12th EUROPEAN VLBI NETWORK SYMPOSIUM

and Users Meeting

Book of Abstracts

Hotel Regina Margherita, Cagliari

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Session 1 - Low luminosity AGN and starburst galaxies

Mar Mezcua – IAC
Revealing jet radio emission from intermediate-mass black holes **(Invited)**

Relativistic jets were first discovered in the nuclei of galaxies. The later finding of collimated jets arising from the compact counterpart of X-ray binaries suggested that jets should be present not only in supermassive and stellar-mass black holes (BHs), but also in intermediate-mass BHs (IMBHs). According to evolutionary models of BH growth, IMBHs are the initial seed of supermassive BHs, which subsequently grow either through hierarchical BH merging or gas accretion. IMBHs with masses up to 1000 Msun could be formed from very young and massive stars via super-Eddington accretion or from the core collapse of young and massive stars, while < 1E6 Msun BHs could result from the direct collapse of pre-galactic gas discs. These processes should have left a population of IMBHs in the haloes of galaxies, where the presence of wandering BHs is also expected after tidal stripping of merging satellite galaxies. The most probable IMBH candidates are the most extreme ultraluminous X-ray sources (ULXs), whose X-ray luminosities in excess of 5E40 erg/s can difficulty be explained by stellar evolution models or super-Eddington accretion. However, observational evidence of IMBHs and of their jet radio emission is scarce. I will review the few detected IMBHs with jet radio emission and present the results of an EVN program aimed at studying radio emission in ULXs and clarifying the nature of these sources. The radio observations reveal compact radio emission from two ULXs, which become potential IMBH candidates, as well as the first detection of possible steady jet emission from an IMBH. With a total size of ~650 pc, this source could be the largest non-nuclear extragalactic jet ever discovered.

Sandor Frey - FOMI Satellite Geodetic Observatory
Four hot DOGs eaten up with the EVN

Hot dust-obscured galaxies (hot DOGs) are a rare class of hyperluminous infrared galaxies recently identified with the Wide-field Infrared Survey Explorer (WISE) satellite. The majority of the ~1000-member all-sky population should be at high redshifts (z~2-3), at the peak of star formation in the history of the Universe. It seems that this class represents a short phase during galaxy merging and evolution, a transition from starburst-to AGN-dominated phases. Recently we observed four hot DOGs with known mJy-level radio emission using the e-EVN at 1.6 GHz, in a hope to find compact radio features characteristic to AGN activity. Here we report on the results and show that all four target sources are detected at ~15-30 mas angular resolution. The flux density of the VLBI-detected components is smaller in these sources than the total flux density, suggesting that a fraction of the radio emission may originate from larger-scale (e.g. starburst-related) activity. The source W1146+4129 is the most convincing case where the dominant source of radio emission is an active nucleus.

Francesca Panessa - IAPS-INAF
On the origin of radio emission in Radio-Quiet AGN and their connection to X-rays

The accretion-ejection mechanism acting in Active Galactic Nuclei(AGN) is one of the main astrophysical open issues,being connected to the role of AGN feedback in galaxy formation evolution studies. The X-ray emission in AGN, associated with the accretion flow, is strongly coupled with the radio emission, associated with a jet. Strong correlations between the radio and the X-ray luminosities are found both in radio-loud (RL) and in radio-quiet (RQ) AGN, despite the fact that in RQ AGN jets are often absent or very weak. For two well defined and complete samples of low and high luminosity AGN, we have investigated the origin of the radio emission. In particular, for the low luminosity AGN sample, I will present the results from the first census of VLBI sub-parsec cores of a complete sample of radio-quiet Seyfert galaxies. Eventually, the connection between the radio and the X-ray and hard X-ray emission will be discussed within the current accretion-ejection physical scenarios.

John McKean - ASTRON / University of Groningen
Testing galaxy formation at the highest angular resolution with gravitational lensing

The cold dark matter model for galaxy formation predicts that there should be a large abundance of satellite haloes found around galaxies like our own Milky Way. However, we find that the number of dwarf galaxies within the Local Group that are actually observed is an order of magnitude lower than is predicted by models for galaxy formation. This could be due to the satellites being purely dark (not luminous), the Milky Way being an odd case, or the model for dark matter being wrong. To test this, the SHARP collaboration uses high resolution imaging at infra-red and radio wavelengths to study the perturbing effect low mass dark matter dominated galaxies have on the images produced by a strong gravitational lens. In this talk, I will present the latest constraints on the dark matter halo mass function using the gravitational lensing technique. In particular, I will present new high resolution imaging of extended gravitational arcs with the global VLBI array at 1.7 GHz that probe substructures at the million solar mass limit, a regime where different models (cold and warm) diverge.

Megan Argo - JBCA / Manchester
Things that go bump in the night: the curious case of NGC660

NGC660 is a nearby (and particularly photogenic) example of a polar ring galaxy. Fairly unremarkable in the radio until a few years ago, a sudden increase in luminosity led to a flurry of observations with a variety of telescopes. I will present an overview of our recent observations carried out with WSRT, e-MERLIN and the EVN. We have used these observations to investigate the nature of the new radio source detected at the centre of the disk, plotting its SED at GHz frequencies, resolving its structure, and measuring the HI absorption seen along this new line of sight.

Rebeca Soria-Ruiz -- IGN Obsevatorio Astronómico Nacional
Reliable dense-gas tracers at high redshift: the case of CN in the z~4 quasar APM 08279

Molecular line emission from high-redshifted galaxies has been widely used for the study of galaxy formation and evolution. Although the emission is weak, it can be detected with large mm-wave interferometers. We report the first clear detection of CN(5-4) and CN(6-5) molecular lines in the extreme quasar APM 08279+5255 at z=3.9. Together with the previous detection of CN(4-3), we have been able to model the SED of CN through radiative transfer schemes. We have found that, contrary to the other known tracers of dense gas such as HCN, HNC or HCO+, the CN molecular lines are mostly free from IR pumping.

Franco Mantovani - MPIfR Bonn / INAF-IRA
EVN observations of weak blazars

Results from a survey of weak blazars made by the EVN at 5 GHz will be presented. The sample, which includes 87 sources, can be considered “complete”, therefore suitable for statistical studies. It was built extracting objects from the “Deep X-ray Radio Blazars Survey” (DXRBS) with Dec. > -10 deg as unique selection criteria. DXRBS is currently the faintest (down to 50 mJy) and largest blazars sample with radio spectral indices availability and nearly complete optical identifications including both Flat Spectrum Radio Quasars and BL Lac sources. The EVN observations allowed us to derive source parameters like structure, size, brightness temperature for each object, and their classification based on spectral index. Several DXRBS sources are associated with gamma-ray objects detected by Fermi LAT. A comparison between the results achieved observing bright blazars like in the MOJAVE programme and those achieved by EVN observations of the present sample of weak blazars is also made.

Magdalena Kunert-Bajraszewska - Torun Centre for Astronomy
Broad absorption line (BAL) quasars as a class of low luminosity AGNs

Outflows are one of the most common astrophysical processes in the Universe. This extremely fast (reaching 0.3c) outflows of highly ionized plasma which are lunched in proximity of Supermassive Black Hole are responsible for blue-shifted Broad Absorption Lines - BALs in QSO spectrum. They have been under scrutiny for over 20 years. Together with powerful jets they are phenomena which account for mass transfer from accretion disk. Therefore, understanding physics behind BAL outflows might be a key to comprehend Galaxy Evolution as a whole. There are two scenario which attempt to explain BALQSO. According to the first one outflows manifest as BAL in spectrum only if seen under specific inclination - “Orientation scenario”. Latter one suggest that BALQSO are connected with particular stage in quasar evolution - “Evolutionary scenario”. Discovery of the existence of radio-loud BAL quasars gave us another opportunity to study the BAL phenomenon, this time on the ground on radio emission. The radio emission is additional tool to understand their orientation and age by the VLBI imaging (detection of radio jets and their direction, size determination), the radio-loudness parameter distribution and variability study. Our high resolution VLBA and EVN observations of a sample of compact BAL quasars revealed they posses one-sided, core-jet structures typical for quasars, but their radio jets are not prominent. They belong to the high luminosity tail of the radio power distribution of BAL quasars and the brightness temperatures of their central components indicate the AGN origin of their radio emission. However, most of the BAL quasars are intermediate or low radio objects with radio luminosities in the FR\,I – FR\,II transition region similar to low power compact steep spectrum (CSS) and gigahertz peaked spectrum (GPS) sources. There is a hint in our analysis that the strongest absorption is associated with the lower jet powers in BAL quasars. The radio-to-optical (i-band) ratio of quasar core – radio-loudness parameter logR - analysis shows that most of the BALQSOs have logR< 1.5. The radio-loudness parameter is thought to be a good indicator of the orientation and their low values indicate large viewing angles. What is more these lower values of logR are associated with the strongest absorption. However, the large span of the absorption values in the whole group of BALQSOs indicates that orientation is only one of the factors that influence the value of measured absorption. Rather than separately, BALQSO phenomenon can be explained as hybrid scenario of orientation and evolutionary schemes.

Naím Ramírez-Olivencia - IAA - CSIC
EVN imaging of the LIRGI sample

We present milliarcsecond angular resolution radio observations of 22 of the most Ultra/Luminous Infra -Red Galaxies (U/LIRGs) in the local universe (Log(L_ir/L_sol) >= 11.4), obtained with the European VLBI Network (EVN) at the wavelengths of 6 and 18 cm. We aim at studying in spatial detail (~few parsec) the central few hundred pc of these sources, and more specifically at tackling the following relevant questions: 1) Discern whether the dust in the central kpc is heated by a starburst or by an AGN, or both, 2) Unveil the dust-obscured core-collapse supernova population, and 3) study the relation between the supernova remnant luminosity function and the SFR.

Rob Beswick - JBCA
LeMMINGs e-MERLIN survey of nearby galaxies

The e-MERLIN legacy project will survey 300 galaxies in the local Universe at sub-arcsecond resolutions and microJy sensitivities to study star-formation and accretion processes. In this talk we will present early results from this survey, including deep observations of the nearby starburst galaxy M82 and selected other early targets from this survey.

Tom Muxlow - Jodrell Bank Centre for Astrophysics
The e-MERGE Galaxy Evolution Survey

The e-MERLIN Galaxy Evolution Survey (e -MERGE) is an ambitious multi-tiered legacy survey to exploit the unique combination of very high sensitivity and spatial resolution to study the formation and evolution of star-forming galaxies and AGN out to redshifts of z > 5. These observations will provide a powerful, obscuration-independent tool for measuring the massive star formation and AGN activity in high-redshift galaxies, hence tracing the development of the stellar populations and the black hole growth in the first massive galaxies. With a resolution of 50-200 mas in C- and L-Bands, corresponding to < 0.5-1.5kpc at z > 1, e-MERLIN gives us our first truly reliable view of the distribution of star-formation within typical galaxies at the epoch where the bulk of the stars in the present-day Universe were being formed. In a previous study (Muxlow et al, 2005 it was shown that high angular resolution imaging of the distant radio source population with MERLIN is able to separate radio emission from AGN and star-forming regions. Thus in the deep e-MERGE Tier 1 observations of a 30 arcminute field centred on GOODS-N, combination EVN+e-MERLIN+JVLA imaging will disentangle the relative contributions of AGN and star-formation - an essential step given the apparently simultaneous growth of the black holes and stellar populations in galaxies. With the central region of the Tier 1 field ultimately reaching sub-uJy noise levels, e-MERGE will image several thousand star-forming galaxies, and statistically characterize the nature of the sub-μJy radio population - which are the target objects for the SKA. Initial results from e-MERLIN, JVA, and EVN on the e-MERGE Tier 1 region are presented here.

SESSION 2: Powerful AGN, jets and gamma-ray emission

Monica Orienti - INAF-IRA
Radioemission of relativistic jets and gamma-ray connection **(Invited)**

Relativistic jets are one of the most powerful manifestations of the release of energy produced around supermassive black holes at the centre of active galactic nuclei (AGN).
Their emission is observed across the entire electromagnetic spectrum, from the radio band to gamma rays. Despite decades of efforts, many aspects of the physics of relativistic jets remain elusive. In particular, the location and the mechanisms responsible for the high-energy emission and the connection of the variability at different wavelengths are among the greatest challenges in the study of AGN. Recent high resolution radio observations of flaring objects locate the high energy emitting region downstream the jet at parsec scale distance from the central engine. Furthermore, monitoring campaigns of the most active blazars indicate that not all the high energy flares have the same characteristics in the various energy bands, even from the same source, making the interpretation of the mechanism responsible for the high-energy emission not trivial.
In this talk I will discuss recent results obtained by multiwavelength campaigns of blazars and the implication for the physics of relativistic jets, particularly focusing on the role played by high resolution polarimetric observations.

Thomas P. Krichbaum et al. - Max Planck Institute fuer Radioastronomie
Millimeter VLBI observations: Black Hole Physics and the Origin of Jets

VLBI observations at the highest possible frequency penetrate the opacity barrier in the nuclear regions of radio-galaxies and blazars, which are synchrotron self-absorbed at longer wavelength. This facilitates a direct and sharper than ever view into the 'heart' of Active Galactic Nuclei (AGN), into region in which BH physics and general relativity

become important and radio jets are launched. Here we report on new results from global 1.3mm VLBI observations adding the APEX and IRAM to the Event Horizon Telescope. The present status of mm-VLBI and its future are presented and discussed.

