, and make up about $\sim$1-2% of all AGN observed by *Fermi*-LAT. Nonetheless, they provide us with a view of AGN jets which is less biased by Doppler boosting effects, and allow us to test jet production and emission models in light of the unified scheme of radio-loud AGN. The combination of γ-ray data and high-resolution VLBI studies is a powerful tool in order to investigate these objects. We present an ongoing study focused on the radio galaxies in the southern-hemisphere VLBI (and multi-wavelenght) monitoring program TANAMI. We combine VLBI kinematics at 8.4 GHz with γ-ray monitoring provided by *Fermi*-LAT. Here we present the results on the γ-ray detected sources (Pictor A, PKS 0521−36, PKS 0625−35, Centaurus B and PKS 1718−649).

Session III / 9

Kinematics and radio emission of the multiple stellar systems AB Dor and HD 160934

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Radio observations play an important role to understand the processes involved in the formation and evolution of stellar and substellar objects. In this context, we have made several contributions to binary stars belonging to the AB Doradus moving group, namely, AB Dor A/C (Guirado et al. 2006; 2011), AB Dor Ba/Bb (Azulay et al. 2015), and HD 160934 A/c (Azulay et al. 2014; 2017). In these cases, VLBI astrometric programs provided precise estimates of the dynamical mass of the individual components, providing relevant results in terms of calibration of the mass-luminosity relationship for young, low-mass objects. We intend to extend the study of these binaries with new observations at different frequencies directed to characterize the radio emission from each one of the components and to refine the determination of the orbital elements and dynamical masses.

Session II / 20

The jet collimation in Cygnus A

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The powerful radio galaxy Cygnus A is one of the very few targets where the jet acceleration and collimation region can be probed directly through VLBI imaging. Through a rich, multi-wavelength VLBI data set, we were able to reconstruct the two-sided collimation profile of the outflow, and to follow its evolution from scales of a few hundreds to millions Schwarzschild radii. Preliminary results suggest that important transitions occur over the examined scales. These are likely to mark changes in the physical conditions of the plasma or of the ambient medium.

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Low frequencies and interplanetary scintillation: Peaked-spectrum sources at high-redshift?

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Many active galactic nuclei (AGN) show a spectral peak in their radio spectra. Peaked-spectrum radio sources (including gigahertz-peaked spectrum and compact steep spectrum sources) are radio galaxies that often display small angular extents, suggesting that they are either very young AGN or are confined by a dense surrounding medium. We here present a spectacular sample of 1484 low-frequency peaked-spectrum sources derived from the Murchison Widefield Array's GLEAM survey; for 95% of this sample, the peaked spectral behaviour is newly identified. We will also discuss the use of interplanetary scintillation to constrain the arcsecond scale of many of these sources at 150 MHz, exploring the possibility that the combination of an observed MHz peak and small radio structure at 150 MHz are good identifiers to find radio sources at redshifts greater than 5.

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3mm GMVA observations of total and polarised emission from blazar and radio galaxy core regions.

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We present 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 μarcseconds, 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. We also compare two different methods used for the calibration of instrumental polarisation and we present the results applied to some of the sources in the analysed sample.

Session I / 15

Studies of circumstellar shells in AGB stars by mm-VLBI observations of maser emission

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VLBI observations of maser emission are a basic tool to study the circumstellar envelopes (CSEs) around evolved stars, mainly around AGB and post-AGB stars. The maser lines of water and silicon monoxide are particularly intense. They provide us with high spatial resolution data on the very inner CSEs around AGB stars, including the pulsating layers previous to grain formation and outer regions where the fast expansion characteristic of such envelopes is already present. The analysis of the pumping mechanism of SiO masers and of the physical conditions in the emitting clumps requires accurate maps of the various lines, which show different excitation requirements. We will discuss recent observations of SiO masers with the Global Millimeter VLBI Array (GMVA) which, when compared with the maps of other SiO lines, provide a new view into the physics of these AGB envelopes.

