

# EVN2002 SYMPOSIUM, BONN — ABSTRACTS

I. Agudo, J. L. Gómez, et al

## **Multi-frequency VLBI observations of the BL Lac object 0735+178**

Presentation: ORAL

We present new polarimetric multifrequency VLBI and VSOP observations of the BL Lac object 0735+178. This source presents one of the most pronounced curvatures observed in jets of AGNs, with two sharp apparent bends of about  $90^\circ$  within the inner 2 milliarcseconds from the core. The new images suggest a scenario in which the plasma of the jet is traveling inside a curved funnel, probably produced by the interaction of the jet with the external medium.

W. Alef & D. A. Graham

## **The New Bonn MK IV – AIPS Data Export Path**

Presentation: POSTER

We have written an interface program for exporting raw MIV correlator data into AIPS. This program – called MK4IN – is realized within AIPS and uses the Haystack MKIV data routines to access the correlated data. Together with the Haystack Observatory Postprocessing System (HOPS) and a modified AIPS task for estimating antenna-based residuals from the baseline-based fringe fit results from HOPS, a complete export path is now in place. It is optimized for mm-VLBI and astrometry, but it also simplifies the reduction of continuum VLBI data in AIPS; data can be mapped without any further fringe fitting in AIPS.

H. D. Aller, M.F. Aller & P.A. Hughes

## **Oblique Polarization Structures in AGN and QSO Radio Jets**

Presentation: ORAL

We interpret the linear polarization structures observed in extragalactic radio sources, even those oriented at oblique angles to the jet flows, to be due to oblique, relativistic shock fronts in the emitting regions. Many sources exhibit indications of such oblique structures, and the goal of this investigation is to test this hypothesis quantitatively. A selected group of ten highly variable extragalactic sources were observed with the VLBA at 15 and 43 GHz, on nine epochs spanning a 30-month period; five of these objects were also observed at 8.0 and 22 GHz. The integrated total flux densities and linear polarizations of the selected objects were also observed several times a month at 4.8, 8.0 and 14.5 GHz with the University of Michigan 26-meter telescope. All objects exhibited variability with several exhibiting more than one independent outburst during the period. We show the evolution of the polarized components with time and discuss the relativistic shock parameters required to match the observed polarization structures. Even cases where the magnetic field is apparently oriented along the jet flow can be fit by oblique shock models when relativistic aberration effects are included.

M. F. Aller, H. D. Aller, P. A. Hughes, & R. M. Plotkin

## **Centimeter-band Variability in GPS Sources**

Presentation: ORAL

To investigate the total flux density and polarization properties of GHz-peaked sources, we commenced systematic observations of the Stangellini et al. (*A&A Suppl*, **303**, 131, 1998) 1 Jy sample with the UMRAO 26-meter telescope in November 1999; prior UMRAO data, spanning up to 3 decades, exist for 18 sources. Expected class properties are low variability and low fractional polarization.

Comparison of the distribution of the time-averaged polarization at 4.8 GHz with that for the Pearson-Readhead sample confirms that low fractional polarization is a class property. At 14.5 GHz, however, we find several sources, as illustrated with examples, that show time-variable polarization reaching values of 5-10%, and comparable in magnitude to our program blazars. While the compact symmetric objects ( $\sim 1/3$  of the sources) generally show low-to-no total flux variability as expected, other Gs and QSO exhibit slow outbursts or long-term changes. A first-order structure function analysis confirms slow variability compared to AGNs, with  $\tau_{char} \sim 4$ -10 years; the GPS spectrum characteristic of a transparent source is maintained during most variability.

An in-progress search for objects with detectable circular polarization yields one strong detection. The presence of CP (plausibly attributed to linear-to-circular mode conversion in partially-opaque emitting regions) and flux variability are both indirect evidence for the presence of opaque emitting regions in some GPS sources. Confirmation will require VLBI-scale spectral mapping.

P. Augusto, J.I. Gonzalez-Serrano, A.C. Edge & I. Perez-Fournon

### **Classification of a sample of 23 Compact-Medium Symmetric Object candidates from multi-wavelength observations**

Presentation: ORAL

Augusto et al. (1998) have presented a list of 23 flat spectrum radio source candidates for Compact-Medium Symmetric Objects (C-MSO). Since then we have gathered multifrequency data for many of these in an attempt to definitively classify them as CSO/MSOs. Almost all of these have optical identifications in BVRI (NOT) observations (down to 24th mag in B) and only two (of the 20 observed/with published optical data) remain empty fields. At the symposium, we intend to present the classification (judging from the location of the centre of activity and overall symmetry) as CSO/MSOs (or not) for 12 of the candidates which have VLBA 1.6/5 GHz and MERLIN 22 GHz or VLA-BnA 22 GHz data available, since reduction is under way.

U. Bach, T.P. Krichbaum, E. Ros, S. Britzen, A. Witzel & J.A. Zensus

### **0716+714 a superluminal quasar?**

Presentation: POSTER

The S5 blazar 0716+714 is extremely variable on time scales from hours to months. In the radio bands 0716+714 is an intraday variable (IDV). It exhibits a very flat radio spectrum, extending up to at least 300 GHz. The variability appears to be correlated over wide ranges of the electromagnetic spectrum (from radio bands to Gamma-rays). 0716+714 has no known redshift yet. Optical imaging of the underlying galaxy however reveals an estimate of  $z \geq 0.3$ . At present it is not clear if 0716+714 is a superluminal VLBI source and how fast the motion of VLBI components is. Here we present an analysis of new and old high frequency VLBI data collected during the last 10 years at 5 - 43 GHz. For the jet components in the mas-VLBI jet, two component identifications are possible, one with quasi-stationary components oscillating about their mean positions. Another identification scheme, which formally also gives a better expansion fit, yields motion with  $\approx 9c$  for  $H_0 = 65 \text{ km s}^{-1} \text{ Mpc}^{-1}$  and  $q_0 = 0.5$ . This model would be in better agreement with the observed rapid IDV and the expected high Lorentz-factor, deduced from this.

U. Bach, T.P. Krichbaum, W. Alef, A. Witzel & J.A. Zensus

### **Proper motion in Cyg A**

Presentation: ORAL

Our recent VLBI observations of the prominent FR II radio galaxy Cygnus A with the EVN and the VLBA reveal a pronounced two-sided jet structure. At 5 GHz, we now have 4 epochs from 1986, 1991 (Carilli *et al.*, 1991 & 1994), 1996 and 2002 (Bach *et al.*, *in prep.*) from which we could derive the kinematics of the jet and counter-jet. On the jet side and on mas scales, the jet seems to accelerate from  $\beta_{\text{app}} \approx 0.1 - 0.2$  (Krichbaum *et al.* 1998) at core-separations near 1 mas to  $\beta_{\text{app}} \approx 0.4 - 0.6$  at  $r \geq 4$  mas ( $H_0 = 65 \text{ km s}^{-1} \text{ Mpc}^{-1}$ ,  $q_0 = 0.5$ ). For the first time we also measure subluminal motion on the counter jet side. The flat spectrum of the inner region of the counter-jet (free-free absorption) and the frequency dependence of the jet to counter-jet ratio provide strong evidence for an obscuring torus in front of the counter-jet (Krichbaum *et al.*, 1998; Bach *et al.*, *in prep.*).

L. Bähren, P. Schneider & L.J. King (Institut für Astrophysik und extraterrestrische Forschung, U. Bonn)

### **Extraction of relative magnification matrices from VLBI observations of gravitational lens systems**

Presentation: POSTER

To get more reliable constraints on the reconstruction of gravitational lenses, we are working on a method to extract relative magnification matrices of the lensed images directly from VLBI visibilities. Instead of independently reconstructing multiple images of the source, we describe the sky brightness distribution  $I(\vec{x})$

by that of one of the images, and a set of linear coordinate transformations characterizing the action of the lens; parameters then are to be adjusted by fitting visibilities.