Marcello Giroletti - INAF-IRA
An EVN survey of hard spectrum gamma ray sources

The First Fermi-LAT Catalog of Sources above 10 GeV (1FHL) is an ideal sample to characterize the properties of the most extreme gamma-ray sources in the Universe. It is wide, deep, and unbiased, being selected from an all-sky survey. We present 1.6 GHz European VLBI Network (EVN) observations of the sky regions of the 71 1FHL sources in the northern sky without any existing VLBI observation, classified partly as blazars and partly unidentified. The VLBI observations help to confirm and characterize the proposed blazars (typically of the enigmatic class with high frequency synchrotron peak), and to find high confidence counterparts for the unidentified sources. We also explore the presence of a flux- flux correlation between radio and E>10 GeV gamma-rays: such correlation was found to be very significant for blazars detected at E<10 GeV but it is entirely elusive for TeV sources; our data fill the gap between these two conflicting extremes.

Venkatessh Ramakrishnan - Aalto University Metsähovi Radio Observatory
Connection between parsec-scale radio jet and gamma-ray flares in the blazar 1156+295

We present results from an analysis of the connection of gamma-ray events to the ejection of superluminal components and other structural changes in the jet of 1156+295. The blazar 1156+295 was active at gamma-ray energies, exhibiting three prominent flares during the year 2010 as detected by Fermi/LAT. We study the kinematics of the jet over the interval 2007.0-2012.5 using the 43 GHz Very Long Baseline Array observations, which reveal the presence of four moving and one stationary component in the inner region of the blazar jet. The propagation of the third and fourth components in the jet corresponds closely in time to the active phase of the source in gamma rays. Through cross-correlation of the 43 GHz radio core and the gamma-ray light curve, and, also the causality of the component interaction to the gamma-ray sub -flare, we were able to constrain the gamma-ray emitting region in the parsec-scale radio jet.

Biagina Boccardi - MPIfR
High resolution mm-VLBI imaging of Cygnus A

The prototypical radio galaxy Cygnus A is an ideal target for high resolution VLBI studies aimed at a deeper understanding of the mechanism of launching and acceleration of relativistic jets. The jet´s orientation close to the sky plane facilitates the study of the underlying plasma flow, almost free from relativistic boosting effects. Due to its relatively close proximity (z=0.056, 1 mas=1.07 pc), CygA can be imaged with mm-VLBI on scales down to ~ 200 Schwarzschild radii, providing an extremely sharp view towards the central engine and the jets´ base, and the possibility of transversally resolving both jet and counter-jet, in order to study their collimation profile and transverse stratification. Results from a kinematic and ridge line analysis of Global VLBI data at 43 and 86 GHz, complemented by 15 GHz data from the MOJAVE survey, will be shown.

Anne-Kathrin Baczko Dr. Remeis Observatory/ECAP/Univ. Würzburg **-**
VLBI Observations of NGC1052

Because of its distance of only about 20Mpc and the orientation of its twin-jet system near the plane of the sky, the active galaxy NGC 1052 is the ideal target for mm-VLBI studies of jet formation on the smallest accessible scales. At cm wavelengths, NGC 1052 is well known for its prominent emission gap between the two jets due to free-free absorption in a circumnuclear torus obscuring the central engine. Our mm-VLBI observations at 43 GHz and 86 GHz peer through the absorber and reveal one strong central feature with a high brightness temperature of Tb > 2 × 10^11 K, well above the equipartition limit. Interpreting this as blended emission from the bases of both jets, their separation can be constrained to less than about 0.0014 pc or 90 Schwarzschild radii. We present results from four years of mm-VLBI monitoring observations, studying the variability and the symmetry of the twin-jet production.

Kazuhiro Hada - IRA/NAOJ
Continuing EVN monitoring of HST-1 in the jet of M87

The relativistic jet in M87 offers a unique opportunity for understanding the detailed jet structure and emission processes due to its proximity. In particular, the peculiar jet region HST-1 at ~1" (~80pc, projected) from the nucleus has attracted a great deal of interest in the last decade because of its superluminal motion and broadband radio-to-X-ray outbursts, which may be further connected to the gamma-ray productions up to TeV energies. Over the last five years,

we have been doing an intensive monitoring of HST-1 with EVN at 5GHz in order to examine the detailed structural evolution and its possible connection to high-energy activities. As reported in Giroletti et al. 2012 and the last EVN symposium, this program yielded the interesting results in terms of the HST-1's detailed mas-scale structure, proper motion measurements and structural variations near in time with some TeV gamma-ray events. While the 5GHz campaign has been successful, the recent HST-1 brightness is decreasing. To counter this and further continue our monitoring, we have shifted to 1.7GHz from the recent session in October 2013. This strategy successfully recovered the fainter emission that was missed in the last 5GHz session. Moreover, we again discovered the sudden emergence of a new component at the upstream edge of HST-1. These results demonstrate that the use of EVN 1.7GHz is indeed powerful to probe the current weak, extended nature of HST-1. In this talk we will report results from the 1.7G monitoring as well as further progress on the long-term kinematic study.

Tuomas Savolainen - MPIfR Bonn
Imaging nearby AGN at ultra high resolution with RadioAstron

The space-VLBI program RadioAstron offers an opportunity to study the nuclear structure in nearby radio galaxies with a spatial resolution of only a few to a few hundreds of Schwarzschild radii and to probe the region of jet acceleration and collimation. The Nearby AGN key science program has carried out RadioAstron perigee imaging of three bright nearby radio galaxies - M87, Centaurus A and 3C84 - at 18, 6, and 1.3 cm during the AO-1 period in 2013-2014. In the cases of M87 and 3C84, the observations were supported by a global VLBI array of over thirty ground telescopes - including EVN. We will report on the first results from the project. These include a detection of 3C84 on baseline lengths up to 6.9 Earth diameters at 6 cm, and the first RadioAstron space-VLBI image of 3C84.

Yuri Kovalev - Astro Space Center of Lebedev Physical Institute
AGN cores at extreme angular resolutions

The RadioAstron Space VLBI mission utilizes the 10-m radio telescope on board the dedicated Spektr-R spacecraft to observe cosmic radio sources with an unprecedented angular resolution at 92, 18, 6 and 1.3 cm. The longest baseline of the space-ground interferometer is about 350,000 km. The AGN survey is performed at the three highest frequencies and has already found detections of about 80 AGNs at projected spacings until 27 Earth diameters. Formal resolution as high as 14.5 microarcsec has been achieved for an AGN observed at 22 GHz. Current status and results of the RadioAstron AGN survey program will be summarized, including measurements of very high brightness temperatures in AGN cores and implications of these findings.

Gabriele Giovannini - Dip. di Fisica e Astronomia / INAF-IRA
The nuclear structure of 3C84 with space VLBI (RadioAstron) observations

I will present and discuss a study on the sub-pc scale radio structure of the radio galaxy 3C84, based on space VLBI observations obtained with Radioastron. I will compare these data with results obtained with VLBA at 15 and 43 GHz and with a long time monitor at high frequency with the VERA array. I will discuss the jet limb-brightening structure and restarted activity associated with a 2005 outburst.

Jose L. Gomez - Instituto de Astrofisica de Andalucìa (CSIC), Spain
Probing the innermost regions of AGN jets and their magnetic fields with RadioAstron

How relativistic jets are launched and collimated, and what are the sites and mechanisms for the high-energy (X and gamma-rays) emission are probably some of the most important questions related to AGN jet physics. The space VLBI program RadioAstron provides the first full-polarization observations of AGN jets on baselines longer than one Earth diameter, yielding the highest angular resolution measurements of magnetic field properties in the vicinity of the central black hole to date. First results from our RadioAstron Key Science Project (KSP) "Probing the innermost regions of AGN jets and their magnetic fields" will be presented. These include successful polarization observations of BL Lac at 18 and 1.3 cm with ground-space baseline detections up to 6 Earth diameters, revealing the innermost magnetic field structure with an angular resolution of 33 microarcseconds, the highest achieved to date.

Kirill Sokolovsky - ASC Lebedev / SAI MSU
RadioAstron dual-band Space-VLBI observations of 3C 418 and TXS 2013+370

We report on Space-VLBI observations of two radio-loud quasars: 3C 418 and 2013+370 conducted with RadioAstron. The sensitive European VLBI network complemented by Robledo 70m, Evpatoria 70m, and Usuda 64m telescopes is used together with the 10m space radio telescope to observe the sources simultaneously at 4.8 and 22 GHz. Both 3C 418 and TXS 2013+370 are resolved at 4.8 GHz down to the level of tens of mJy. Cores of both sources are scatter-broadened at 4.8 GHz. The measured 22 GHz core brightness temperatures of >10^12 K for the two sources are higher

than typical values found with ground-based VLBI. The values are consistent with Doppler-boosted incoherent synchrotron radiation where the Doppler boosting factor is estimated from ground-based VLBI observations of moving jet features. Spectral properties of the jets are also discussed.

Cornelia Mueller - University of Wuerzburg, Dr. Remeis Observatory & ECAP
TANAMI monitoring of Centaurus A: The complex dynamics in the inner parsec of an extragalactic jet

Centaurus A is the closest radio-loud active galaxy. Very Long Baseline Interferometry (VLBI) enables us to study the jet-counterjet system on unprecedented small linear scales, providing essential high-resolution data on jet emission and propagation within the inner parsec of an AGN jet. I will present the results of a kinematic study performed within the framework of the AGN monitoring program TANAMI. Over 3.5 years, the evolution of the central-parsec jet structure of Cen A was monitored with VLBI. These observations reveal complex jet dynamics which are well explained by a spine-sheath structure supported by the downstream acceleration occurring where the jet becomes optically thin. Both moving and stationary jet features are tracked. A persistent local minimum in surface brightness suggests the presence of an obstacle interrupting the jet flow, which can be explained by the interaction of the jet with a star at a distance of 0.4pc from the central black hole.

Agudo Ivan - JIVE
Signs of internal rotation and helical magnetic field in the inner jet of NRAO 150

NRAO 150 is a powerful radio-millimeter quasar for which ultra-high-resolution VLBI monitoring has revealed an extreme counter-clockwise position-angle swing in the inner jet. This phenomenon, known as jet wobbling, is found in an increasing number of blazars. In this talk we will present the results from new multi-epoch, multi -frequency polarimetric VLBI observations of the source from 8 to 86 GHz, as well as the preliminary results from a new high-precision astrometric program with the Global array at 43 GHz. The highest frequency data show clear signs of helical magnetic fields in the inner regions of the jet. Moreover, our latest kinematic results allow us to propose, for the first time, a new scenario based on the internal rotation of the emission features around the jet axis, which is compatible with current jet-formation models.

Rocco Lico - Università di Bologna e IRA/INAF
Very Long Baseline Polarimetry and the Gamma-ray connection in Markarian 421 during the broadband campaign in 2011

In this talk we focus on the evolution and the connection between the high angular resolution polarization structure, magnetic field topology, total intensity light curve, and the gamma-ray flux and photon index. We present the analysis of data in polarized intensity obtained with the Very Long Baseline Array (VLBA) at twelve epochs (one observation per month from January to December 2011) at 15, 24 and 43 GHz. For the absolute orientation of the electric vector position angles we use the D-terms method and we also confirm its accuracy. We also make use of gamma-ray data from the Fermi Large Area Telescope on weekly time bins throughout the year 2011. The source shows polarized emission, and its properties vary with time, frequency, and location along the jet. The core mean polarization fraction is generally between 1% and 2%, with a 4% peak at 43 GHz in March; the polarization angle is variable, mainly at 15 GHz where it flips frequently and less at 43 GHz where it oscillates in the range 114−173 deg. The jet polarization properties are more stable, with a fractional polarization around 8% and a polarization angle nearly perpendicular to the jet axis. The gamma-ray light curve shows variability,with a main peak at the beginning of March and two later peaks centered around September 8 and November 13, respectively. The first gamma-ray peak appears to be associated with the peak in the 43 GHz core polarized emission, as well as with the total intensity light curve. By means of the discrete correlation function analysis, we obtain a correlation coefficient of 0.54, for a zero delay with a significance level > 99.7%. With the present multi-frequency study, we accurately determine the polarization properties of Mrk 421, both in the core and in the jet region. We find a good correlation between the radio and gamma -ray light curves. The observed EVPA flips, at 15 GHz, and the low degree of polarization in the core region point out to the presence of a blend of multiple cross-polarized sub-components, with different polarization properties, within the beam. This scenario is supported by the rotation measure values, that show a variable behavior with time.

Florent Mertens - Max Planck Institute for Radio Astronomy
Longitudinal and transverse velocity fields in parsec-scale jets

Radio -loud AGN typically manifest powerful relativistic jets extending up to millions of light years and often showing superluminal motions organised in a complex kinematic pattern. A number of physical models are still competing to explain the jet structure and kinematics revealed by radio images using the VLBI technique. Robust measurements of longitudinal and transverse velocity field in the jets would provide crucial information for these models. This is a difficult task, particularly for transversely resolved jets in objects like 3C273 and M87. To address this task, we have developed a new technique for identifying significant structural patterns (SSP) of smooth, transversely resolved flows

and obtaining a velocity field from cross-correlation of these regions in multi-epoch observations. Detection of individual SSP is performed using the wavelet decomposition and multiscale segmentation of the observed structure. The cross-correlation algorithm combines structural information on different scales of the wavelet decomposition, providing a robust and reliable identification of related SSP in multi -epoch images. The algorithm enables recovering structural evolution on scales down to 0.25 FWHM of the image PSF. We present here the results from application of this algorithm to obtaining the first detailed transverse velocity fields and studying the kinematic evolution in the parsec-scale jets in 3C273 and M87.