Session I / 18

A Global Millimeter VLBI Array Survey of Compact Extra Galactic Radio Sources at 86 GHz

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Very Long Baseline Interferometry (VLBI) Observations at 86 GHz reach a resolution of about 50 μas and sample the scales as small as 10^3–10^4 Schwarzschild radii of the central black hole in Active Galactic Nuclei (AGN), and uncover the jet regions where acceleration and collimation

of the relativistic flow takes place. Synchrotron radiation becomes optically thin at millimetre wavelengths; making it possible to look deeper into the core and inner jets of AGN which are invisible at centimetre and longer wavelengths due to self-absorption or free-free absorption by the torus. We present the results from a large global VLBI survey of 162 ultra compact radio sources at 86 GHz conducted in 2010 – 2011. This survey has contributed an increase of ~ 2 on the total number of AGNs imaged with VLBI at 86 GHz. The survey data attained a baseline sensitivity of 0.1 Jy and a typical image sensitivity of 5 mJy/beam.
We have used Gaussian model fitting to represent the structure of the observed sources and to estimate the flux densities and sizes of the core and jet components. The model fitting yields estimates of the brightness temperature ($T_{\rm b}$) of the VLBI bright core (base) of the jet and inner jet components of AGN, taking into account the resolution limits of the data at 3mm. We have applied a basic population model with a single value of intrinsic brightness temperature, T_0, in order to reproduce the observed distribution of $T_{\rm b}$. In this talk, the analysis and the results of the basic population model will be presented. We also present the brightness temperature limits made directly from the visibility data.

Session I / 23

Measuring Magnetic Fields from Water Masers in the Synchrotron Protostellar Jet in W3(H2O)

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We performed full polarimetric VLBA observations of water masers towards the Turner-Welch Object in the W3(OH) high-mass star forming complex. This object drives a synchrotron jet, which is quite exceptional for a high-mass protostar, and is associated with a strongly polarized water maser source, W3(H_2O), making it an optimal target to investigate the role of magnetic fields on the innermost scales of protostellar disk-jet systems. The linearly polarized emission from water masers provides clues on the orientation of the local magnetic field, while the measurement of the Zeeman splitting from circular polarization provides its strength. The water masers trace a bipolar, biconical outflow at the center of the synchrotron jet. Although on scales of a few thousand AU the magnetic field inferred from the masers is on average orientated along the flow axis, on smaller scales (10s to 100s of AU), we have revealed a misalignment between the magnetic field and the velocity vectors, which arises from the compression of the field component along the shock front. Our measurements support a scenario where the magnetic field would evolve from having a dominant component parallel to the outflow velocity in the pre-shock gas, with field strengths of the order of a few tens of mG (at densities of 10^7 cm^{-3}), to being mainly dominated by the perpendicular component of order of a few hundred of mG in the post-shock gas where the water masers are excited (at densities of 10^9 cm^{-3}). The general implication is that in the undisturbed (i.e. not-shocked) circumstellar gas, the flow velocities would follow closely the magnetic field lines, while in the gas shocked by the prostostellar jet the magnetic field would be re-configured to be parallel to the shock front.

Session II / 7

How to make fast radio bursts smile for the photograph

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Fast radio bursts (FRBs) are a new radio transient phenomena that puzzles scientists over their nature. These millisecond, Janksky bright single pulses are seen with dispersion measures (DMs) several times larger then those caused by the electron density in our own Milky Way and therefore thought to be of extra-galactic origin. Their non-repetitive behaviour (only one FRB has seen

to repeat thus far) and the majority being single-dish detections make it hard to pinpoint their exact location on the sky and deduce which sources produce them. Efforts by the MPIfR and Radboud University try to resolve this issue using the unique properties of LOFAR to catch and image the dispersion tail of the same FRB as detected in real-time with the Effelsberg Telescope. Detection of the same FRB is possible because of the large dispersive delay between the two observatories of several seconds to a few minutes. Once LOFAR receives a trigger from Effelsberg upon the detection of an FRB in the later, LOFAR's Transient Buffer Boards (TBBs) are frozen and read out to obtain low frequency, high time and frequency resolution data of the burst. Due to LOFAR's long baselines this data can then be used to image the detected FRB and localise it down to several arc-seconds. A multitude of so localised FRBs might shed some light on their progenitors and unravel their nature.

Session I / 5

Polarimetric Millimeter-VLBI Study of Radio Galaxy M87 and 3C84

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Understanding how mass accretion and jet formation occurs near the central engine of AGN has been one of major challenges in modern astrophyiscs. The apparent size of the jet forming region is desperately small even for an extraordinary massive BH system (10Rs=0.001pc for a BH mass of 10^9Msun), making a direct comparison of theories and observations difficult. Therefore, it is indispensable to image the vicinity of the SMBH and the accretion disk with ultra-high resolution VLBI technique. In this talk, I will present an observational study of the innermost region (7 - 100s of Rs) of nearby radio galaxies M87 and 3C 84. The data obtained by global VLBI observations at 86 GHz, with high-sensitivity stations such as the 100m GBT and the IRAM 30m being included, reveal several new features which were not seen by previous VLBI at lower-resolution and/or lower-frequency. Analysis and interpretation of the total intensity and linear polarization structures will be mainly presented.