To parametrize the brightness profile of the source we use the shapelet formalism as introduced by Refregier (2001). Within this formalism a localized object is linearly decomposed with respect to a complete set of orthonormal basis functions. These basis functions have a number of remarkable mathematical properties – simple behaviour under Fourier transform, convolution and coordinate transformations. This makes them a promising candidate to model compact sources as observed in strong gravitational lensing.

Our method is tested on synthetic visibility data, and will later be applied to several gravitational lens systems for which high S/N VLBI data are available.

Thomas Beckert

### **Beyond VLBI-scales: Understanding Scintillation of Intraday Variables**

Presentation: ORAL

Intraday Variability of compact extragalactic radio sources is interpreted as quenched scintillation due to turbulent density fluctuations of the nearby ionized interstellar medium. We demonstrate that the statistical analysis of IDV time-series contains both information about sub-structure of the source on the scale of several 10 micro-arcsec and the turbulent state of the ISM. The source structure and ISM properties cannot be disentangled from IDV observations alone. A comparison with the morphology of the 'local bubble' and the turbulent ISM known from pulsar observations constrains possible source models. We further argue that earth orbit synthesis fails for non-stationary relativistic sources and no reliable 2D-Fourier reconstruction is possible.

Andy Biggs

### **Multi-frequency VLBI observations of the lens system B0128+437**

Presentation: ORAL

We present high-resolution VLBI observations of the gravitational lens system B0128+437 discovered as part of the CLASS survey. VLBA observations at 5 GHz of this four-image system show that the background source consists of three separate sub-components, potentially giving a very large number of constraints when constructing the lens model. However, the three sub-component morphology is only reproduced in three of the images, the fourth image looking significantly different to the others. At the same time, a model of the mass distribution in the lens derived from MERLIN 5-GHz observations cannot reproduce the orientation of the sub-components in another of the images. The reasons for these unusual discrepancies are discussed, especially in the light of more recent VLBA+Effelsberg observations at 8.4 and 2.3 GHz.

A.D. Biggs, O. Wucknitz, R.W.Porcias, I.W.A.Browne, N.Jackson, S.Mao, A.R.Patnaik, & P.N.Wilkinson

### **EVN/Global observations of the Gravitational Lens JVAS B0218+357 at 8.4 GHz**

Presentation: POSTER

We present new observations of the gravitational lens system JVAS B0218+357 made with a global VLBI network at 8.4 GHz. Our maps have an rms noise of  $30 \mu\text{Jy beam}^{-1}$  and high resolution ( $\sim 1$  mas), permitting us to detect more of the extended structure of the radio jets in the A and B images. We can identify several sub-components common to both images with the expected parity reversal, including a possible counter-jet. We do not detect either the core of the lensing galaxy or any third image. Using a model of the lensing galaxy, we have back-projected both images to the source plane and find that they agree well. However, there are small, but significant, differences and we discuss their possible origins. We find an exponent of the radial mass distribution of  $\beta \approx 1.04$ , in agreement with applications of the LensClean algorithm to an independent and much lower resolution dataset.

M. Bradač, P. Schneider, M. Steinmetz, M. Lombardi, L. J. King & R. W.Porcias

### **Using VLBI Data to Investigate the Galaxy Structure in the Gravitationally Lensed System B1422+231**

Presentation: POSTER

Gravitationally lensed systems with multiply imaged quasars provide an excellent tool for studying the properties of distant galaxies. In particular, they provide the most accurate mass measures for the lensing galaxy. The system B1422+231 is a well studied example of a quadruply imaged quasar, with high-quality

VLBI data available. Very accurate data on image positions, fluxes and deconvolved image sizes provide good constraints for lensing models. We discuss here the failure of smooth models in fitting the data. Since it is intuitively clear that the mass of a lens galaxy is not a smooth entity, we have investigated how deviation from a smooth model can influence lensing phenomena, especially the image flux ratios. To explore expectations about the level of substructure in galaxies and its influence on strong lensing, N-body simulations of a model galaxy are employed. By using the mass distribution of this model galaxy as a lens, synthetic data sets of different four image system configurations are generated. Their analysis can possibly provide evidence for the presence and strong influence of substructure in the primary lens galaxy.

S. Britzen, R. Vermeulen, W. Brinkmann, G. Taylor, et al.

### **The complete CJF: correlating the radio and the soft X-ray properties**

Presentation: ORAL

The CJF — the just completed VLBI survey of 293 Caltech-Jodrell Bank flat-spectrum sources performed at 5 GHz — yields an unprecedented basis for a statistical analysis of jets in AGN. With our analysis we specifically want to address the following topics:

- the superluminal motion statistics for the complete sample
- the jet component paths (bending, multiple paths) as dependent on AGN class
- search for evolution with redshift
- test of the beaming hypothesis
- a possible correlation between X-ray prominence and radio properties

We here present first results of the analysis of the completed survey and discuss implications for unified theories and cosmology.

A. Brunthaler, H. Falcke, M. Reid, L. Greenhill & C. Henkel

### **Proper motions in the Local Group**

Presentation: ORAL

Key and still largely missing parameters for measuring the mass content and distribution of the Local Group are the proper motion vectors of its member galaxies. The problem when trying to derive the gravitational potential of the Local Group is that usually only radial velocities are known, and hence statistical approaches have to be used. The expected proper motions for galaxies within the Local Group, ranging from 20 to  $100 \mu\text{as}/\text{yr}$ , are detectable with VLBI using the phase-referencing technique. We present phase-referencing observations of bright masers in IC10 and M33 with respect to background quasars. We observed the H<sub>2</sub>O masers in IC10 three times over a period of two months to check the accuracy of the relative positions. The relative positions were obtained by modeling the interferometer phase data for the maser sources referenced to the background quasars. The model allowed for a relative position shift for the source and a single vertical atmospheric delay error in the correlator model for each antenna. The rms of the relative positions for the three observations is only 0.01 mas, which is approximately the expected position error due to thermal noise. The second epoch is now in reduction and first hints of proper motions may be presented. Also, we present a method to measure the distance to M33, ultimately to better than about 5% accuracy. This will allow re-calibration of the extragalactic distance scale based on Cepheids. The method is to measure the relative proper motions of two H<sub>2</sub>O maser sources on opposite sides of M33. The measured angular rotation rate, coupled with other measurements of the inclination and rotation speed of the galaxy, yields a direct distance measurement.

A. Brunthaler, H. Falcke, G.C. Bower, M.F. Aller, H.D. Aller, H. Teräsranta & T.P. Krichbaum

### **III Zw 2: Evolution of a radio galaxy in a nutshell**

Presentation: POSTER

III Zw 2 shows dramatic radio outbursts roughly every five years. Here we present the full set of lightcurves and VLBA observations of the latest flare with an excellent time sampling. We have discovered superluminal motion with a lower limit for the apparent expansion speed of  $1.25 \pm 0.09 c$ . Spectral and spatial evolution are closely linked. Before and after this rapid expansion we have seen a period of virtually no expansion with an expansion speed less than 0.04 c. However, at 15 GHz the picture is completely different. III Zw 2 shows slow expansion ( $\sim 0.6c$ ) during the time of no expansion at 43 GHz and no expansion during the rapid expansion at 43 GHz. The difference between the two frequencies is qualitatively explained by optical depth effects in an 'inflating balloon-model', describing the evolution of radio lobes on an ultra-compact scale. The stop-and-go

behavior could be explained by a jet interacting with a molecular cloud or the molecular torus. The unique and simple structure and timescales of such outbursts within 5 years makes III Zw 2 an ideal source to study radio jet evolution relevant also to radio galaxies, especially those that appear as CSOs and GPSs. Since III Zw 2 is also part of a sample of so called radio-intermediate quasars (RIQ), it confirms earlier predictions of superluminal motion for this source, based on the argument that RIQs could be relativistically boosted jets in radio-weak quasars and Seyfert galaxies.