Talvikki Hovatta - Aalto University Metsahovi Radio Observatory
S*pectral Index Distributions of Parsec-Scale AGN jets*

We have obtained spectral index distributions for a sample of 190 parsec-scale jets through the Monitoring of Jets in Active Galactic Nuclei with the VLBA Experiments (MOJAVE) project. The large sample of jets allowed us to study the statistical properties of a population of blazars and obtain typical values for the core and jet spectral indices. We found that the core spectral indices were on average flat with a mean spectral index of +0.22, while the jet spectra were in general steep with a mean value of -1.04. However, we found that the jet spectral distributions of quasars and BL Lac objects are significantly different, with quasars having steeper spectra (mean of -1.09 compared to mean of -0.85 for BL Lacs). In both types of objects the jet spectra also flattened at the locations of jet components, indicating on-going particle acceleration or density enhancements. Furthermore, we found a trend that jet components that had linear polarization parallel to the jet have flatter spectra, as expected for transverse shocks. There were more such components in BL Lacs, which may explain the generally flatter spectra observed in them. Overall the jet spectra steepen as a function of distance from the core, which can be explained with radiative losses or with the evolution of the high-energy cutoff in the electron spectrum.

Jeffrey Hodgson - Max Planck Institute fuer Radioastronomie
5 year Global 3-mm VLBI survey of Gamma-ray active blazars

With 6-monthly global 3-mm observations, we can determine the time varying nature of a significant sample of blazars above the opacity limit for synchrotron self-absorbed radiation and at resolutions exceeding 50 uas. With such high resolutions, we can study the origin of jets at a spatial level not available with other methods. Using concurrent 7 mm monthly monitoring and Fermi/LAT Gamma-ray data, we can help determine the location of the Gamma-ray emission and derive estimates of the magnetic field. For example, in the prominent blazar OJ287, we have found evidence of an optically thin spectrum in the VLBI `core' during a component ejection, allowing magnetic field estimates to be derived. Additionally, the non-stationary nature of the `core' is considered very likely, leading to the conclusion that Gamma-rays likely come from the `core' region which is itself likely to be parsecs away from the central engine. If the `core' and downstream stationary features are taken to be recollimation shocks, we propose a new model for the phenomenon of `jet-wobbling'.

Andy Biggs - ESO
Mapping HI absorption at z=0.026 against a resolved background CSO

Observing atomic hydrogen in absorption is an extremely powerful probe of galaxies at all redshifts: the detection sensitivity is not dependent on many of the properties of the system under study, but rather depends on the unrelated characteristics of the background source. The HI hyperfine 21-cm line enables a determination of the kinematics and gas distribution in the intervening absorbers and presents several advantages over Ly-alpha as it does not saturate and is unaffected by dust. One application is the study of small-scale structure in the ISM of external galaxies as, if the background radio source is resolved into several components, different independent sight lines through the absorbing gas layer can be studied. Here we present global VLBI observations of J0855+5751, a Jy-strength Compact Symmetric Object against which HI absorption at a redshift of 0.026 was previously discovered using observations with the Green Bank Telescope. The combination of high angular resolution and sensitivity has allowed us to map the HI absorption across the lobes and to probe the spatial distribution of cold gas in the foreground galaxy on scales ranging from 3 to 30 pc.

Paola Castangia et al. - INAF-OA Cagliari
VLBI observations of the water megamaser in the nucleus of the Compton-thick AGN IRAS15480-0344

As part of a search for water maser emission in a complete sample of Compton-thick AGN, we detected bright H2O maser features in the FIR-bright Seyfert2 galaxy IRAS15480-0344. The maser spectrum shows two main features: a broad weaker blueshifted (w.r.t. the systemic velocity of the galaxy) component with a full width at half maximum (FWHM) linewidth of about 90 km/s, and an extremely bright narrow line feature at the systemic velocity. VLBI (VLBA and EVN) observations have been obtained to image both the line and continuum emission from the innermost regions of the galaxy. In this talk, I will report the results from these very high angular resolution observations, and

their positive contribution to unveil the nature of the megamaser associated with a nuclear jet/outflow, a particularly vigorous star formation activity in the proximity of the galactic nucleus, or an accretion disk around the central supermassive black hole.

SESSION 3: Technological issues and new developments

Michael Lindqvist - Onsala Space Observatory
Present status and technical directions of the EVN **(Invited)**

The EVN is a collaboration of major institutes in Europe, Asia, South Africa and the Americas and performs high angular resolution observations of cosmic radio sources. It has evolved significantly during recent years. We will describe the present status of the array and outline some of the planned future technical directions.

Gino Tuccari et al. - IRA-INAF
DBBC3 Development

The Radionet3 JRA project named 'DBBC3' is progressing as formally planned. The first units of the 4 GHz bandwidth samplers are available as well as the Core3 processing elements. The first functional mode for both of them has been successfully tested and the construction of two further DBBC3 units is under way. The main parts of the system are shown together with their performance, and an overview of the implementation is presented for data-rates of 32 and 64 Gbps with two examples of their application: a) astronomical for EVN and for the millimeter VLBI network with the EHT (Event Horizon Telescope), and b) geodetic for the VGOS broadband network. The latest measurements and progress will be shown.

Cristina Garcia-Miro - Madrid Deep Space Communication Complex NASA
The X/Ka Celestial Reference Frame

An X/Ka-band (8.4/32 GHz) celestial reference frame has been constructed using single baselines from the combined NASA and ESA Deep Space Networks for approximately 100 sessions each of ~24-hour duration. The frame solution has dramatically improved with respect to the last reported frame due to the inclusion of Southern NASA-ESA baselines, 2 Gbps (nowadays routinely) digital VLBI terminal operations and correction of instrumental delays by recently installed Ka-band phase calibration tones. Comparisons with the S/X-band (2.3/8.4 GHz) ICRF2 reference frame will be presented showing increasing agreement for overlapping defining sources, over 25 of them located at the south polar cap, accessible for first time by our VLBI network. There is still evidence for systematic errors at the 100 uas level, the known sources of error will be discussed. A Gaia frame tie has been studied using existing X/Ka data and simulated Gaia data which predict a frame tie precision of +-7 uas (1-sigma, per 3-D rotation component). Compared to X-band, Ka-band allows access to more compact source morphology and reduced core shift which should reduce systematic errors in the proposed frame tie.

Ivan Marti-Vidal - Onsala Space Observatory
Solving the polarization problem in ALMA-VLBI observations

The ALMA Phasing Project (APP) will allow us to use ALMA as one VLBI station. This will be a key component of the Event Horizon Telescope (EHT), formed by the most sensitive mm VLBI antennas in the World. A problem in the APP is the polarization calibration and conversion. The circular basis is used in VLBI, but ALMA observes in a linear basis. The strategy that will be followed in the phased-ALMA VLBI observations is to correlate in a "mixed" basis (i.e., linear-to-circular) and convert the visibilities to pure circular basis after correlation. This approach minimizes hardware implementation and we can optimize the conversion by using special calibration matrices in the frame of the Measurement Equation. We have developed an algorithm to perform the polarization conversion in the APP. The results of this algorithm, applied to realistic simulations, will be presented. Results of a polarization test between Onsala (linear basis recording) and Effelsberg (circular basis recording) at 86GHz will also be presented. Tests with real ALMA data will be performed soon.

Leonid Petrov - ADNET Systems Inc.
Modeling of propagation in the neutral atmosphere for radio astronomy data analysis: a paradigm shift

Computation of propagation effects in the neutral atmosphere, namely path delay, extinction, and bending angle is a trivial task provided the 4D state of the atmosphere is known. Unfortunately, the mixing ratio of water vapor is highly variable and it cannot be deduced from surface measurements. That fact led to a paradigm that considers path delay and extinction in the atmosphere a priori unknown quantities that have to be evaluated from the radio astronomy data themselves. Development on our ability to model the atmosphere and to digest humongous outputs of these models that

took place over the course of the 21st century changed the game. Using the publicly a available output of operational numerical weather model GEOS run by NASA we are in a position to compute path delay through the neutral atmosphere for any station and for any epoch from 1979 through now with accuracy of 50 ps * cosec elevation. We are in a position to compute extinction with accuracy of several pro cents. We are in a position to do it routinely, in a similar way how we update apparent star positions for precession and nutation. Moreover, we are in a position to do it now. As a demonstration of current capabilities, I have computed time series of path delays for radiotelecopes that I was aware of (220 sites)since 1979 with a step 3-6 hours. Results of validation tests are presented. A new paradigm of data analysis assumes that we know the atmosphere propagation effects a priori with the accuracy higher that one could deduce them from radio astronomy observations. Implications of the new paradigm are discussed.

Uwe Bach - MPIfR, Bonn
Out of focus holography at Effelsberg

Traditional holography methods require beam maps with very high signal to noise ratios that are usually only provide by terrestrial transmitters or the beacon signals from geostationary satellites. Over the years several holography measurements using geostationary satellites were done at Effelsberg. Therewith the surface rms of the main reflector was reduced to only 0.55mm at an elevation of 32deg, which is the elevation of the satellite. In 2007 B. Nikolic et al. published a method to obtain low- resolution maps of the wavefront-errors in an antenna surface using astronomical sources and detectors. The technique requires several out-of-focus images of a compact source at a good signal to noise ratio. The aperture is then parametrized by Zernike polynomials that describe different modes of surface errors. The obvious advantage is that this technique can be applied over a wide range of elevations. Motivate by this study, the OOF technique was successfully tested at the 100m Effelsberg telescope using a multi-horn receiver at 32 GHz. Here I would like to report on the implementation of the OOF at Effelsberg and the observations, data reduction and analysis of the OOF maps. Several test were made where known errors were introduced into the active surface to prove the OOF method. The final aim is to further improve the correction table that is used for the active surface of the Effelsberg sub-reflector and therewith reduce the elevation dependent gain loss.

Presentations on the SRT at Is Alinos

Andrea Possenti (INAF-OAC)
Astronomy at the Observatory of Cagliari

Founded in 1899 as an International Latitude Station, the INAF-Astronomical Observatory of Cagliari is now one of the major players in the italian radio-astronomical context. While keeping its role of scientific and cultural reference for the whole island, it also represents one of the fulcrums of the development of innovative technologies in Sardinia. The talk will present a short summary of the current activities and future projects at the Observatory of Cagliari.

Nichi D'Amico (Univ. Cagliari/INAF-OAC)
SRT: Present status and prospects

We review the most relevant milestones of the Sardinia Radio Telescope construction. We discuss the present operational status, the present logistics and organization, and the timeline foreseen for the complete commissioning of the technological infrastructures. The Operation Plan of the facility is presented and analised.

Isabella Prandoni (INAF-IRA)
The SRT: Astronomical Validation & Scientific Perspectives

At one year from the opening of the SRT, post-commissioning activities are now in a very advanced status. The integration and optimization of the telescope sub-systems (fine-tuning) is almost completed, and the astronomical validation is well under way. I will present the current status of the ongoing activities, aimed at transforming a powerful technological instrument into a real radio-astronomical facility, as well as a brief overview of the scientific areas where we expect the SRT can have a major impact. Particular emphasis will be given to the work done to test and validate the use of the SRT as part of VLBI networks.

SESSION 4: Star Formation

Luca Moscadelli - Osservatorio Astrofisico di Arcetri
*High-Mass Star Formation and Maser VLBI (***Invited)**

The main kinematic features of low-mass Star Formation (SF) -- observable in different tracers from radio to optical wavelengths -- are mass accretion onto the protostar through a Keplerian disk and ejection of material via a jet collimated along the disk axis. Scaling the SF models from the low-mass to the high-mass case is questionable, since massive (M > 8 M_sun) Young Stellar Objects (YSOs) emit intense and energetic radiation, which, ionizing and pushing against the infalling material, could drive gas motions substantially different from those characteristic in low-mass protostars. This talk concisely reviews the main contribution of VLBI maser observations to investigate high-mass SF. Accurate distances of many high-mass star forming regions have been recently derived via measurements of maser trigonometric parallaxes. VLBI of the intense 6.7 GHz methanol and 22 GHz water masers are unique tools to infer the 3-D gas kinematics in proximity to (at distances of hundreds AU from) the high-mass YSOs, tracing rotation and infall, and also revealing the detailed structure of the outflows. Maser polarization measurements allow us to determine the magnetic field configuration in the region of jet acceleration and collimation, where the maser observations can be usefully compared with the model predictions of magnetocentrifugally driven jets. In sinergy with recently upgraded interferometers (JVLA, e-MERLIN), as well as with ALMA at higher frequencies, maser VLBI can play a fundamental role to address the many, still open problems of high-mass SF.

Anita Richards - JBCA / Uni. Manchester
Sub-mm maser VLBI: how do stellar winds break free from the star's gravity?

Sub-mm VLBI with ALMA will be a superb tool for imaging masers, as well as its capabilities as the "Event Horizon Telescope". Individual masing clouds will be resolved in multiple velocity channels, providing both beamed and unbeamed sizes. The relationship between beaming and intensity can then be used to distinguish between steady or turbulent and shocked outflows. Sub-au resolution will also confirm which transitions are cospatial or segregated, compared with maser models predicting the required small-scale variations in density, temperature, velocity structure and radiation field. This will be aided further by micro-arcsec cm-wave maser results which are already starting to appear from Radio Astron. ALMA alone will resolve the overall structure and differing extents of the various maser species, along with thermal lines, dust and continuum. Commissioning data and a Cycle 2 filler program, using few-km baselines will reach 50-100 mas resolution around the water maser lines in the 450 and 850 micron bands, predicted to occur both inside and outside the dust formation zone. This will also locate the maser shells with respect to dust clumps and the star itself. Such studies are vital to understanding how material ejected from cool stars breaks free from the stellar gravity, and the role of dust in this.