Session III / 21

The peculiar light-curve of J1415+1320: Symmetric Achromatic Variability in Active Galaxies

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I will briefly discuss the interpretation of the peculiar light curve of J1415+1320, that shows time-symmetric and recurring U-shaped features across the cm-wave and mm-wave bands, which we call Symmetric Achromatic Variability (SAV). Although a common proposal to explain simmilar features in blazar radio light curves are Extreme Scattering Events (ESEs), this is shown to be not viable for this particular source. An alternative explanation involving lensing of the jet by mass condensates in the 10^3 to 10^6 solar mass scale is shown to be consistent with the observed light curves. The scales involved in the lens can be studied with GMVA observations, which will allow us to test this idea.

Session II / 19

The Africa Millimetre Telescope

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The Event Horizon Telescope (EHT) project aims to image the supermassive black holes in the center of our Galaxy (Sgr A*) and M87 at event horizon scales using very long baseline interferometry (VLBI) at (sub-)millimetre wavelengths. The EHT currently consists of a number of telescopes around the globe. A telescope in Africa will greatly improve the uv-coverage and the image quality. We propose to build a mm-wave radio telescope on the Gamsberg in Namibia. This location has many advantages: for example, the Galactic Center passes almost exactly overhead and there is mutual visibility on Sgr A* with the IRAM telescopes, SPT, LMT, and the ALMA. In this talk, I will give an overview and update on the current status of the project.

Session III / 17

Water masers and the death of stars

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Stars similar to our Sun undergo radical changes as their lives draw to an end. After swelling up to huge red giants, they start to pulsate, blowing off large clouds of gas and dust, to create intricately shaped and mesmerizing planetary nebulae. The remaining part of the star collapses under gravity, creating a compact white dwarf to slowly cool and fade away. One of the pivotal questions in this evolutionary scenario is how to explain the shapes of planetary nebulae, whose morphology depart significantly from spherical symmetry. Fortunately, we can use VLBI observations of water masers to get some insight into the last throes of dying stars by tracing their powerful molecular jets forming and shaping their environments. In my talk I will show results from such VLBI observations to get an idea on how stars like our Sun behave when they finally die.

Session III / 16

VLBI astrometry of nearby star-forming regions

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We use the VLBI technique to obtain precise astrometric measurements to several young stars in nearby star-forming regions belonging to the galactic structure known as the Gould's Belt. These measurements will allow us to investigate the structure of the clouds and their internal kinematics and eventually to characterize the overall dynamics of the Belt. I will present the current status of the project focusing on three regions for which accurate distances and proper motions have been collected: Ophiuchus, Serpens and Orion. In addition, I will discuss how the high angular resolutions achieved with this technique will allow us to characterize the population of young, very tight, binary and multiple systems. Our results will be relevant to test the astrometry quality of both VLBI and Gaia observations by considering objects that both instruments can detect.

Session II / 0

e-EVN follow-up of candidate electromagnetic counterparts to GW events

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We have established the Euro VLBI team to follow-up candidate electromagnetic counterparts to gravitational wave events with the EVN and e-MERLIN. The LIGO-VIRGO consortium and

partners inform each other through private circulars. The role of VLBI is on the one hand to help filter out some candidates like Galactic transients or variable AGN that are not true counterparts, and on the other hand measure or give upper limits to the proper motion or expansion speeds to likely extragalactic counterparts.

Session II / 4

Preparing a Proof-Of-Concept Observation with the Juelich Solar Power Tower

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SKA phase 2 sensitivity could be achieved at relatively low cost if we can piggyback a radio astronomy receiver on solar concentrators, of which four square kilometres are operating in the form of solar power towers. However the mirror arrays form a speckle pattern rather than a point focus, but we can restore full sensitivity in principle using a focal-plane array to collect the power from the many speckles and sum it coherently. That is, provided we can predict the speckle pattern from the array geometry sufficiently well. Certainly in simulations it works perfectly well. To test this in practice we are preparing a proof-of-concept experiment on the Juelich research SPT, for simplicity starting with a single-pixel receiver and with Effelsberg to serve as a phase-reference antenna for obtaining the speckle phases as well as amplitudes in a single-baseline VLBI experiment.
This talk will give background and simulation results and sketch our plans for the first observation.