Bob Campbell (JIVE)

### **Operational issues of improved station positions for phase-reference experiments correlated at JIVE**

Presentation: ORAL (in the Users Meeting)

I will go over the following points, especially in view of the new coordinates available for EVN stations derived from the TP001 observations:

1. review the 'history' of station positions used for correlations (& other factors that could affect phase referencing, viz. Wb mosaicing)
2. review impact on FR005 (if not done by Patrick Charlot), phase-referencing NMEs, etc. to give an idea of the improvements resulting from the new station positions (i.e., whether PIs need to bother with them or not)
3. explain interface/liason procedures with PIs, including resources on the EVN web page, individual communication with affected PIs, the new experiment pipelining, etc.

James Campbell, Axel Nothnagel & Markus Vennebusch

### **Measuring Crustal Deformation in Europe by High Precision Geodetic VLBI**

Presentation: ORAL

At the western tip of the Eurasian plate, the European continent is besieged by thrusting and receding neighbour plates, causing deformations and ruptures of the Earth's crust, as evidenced by earthquakes and volcanic outbursts. Measuring the extent and progress of crustal deformation has become one of the primary tasks of geodesists and geophysicists. Realizing that Europe enjoys one of the densest networks of radio telescopes especially equipped for high precision geodetic VLBI has provided the incentive to organize a campaign of regular geodetic VLBI observations in the European network of fixed radio telescopes. The measurements have been carried out since the late eighties at an average rate of six sessions per year. From these data, site coordinates, baseline length changes and station velocity vectors have been derived with steadily increasing accuracy. The overall picture of the observed present-day site motions emulates quite well the pattern of tectonic motions inferred from the geotectonic setting of central Europe and the western Mediterranean. Interesting details are emerging for horizontal motions of the three stations in Italy, which are strongly affected by the complex interactions between the different tectonic regimes in this area. The results for vertical components are also improving with increasing length of the observational record, allowing the placing of upper bounds on the relative vertical motions of the sites.

The geodetic VLBI network operations have received supportive funding from the European Union under the current Framework Programmes.

P. Charlot, R. M. Campbell, W. Alef, K. Borkowski, J. E. Conway, A. Foley, S. T. Garrington, A. Kraus, A. Nothnagel, O. J. Sovers, C. Tringilio, T. Venturi & H. Xinyong

### **Improved Positions of Non-geodetic EVN Telescopes**

Presentation: ORAL

The European VLBI Network (EVN) has conducted a dedicated non-standard 5 GHz geodetic VLBI experiment in November 2000 with the goal of improving the positions of the Torun, Westerbork (single dish) and Jodrell Bank Mk2 telescopes. The geodetic coordinates of these telescopes were previously known to a few meters only, which is not sufficient for proper reduction of VLBI observations conducted in phase-referencing mode. The experiment design and data analysis will be discussed with special emphasis on the effects of the ionosphere, the dominating error source in such single-frequency observations. Based on various statistical tests, we estimate that the newly-derived telescope positions are accurate to about 5 cm. Additionally, improved geodetic coordinates of the nearby Lovell telescope in Jodrell Bank and Cambridge antenna were obtained using locally-derived ties. The position of the phased-array at Westerbork was derived from the

single-dish position through tracing the effects of the fringe-stopping algorithm. Overall, these new EVN telescope positions dramatically improve phase-referencing results.

A. Chuprikov

**An imaging software project Astro Space Locator (ASL for Windows). New methods and software abilities**

Presentation: ORAL

A new version of an imaging software project Astro Space Locator (ASL for Windows) being developed at the Astro Space Center is presented. The ASL software is oriented towards the processing of post-correlation VLBI and Space VLBI data. ASL can be used for image processing of data obtained from any modern VLBI instrument including the future SVLBI project "Radioastron" or the "Low Frequency VLBI Network (LFVN)" project being developed at the Astro Space Center. The new version of the ASL software contains the advanced procedures of Fringe Fitting and Hybrid Mapping. New methods and capabilities in the current version of the ASL software are demonstrated by processing data from VLBI observations organized at the Astro Space Center during recent years.

Giuseppe Cimò, T. P. Krichbaum, L. Fuhrmann, A. Kraus, T. Beckert, A. Witzel & A. Zensus

**Multifrequency Study of Intraday Variable Sources**

Presentation: ORAL

Intraday variability (IDV) of compact extragalactic radio sources is a complex phenomenon and shows a wavelength dependent mixture of refractive interstellar scintillation (RISS) (dominant at long cm-wavelengths) and source-intrinsic effects (dominant at shorter wavelengths). Detailed investigations of individual sources and new high frequency observations suggest a source-intrinsic contribution to the IDV pattern. However, the sizes of intraday variable sources at cm-wavelength are typically smaller than the scattering size set by the ISM in our galaxy and scintillation must be present, too.

We present new IDV observations in different regimes (from cm to sub-mm wavelengths) and show how such a multifrequency study can be used as a powerful tool to describe different aspects of IDV.

J.-F. Desmurs, F. Colomer, K. B. Marvel, R. Soria-Ruiz, V. Bujarrabal, J. Alcolea, P. J. Diamond, D. Boboltz & A. Kembal

**The Spatial Distribution of SiO Masers in AGB Stars at 43 and 86 GHz**

Presentation: ORAL

We present first VLBI images of the SiO masers in the circumstellar envelopes of AGB stars obtained with the newly developed capabilities of the Very Long Baseline Array (VLBA) at 86 GHz. We combine these data with those obtained at 43 GHz. This has allowed us to simultaneously observe multiple SiO maser transitions at these frequency bands towards the stars chi Cyg and TX Cam. These observations provide information on the structure and dynamics of the innermost circumstellar shells, where the return of large quantities of stellar material to the interstellar medium starts.

Phil Diamond (JBO)

**VLBI with the SKA**

Presentation: ORAL

The quest for resolution in previous decades has led astronomers to the development of Very Long Baseline Interferometry. However, with the advent of new, 8-m class optical telescopes and the funded development of fibre-optic connected radio interferometers of moderate resolution, it is clear that VLBI will eventually fall behind due to limited sensitivity. Intermediate measures, such as connecting VLBI telescopes with fibre-optic cables will help but, ultimately, astronomers will have to harness the power of the proposed Square Kilometre Array for VLBI studies. I will describe the results of a recent European workshop on high resolution options for the SKA and attempt to touch on some of the science that may be possible in the future.

S. Doleman and the 2mm-VLBI team.

**Successful 2mm Wavelength VLBI of SiO Masers and AGN**

Presentation: ORAL

In April 2002 an array of antennas operating at 129 GHz successfully detected VLBI fringes on both continuum AGN and SiO spectral line sources. The 129 GHz fringes represent the highest frequency spectral line VLBI detections to date. The array consisted of the University of Arizona 12m antenna, the Sub Millimeter Telescope Observatory 10m, and the IRAM 30m dish on Pico Veleta. These observations are the first fringes at any frequency at the SMTO and we discuss the technical challenges involved.

At 129 GHz, a number of evolved stars and several young stellar objects exhibit strong SiO maser emission in the  $v=1$  J=3-2 transition. Preliminary cross power spectra of VYCMa on the SMTO-12m baseline ( $\sim 160$ km) are consistent with multiple, spatially-separate maser spots associated with the star. We discuss phase mapping this emission and the implications for constraining the SiO maser pumping mechanisms and circumstellar dynamics around these objects. Future observations will include continuum observations of the Galactic Center SgrA\* and higher frequency maser lines including HCN and methanol.

Heino Falcke, Sera Markoff & Feng Yuan (MPIfR Bonn)

### **Jet-Domination in Sub-Eddington Black Holes**

Presentation: ORAL

With better sensitivity in radio and X-rays more and more detailed observations of sub-Eddington black holes are possible. This is especially important for Low-Luminosity AGN and X-ray binaries in the low/hard-state. Fitting the spectral energy distribution of these sources with a combined jet and disk model (either standard thin disks or ADAFs) we find that the contribution from jets becomes relatively stronger compared to the emission from the accretion disk. In that sense, sub-Eddington black holes tend to look more and more like BL Lac objects, albeit at much lower absolute flux levels. For that reason, there is now very strong evidence that the X-ray emission in some X-ray binaries and perhaps also LLAGN is in fact jet-synchrotron rather than disk emission. This allows one to explain a range of phenomena like, for example, the intriguing radio-X-ray correlation in some X-ray binaries. In turn this seriously constrains fundamental processes important for AGN physics, such as jet formation and particle acceleration.