Kee-Tae Kim - Korea Astronomy & Space Science Institute
KVN Observations of Class I Methanol Masers

Methanol masers are divided into two classes, class I and class II. Class II methanol masers trace the disk-outflow systems of massive young stellar objects (YSOs), while class I methanol masers appear to trace the interaction regions of outflows with the ambient molecular gas. Class II masers have been extensively studied by single dishes, connected arrays, and VLBIs. Meanwhile, class I masers have been much less studied. They have not been detected by any VLBI facility. Thus they have been believed to have more extended structures than class II masers. We made fringe surveys of 44GHz class I methanol maser emission towards more than 150 massive YSOs with flux densities >10 Jy using the Korean VLBI Network (KVN), and detected fringes in ~15% of the sources. We performed follow- up imaging observations of the detected maser sources with KVN and KVN+VERA. The observations aim to investigate the distribution and kinematics of 44GHz methanol maser features in each source at milli-arcsecond resolutions, and to understand what they trace. In this talk we will present the fringe survey and imaging results, and discuss the implications.

Anna Bartkiewicz - Torun Centre for Astronomy
The methanol maser ring G23.657-0.127 after 9 years

We report preliminary results of proper motion studies of the methanol maser ring G23.657-0.127 observed using EVN 9 years after its discovery. What do data indicate: rotation or expansion?

Ciriaco Goddi - JIVE
3D Gas Dynamics from Methanol Masers observed with the EVN reveals Rotating Disks around O-type Young Stars

NGC7538 IRS1 is considered the best high-mass accretion disk candidate around an O-type young star in the northern hemisphere. We investigated the 3D kinematics and dynamics of circumstellar gas with very high linear resolution,

from tens to 1500 AU, with the ultimate goal of building a comprehensive dynamical model for this YSO. We employed four different observing epochs of EVN data at 6.7 GHz, spanning almost eight years, which enabled us to measure, besides line-of-sight (l.o.s.) velocities and positions, also l.o.s. accelerations and proper motions of methanol masers. In addition, we imaged with the JVLA-B array highly-excited ammonia inversion lines, from (J,K)=(6,6) to (14,14), which enabled us to probe the hottest molecular gas very close to the exciting source(s). We found five 6.7 GHz maser clusters which are distributed over a region extended N-S across ~1500 AU and are associated with three peaks of the radio continuum. We proposed that these maser clusters identify three individual high-mass YSOs, named IRS1a, IRS1b, and IRS1c. We modeled the maser clusters in IRS1a and IRS1b in terms of edge-on disks in centrifugal equilibrium, demonstrating quasi-Keplerian rotation around IRS1a, a high -mass YSO of up to 25 solar masses. In summary, we present compelling evidence that NGC7538 IRS1 is not forming just one single high-mass YSO, but consists of a multiple system of high-mass YSOs, which are surrounded by accretion disks.

Gabriele Surcis - JIVE
Magnetic field measurements at milliarcsecond resolution around massive young stellar objects.

Magnetic fields have only recently been included in theoretical simulations of high-mass star formation. The simulations shows that magnetic fields play a crucial role not only in the formation and dynamics of molecular outflows but also in the evolution of circumstellar disks. Therefore, providing new measurements of magnetic fields at milliarcsecond resolution close to massive young stellar objects are fundamental for providing new input for numerical simulations and for understanding the formation process of massive stars. The polarized emission of 6.7 GHz methanol masers allow us to investigate the magnetic field close to the young stellar object where the outflows and disks are formed. In the recent past we have detected with the EVN the methanol maser polarized emission towards 10 massive star-forming regions. From a first statistical analysis we have found evidence that magnetic fields around young stellar objects are primarily oriented along the molecular outflows. This is supported by a Kolmogorov- Smirnov test that shows a probability of P_K-S=10% that our distribution of angles (e.g., the difference between the projected angles of magnetic fields and of outflow axes) is drawn from a random distribution. To improve our statistics and to decrease the K-S probability below 1% we are carrying on a large observational EVN campaign for a total of 19 sources and 133 observational hours. During my talk I will show both the results of the first 7 sources and the updated statistical results. Furthermore, I will also discuss the implications that the recent modelled Lande' g-factors of the methanol maser transitions have on our Zeeman-splitting measurements.

Jeoung Sook Kim - NAOJ
Transition in the Outflow Evoution of the Massive Star-forming Region W75N

One of the unsolved problems in astrophysics is how massive stars form. In the early stage of stellar evolution, the maser phenomena are caused by the interaction of outflows or jets with interstellar medium. W75N is one of the representative massive star forming region and very bright H2O maser source at 22 GHz. Although they share the same environment in W75N, VLA1 and VLA2 have been detected with different H2O maser features in 1999 and 2005 VLBA observations: jet-like and wind-like outflows, respectively. In 2007 VERA observation, we found that the outflow of VLA2 has a transition from wind-like to jet like outflow. The result has been confirmed by further VLBI observations of Surcis et al. (2014). We show the acceleration of the outflow as a result of the transition. Previously, such transition and acceleration have never been explicitly observed. Our result is consistent with a recent MHD simulation of Seifried et al. (2012). I will discuss the 2007 VERA result together with recent observations, and future plan to trace the outflow evolution of VLA 2 in W75N.

SESSION 5: Current & future facilities and international collaborations

Phil Diamond – SKA Organisation
SKA in the VLBI context **(Invited)**

Jonas Trüstedt - Universität Würzburg
Blazars at Low Radio Frequencies

We explore the low radio -frequency properties of the MOJAVE1 blazar sample using the LOFAR Multi-Frequency Snapshot Sky Survey (MSSS). We compare the 120-160MHz MSSS flux densities to simultaneously measured single dish and VLBA 15GHz flux densities from the OVRO and MOJAVE programs and to historical 151MHz measurements. We find the characteristically flat blazar spectrum to extend down to the LOFAR bands, demonstrating that the emission at these low radio frequencies is still dominated by relativistically beamed emission. Sources found by LOFAR in higher states than the historical average level tend to show steeper radio spectra than sources in low states suggesting substantial low-frequency variability. As most sources remain unresolved at the MSSS angular resolution, we are currently reimaging these data using baselines beyond the standard MSSS uv-range. This results in

an angular resolution of ~10arcsec. We present first LOFAR-MOJAVE images from this project. Deeper follow-up LOFAR observations with further improved angular resolution from the inclusion of international baselines can probe the unbeamed lobe contribution. This allows for tests of the AGN unification model and serves as a proxy of kinetic jet power and thus the power emerging from the central engine of powerful blazars into their environment.

Do-Young Byun - Korea Astronomy and Space Science Institute
Recent Activities of KVN

KVN (Korea VLBI Network) is a dedicated mm-VLBI array composed of three 21 -m antennas in Korea. It has a unique capability to observe 22, 43, 86 and 129GHz bands simultaneously. It is now almost full operation phase. About 3000 hours were used for VLBI observations during recent one year period and one third of them were used for joint operation with VERA (VLBI Exploration of Radio Astronomy) of Japan. KVN and VERA Array, called KaVA, has good uv-coverage combining short (300-500km) baselines from KVN and long (1000-2300 km) baselines from VERA. KaVA began to produce early science results using its good imaging capability. We introduce recent activities and plans of KVN and KaVA.

Matteo Stagni - IRA
Towards the Italian VLBI network: first tests and perspectives

Since the adoption and deployment in 2012 of the DiFX software correlation facility in Bologna we have gained momentum thanks to the inclusion of the Sardinia Radio Telescope. The four Italian antennas, Medicina, Noto, Matera and SRT have all taken part in VLBI tests that involved numerous brand new hardware and software solutions coupled with a high speed network infrastructure. The talk will describe the technical difficulties and first results that are paving the path towards an Italian very long baseline interferometry instrument.

SESSION 6: Astrometry and planetary science

Maria Rioja - ICRAR
Astrometry and new methods made possible by the new generation instruments **(Invited)**

I will provide a review of astrometry with a particular focus on the new possibilities opened by the next generation of instruments. The capabilities for simultaneous multi-frequency observations at high frequencies, and for multiple beams at low frequencies, provide exciting opportunities for new research based on high precision astrometry

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Nobuyuki Sakai - NAOJ / Univ. of Tokyo
Direct comparison between VERA, VLBA and EVN astrometry results and an analytic gas dynamics model

The Perseus arm, the nearest main arm from the Sun, has been studied with multi-wavelength observations and numerical simulations. It has been revealed that the Perseus arm has an effect on gas kinematics known as the streaming motion (i.e., systematic peculiar motion), although direct comparisons between the observations and simulations have been limited due to technical issues (e.g., insufficient spatial resolution). Aims. We aim to model the peculiar motion, and to derive physical parameters of the Perseus arm. Using the parameters, we discuss the role of the main arm in the Milky Way Galaxy. Methods. We directly compare VLBI astrometry results of the Perseus arm, including accurate three-dimensional position and velocity information, with the analytic gas dynamics model proposed by Pinl-Ferrer et al. (2012). Results. We succeeded to explain the VLBI results with seven model parameters. The model shows offset between gas dense regions and bottom of the asymmetric potential (i.e., spiral arm). Also, the model parameters, the pattern speed of the Perseus arm and number of spiral arms, derive a period of spiral arm passages to be 120 +/- 20 Myr. The period is consistent with that of the ice age epochs, ~140 Myr in Gies & Helsel (2005), within error. Conclusion. Astrometry results can be used to judge previous theoretical works explaining nature of the spiral arm (e.g., density-wave theory, recurrent and transient spiral, etc.). The offset predicted from our model can be confirmed by stellar astrometry (e.g., Gaia astrometry). A combination of gas and stellar astrometry results would drastically change our understanding of the spiral arm in the near future.

Marcin Gawronski - Torun
Project RISARD - the story so far

In 2011 we have started new astrometric survey of active red dwarfs with the EVN at 6cm. The main goal of this project is to detect an exoplanet by direct, precise measurements of a red dwarf position and possible changes to this position caused by the planet. We will summarise current status of our survey, present first results and discuss the influence of flux variability on the astrometry precision in the case of VLBI observations. We will also show that it may be possible to obtain radio images of the gas giants/brown dwarfs using EVN.

Guifre Molera Calves - JIVE
Scintillation of Venus and Mars Express radio signal on interplanetary and ionosphere plasma

Observations of spacecraft radio signals within the solar system give a unique opportunity to study the temporal and spatial behaviour of the signal's phase fluctuations caused by its propagation through the interplanetary plasma and the Earth's ionosphere. The phase scintillation of the telemetry signal of the European Space Agency's (ESA) Venus Express spacecraft was observed at X-band with a number of radio telescopes of the European VLBI Network (EVN) in the period 2008-14. It was found that the phase scintillation spectra follow a Kolmogorov distribution with nearly constant spectral index of -2.42 for a full range of Venus orbital phases, from superior to inferior conjunctions and back. The scintillation index and Doppler noise along the orbit from superior conjunction to the greatest elongation is dominated by the solar wind plasma. Here, I will present the latest results of these observation, while approaching the inferior conjunction, where the Earth ionosphere starts to dominate. Empirical coefficients for both contributions were estimated. Furthermore, other spacecraft related VLBI projects will be presented as well, such as: study of the gravity field of Phobos with Mars Express fly-by, radio occultation experiments of Venus Express or probing solar wind turbulence using intensity and phase scintillation analysis. A combined effort between LOFAR and VLBI observations.

Jun Yang - Onsala Space Observatory, Sweden
VLBI detection of the internal shocks in nova V959 Mon

Nova V959 Mon is a classical nova firstly found in Gama-ray in 2012. With rapid e-EVN and VLBA observations of the nova at the earlier stage of its outburst, we detected a few compact features in nova V959 Mon. Together with the structure evolution observed by JVLA and e-MERLIN, we think that these VLBI features represent the internal shocks formed by the fast outflow of the white dwarf interacting with the slower-expanding dense ejecta mainly along the equatorial plane of the binary system.

SESSION 7: Supernovae and late stages of stellar evolution

Michael Bietenholz - HartRAO
VLBI of Supernovae and Gamma-Ray Burst **(Invited)**

I will discuss VLBI observations of supernovae and GRBs, including recent results for SN 1996cr, SN 2003gk, and SN 2011dh and others. Such observations allow us to place a direct observational constraint on the size of the emission region, and thus of the forward shock, and in a few well-resolved cases like SN 2011dh, on the morphology. Most resolved supernovae seem to have shell structure indicating interaction of the ejecta with the circumstellar medium. VLBI imaging of SNe and GRBs can provide constraints on relativistic ejecta, which are important in discussions concerning the relationship between SNe Ic and Gamma-ray bursts. VLBI observations can also provide a crucial diagnostic as to whether late-time radio emission from a supernova is due to the orphan afterglow of a (mis-aligned) GRB event, or to circumstellar interaction. I discuss the limits placed on orphan afterglows by observations of SN 2003gk, and the future prospects for such observations.