Session I / 3

The parsec-scale distribution of atomic hydrogen in the radio galaxy 3C236

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The jets of powerful radio galaxies are known to play a vital role in regulating the gas distribution of the host galaxy. Evidence for this includes observations of fast outflows of neutral hydrogen gas detected in absorption in a number of radio galaxies, though these observations mostly lacked the resolution to pinpoint the location of the outflow with respect to the jet system. However, this can be achieved by Very Long Baseline Interferometry (VLBI) and it was demonstrated for the first time in 4C12.50. Based on this, we have been conducting a study to locate and characterise the outflow of neutral gas on parsec scales in a small sample of young and recently restarted radio galaxies. Here, we will present results from a global VLBI observation of the restarted giant radio galaxy 3C236 revealing a complex gas distribution and kinematic. The improved sensitivity and bandwidth compared to previous observations enable us to recover at least part of the outflowing gas over a broad velocity range of about 600km/s and to pinpoint its location to be within 40pc of the nuclear region. We also detect diffuse gas in the region of the counter-jet lobe that is not just related to the regular rotating disk. These clouds seem to trace the gas through which the jet is travelling, thus providing constrains on the physical conditions that could be important for theoretical models.

Session III / 2

AGN relics in MccD Abell cluster galaxies

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The high resolution and high sensitivity to diffuse emission at low radio frequencies make LOFAR a unique discovery instrument. I will outline how I use its potential to time the activity of AGN hosted by massive, multi-core galaxies found in nearby galaxy clusters.

Session II / 22

Latest developments with the Casa fringe-fitting task

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As a participant in the Black Hole Cam project, JIVE undertook to develop a fringe-fitting tool in the Casa dataprocessing package closely modeled on the AIPS FRING task. A Python prototype has been completed and is now in preliminary use by colleagues at Radboud University Nijmegen; the C++ code to apply the calibrations is now mature, and a first draft of a C++ implementation is now complete although many further features remain to be added.

Session II / 6

Tracing the fundamental jet properties in the gamma-ray active 2013+370 blazar

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Blazars, a subclass of AGN jets, show extreme flux variability across the electromagnetic spectrum from radio to gamma-rays. A challenge to theoretical interpretation is the rapid flux variability at GeV energies, which implies an origin from ultra-compact emission regions (< sub-pc). The exact location of the gamma-ray emitting region within the AGN is also controversially discussed. The prime objective of my project is, therefore, to identify such gamma-ray emitting regions and constrain their physical conditions using multi-epoch high-resolution VLBI imaging.
In this talk, I will present a case study of the gamma-ray flaring events which occurred in the compact blazar 2013+370 during 2002-2012. Preliminary analysis of gamma-ray light curves sampled by the Fermi space satellite and multi-epoch VLBI imaging from 15 to 86 GHz reveal the following: (a) the flaring events are clearly correlated with the jet kinematics on VLBI scales and (b) with the flux density of the VLBI core. A tentative interpretation of our results will be presented.

Session I / 1

Astrometric maser measurements compared with GAIA

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Using Very Long Base Interferometry (VLBI), the Bar and Spiral Legacy (BeSSeL) survey has provided distances and proper motions for maser-bearing young massive stars (Reid et al. 2009,2014), allowing an accurate measure of the spiral Galactic structure and kinematics. By the

same technique, we are planning to map the inner Galaxy and bulge using positions and velocities of SiO masers stars (Bulge Asymmetries and Dynamical Evolution - BAaDE survey: Sjouwerman et al. 2015) wich are expected to be associate with evolved, mass-loosing stars. These radio astrometric measurements (BeSSeL and BAaDE) will be complementary to Gaia results since, at optical wavelengths, the inner plane of the Galaxy will be obscured. The overlap between optical and radio surveys provides important clues on the intrinsic properties and population distribution of evolved stars. Moreover, using radio observations on different targets: young massive stars (BeSSeL) and AGB stars (BAaDE), we expect to make a fundamental comparison of Galactic parameters obtained with Gaia and VLBI.

Session II / **14**

Jet spectral properties from matched-resolution ground/space VLBI observations

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I will present new results on spectral index imaging of several AGN using multi-frequency space VLBI observations with RadioAstron, in combination with ground array images. I will introduce a GUI-based Python tool for spectral analysis of VLBI data, that was used to produce the results.

Session I / **11**

Welcome Address

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Welcome Address