Ed Fomalont & Sergei Kopeikin

### **Phase Referencing Using Several Calibrator Sources**

Presentation: ORAL

Phase referencing permits the imaging of faint radio sources, and the measurement of the accurate separation between sources. Even with fast temporal switching between a calibrator and target source, decorrelation becomes significant when calibrator-target separations become greater than a few degrees, producing a degradation of the image quality and in the astrometric accuracy. Motivated by the Jupiter-J0842+1835 near encounter in September 2002, we were given three days of VLBA observations in March 2002 to investigate the use of several calibrators near a target source in order to increase the positional accuracy.

Preliminary analysis of three 5-hour observations (simultaneous S/X-Band with fast switching among five calibrators) shows that a significant gain in coherence and astrometric accuracy can be obtained by properly combining the measured phases from several well-placed calibrators. This technique removes the slowly changing large-scale phase fluctuations associated with the ionosphere, dry atmosphere, EOP and antenna position errors. For baselines longer than about 2000 km and source-calibrator separations more than one degree, these phase errors produce more decorrelation than the short-term fluctuations caused by the wet atmospheric component and ionospheric events at frequencies between 1.4 GHz and 15 GHz.

S. Frey, L. Gurvits, A. Lobanov, R. Schilizzi, et al.

### **Space VLBI observations of the quasar 1351-018: tentative detection of apparent superluminal motion at $z=3.71$**

Presentation: POSTER

Sub-milliarcsecond resolution images of the extremely distant quasar 1351-018 ( $z=3.71$ ) were made using the VLBI Space Observatory Programme (VSOP) at two epochs. The high angular resolution of VSOP at 5 GHz allowed us to identify a jet component within 1 mas of the quasar radio core. The inner jet position angle is misaligned by  $\sim 120^\circ$  with respect to the 10-mas scale jet. The position of the innermost jet component has changed significantly over a period of less than 3 years, implying a proper motion of 0.18 mas/year which corresponds to an apparent superluminal speed. We present our imaging results and discuss the potential importance of the detection of superluminal motion in high redshift quasars.

S. Frey, L. Gurvits, D. Gabuzda, C. Salter, D. Altschuler, P. Perillat, M. Aller, H. Aller, H. Hirabayashi & M. Davis

### **Space VLBI monitoring of AO 0235+164**

Presentation: POSTER

The very compact, variable BL Lac object AO 0235+164 has been identified as the highest brightness temperature AGN observed with the VLBI Space Observatory Programme (VSOP) to date ( $T_B > 5.8 \times 10^{13}$  K). Since then the sub-milliarcsecond radio structure of the source has been studied with dual-frequency (1.6 and 5 GHz), polarization-sensitive VSOP observations at four different epochs during 2001 and 2002. Here we present the first results of this monitoring campaign. The source is weakly polarized and characterized by a radio core that is clearly resolved on space-ground baselines.

L. Fuhrmann, T.P. Krichbaum, G. Cimò, A. Kraus, T. Beckert, A. Witzel & J. A. Zensus

### **Compact Intraday Variable Radio Cores: New Observational Approaches**

Presentation: ORAL

The evidence for refractive interstellar scintillation (RISS) being the main cause for rapid intraday variations (Intraday Variability, IDV) in Quasars and BL Lacs has recently become very strong. If IDV is still a complex composition of extrinsic and source intrinsic effects, the intrinsic part of the IDV pattern should show up in the millimeter and sub-millimeter regime due to the frequency dependence of RISS. Hence, observations at higher frequencies are essential in order to exclude RISS as the sole cause of IDV. Here we report on our new attempt to search for rapid variations at much higher frequencies. In addition, the possibility of a direct detection of the scattering screen in front of IDV-sources will be discussed.

D. C. Gabuzda & I. N. Pashchenko

### **Multi-frequency Polarization Observations of 2007+777**

Presentation: POSTER

We present an analysis of multi-frequency (5, 8.4 & 15 GHz) VLBA polarization observations of the BL Lac object 2007+777. There is evidence for non-uniformity in the distribution of thermal gas in the vicinity of the AGN, with an enhancement of the rotation measure in the VLBI core region. 2007+777 is now one of several sources in a 1-Jy complete sample of BL Lac objects for which non-uniform thermal plasma has been detected on parsec scales. After correction for the rotation measure distribution, the polarization electric vectors coincide with the local jet direction; since the jet emission is optically thin, this indicates that the jet magnetic field is perpendicular to the local flow direction. This is probably associated with the presence of transverse shocks on parsec scales and/or of a high pitch-angle helical field associated with the VLBI jet.

D. C. Gabuzda & E. A. Rastorgueva

### **Rapid Evolution of the Parsec-Scale Structure of the Nearby BL Lac Object 1219+285**

Presentation: POSTER

We are studying the evolution of the parsec-scale structure of 1219+285 using a dense series of VLBI total intensity and polarization images at 1 and 2 cm obtained at nine epochs spanning three years. There is rapid evolution of the VLBI structure in some periods, with the appearance of the images sometimes changing drastically between epochs separated by only a few months. A number of superluminal components can be identified, and their motions will be analyzed to study the systematics of their motion from the core (e.g. evidence for acceleration or deceleration with distance from the core). 1219+285 is one of only a few active galactic nuclei for which there is good evidence for periodicity in the optical variability (Belokon et al. 2000). Further, our series of VLBI images will be used to search for possible correlations between various changes in properties of the VLBI structure and the optical variations.

D. C. Gabuzda

### **New 5-GHz VSOP Polarization Images of BL Lac Objects**

Presentation: ORAL

An analysis of 5-GHz space-VLBI polarization images of several BL Lac objects obtained using the HALCA orbiting antenna together with ground VLB arrays is presented. Such results are now available for



more than a half dozen compact AGN. The general tendencies shown by these high-resolution, relatively low-frequency images are discussed.

N. N. Garnich, D. C. Gabuzda & T. V. Cawthorne

### **Characteristic Evolution of the VLBI Structure of BL Lac Objects**

Presentation: ORAL

We are engaged in an ongoing multi-frequency, multi-epoch study of the VLBI properties of a complete sample of 1-Jy BL Lac Objects. Multi-epoch VLBI polarization observations at 6 cm have now been reduced for the entire sample. We present an analysis of the characteristic evolution of the VLBI structures of these radio-loud BL Lac objects. Our new results confirm that the superluminal motions displayed by the sample sources are systematically lower than for a similar sample of core-dominated quasars.

M.A. Garrett

### **The detection and imaging of distant star forming galaxies with next generation radio telescopes**

Presentation: ORAL

Next generation radio telescopes such as LOFAR, EVLA, eMERLIN, eEVN and SKA will be orders of magnitude more sensitive than existing facilities. I investigate and compare the ability of each instrument to detect radio continuum emission from distant star forming galaxies which are expected to dominate the faint sub-mJy and microJy radio sky. Using realistic spectral energy distributions (based on “local” starburst systems) I consider the Star Formation Rates that can be probed by these next generation radio telescopes and discuss the optimum frequency for deep surveys of the distant Universe in general. I also consider the use of “radio photometry” at meter, centimeter and millimeter wavelengths as a redshift indicator for obscured star forming galaxies at  $z > 5$ . I also discuss the application of the FIR-radio correlation and ultra-deep, wide-field Global VLBI as discriminators between AGN and starburst activity in distant galaxies.