Miguel Perez-Torres - IAA-CSIC
Constraints on the progenitor system and the environs of SN 2014J from deep EVN and MERLIN radio observations

We report deep EVN and eMERLIN observations of the Type Ia SN 2014J in the nearby galaxy M 82. Our observations represent, together with JVLA observations of SNe 2011fe and 2014J, the most sensitive radio studies of Type Ia SNe ever. By combining data and a proper modeling of the radio emission, we constrain the mass-loss rate from the progenitor system of SN 2014J to $\dot{M} \lesssim 7.0 \times 10^{-10} M_\odot yr^{-1}$ (3-σ; for a wind speed of 100 kms−1). If the medium around the supernova is uniform, then $n_{ISM} \lesssim 1.3 cm^3$ (3-σ), which is the most stringent limit for the (uniform) density around a Type Ia SN. Our deep upper limits favor a double-degenerate (DD) scenario--involving two WD stars--for the progenitor system of SN 2014J, as such systems have less circumstellar gas than our upper limits. By contrast, most single-degenerate (SD) scenarios, i.e., the wide family of progenitor systems where a red giant, main-sequence, or sub-giant star donates mass to a exploding WD, are ruled out by our observations. Our estimates on the limits to the gas density surrounding SN 2011fe, using the flux density limits from Chomiuk et al. (2012), agree well with their results. Although we discuss possibilities for a SD scenario to pass observational tests, as well as uncertainties in the modeling of the radio emission, the evidence from SNe 2011fe and 2014J points in the direction of a DD scenario for both.

SESSION 8: Milky Way

Mareki Honma (NAOJ)
Maser Astrometry with VLBI and Galactic Structure **(Invited)**

VLBI provides unprecedented accuracy in measuring positions of radio emitting stars, which makes VLBI a very powerful tool to explore the three-dimensional structure and dynamics of the Milky Way Galaxy through the parallax and proper motion measurements. In fact, to date the currently-existing VLBI arrays have already conducted astrometry for ~100 maser sources and provided valuable information on the Galactic structure, such as the size and rotation speed of the Galaxy, spiral structures and so on. In this talk, I would like to review the current status and recent achievements of the Galactic-scale astrometry with VLBI, particularly focusing on the most recent results obtained by VERA, VLBA/BeSSeL and EVN.

Rebecca Azulay - Universidad de Valencia / MPIfR
Binary stars in moving groups

We are going to present radio interferometric data of the binary systems HD 160934 and AB Doradus B, members of the AB Doradus moving group. We observed these targets with the EVN at 5GHz between 2012 and 2014 and with the LBA at 8.4GHz between 2007 and 2013, respectively. In both cases it was possible to detect, for the first time, radio emission of the two components of the binary. This has allowed us to measure the relative orbital motion and to estimate the orbital parameters and the masses of the objects. The study of these two binaries, along with other stars of the same association, will help to calibrate the pre-main sequence (PMS) stellar evolution models for low-mass stars, which is essential, because the contrast with empirical data reveals some discordances.

Benito Marcote - University of Barcelona
Discovering the colliding wind binary HD 93129A

HD93129A is a binary system including an O2 If+ primary and probably an O3.5 V-star orbiting at a distance of 140 AU (55 mas), which potentially makes the system the most massive one in the Galaxy, ahead of eta-Carina. Its non-thermal radio emission is proposed to be originated by the collision between the winds of both stars. We conducted an observation with the Australian Long Baseline Array (LBA) of HD 93129A at 2.3 GHz to resolve the radio source and its location within the stellar system. HST-FGS data were also reanalyzed to derive an accurate absolute position of the stars to compare them with the radio emission. The X-ray emission has also been explored with Chandra observations. The radio observation revealed a bow-shape extended emission located between both stars and slightly curved around the main component of the system. This result allows us to estimate the mass loss rates for the two stars in the system. The multiwavelength analysis points out that the detected radio emission is originated by one of the youngest and most massive collision wind binary (CWB) in the Galaxy, and represents the starting point for further studies of this specially interesting member of the still scarce population of CWB with resolved radio emission.

Danielle Fenech - University College London
Preliminary results the COBRaS e-MERLIN legacy project

The e-MERLIN Cyg OB2 Radio Survey (COBRaS) is legacy project designed to exploit e-MERLIN's enhanced capabilities to conduct uniquely probing, targeted deep-field mapping of the tremendously rich Cyg OB2 association in our Galaxy. The project aims to deliver the most detailed radio census for the most massive OB association in the northern hemisphere, offering direct comparison to not only massive clusters in general, but also young globular clusters and super star clusters. This project has been awarded ~300 hours of total observing time split between L and C bands. Observation of the ~42 hrs l-band allocation is now virtually complete and reduction is on-going. We will present the preliminary results from these l-band observations focussing on the well-known objects within the Cyg OB2 association.

Sandra Etoka - Hamburg Observatory
Phase-lag distance of OH83.4-0.9 from eMERLIN and NRT observations

OH/IR stars are AGB stars with an optically thick circumstellar envelope of dust and gas commonly exhibiting ground-state OH maser emission at 1612 MHz. With a typical extent of 10000 AU (corresponding to 1.25 arcsec at 8 kpc and 0.2 arcsec at 50 kpc) these objects can be used to determine distances throughout the Milky Way and potentially beyond as far as the LMC and SMC via the so-called "phase-lag method". This method combines the linear diameter of the circumstellar shell, obtained from a phase-lag measurement from the variability curves of back and front sides of the shell, with the shell angular diameter obtained from interferometry. We present here the preliminary results towards the phase-lag distance determination of OH83.4-0.9 from eMERLIN observations and a NRT (Nancay Radio Telescope) monitoring program.

Jean-Francois DESMURS - IGN-OAN
SiO masers from AGB stars in the vibrationally excited v=1,v=2, and v=3 states

The v=1 & v=2 J=1-0 (43 GHz), and v=1 J=2-1 (86 GHz) SiO masers are intense in AGB stars and have been mapped using VLBI showing ring-like distributions. Those of the v=1, v=2 J=1-0 masers are similar, but the spots are rarely coincident, while the v=1 J=2-1 maser arises from a well separated region farther out. The v=3 J=1-0 line is not directly affected by any line overlap and its spot structure and position, relative to the other lines, is a good test to the standard pumping models. We will present simultaneous VLBI and single dish observations of the v=1, v=2, and v=3 J=1-0 maser transitions of 28SiO in several AGB stars and compare them to model predictions.

Soon-Wook Kim - KASI
Flaring Episodes of Cyg X-3 with Korean and Japanese VLBI

Cyg X-3 is the brightest X-ray binary in the radio. Cyg X-3 displays restless flaring activity with associated relativistic jets, a representative black hole microquasar together with GRS 1915+105. We have studied Cyg X-3 with Korean and Japanese VLBI facilities, KVN and VERA, since 2007. In particular, we first catched an initial rise of the 2007 major flare during a state transition from ultrasoft to hard X-ray state (Kim et al. 2013 ApJ 772, 41). We present our recent results for observations of flaring episodes in Cyg X-3.

SESSION 9: Pulsars and transient objects

Maria Massi – MPIfR
Transient sources at the highest angular resolution (**Invited**)

A large number of transients can be followed-up by VLBI. First I will present an overview of radio transient sources then I will focus on transients in stellar binary systems.

Javier Moldon - ASTRON Netherlands Institute for Radio Astronomy
A pulsar wind nebula associated with PSR J2032+4127 as the powering source of TeV J2032+4130

The very-high-energy gamma-ray source TeV J2032+4130, in the Cygnus region, was the first source discovered of a population of extended TeV sources without low-frequency counterparts. In its field there is a pulsar, namely PSR J2032+4127, which has been detected by Fermi in gamma-rays and in radio by GBT. We report on the discovery of a new pulsar wind nebula associated with PSR J2032+4127 through radio and X -ray observations. Moreover, a multi-epoch VLBI campaign was conducted with the EVN in order to measure the pulsar proper motion and to find its relation with the radio nebula and the TeV extended source. All these results together, combined with a theoretical modelling of the system, enable us to propose a conceivable physical scenario in which the extended radio, X-ray and TeV emissions are accounted for.

Andrey Andrianov - Astro Space Center (ASC LPI)
Study of scattering material with RadioAstron-VLBI observations

The RadioAstron spacecraft provides a unique opportunity to measure properties of interstellar scattering. The fluctuations responsible for scattering of radio waves from astronomical sources are small-scale (~ 0.1 AU) fluctuations in the electron density of the interstellar medium. Pulsars offer a variety of observables for interstellar scattering. Observations of scattering of nearby pulsars and intra-day variable quasars point to the existence of a component of the interstellar medium (ISM) which has properties that are quite different from the more distant, diffuse ISM. We observed several nearby pulsars as a part of RadioAstron Early Science Program (ESP) and first year of Radioastron Key Science Program (KSP). These programs included pulsars B0950+08 and B1919+21. The results concerning the distribution and properties of scattering material in the direction to these pulsars obtained with cosmic interferometer are presented in this report.

Alexey Rudnitskiy - Astro Space Center (ASC LPI)
Preliminary results of giant pulse investigations from Crab pulsar with Radioastron.

Giant pulses from Crab pulsar were observed using Radioastron to study the scattering effects of the ISM. Four observations were done at 18 cm (EVN codes: EG060A, EG060B, EG067B, EG075) and one at 92 cm (EVN code: GS033A). According to the preliminary results obtained for 18 cm and 92 cm, estimations of the scattering disk angular size and scattering time were done. A significant change in the shape of cross-correlation functions for Earth-Radioastron baselines (starting from 4 up to 12 Earth diameters) is seen. The same feature was observed for PSR

0329+54, PSR 0833-45 (Vela). Radio emission can be strongly affected by the scattering of the ISM, while propagating from the source to the observer. In this report presented the estimations for basic parameters of the scattering conditions for the Crab pulsar, also estimations for the distance to the scattering screen. Certainly, it is required to obtain more statistics on giant pulses correlation at Earth-Radioastron baseline, especially at smaller baselines. Smaller baselines can give us the information of the transition point, where the shape of cross-correlation function of giant pulses change dramatically and at what baselines this happens.

Olaf Wucknitz - MPIfR Bonn
Scattering as a nuisance and as a tool

Temporal scatter-broadening can seriously affect our ability to find pulsars orbiting the central mass in our Galaxy. Many of these invaluable probes of geometry around the black hole are expected, but none have been found in close orbits so far, possibly as result of strong scattering. The magnetar discovered in 2013 at a separation of < 3 arcsec is not the optimal type of pulsar for GR studies, but it can be used to investigate the scattering properties so that search strategies can be adapted accordingly. I present an observation of this magnetar using short baselines between VLBI stations in Europe in a non-standard mode. The most important goal is determining the distance of the scattering screen, or the distribution of matter if not confined to one screen. In the second part of the talk I show first steps in using low-frequency VLBI with LOFAR, the GMRT and the Algonquin telescope to do "scintellometry", i.e. using the interstellar scattering speckles as elements of a huge natural interferometer.

Posters

Megan Argo - *Resolving the nature of compact ultra-steep spectrum sources*

Source with ultra-steep radio spectra (<-1.2) come in several flavours, some more well-studied than others. A group which have received little attention is those which are compact on arcsecond scales. Suggestions as to their nature include unidentified Galactic pulsars or active galaxies in the early universe. Using existing catalogues, we have created a sample of 73 such objects covering a large part of the northern sky. Here we will present the results of a mini -survey carried out with the EVN, and a recent e-MERLIN snapshot survey of a large part of the sample at 1.4GHz, looking for evidence of source structure at high resolution.

Uwe Bach - *10 Years of Multi-Frequency Monitoring of Blazars with Medicina and Noto*

Being dominated by non-thermal emission from aligned relativistic jets, blazars allow us to elucidate the physics of extragalactic jets, and, ultimately, how the energy is extracted from the central black hole in radio-loud AGN. Crucial information is provided by their spectral energy distribution (SED) from radio to gamma-rays, their trends with luminosity and correlated multi-frequency variability. Since December 2004 we perform a monthly multi-frequency radio monitoring of a sample of blazars at the antennas in Medicina and Noto. The lower frequencies of 5, 8, and 22 GHz are observed at Medicina and 43 GHz at Noto. We organise contemporaneous near-IR and optical observations for all our observing epochs which provides a valuable database of time dependent SEDs of our sample. Most sources show significant variability in all our observing bands, which allows detailed studies of multi-frequency correlations and time-lags between radio, near-IR and optical wavelengths. The detections of blazars by the ASI AGILE and the NASA FERMI GST gamma -ray satellites initiated intensive broad band campaigns. Here we would like to report on the progress of our monthly blazar monitoring during the last 10 years, show radio spectra and light curves and present some of the results on individual sources like BL Lac and 3C454.3.

Uwe Bach - *Probing high resolution spectroscopy with the Digital BBC VLBI-backend*

To perform spectroscopic observations the 100m Effelsberg antenna is equipped with a number of state of the art Fast Fourier Transform Spectrometer (FFTS). They are available in different configurations and provide between 32k and 64k channels over a band width range of 50 to 2500 MHz depending on the receiver and the required resolution for the observations. With the installation and commissioning of the new digital VLBI backends, like the dBBC, which record the data in base band, it became evident that with some software the DBBC could be used as spectrometers as well. The advantage of the transformation of the base band data in software is that the number of channels can be chosen freely and therewith observations with much higher spectral resolution are possible. In principle, also spectro-polarimetry should be possible by cross-correlation of two orthogonal polarizations. Here we would like to present the successful development of the software to read, process, and calibrate VLBI Mark5B format data from the DBBC and therewith produce calibrated astronomical spectra. We'll show first observations, discuss the advantages and downsides of the software correlation compare to the well established FFT spectrometers and give some outlook on possible implementations and further developments.