S. Garrington, H. van Langevelde & A. Gunn

### **MERLIN and Global VLBI Observations of Theta 1 Ori A**

Presentation: ORAL

The Orion Nebula offers a unique opportunity to study the formation of both low and high mass stars at close hand and the Trapezium Cluster is the richest and densest young stellar cluster known in our Galaxy. High resolution VLA observations identified compact thermal sources, now known to be associated with the spectacular ‘proplyds’ revealed by the HST as photo-evaporating proto-stellar disks, as well as a number of non-thermal active stars. The brightest of these (Theta 1 Ori A) has been detected at VLBI resolution by Felli et al, but its nature has been unclear.

We discuss MERLIN observations which showed that the radio emission is associated with a companion (seen in IR speckle images) 200 mas from the primary. The IR colours suggest a  $4-5M_{\odot}$  pre-main-sequence star. We present new 6cm global VLBI observations of this object which show that it is barely resolved and discuss possible origins for such high brightness temperature emission in this type of star. Future multi-wavelength observations may shed more light on the emission mechanisms and offer the possibility of high precision astrometric measurements.

G. Giovannini, M. Giroletti, A.G. Taylor, et al.

### **Parsec-Scale Properties of Low Power Radio Sources**

Presentation: ORAL

There are several strong and widely accepted lines of evidences for the existence of relativistic bulk velocities in the parsec-scale jets of radio sources. Moreover it became evident recently that relativistic jets are present in high and low power radio sources. Observational results imply similar jet velocities with a Lorentz factor in the range 3 – 10 for radio galaxies, despite the variety in their large scale morphology and different total radio power. I will present VLBI data on 46 objects from a new sample of radio sources selected from the B2 and 3CR catalogues, with  $z < 0.1$ . Using these data I investigate the parsec-scale morphology of radio sources with different radio power and kpc-scale morphology. I will stress the evidence for high velocity

pc-scale jets in all sources and conclude that the properties of pc-scale jets are similar, regardless of the source total power and large-scale morphology. A few interesting objects will be presented in detail.

Nectaria Gizani, M. A. Garrett, R. Morganti, I. Gonzales-Serano & J. P. Leahy

### **A Multi-Wavelength Study of the two Unique Radio Galaxies Hercules A and 3C310 - The story so far.**

Presentation: POSTER

We are studying the two unique radio galaxies Hercules A and 3C310. We are trying to determine whether their unusual and similar structure and behaviour originates in a similar fashion or not. In other words we try to find why these sources are different from double-lobed AGNs. For this reason we are probing their pc- and kpc- scale environment using multi-wavelength observations across the electromagnetic spectrum.

Nectaria Gizani & M. A. Garrett

### **3C310 and Hercules A: The pc-scale Study**

Presentation: ORAL

We present the most recent results from the analysis of radio data on the pc-scale structure of two radio galaxies, namely Hercules A and 3C310. Both radio galaxies were observed at 18 cm, using the EVN-MERLIN and Global VLBI arrays respectively.

A faint but resolved radio source was detected in Hercules A by the EVN at 18 mas resolution with total flux density 14.6 mJy. Its measured size implies a brightness temperature  $\sim 2 \times 10^7$  K. There is evidence for extended emission in the NW-SE direction, most probably from the eastern pc-scale jet. If this is true then there is a misalignment between the direction of the pc-eastern and the aligned kpc-scale jets of about 35 degrees.

A possible misalignment exists also between the pc- and kpc-scale jets of 3C310 at 4 mas. Two compact components are detected in the core region with angular sizes  $8 \times 7$ , and  $8.8 \times 3.6$  mas. Their total flux densities are 9.5 and 8.8 mJy respectively. The global VLBI detected about 16% of the flux detected from the core region with the VLA at 4 arcsec. The implied brightness temperature is  $\simeq 6.12 \times 10^8$  K.

J. L. Gómez, et al

### **The inner jet: Intensive mm-VLBI monitorings vs. RHD+emission simulations**

Presentation: ORAL

The inner jet structure is analyzed by comparison between intensive mm-VLBI monitorings and relativistic hydrodynamic and emission simulations of jets. Continued monitoring of the radio galaxy 3C120 covering more than 3 years of monthly polarimetric mm-VLBI reveals a jet region where superluminal components flash on and off on timescales of months. This is interpreted as the interaction of the jet with a cloud, with properties intermediate between those of the broad and narrow emission-line regions. Furthermore, several radio knots are observed to appear in the wake of a new superluminal component, moving with proper motions about 4 times slower than any of the other moving knots observed in 3C120. These features have properties similar to those of the "trailing" shocks seen in relativistic time-dependent hydrodynamical and emission simulations of compact jets. This agreement between observations and simulations reinforces the idea that the non-linear fluid character of jets in AGNs and microquasars determines most of the observational features seen in these objects. As observed in the microquasar GRS1915+105, dips in the X-ray light curve of 3C120 are followed by the ejection of superluminal components, providing evidence for the existence of an inner X-ray accretion disk feeding the radio jets of 3C120. This represents the first confirmation for the black hole + accretion disk + radio jets scenario in an AGN.

Ioannis Gonidakis

### **SiO maser emission around the Mira variable TX Cam**

Presentation: ORAL

The general characteristics of the SiO molecule and its masing properties will be described. Some discussion about Mira variables, and TX Cam in particular, will follow and a movie of the 43 GHz SiO maser emission around this star will be presented. The new movie consists of 60 epochs, covering about 1.7 cycles of the star's phase. The physical conditions that can cause such a complex structure will be discussed.

J.C. Guirado (UV), E. Ros (MPIfR), D. Jones (JPL), W. Alef (MPIfR), J.M. Marcaide (UV) & R. Preston (JPL)

### **Searching for very low mass objects around nearby radio stars**

Presentation: ORAL

Nearby M-dwarfs are best suited for searches for very low mass companions. VLBI phase-referencing observations with sensitive telescopes are able to detect radio star flux densities of tenths of mJy, as well as to position the star on the sky with submilliarcsecond precision. We have initiated a long-term observational program, using EVN telescopes in combination with NASA DSN dishes, to revisit the kinematics of nearby, single M dwarfs. The resolution of the astrometry allows us to search for possible companions to these stars down to 1 Jupiter mass. In this contribution, we present preliminary results from the first experiments of this program.

L.I.Gurvits, J.Dennett-Thorpe & A.G. de Bruyn

### **From IDV to Space VLBI and back: the story of J1819+3845**

Presentation: ORAL

The quasar J1819+3845 is the most extremely variable extragalactic radio source known to date: at some phases of its seasonal activity, it shows peak to peak variations of more than 600% at 5 GHz, with just an hour between the minima. We will present results from a VSOP observation of this source at 5 GHz obtained with a ground-based array composed of the VLBA, phased VLA and WSRT tied-array. The latter two telescopes supplied also “single dish” (or “zero spacing”) flux density monitoring data during the VLBI experiment. In addition to a “traditional” VLBI self-calibration, we were able to study the light curves obtained on 78 baselines, simultaneously with the two “single dish” light curves from VLA and WSRT. These data, together with “traditional” VLBI techniques, allow us to make several conclusions on both the source sub-mas radio structure and the properties of the medium responsible for the scintillations.

Kazuya Hachisuka (University of Valencia)

### **Towards determination of the Outer Galactic rotation curve**

Presentation: POSTER

To determine the outer Galactic rotation curve, we observed the Galactic water maser source W3(OH), relative to an adjacent extragalactic continuum source, with phase-reference VLBI. The observations were carried out using the VLBA at 22GHz. The results of preliminary observations were as follows:

1. The phase referencing VLBI observation between maser and continuum source was successful.
2. The detected proper motions of maser sources were consistent with the predicted astrometric motion.

The preliminary results from these VLBA observations indicate that the detected proper motions of W3(OH) relative to the extragalactic source follow an elliptical orbit. The proper motions of masers due to Galactic motion, Solar motion and intrinsic motion are nearly linear; therefore, these orbits were mainly due to annual parallax. We also observed other Galactic water maser sources with the VLA. We found useful sources for phase referencing VLBI astrometry. We also report this result.

Y.Hagiwara (NFRA/WSRT), P.J.Diamond (JBO) & M.Miyoshi (NAOJ)

### **Recent observational results on extragalactic H<sub>2</sub>O masers**

Presentation: POSTER

Recently, two new extragalactic H<sub>2</sub>O masers were discovered during a single-dish monitoring survey using the Effelsberg 100m radio telescope. Subsequently they were observed with the VLA or VLBA to determine the distribution of the maser emission. We report on preliminary results from these follow-up observations at higher angular resolution.

A.Horneffer & H.Falcke

### **LOPES - Detecting Radio Emission from Cosmic Ray Air-Showers**

Presentation: POSTER

High energy cosmic rays, hitting the Earth's atmosphere, produce large amounts of secondary particles in an air-shower. Radio pulses from these air-showers were measured during the late 1960s in the frequency

range from 2 MHz to 520 MHz. These measurements ceased in the late 1970s, mainly due to difficulties with radio interference. LOFAR (Low Frequency ARray), the new digital radio interferometer under development, will work at 10-200 MHz, hence just in the range of interest for air-showers. Due to its fully digital nature it will be able to store the collected radio data for a short time and form beams after a transient event like an air-shower has been detected. With this ability LOFAR will be capable of detecting air-showers from  $> 2 \cdot 10^{14}$  eV to  $\sim 10^{20}$  eV.

To test this new technology we are building a “LOFAR Prototype Station” (LOPES). This will operate in conjunction with an existing air-shower array (KASCADE in Karlsruhe) to clarify the nature and properties of radio emission from air-showers and develop the software to use LOFAR as a cosmic ray detector. The same technology can be applied to other forthcoming digital radio telescopes like the SKA. In the long run such a digital radio telescope could in principle also form the northern part of the Pierre Auger Project.

T. Huege & H. Falcke

### **Radio-Emission from Cosmic Ray Air-Showers - A Theoretical Perspective for LOPES**

Presentation: POSTER

High-energy cosmic ray induced air-showers have been known for over 30 years to emit strong radio pulses in the regime from a few to a few 100 MHz (Allan, 1971). To date, however, a thorough analysis of the emission mechanisms has not yet been conducted. Adopting a simplified shower geometry and electron-positron energy distribution, we analytically calculate theoretical spectra in the scheme of synchrotron emission from highly relativistic electron-positron pairs gyrating in the Earth's magnetic field. Coherence effects arising from the low shower-thickness in relation to the observation wavelength significantly enhance the emission at frequencies  $< 100$  MHz. For a given observational bandwidth, the corresponding pulse shape can be reconstructed from the spectral information. These calculations will play an important role for the calibration of observational data on radio emission from cosmic ray air-showers acquired with LOPES and later LOFAR and SKA. We present a set of model calculations and compare them with empirical results and theoretical estimates (Falcke & Gorham, in press) to assess the ability of the model to reproduce known emission features.

Hiroshi Imai

### **A collimated jet of molecular gas from the AGB star W43A**

Presentation: POSTER

We present VLBA observations of the spatial and velocity distributions of 22 GHz H<sub>2</sub>O and 1612 MHz OH masers in the OH/IR star W43A. These masers have the same systemic velocity and are, therefore, likely to be associated with a common stellar object. However, their kinematic structures are quite different and independent. Most of the H<sub>2</sub>O masers are extremely collimated spatially and kinematically. The H<sub>2</sub>O maser jet also seems to be precessing. On the other hand, the OH masers exhibit clear arc-shaped structures, indicating an aspherically-expanding shell with weak collimation. The W43A jet is very likely to be predominantly composed of hot molecules traced by H<sub>2</sub>O maser emission and formed in the immediate vicinity of an unknown star next to another OH/IR star. Such a “molecular jet” is likely to appear only during the short period before a star forms an elongated planetary nebula.

M. Kadler, E. Ros, J. Kerp, A.P. Lobanov, H. Falcke & J.A. Zensus

### **The twin-jets of NGC 1052 – Radio and X-ray observations**

Presentation: ORAL

Multi-frequency studies of the pc-scale twin-jets in NGC 1052 have revealed the presence of a dense circum-nuclear absorber obscuring the central engine. We have observed NGC 1052 with the VLBA at 5, 8.4, 22 and 43 GHz, and used these observations to investigate the spectral properties and the brightness temperature distribution along the jet. In combination with an analysis of the frequency dependence of the core position this indicates a strong influence of free-free absorption in conjunction with steep pressure gradients at the bases of both jets.

Further constraints on the properties of the circum-nuclear absorber in NGC 1052 are obtained using the CHANDRA X-ray observatory. A rather moderate X-ray absorbing column density, substantially lower than previously published values, is derived from the nuclear X-ray spectrum. Imaging the extended X-ray emission reveals the presence of various jet-related X-ray emitting regions in NGC 1052: a bright compact core, unresolved knots in the jet structure, and an extended cavity of thermal gas. We compare the spatial

distribution of the hot X-ray emitting gas on kpc-scales with the radio structure derived from a MERLIN observation and an optical image taken by the Hubble Space Telescope.

K.I. Kellermann, M. Lister & I.I.K. Pauliny-Toth

### **The Diversity of GPS Radio Source Properties**

Presentation: ORAL

We discuss the wide range of properties observed for the GPS sources, 1345+12, 1607+26 (CTD93), 2134+004, and 2211+15 (CTA 102). While all four sources have classical core-jet structures, only the nearby AGN 1345+12 shows superluminal component motion near the base of a 250 parsec highly curved jet. Images of CTD 93 made 18 months apart have a remarkably identical core-jet structure with no evidence of any motions greater than 0.025 mas/yr (0.5c). CTA 102 appears to have a winding jet extending 17 mas to the south of a bright core. Rapid flux density variations in CTA 102 and evidence for Doppler boosting are in sharp contrast to the absence of observable motions in the jet. Although the low frequency spectral cutoff in GPS sources is probably mostly due to synchrotron self absorption, there is evidence that free-free absorption may be important in CTD 93 and 2134+004 as both sources appear to have a sharp spectral cutoff in the low surface brightness jets as well as the high surface brightness core components.

J. Klare, T.P. Krichbaum, A.P. Lobanov, E. Ros, A. Witzel & J.A. Zensus

### **The Quasar 3C345 at Highest Resolution with VLBA and VSOP**

Presentation: ORAL

The pc-scale jet in 3C 345 presents one of the best examples of component motion on helical paths. The VLBI images of this QSO typically show a core-jet structure formed by an unresolved, stationary, flat spectrum region (the “core”) and several partially resolved jet components ejected at apparent speeds  $\beta_{app} \sim 2-20$ . To better constrain the jet physics, we need to have a detailed view of the inner regions of the jet. To achieve this goal, this implies observing at the highest resolution available in intervals of months which can be achieved with VLBI observations made at high frequencies or with baselines longer than the diameter of the Earth (space-VLBI). We applied both approaches to 3C 345; we have observed the source between 1997 and 2000 with the VLBA at 16 epochs (7 at 22 GHz and 9 at 43 GHz), and with space VLBI at 8 epochs (4 at 1.6 GHz and 4 at 5 GHz). We present here these observations and discuss the properties of the jet and moving components on scales ranging from 0.1 to 20 mas. The jet components show superluminal motions on differently curved trajectories, with variable speeds and distinct flux changes.

Hans-Rainer Klöckner (Kapteyn Institute)

### **The Treasure Chamber in the OH Megamaser Mrk 273**

Presentation: ORAL

New EVN observations of the hydroxyl (OH main-lines) emission in the Megamaser galaxy Mrk 273 will be presented. Mrk 273 exhibits typical Megamaser properties and is morphologically peculiar, with a thin tidal tail extending up to 20 arcsec to the south of the central region as well as a faint fan-like plume to the north, suggesting an interacting or merging scenario of two disk galaxies. The central region, 15 arcsec in size, is revealed in the near infrared (NIR) to be 2 separate nuclei around 1 arcsec apart: a bright northern nucleus (300 x 500 mas) which is optically determined to be a Seyfert 2 nucleus and a less bright one towards the south west (Mazzarella & Boroson 1993, ApJS, 85, 27; Majewski et al. 1993, ApJ, 402, 125; Zhou et al. 1993, ApJ, 409, 149). In addition, radio observations show a third nucleus 800 mas away from the northern component towards the south east (Knapen et al. 1997, ApJ 490, L29).