Gabriele Bruni - *Space-VLBI with RadioAstron: new correlator capabilities at MPIfR*

RadioAstron is a 10m space-based antenna, launched in 2011 by the Russian Astro Space Center. Observing time has been offered for the first time to the community in 2012, and it has now entered the second astronomical observations period (AO-2, July 2014 - July 2015). Since the beginning of the AO-1 observing period (July 2013), the Max-Planck Institute for Radio Astronomy (MPIfR) correlator is processing spacecraft data, correlating them with ground based antennas from all over the world, in the framework of the three Bonn-based AGN imaging Key Science Projects. A customized version of the DiFX has been developed at MPIfR, in order to handle the RadioAstron native data format, calculate the delay model for an orbiting antenna, and reconstruct the parallactic angle for polarisation studies. Moreover, a correlator upgrade in the near future will also sensibly improve the processing capabilities.

Maciej Ceglowski - *Orientation of the cores of hybrid morphology radio sources*

The FR I/FR II dichotomy is a much debated issue in the astrophysics of extragalactic radio sources. Study of the properties of HYbrid MOrphology Radio Sources (HYMORS) may bring crucial information and lead to a step forward in understanding the origin of FR I/FR II dichotomy. HYMORS are a rare class of double-lobed radio sources where each of the two lobes clearly exhibits a different FR morphology. We describe the follow-up high resolution VLBA observations of the five discovered by us HYMORS. The main aim of the observations was to answer the questions whether the unusual radio morphology is connected to the orientation of objects towards the observer. We obtained the high resolution radio maps of five hybrid radio morphology objects with the VLBA at C-band and L-band. The cores of all five sources have been detected at both radio bands. Two of them revealed milliarcsecond core-jet structures, the next two objects showes hints of parsec-scale jets, and the last one remained point-like at both frequencies. We find that on both scales the fluxes of their central components are similar, which may indicate the lack of additional emission in the proximity of the nucleus. This suggests that jets present on the ~1 − 10 kpc scale in those objects are FR II-like. Detected core-jet structures were used for estimating the core's spatial orientation. The result is that neither the FR I-like

nor the FR II-like side is preferred, which may suggest that no specific spatial orientation of HYMORS is required to explain their radio morphology. Their estimated viewing angles indicate they are unbeamed objects. The 178/151 MHz luminosity of observed HYMORS exceed the traditional FR I/FR II break luminosity, indicating they have radio powers similar to FR II

Hikaru Chida - *Probing Very Early Stage of Radio Source Evolution in NGC 1275 with VERA*

The jet activity in the nearby radio galaxy NGC 1275 (3C 84, Per A, z=0.0176) has been reactivated very recently. On parsec scales, a new radio component associated with the re-occurrence was identified at the south of the core with VLBI Exploration of Radio Astrometry (VERA) in 2007 (Nagai et al. 2010), and Very Long Baseline Array (VLBA) observations with higher angular resolution also revealed that this component already emerged in 2002 (Suzuki et al. 2012). This new component is ideally suited for studying the physical properties of young radio sources at very early stage of its evolution to radio source. Using VERA at 22 GHz, we have continuously observed NGC 1275 in the monitoring program of gamma-ray emitting notable-AGN monitoring by Japanese VLBI (GENJI: Nagai et al. 2013). Our observations revealed following proprieties of the new component; (1) it moved to the south with a velocity of ~0.2c, (2) its radio flux increases steadily, and (3) its size increased until 2008 and has been stable since 2009. We will discuss similarities of the observational results and numerical simulations at the early stage of the radio lobe evolution.

Se-Hyung Cho - *Observational Studies of Evolved Stars Using the KVN*

Using the KVN (Korean VLBI Network) four receiving bands of 22, 43, 86, and 129 GHz, we have performed simultaneous observations of H2O and SiO maser lines in order to investigate spatial structure and dynamical effect from SiO to 22 GHz H2O maser regions in AGB stars and characteristics of both maser emission at the evolutionary process from AGB to post-AGB stars.

Richard Dodson - *Non-integer Spectral line Source Frequency Phase Referencing*

Working at the KVN we have been using its capacity for simultaneous multi-frequency VLBI observations. The KVN is a beautiful instrument that provides a perfect test bed for the Source/Frequency Phase Referencing (SFPR) method. SFPR is slowly becoming a well established analytical approach. However our initial formulation insisted on integer ratios between the frequencies, which places great limitations on the general application. For example many interesting spectral line pairs would not possible, eg Water and SiO masers. We have now developed a reduction method which, with care, allows one to retain the astrometric registration of such observations. I will report on the successful registration of a SFPR experiment at 22/43GHz on the water and SiO masers of R LMin.

Dmitry Duev - *Testing the Orbit Determination Accuracy of RadioAstron Using Doppler and VLBI Measurements*

Accurate knowledge of RadioAstron's state vector is of paramount importance for successful space VLBI observations. We put under test the orbital solution obtained by using a new sophisticated dynamical model of RadioAstron motion developed at the Keldysh Institute for Applied Mathematics (Moscow, Russia). We present the analysis of the Doppler measurements of RadioAstron's downlink signal and correlation of VLBI observations made by RadioAstron itself with the ground-based telescope data, performed in order to demonstrate the quality of the improved solution.

Sandra Etoka - *MERLIN and eMERLIN OH maser observations toward the star forming region complex W49A*

We present the preliminary results from OH 18-cm ground state observations carried out with MERLIN and e-MERLIN towards the star forming region (SFR) complex W49 A. There are three active SFRs in this complex; W49 North (W49 N), W49 South West (W49 SW) and W49 South (W49 S). The first epoch of observations was obtained in 2005 with MERLIN while the second epoch was obtained in 2013 with the e-MERLIN upgraded system. Overall, both epochs show good agreement with the previous observations from Argon et al. (2000) carried out with the Very Large Array (VLA). Due to a better sensitivity and a wider velocity coverage, we also found new maser sites towards W49 N and W49 SW, particularly spread out towards W49 N.

Sandor Frey - *J1026+2542: proper motion in a blazar jet at z=5.27*

The radio-loud AGN J1026+2542 has recently been classified as the second most distant blazar, based on its broad-band spectral energy distribution and X-ray spectrum. The source with a prominent one-sided jet extending to at least ~20 mas was earlier observed with the VLBA at 5 GHz in January 2006. With our new EVN observation (May 2013), we detected the displacement and directly measured the apparent proper motion of the jet components - for the first time at such a high redshift. The 1.6-GHz observation provided additional information on the extent and the spectral properties of the jet. The VLBI results are consistent with the picture in which J1026+2542 has its jet oriented close to the line of sight, with significant Doppler boosting and a large bulk Lorentz factor.

Yoshitaka Fujinaga - *The survey for new AGN candidates within the field of Fermi unassociated gamma-ray sources*

We report on the results of survey for new gamma-ray AGN candidates by using Japanese VLBI Network. Aims of the survey are 1) verification of Blazar Sequence with taking account of faint blazars and 2)

discovery of new types of AGN with gamma-ray emission. To achieve our purpose, we observed all NVSS and FIRST sources located within the positional uncertainty of unassociated gamma-ray sources listed in Fermi/LAT 2nd catalog. As a result of our JVN observation of 845 radio sources, we detected 29 VLBI sources. In our poster, we will show not only the results of estimations of types of these sources but also several correlation diagrams of them.

Krisztina Gabanyi - *e-MERLIN observation of the puzzling TeV source HESS J1943+213*

HESS J1943+213, a TeV point source close to the Galactic plane discovered by the H.E.S.S. Collaboration in 2011, was proposed to be an extreme BL Lacertae object. Our exploratory e-EVN observation at 1.6 GHz revealed a low brightness temperature point source, with flux density one-third of the archival large -scale VLA observations. Additionally, archival HI observations showed that the source is located in the interior of a ring-like feature of a diameter of 1 degree. Based upon these results, we proposed that the source might be of Galactic origin, a pulsar wind nebula. However our recent dual-frequency e-MERLIN observations (at 1.6, and 5 GHz) failed to reveal any large-scale radio-emitting feature around the source. The recovered flux density is comparable to the one observed by EVN, thus still significant flux density is resolved out compared to the VLA-scale image.

Krisztina Gabanyi - *Investigating dual AGN candidates with VLBI*

In hierarchical structure formation models, interactions and mergers between galaxies play an important role in their evolution and consequently in the growth of their central supermassive black holes (SMBH). Thus, it is expected that a particular phase in the merging process, namely systems with dual SMBHs exist in the Universe. In such systems one or both of the SMBHs may be active; some studies show that merging process may initiate activity, thus dual active galactic nuclei (AGNs) are expected to be observed. I will summarize the results of a few VLBI projects targeting dual AGN candidates. While the high angular resolution provided by VLBI is helpful, there is currently no efficient selection method to find dual AGN candidates with kpc-scale separation.

Cristina Garcia-Miro - *The X/Ka-band (8.4/32 GHz) Celestial Reference Frame: Results from combined NASA-ESA baselines including Malargüe, Argentina*

An X/Ka-band (8.4/32 GHz) celestial reference frame has been constructed using a combined NASA and ESA Deep Space Network. Observations at X/Ka-band are motivated by their ability to access more compact source morphology and reduced core shift relative to observations at the historically standard S/X-band. In approximately 100 observing sessions we detected more than 600 sources covering the full 24 hours of right ascension and the full range of declinations. The collaboration between NASA and ESA's deep space antenna in Malargüe, Argentina was created with an emphasis on addressing weaknesses in the southern hemisphere. The accuracy of the resulting CRF was quantified by comparison of about 525 X/Ka sources in common with the S/X-band (2.3/8.4 GHz) ICRF2 producing wRMS agreement better than of 165 uas in RA cos(dec) and 210 uas in Declination. There is evidence for systematic errors at the ~100 uas level. Known errors include limited SNR, lack of phase calibration, troposphere mismodelling, and terrestrial frame distortions. Actions are underway to reduce all of these errors. The recent successful launch of the Gaia optical astrometric satellite motivates work to tie the radio and optical frames. Existing X/Ka data and simulated Gaia data predict a frame tie precision of ~7 uas (1-sigma, per 3-D rotation component) with anticipated improvements having the potential to produce a tie of 5 uas per component. If X/Ka precision can be pushed below 100 uas, the X/Ka frame has potential to produce a tie to Gaia that is superior to S/X due to reduced astrophysical systematics at X/Ka relative to S/X.

Cristina Garcia-Miro - *VLBI Digital Terminal at the Deep Space Network: first results from non-JPL correlators*

The Deep Space Network (DSN) has replaced the Mark IV Data Acquisition Terminal (DAT) with a digital backend, the DSN VLBI Processor (DVP). The DVP is an in-house JPL development that uses a CASPER ROACH board for real-time digital signal processing and channelization and streams the data into a Mark 5C recorder in VDIF format. The digital terminal improves considerably the recording rate providing at least 2 Gbps with the goal of achieving 4 Gbps. The DVP has been successfully supporting JPL VLBI Astrometry and Earth Orientation observations since 2013, using the JPL software correlator. As the DVP does not use the standard Field System environment to perform the VLBI observations, efforts are under way to make it compatible with non -JPL correlators, providing monitor and calibration data in the appropriate format. This contribution presents first successful results obtained with non-JPL correlators.

Myriam Gitti - *Twin SMBH candidates in the BCG of RBS 797*

The radio-loud BCG at the center of the cool core cluster RBS 797 is known to exhibit a misalignment of its 5 GHz radio emission observed at different VLA resolutions, with the innermost kpc-scale jets being almost orthogonal to the radio lobes which extends for tens of kpc filling the X-ray cavities seen by Chandra. The different radio directions may be caused by rapid jet reorientation due to interaction with a secondary supermassive black hole (SMBH), or to merger of two jet-emitting AGNs. In this talk, I will show the results of new 5 GHz observations performed with the EVN in May 2013. In particular, we detectedtwo compact radio components, with a projected separation of ~77 pc. I will discuss two possible scenarios for the origin and nature of the EVN double source, showing that both

interpretations are consistent with the presence of a SMBH binary system in the BCG of RBS 797. Time permitting, I will also present the preliminary results of the long follo-up EVN observations performed at 1.6 GHz and 5 GHz in early 2014.

Ruben Herrero-Illana - *Star formation in the central kpc region of NGC1614*

The Luminous Infrared Galaxy NGC 1614 hosts a prominent circumnuclear ring of star formation. However, the nature of the dominant emitting mechanism in its central ~100 pc is still under debate. We present sub -arcsecond angular resolution radio, mid-infrared, Paα, optical, and X -ray observations of NGC 1614, aimed at studying in detail both the circumnuclear ring and the nuclear region. The 8.4 GHz continuum emission traced by the Very Large Array (VLA) and the Gemini/T-ReCS 8.7 micron emission, as well as the Paα line emission, show remarkable morphological similarities within the star-forming ring, suggesting that the underlying emission mechanisms are tightly related. We used an HST/NICMOS Paα map of similar resolution to our radio maps to disentangle the thermal free- free and non-thermal synchrotron radio emission, from which we obtained the intrinsic synchrotron power-law for each individual region within the central kpc of NGC 1614. The radio ring surrounds a relatively faint, steep-spectrum source at the very center of the galaxy, suggesting that the central source is not powered by an AGN, but rather by a compact ($r < 90$ pc) starburst. Chandra X-ray data also show that the central kpc region is dominated by starburst activity, without requiring the existence of an AGN. We also used publicly available infrared data to model-fit the spectral energy distribution of both the starburst ring and a putative AGN in NGC 1614.