Preliminary results of detailed imaging will be discussed and presented. The continuum (1.6 GHz) and line emission at 44x30 mas resolution reveal the kinematic and physical conditions in the central region of Mrk 273. Wherever possible the EVN detections are compared with VLBA HI absorption and continuum observations at a higher spatial resolution (Carilli & Taylor 2000, ApJ 532, L95). The observed continuum emission shows two compact emission features in the northern component, 100 mas apart, and reveals a slightly extended emission structure in the southern (east) component. The detected continuum emission features are consistent with the dominant sources observed with the VLBA at 1.3 GHz. With respect to the HI absorption the OH line emission has been detected only within the northern nucleus. The integrated emission spectra indicate a rather complex emission structure; a strong, 200 km/s broad 1667 MHz emission component showing three individual emission features and weaker 1665 MHz emission, possibly associated with these components. Compared to single dish observations we detect around 70 % of the 1667 OH peak flux density and miss a

weaker emission component within the velocity range of both OH lines (Baan et al. 1985, ApJ 298, L51; Yates et al. 2000, MNRAS, 317, 28). A similar (missing) emission component has also been observed in the Mega maser galaxy Mrk 231 (Klöckner, Baan & Garrett 2002, A&A, in prep.), indicating a more diffuse OH emission component spread within the nuclear region. This missing emission component will be discussed in combination with new WSRT observations.

H.Kobayashi, T.Sasao, N.Kawaguchi, S.Manabe (NAO, Japan) & T.Omodaka (U. Kagoshima)

### **Status of VERA: VLBI Exploration of Radio Astrometry**

Presentation: ORAL

VERA aims to make highly precise astrometry observations and highly sensitive VLBI observations. It consists of four 20-m diameter antennas as VLBI stations in Japan. The maximum baseline length is 2,300 km. It has a two beam receiving system and receives signals from two celestial objects simultaneously. Thus it makes fully phase-referenced VLBI observations. This technique leads to high accuracy astrometry from the phase referencing technique and highly sensitive observations from long time integrations. Our goal for astrometry observations is 10 microarcseconds, which means 10% accuracy for measurements of the distance to the Galactic Center from parallax observations. By using VERA, an accurate Galactic map of H<sub>2</sub>O and SiO masers and a three-dimensional velocity map will be generated. Thus the kinematics of the Galaxy will be revealed without the hypothesis of symmetry. We will show the current status of this project and the feasibility.

E. Körding, H. Falcke & S. Markoff

### **Are ultra-luminous X-ray sources microblazars ?**

Presentation: ORAL

ROSAT and Chandra observations discovered several ultra-luminous X-ray sources (ULXs) exceeding luminosities of  $5 \times 10^{39}$  erg/s . Assuming isotropic emission these sources should obey the Eddington limit suggesting the existence of intermediate-mass black holes of  $20 - 500 M_{\odot}$  . However, the measured inner disk temperatures are too high for these masses and there is no convincing creation mechanism known for these objects. Recently, Markoff, Falcke, Fender (2001, AA 372, L25) suggested that jets could be dominantly contributing to the hard X-ray emission from X-ray binaries (XRB) at least in the Low/Hard State, suggesting that some X-ray sources could be beamed. A beaming model could reduce the required black hole masses for ULXs to normal values. To test the hypothesis of beamed emission we consider a simple population synthesis model for XRBs, where the X-ray emission is produced by both jet (beamed) and accretion disk (isotropic). The model is tested on a combined dataset of X-ray point sources of nearby galaxies. It can explain the known population of ULXs with  $M < 10 M_{\odot}$  and bulk Lorentz factors for jets of  $\gamma_j \sim 5$ . If this is true, the ULXs would be the stellar-mass analogs of BL Lacs and Blazars in the universe. As a further hint to the prominence of jets we analyze the timing behavior of XRBs. Their statistical properties can be reproduced by extrapolating the behavior of BL Lac objects to XRBs.

Sergei Kopeikin (University of Missouri-Columbia, USA)

### **A general relativistic model for an experimental measurement of the speed of propagation of gravity by VLBI.**

Presentation: ORAL

A relativistic sub-picosecond model of the gravitational time delay in radio astronomical observations is worked out and a new experimental test of general relativity is discussed in which the effect of the retardation of gravity associated with its finite speed can be observed. As a consequence, the speed of gravity can be measured by differential VLBI observations. Retardation in propagation of gravity is a central part of the Einstein theory of general relativity which has not been tested directly so far. The idea of the proposed gravitational experiment is based on the fact that gravity in general relativity propagates with finite speed, so that the deflection of light caused by a body must be sensitive to the ratio of the body's velocity to the speed of gravity. The interferometric experiment can be done every time during the very close angular passage of a quasar by Jupiter. Due to the finite speed of gravity and orbital motion of Jupiter, the variation in its gravitational field does not reach an observer on Earth instantaneously but at the retarded instant of time, and should appear as a velocity-dependent time delay, additional to the well-known Shapiro delay caused by the static part of Jupiter's gravitational field. Such Jupiter-QSO encounters happen once in a decade. The next such event will take place on September 8, 2002 when Jupiter will pass by quasar J0842+1835 at an

angular distance 3.7 arcminutes. If radio interferometric measurements of the quasar coordinates in the sky are done with a precision of a few picoseconds, the effect of retardation of gravity and its speed of propagation may be measured with an accuracy of about 10%.

Y.Y. Kovalev

### **An EVN and RATAN-600 study of AGN undergoing strong radio flares**

Presentation: POSTER

The onsets of strong radio flares in several tens of AGNs have been detected, and their evolution studied using 1-22 GHz, 6-frequency instantaneous spectral monitoring of compact extragalactic objects in 1997-2002 with RATAN-600. We observed six of these sources twice with the European VLBI Network (including HartRAO) at 5 GHz, in February and September 1999. A resolution of about 1-3 mas was achieved. Results from this VLBI project are reported and discussed. It is inferred that more than 80% of the total emission from these sources comes from the mas scale. The flares started at the highest frequency and moved to lower frequencies in a regular fashion. A typical behavior of spectral evolution during strong radio outbursts in various objects is recognized, suggesting a common physical nature of the variability. The behavior of the flares is explained by synchrotron emission from an evolving blob in a compact relativistic jet of an active galactic nucleus. Different physical models are discussed considering the single dish and VLBI data.

T.P. Krichbaum, D. Graham et al. (on behalf of the mm-team)

### **New Results from Millimeter-VLBI Observations**

Presentation: ORAL

With the aim of achieving higher angular and spatial resolution, mm-VLBI tries to extend the standard VLBI observing technique towards shorter wavelengths. VLBI observations at 3 mm are nowadays performed with global antenna arrays consisting of up to 14 stations. The number of radio telescopes presently capable of doing VLBI at wavelengths shorter than 3 mm is still limited, but is expected to increase within the next few years. In recent years several VLBI test experiments in the 2 mm and 1 mm bands have been performed to investigate future possibilities. Here we report on the most recent results achieved.

A.P. Lobanov, T.P. Krichbaum, D.A. Graham, A. Medici, A. Kraus, A. Witzel & J.A. Zensus

### **An 86 GHz VLBI survey of compact radio sources.**

Presentation: POSTER

We present here our ongoing VLBI survey of compact radio sources at 86 GHz, and compare it with earlier VLBI surveys made at this frequency. The ongoing survey will increase the total number of objects imaged at 86 GHz by a factor of 3-5 (with a baseline sensitivity of  $\approx 0.1$  Jy and image sensitivity of better than 10 mJy/beam). Such an expanded 86 GHz database will be essential for implementation of the VLBI technique in space and at shorter wavelengths. The survey data will also advance both observational and theoretical studies of extragalactic jets, since it probes those regions of extragalactic jets where radio emission reflects the dynamics and physics of the central engine of active galactic nuclei.