Noelia Herrera Ruiz - *Wide-field VLBA observations of the COSMOS field*

The aim of the project 'bm360' is to observe ~3000 radio sources in the COSMOS extragalactic field with the Very Long Baseline Array (VLBA) at 1.4GHz. The goals are to study with statistically relevant numbers the faint radio source population, and so complement the sensitive multi-wavelenght COSMOS data with milli-arsec resolution radio images. The scientific motivation of this project is to investigate the interplay between Active Galactic Nuclei and their host galaxies. The radio ejecta from AGN can severely impact on the way that stars are formed in galaxies - they can either heat the gas and so prevent it from collapsing into stars, or they can compress clouds of gas, thereby triggering star formation. It is therefore necessary to determine which galaxies do have radio-active AGN. Whilst there are several diagnostics, a relatively easy and direct way is a detection in a Very Long Baseline Interferometry (VLBI) observation. The reason is that the emission needed to make a detection must come from a very small volume in the target object, because the resolution is so high in VLBI observations. In this overview I will present the survey design, observations and calibration. Also I will describe the multi-field self-calibration technique used to improve the coherence of the images, along with a few first results.

Taehyun Jung - *Mm-VLBI Phase Correction Capability with the Korean VLBI Network (KVN)*

A unique four-band receiving system having a characteristic receiver optics which supports simultaneous observations in four radio bands of 22, 43, 86 and 129 GHz has been introduced in the Korean VLBI Network (KVN) to calibrate tropospheric phase fluctuations in mm-VLBI observations and fully operational since March 2012. By applying band-to-band phase transfer, one can expect a higher performance in phase correction of VLBI. We have been conducting test observations in order to investigate how effectively this works in particular for millimeter wavelengths, where the distribution of water vapor is highly irregular and thus the coherence time is shortened. In this talk, we report the results of phase correction with the KVN and demonstrate its high capability for mm-VLBI observations.

Vassilis Karamanavis - *Millimeter VLBI and broadband radio study of PKS 1502+106: Constraining the gamma-ray emitting region and testing the shock-model predictions*

Blazars as the beamed population of AGN, are among the most copious and variable emitters of radiation in the Universe. The detailed processes that give rise to those characteristics though, are still under intense debate. In August 2008, Fermi/LAT discovered the blazar PKS 1502+106 showing a rapid and strong gamma-ray outburst followed by bright and variable flux over the next months. This activity at high energies triggered an intensive multi-wavelength campaign indicating that the outburst was accompanied by a simultaneous flare at optical/UV/X-rays with a significantly delayed counterpart at radio bands as observed by the F-GAMMA program. Taking advantage of the densely sampled 2.6 to 345 GHz F-GAMMA light curves and spectra along with broad-band data up to Fermi gamma-ray energies and with the addition of ultra-high angular resolution VLBI imaging at 43 and 86 GHz, we attempt to shed light on the physical processes at work during this high-energy flare. In particular, we aim at probing the gamma-ray emitting region, its size and location in the innermost core region and the gamma-ray production mechanism. In this talk the findings of the mm-VLBI study using the Global Millimeter VLBI Array (GMVA) data between 2009 and 2012, will be presented. Furthermore the analysis of the radio light curves and spectra in the framework of a shock-in-jet model will be discussed.

Mark Kettenis - *SFXC: The new EVN data processor*

Since the last EVN symposium, the SFXC software correlator has taken over all correlation duties from the venerable Mark4 data processor as the main EVN data processor. Due to its flexible nature it offers many new

observation modes. This poster presents the most important new capabilities, focusing on the most recent developments such as a phased array mode, coherent de-dispersion for pulsar observations and mixed bandwidth correlation. Phased array mode and coherent de - dispersion enhance the capabilities of the EVN to support Pulsar astronomy. Mixed bandwidth correlation enables global VLBI at data rates beyond 512 Mbit/s and provides an upgrade path to 2 Gbit/s and 4Gbit/s EVN observations.

Mikyoung Kim - *44GHz methanol maser observations towards G10.32-0.26 with KaVA/KVN*

Class I methanol masers are one of the traces of star forming region. However, the high - resolution imaging observations for this maser emission is limited, because its extended structures are resolved-out with VLBI resolutions. On that point, KVN has an advantage over other VLBI networks in observing 44~GHz methanol masers for its shorter baselines. We conducted 44GHz Class I methanol maser observations towards G10.32-0.26 with KaVA and KVN. We will report the results of the imaging observations of 44 GHz methanol masers.

Motoki Kino - *AGN observations with KaVA array*

The KaVA array, the combination of Korean VLBI network (KVN) and VLBI Exploration of Radio Astrometry (VERA), is the first international VLBI array dedicated to high-frequency observations in East Asia. Here, we report the first imaging observations of three bright AGNs known for their complex morphologies: 4C 39.25, 3C 273, and M 87 (Niinuma et al. 2014, in press). Next, we show our future plan of monitoring observation of Sgr A* and M87 as our key science program.

Shoko Koyama - *Detection of new jet component perpendicular to the jet axis in Mrk 501*

We present results from 43 GHz (VLBA, six epochs from 2012.2 to 2013.2) and 86 GHz (GMVA, one epoch in 2012.4) observations toward the basis of the jet in Mrk 501. The 43 GHz analysis reveals a new jet feature located ~0.20 mas to the northeast of the radio core, with a flux density of several tens of mJy, perpendicularly to the jet axis. This component has no counterpart at the 86 GHz image.

Evgeniya Kravchenko - *Multi-wavelength observations of blazar 1030+611 in its flaring state during 2008 - 2014*

Radio loud blazar 1030+611 has being monitored with the Large Area Telescope on board the gamma-ray observatory Fermi since 2008. Bright gamma-ray flare was registered in the blazar in 2010, which was the start for triggered multi epochs observations with VLBA simultaneously at 5, 8, 15, 24, and 43 GHz. Our multi wavelength analysis has shown that a strong radio flare has started in the sub-parsec-scale core at about the same time as the gamma-ray flare. This has provided an opportunity to study the blazar during its active state with high resolution. We have measured structure and kinematics of 1030+611 VLBI jet components at parsec scales, which shows superluminal motion of (6.44+-0.4) c. We have reconstructed polarization and Faraday rotation measure maps, which both show variations of their values and structure with time and frequency. Results from joint analysis of gamma and radio data taken together with the frequency depending core-shift measurements provided an estimate of physical conditions inside the blazar jet at parsec scales, as well as its structure and other peculiarities.

Alexander Kutkin - *Short term AGN variability*

We present the results of harmonical, wavelet and cross-correlation analysis of extragalactic radio sources variability. Flux measurements are taken at RATAN-600 radio telescope and consist of daily observations sets (50--100 days long) covering 1999--2013. The analysis reveals cyclic flux variations with characteristic time scales of days in several sources. The long term component also present.

Elisabetta Liuzzo - *Nearby radio loud AGN and the Unified Model*

The study of the parsec scale properties of radio sources is crucial to get information on the nature of the central engine and to provide the foundations of the current unified theories, suggesting that the appearance of active galactic nuclei depends strongly on orientation. We started a project to observe a complete sample of 94 nearby radio galaxies, the Bologna Complete Sample which is not affected by any selection effect on the jet velocity and orientation with respect to the line of sight. Here, we report on the last VLBI observations of the fainter radio core (< 5 mJy at 5 GHz) sources of the sample. We also discuss more in general their nuclear properties in comparison with the parsec scale properties of a sample of low-z BL Lac objects for a better understanding of unified models of radio loud AGN.

Benito Marcote - *The changing morphology of the radio outflow of HESS J0632+057 along its orbit*

Gamma-ray binaries remain as a reduced population of known systems, consisting on a compact object and a young massive star, displaying a spectral energy distribution dominated by the gamma rays. HESS J0632+057 is one of the known gamma-ray binaries that has been poorly studied up to now. This source exhibits orbitally modulated X -ray emission, with a main outburst followed by an X-ray dip, and a dimmer secondary outburst. Radio observations have been conducted along most of the orbital phases with connected interferometers. Only two VLBI observations have been conducted up to now (EVN), with only one of them sensitive to the extended emission. Unveiling the VLBI structure of HESS J0632+057 along its orbit is mandatory in order to constrain the geometry of the shock originated by the interaction between the winds of

the compact object and the primary star, and to study the associated radiative processes. Here we will present preliminary EVN results for the emission of HESS J0632+057 at the end of the secondary outburst, just conducted in 2014 February 20 and in the correlator queue at the time of writing.

Ivan Marti-Vidal - *The Nordic tools for advanced analysis of interferometry data*

We present a set of tools for an advanced analysis of interferometry data. Our tool set allows the users to perform fine-tuned visibility model-fitting, simulations, stacking in Fourier space, etc. The Nordic tools are in continuous process of improvement and extension. Although they are designed to be used in the CASA python interface (casapy), the tools can be adapted for use with other softwares.

Javier Moldon - *The LOFAR long baseline snapshot calibrator survey*

With a current maximum baseline of 1300 km, the International LOFAR array is capable of attaining an angular resolution of 0.4 arcsec at a frequency of 140 MHz, opening for the first time the possibility of true subarcsecond imaging at wavelengths longer than 1 m. We used the multi-beaming capability of LOFAR to conduct a fast and computationally inexpensive survey to inspect 630 sources in two hours to determine if they possess a sufficiently bright compact component to be usable as LOFAR delay calibrators. Here we summarize the differences between cm- and m-VLBI, the characteristics of the survey, and its main results. In particular we have obtained the density of calibrators on the sky that are sufficiently bright to calibrate dispersive and non-dispersive delays for the International LOFAR.

Julian Andres Mora Diaz - *Baseline geometry effects due to source structure in geodetic VLBI*

The technique of very long baseline interferometry (VLBI) uses knowledge about the positions of radio telescopes to measure celestial radio source positions with highest precision down to tens of microarcseconds for ground-based experiments. At the same time, VLBI measurements of stable, point-like celestial radio sources can be used to determine precise station positions the millimeter level. However, the majority of radio sources exhibits extended intrinsic structure at sub-milliarcsecond (or larger) scales that is time and frequency dependent and leads to systematic effects on the group delay observable. The classical approach to correct for structure if the radio sources are to be used for geodesy is to perform VLBI imaging, where the visibility function measured by the interferometer is the mapping of the specific intensity distribution of the source on the sky as a function of the interferometer baseline (u,v) coordinates through a Fourier transform. Radio source images provide information about the sources' appearance and compactness. Ultimately, sources are classified according to their compactness, and for geodesy, the best sources are those of which core structure is compact and astrometrically stable: ‘defining sources’. The sources exhibiting complex structure, ‘special handling sources’, are always adjusted on the session level in the analysis, as they could otherwise corrupt the station position estimates. The imaging is a successful but time consuming method and there is usually not sufficient information about the large number of images available that can be used to identify the temporal evolution of source structure, since most of the sessions designed for geodesy are not intended for imaging. In this study we investigate the effects of source structure on the geodetic/astrometric results, i.e. radio source positions, by considering the different baseline-source geometries. For this purpose, we compare results obtained from astrometrically unstable sources observed with many long East-West baselines (to provide the highest angular resolution) with those from astrometrically stable sources. We assess the impact of the baseline -source geometry by adequately transforming the terrestrial baselines into the celestial reference frame.

Jack Morford - *Massive stellar mass-loss in the context of COBRaS*

The e-MERLIN Cyg OB2 Radio Survey (COBRaS) is legacy project designed to exploit e-MERLINs enhanced capabilities to conduct uniquely probing, targeted d eep-field mapping of the tremendously rich Cyg OB2 association in our Galaxy. This deailed radio census of CygOB2 is designed to resolve the current very serious uncertainties in the mass-loss and energy feedback processes of massive stars. Recent results have strongly challenged the current model of mass-loss via stellar winds, suggesting that currently accepted mass-loss rates of luminous massive stars may be too high by an order-of-magnitude or more.
We will discuss the study of mass-loss in the context of the COBRaS observations and present preliminary results

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Satomi Nakahara - *Multi-epoch, quasi-simultaneous 22/43GHz observations of the M84 nucleus with VERA*

Most of the supermassive black-hole activities in the local universe are in the lower end of luminosity function of active galactic nuclei (low-luminosity AGN). However, the detailed accretion and ejection processes acting in these nuclei are still not well understood. To address this issue, we need to investigate the close vicinity of the central engine using high-resolution VLBI. The nearby elliptical galaxy M84 is one of the representative sources of LLAGN, and its proximity together with the large black hole mass allows us to examine the nuclear structure at a privileged linear/ gravitational scale. Here we report high resolution multi-epoch observations of the M84 nucleus with VERA at 22 and 43GHz. The nuclear structure was resolved down to 226 Rs (or 0.035 pc) at 43GHz, while at 22GHz we detected an elongated, jet-like structure mainly in the northern side of the core, which is consistent with previous mas-scale observations. At most of the observed epochs the radio core shows steep-to-flat

spectra between 22 and 43GHz, suggesting that the core emission at these frequencies is dominated by the synchrotron -self-absorbed jet base. We will further discuss the fundamental parameters for the nuclear radio jet (speed, Doppler factor and viewing angle) based on the multi-epoch data sets.

Kotaro Niinuma - *Multi-epoch and multi-frequency VLBI observation of X-ray to gamma-ray flare in TeV blazar Mrk 421*

In early 2013, large X-ray and GeV gamma-ray flares occurred in TeV blazar Mrk 421. To investigate the spectral behavior in the radio core region of Mrk 421 after the large high-energy flare phenomenon, we carried out multi-frequency (2 – 43 GHz) densely monitor of Mrk 421 using the very long baseline array (VLBA) immediately after the flare. In the poster we report on the result of this monitor program.

Tomoaki Oyama - *A progress report on the development and performance of OCTAVE-DAS for VERA, JVN and Japanese e-VLBI(OCTAVE***)**

The new VLBI observing system (OCTAVE-DAS) have developed based on the VSI-H and VDIF specifications at NAOJ (National Astronomical Observatory of Japan). It consists of 1) a high speed 8-Gsps 3-bit RF direct ADC (OCTAD) enable us to acquire not only wide intermediate frequency but also radio frequency up to 50 GHz and have DBBC functions for VGOS (VLBI Global Observing System), 2) a converter (OCTAVIA and OCTAVIA2) between one 10 GigE port and four 2 Gbps input and output ports conformable to VSI-H, and 3) new recorders (OCTADISK, OCTADISK2 and VSREC) at a rate of 4.5 Gbps and above 8 Gbps and 4) Gbit realtime correlator (OCTACOR) and software correlator system (OCTACOR2) using GICO3 was developed by NICT. These OCTAVE-DAS are connected via 10 GigE network with VDIF and VSI specifications. These components have been used for VERA, JVN (Japanese VLBI network) and KJJVC (Korea-Japan Joint VLBI Correlator). This paper reports a two -year progress since the last EVN symposium and results of scientific broad-band(>8 Gbps) VLBI observations using the OCTAVE-DAS.

Leonid Petrov - *Radio Fundamental Catalog*

For the course of the 21st century the number of compact extragalactic sources with positions known at milliarcsecond level has grown by a factor of 15 and surpassed 9000. For the majority of sources the brightness distributions are available. This makes the radio fundamental catalog the major resource in high resolution astronomy. The overview of the project is given, its status, and direction of future development. At the moment, the project is evolving into several directions: a) lowering the flux density completeness level; b) increasing the source density in zones of interest (Galactic plane, ecliptic plane); c) increasing the source density in zones of avoidance; d) pursuing certain populations of sources (nearby galaxies, gamma-ray loud AGNs), e) follow-up of flux density measurements at high frequencies (22-127 GHz). This became feasible due to both improvements in VLBI hardware and data analysis technique, such as 1) totally automatic dynamic scheduling; 2) seamless AIPSless data analysis pipeline; 3) arcminute-wide field of view; 4) the use of numerical weather models for data reduction.

Alexander Pushkarev - *Opening angles and shapes of parsec-scale AGN jets*

For the purpose of our study we used 15.4 GHz VLBA observations of 366 sources having at least 5 epochs from the MOJAVE program and/or its predecessor, the 2 cm VLBA Survey. For each source we constructed a stacked image averaging all available epochs for a better reconstruction of the cross section of the flow. We have analyzed jet profiles transverse to the local jet direction and derived both apparent and intrinsic opening angles of the parsec-scale outflows. The sources detected by the Fermi Large Area Telescope show statistically wider apparent jet opening angles and smaller viewing angles. Results of jet shape analysis will be also presented and discussed.

Bindu Rani - *Perplexing correlations between gamma-ray emission and parsec-scale jet orientation variations in the BL Lac object S5 0716+714*

Our analysis of gamma-ray flux variability along with the parsec-scale jet kinematics suggests that the high-energy radiation of S5 0716+714 has a significant correlation with the mm-VLBI core flux and the local orientation of the jet flow. For the first time, we report that the gamma-ray flux variations lead the parsec-scale jet orientation variations by 47+\-22 days. The observed time lag between gamma-ray and core flux variations suggests that the high-energy emission is coming from a region located 3.8+\-1.9 parsecs closer to the central black hole than the “core” seen on the mm-VLBI images. The results imply that the inner jet morphology has a tight connection with the observed gamma-ray flares in the source. However, the absence of a significant correlation between core flux and jet orientation variations challenges currently available relativistic jet models. In this talk, I will present the main results of the study.

Cormac Reynolds - *Monitoring the Radio Emission from Radio Quiet Broad Absorption Line Quasars*

We report on high -frequency (15 to 43~GHz) EVLA, AMI, EVN and VLBA monitoring of two nearby broad absorption line quasars. These observations have shown that, in spite oftheir overall weak radio emission, these objects have dynamic radio cores and can exhibit large flares at high radio frequencies. Our monitoring campaign aims to elucidate why the radio emission cools off and never links to large scale radio lobes and we present preliminary models of the source environment that are consistent with our observations.

Grzegorz Rycyk - *Determination of annual parallax for cataclysmic binary system AM Herculis with the EVN interferometric network.*

The main aim of this work was to determine annual parallax for cataclysmic binary system AM Herculis with made use of the astrometric vector model and the MCMC optimization algorithm. The parallax was derived from the observations made by European VLBI Network (EVN). We calculated precise (~0.1 mas) position of the system for 6 epochs of the observations. The observations were spread in time to cover entire year. The obtained result of 88.5 pc shows that the system is located further than it was estimated from the previous observations (Thorstensen, 2003).

Daisuke Sakai - *Absolute proper motion measurement of Sgr HII region with VERA*

Sgr D HII region is one of the radio sources toward the Galactic Center region. The galactic longitude of this source is l=1.14deg. Line -of-sight velocity of thermal molecular line associated with this source is -16 km/s, which is prohibited in flat rotation at positive galactic longitude. Narrowness of the molecular line width(~4 -5 km/s) seems to avoid this source locating in Galactic Center, because typical line width in Galactic Center region is 20-30 km/s. These facts make determination of distance for this source difficult. We have conducted astrometric observations for 22 GHz water maser source associated with Sgr D HII region with VERA. We obtained absolute proper motion for this source, and the measured motion implies this source locating in near side relative to the Galactic Center. By considering the measured absolute proper motion, we constrained the location of this source on near 3 kpc arm or near central molecular zone(CMZ).

Satoko Sawada-Satoh - *VERA Frequent Monitoring of the Parsec-scale Jet in the BL Lac Object OJ 287 Simultaneous with the Gamma-ray Flares during 2011-2012*

We have carried out frequent monitoring of the BL Lac object OJ 287 in the 22-GHz band from 2010 November to 2012 September using the VLBI Exploration of Radio Astrometry (VERA) telescope array. The 22-GHz light curve of OJ 287 clearly shows three flare events: in 2011 May, 2011 October, and 2012 March, with an activity timescale of < 4 months. The second radio flare event occurred at the same time as the gamma-ray flare detected by the Large Area Telescope on-board Fermi in 2011 October, while the third radio flare seems to precede the gamma-ray flare of 2012 April. This behavior is different from what was observed during the gamma-ray flare in 2009. One jet component moved outward with an apparent superluminal speed of 11 c from 2010 November to 2011 November at a position angle of ~160 degree from North to West, and then it changed direction, moving inward with an apparent superluminal speed of 4 c. The turning point of the jet motion seemed to occur at the same time as the gamma -ray flare in 2011 October. We find a tight connection between an apparent inward motion of the parsec-scale jet and gamma -ray flaring activity seen from 2011 November to 2012 August. Higher resolution images with the Very Long Baseline Array (VLBA) at 43 GHz allow us to detect a new innermost jet component that appeared in 2011 October, simultaneously with the gamma-ray flare. The observed inward motion could be caused by the new jet component unresolved at 22 GHz in the innermost region.

Robert Schulz - *The EVN view of the highly variable TeV active galaxy IC310*

The active galaxy IC310 located in the Perseus cluster has recently been shown to be a highly variable TeV gamma-ray emitter. The extreme variability characteristics observed by the MAGIC telescopes pose serious questions on the emission mechanism and classification of this enigmatic object. We report on the first quasi-simultaneous multi-frequency VLBI observations of IC310 conducted with the EVN. We find a blazar-like one-sided core-jet structure on parsec scales, constraining the inclination angle to be less than ~25 degrees but very small angles are excluded to limit the de-projected length of the large-scale radio jet. We image the EVN/VLBI spectral -index distribution and use multi - epoch VLBA observations from the MOJAVE program to constrain the jet bulk Lorentz factor.

Bong Won Sohn - *KVN and KaVA polarimetry*

We report VLBI polarimetry test observations and early scientific observations of KVN and KaVA (KVN and VERA Array).

Rebeca Soria-Ruiz - *Merlin full polarization observations of OH masers in W3OH*

We present the first full polarization maps of the OH masers at 6030 and 6035 MHz in W3OH. Of the 141 maser components found, about 80% are located in the broad-line region of W3OH. The overall maser structure is compatible with previos maps. LCP data are more intense at both frequencies. From the crosspolarized data, we have been able to resolve 48 Zeeman pairs; 32 at 6030 MHz and 16 at 6035 MHz. The derived magnetic field strengths are compatible with the estimations in OH masers (up to ~ 13 mG). We also present the first clear detection of linear polarization of OH masers in this source. The highest linear polarized components correspond to the brightest ones, with mean values of PL~ 10%.

Minttu Uunila - *Using software spectrometer to ensure VLBI signal chain reliability*

Software spectrometer (SWspec) developed for spacecraft tracking can also be used to ensure VLBI signal chain reliability and phase stability of a VLBI receiver. If problems occur during an EVN session, one can use SWspec and no changes to the hardware setup are needed. Testing performed with SWspec during pre-operations both saves time and eases the tests as one

does not need to gather, couple and setup the hardware anymore. In the future testing can be performed by operators to reduce the workload of technical staff.

Gino Tuccari - *DBBC3: AntArr Project*

A project with an alternative application of the DBBC3 is presented, where a set of antennas operating at frequencies lower than 1 GHz are combined into an array. The individual antennas is cover the broadband frequency range from 10 MHz to 1000 MHz. Moreover dedicated elements can be added to reach still lower frequencies to virtually observe the range down to kHz frequencies. The DBBC3 manages the array operations in a selected portion of the band and the main characteristic is to synthesize a beam with an innovative approach. The final product of the array is a single station standard VLBI data set. Some antenna and array prototypes have been realized and are under test in two locations. The first results are presented with the potential goals that could be met. Results of a first test will be shown at the standard 327 MHz VLBI band.

Harro Verkouter - *e-Shipping in the EVN*

Traditionally, raw VLBI data is sent to the JIVE correlator by means of physically moving disk packs with the recorded telescope signals on them across Europe or from other continents. This is a rather slow and costly operation. As a bonus, physical transportation of hard disks potentially damages them, eventually leading to loss of science data. Now that many of the EVN telescopes are increasingly better connected - with connection speeds of multiple Gbps - to the international networks, it becomes more efficient and less error prone to move a station's recorded data to the correlator via the network: "e-Shipping". Unfortunately, the most widely used network protocol does not perform at all when trying to transport large quantities of data over (very) long international networks. At the Joint Institute for VLBI, specialised utility programs, originally developed to drive real-time VLBI, were modified to allow reliable and fast transfers of large quantities of data over inter-continental distances. This poster shows the developments made over the last eight years in which JIVE has gained experience with e-VLBI and e-Shipping and which transfers are possible at this moment.

Petr Voytsik - *RadioAstron AGN survey with extreme angular resolution: statistics of detections, angular size and brightness temperature*

One of the key science programs of RadioAstron mission is a survey of radio strong active galactic nuclei (AGN) at the highest angular resolution. The survey goals include search for extreme brightness temperatures and study the observed size distribution of the most compact features in AGN radio jets. To date AGN emission is successfully detected from more then 70 sources at interferometer baselines from 1 to 27 Earth diameters. In this report we present brightness temperature statistics and search for a dependence of angular size on galactic coordinates predicted by the interstellar scattering.

Pawel Wolak - *Violent maser events in the circumstellar envelope of pre-planetary nebula IRAS18276-1431.*

OH 1.6 GHz maser emission in the pre-planetary nebula IRAS18276-1431 was monitored with the Nancay Radio Telescope, EVN and MERLIN. Multi-epoch observations over 8 yr interval revealed several narrow-band maser flares superimposed on the monotonic decay and rise of the integrated flux density at 1612/1665 and 1667 MHz, respectively. The emission during each flare is always strongly polarized and emerges from well isolated and compact region. The spatial configuration of the magnetic field in the region of 1612 MHz burst was mapped. The field in this area is parallel to the axis of the bipolar lobes likely excavated in the envelope by tenuous bipolar winds. Violent OH maser activity and reappearance of water maser at 22 GHz in 2013 could be linked to evolutionary changes in the envelope.

Nick Wrigley - *Wide field observations from the e-MERGE survey*

The GOODS North region was captured, in the radio, at high resolution by the MERLIN array back in 1996 revealing 92 sources comprising both star forming and AGN type galaxy components. The largest angular size distribution for these populations indicated a median scale around an arcsec. This presentation updates that result by including the latest data available from the upgraded e-MERLIN array from the maturing e-MERLIN Galaxy Evolution (e-MERGE) survey. A new distribution including hundreds of sources is derived from fast-wide-field-imaging and a bespoke model for non-homogeneous array beam correction.

Guangyao Zhao - *KVN Source-Frequency Phase-Referencing Observation of 3C 66A & 3C 66B*

In this presentation, I will introduce our KVN Source-Frequency Phase -referencing (SFPR) observations of 3C 66A and 3C 66B. The motivation of this work is to measure the core-shift of these 2 sources and study the temporal evolution of the jet opacity. Two more sources are observed as secondary reference calibrators and each source was observed at 22, 43, and 86 GHz simultaneously. Our preliminary results show that after self-frequency phase transfer from the lower frequency, the phase of each source at higher frequencies became more aligned, the coherence time became much longer, and the residual phase of difference sources within 10 degrees follow similar trends. After reference to the nearby calibrator, the SFPRed maps are obtained as well as the astrometric measurements, i.e. the combined core-shift. The core-shift measurements are found to be affected by structural blending effect because of the large beamsize of KVN, but this can be corrected with higher resolution maps (e.g. KAVA maps).