A.P. Lobanov & J. Roland

### **A supermassive binary black hole system in the quasar 3C345**

Presentation: POSTER

Most active galactic nuclei (AGN) present a remarkable variety of signs pointing towards periodical processes determining the observed properties of this class of extragalactic objects. It is expected that these processes must be taking place in the very center of an active galaxy, thereby being related to the core of the AGN. We propose here the hypothesis that most AGN contain supermassive binary black hole systems, in which the orbital motion and precession are ultimately responsible for the observed broad-band emission variations, as well as for the morphological and kinematic properties of the radio emission on parsec scales. We apply this scenario to the archetypical quasar 3C345, and show that our model explains the observed variations of radio and optical emission from the quasar, and reproduces the structural variations observed in the parsec-jet of this object.

A.P. Lobanov & J.A. Zensus

## **Internal structure of compact relativistic jets**

Presentation: ORAL

We present the first direct evidence for the presence of plasma instability in an extragalactic relativistic jet, based on analysis of VSOP observations of the quasar 3C273 made at 5GHz. In the VSOP image of 3C273, the emission across the jet is resolved, revealing two threadlike patterns that form a double helix inside the jet. We have identified 5 wavelengths contributing to the appearance of the patterns inside the jet. These wavelengths are in good agreement with the predicted wavelengths of several modes of Kelvin–Helmholtz (K–H) instability developing in a light jet with Lorentz factor of 2 and Mach number of 3.5. The K–H instability description reproduces in detail the internal structure of the jet on scales of up to 300 parsecs.

F. Mantovani et al.

## **Global VLBI observations of the CSS 2147+145**

Presentation: POSTER

An image of the CSS source 2147+145 obtained with VLBI MK3 Mode B global observations at 18 cm will be presented. The new image shows a 'new component' not detected in previous observations. Previous images showed a core-jet structure with a sharp bend in the jet  $\sim 40$  mas from the core. The new component is found on the opposite side of the jet and also shows a jet-like feature. The classification of 2147+145 as a possible CSO candidate is discussed.

J.M. Marcaide, A. Alberdi, M.A. Pérez-Torres, J.C. Guirado, L. Lara, E. Ros, P. Diamond, F. Mantovani, I.I. Shapiro, K.W. Weiler, R.A. Preston, R.T. Schilizzi, R.A. Sramek, C. Tringilio, S.D. Van Dyk & A.R. Whitney

## **How is the expansion of SN1993J really decelerating ?**

Presentation: ORAL

SN1993J in M81 has now been intensively studied with VLBI for almost ten years. The deceleration of its expansion has been established by two groups using independent VLBI data. Also optical results have added to (or confused) the understanding of the fine details of the deceleration. Since changes in the angular growth of the radio supernova are closely related to changes in the density profiles of the CSM and/or the ejecta, the understanding of the details of the deceleration is a very relevant question. We will present our latest results, analyze the expansion of SN1993J over almost three thousand days, and present a likely emission scenario.

E. Massaro, F. Mantovani, R. Fanti, R. Nesci, G. Tosti & T. Venturi.

## **Structure changes in two BL Lac Objects: ON231 and OQ530**

Presentation: POSTER

Results from follow up observations will be presented for two BL Lac objects, namely ON231 and OQ530. The first EVN images of ON231 at 1.6 GHz and 5 GHz showed these pertinent features: a two-sided jet structure and a low brightness extension South-East of the main jet. The new EVN image obtained from observations done 3 years later at 5 GHz will be compared with the previous one and discussed. A similar comparison will be made for OQ530. We have images of this object separated in time by 3 years, which will be compared with previous images from the literature. The BL Lac objects ON231 and OQ530 were selected because of their long term optical trends. Their optical behaviour will be compared with the changes in the radio structure and discussed.

Maria Massi & Eduardo Ros (Max Planck Institut fuer Radioastronomie)

## **Structure of the Corona of UX Arietis**

Presentation: POSTER

We present a time series of VLBA+Effelsberg images of the RS CVn binary system UX Arietis taken during four almost consecutive days. Two main gaussian components can always be distinguished in each map along with their sequential evolution. The origin of this evolution can be traced out from geometrical factors (i.e. star rotation) and from physical changes (i.e. flares).

A. Medici & A. P. Lobanov



## **Models for studying the broad-band distributions of brightness temperature of radio emission from compact, extragalactic jets.**

Presentation: ORAL

The brightness temperature distribution is a powerful tool to study the conditions in extragalactic radio sources and to test models proposed for the inner jets. In this talk we will present a model which describes the brightness temperature distribution in terms of randomly oriented sources and a) a single value for the intrinsic brightness temperature and Lorentz factor or b) a function which describes the distribution of these two parameters.

E. Middelberg, A. L. Roy, R. C. Walker, H. Falcke & T. P. Krichbaum

## **Higher Sensitivity VLBI imaging with Fast Frequency Switching**

Presentation: ORAL

Millimeter-VLBI is an important tool for studying AGNs, but is limited by short atmospheric coherence times and relatively poor system performance. We demonstrate a new kind of phase referencing with the VLBA that is able to improve the sensitivity of mm-VLBI by an order of magnitude. One observes a weak source while cycling between the target frequency  $\nu_t$  and a lower reference frequency  $\nu_{ref}$ . The visibility phases at  $\nu_t$  are calibrated using the self-calibration phase solutions at  $\nu_{ref}$  scaled by the frequency ratio. We have demonstrated the technique on 3C 279, where we made a 3 mm image which showed 90 % coherence over 10 min, based on phase transfer from 7 mm. We describe the scheduling strategy and data reduction of our experiment.

The main impacts of Fast Frequency Switching are 1) the ability to image some of the nearest AGN cores that are too weak for self-calibration at 3 mm and 2) the ability to phase-reference the  $\nu_t$  data to the  $\nu_{ref}$  core position. This enables one to image weak AGN cores with unprecedentedly high resolution and to detect core shifts in jets produced by optical depth effects. Thus we can discriminate between the two competing models of conical jets and spherical advection-dominated accretion flows.

Vincent Minier

## **Methanol masers and the earliest stages of massive star formation**

Presentation: ORAL

6.7 and 12.2 GHz methanol masers were originally detected towards active star-forming regions. Since their discovery a decade ago, their role and their location have been better understood using high resolution interferometers. Observations with the EVN and the VLBA have shown that methanol masers are clearly associated with the earliest stages of massive star formation. They arise in hot molecular cores (HMC) and in hyper-compact regions of ionised gas (HC HII regions). These recent results obtained with the EVN and the VLBA (Minier et al. 2000, 2001) will be reviewed in this oral presentation.

More recently, millimetre continuum observations of the methanol maser sites have revealed nearby cold condensations only seen at mm and sub-mm wavelengths (Minier et al. 2002). These cold cores are interpreted as pre-stellar condensations of dust and gas, in a phase prior to the HMC phase. Methanol masers can then signpost protoclusters containing massive young stellar objects at various early stages: cold cores, hot cores and hyper-compact HII regions; moreover, methanol masers within these clusters could indicate the position of young massive stars.

An evolutionary sequence for massive star formation will be presented in connection with the evolution of methanol masers. I will also discuss how EVN observations of these masers could provide us information on the kinematics (disk, outflows) and the physical conditions (density, temperature) within the protoclusters of massive young stellar objects. Finally, the possibility of observing methanol masers at millimetre wavelengths with the EVN will be presented.

I. Molotov, S. Likhachev, B. Lipatov, A. Dementiev, Yu. Gorshenkov, A. Kovalenko, A. Konvalenko, C. Stanghellini, G. Tuccari, X. Hong, X. Huang, S. Dougherty, R. Shanks, X. Liu, A. Kus, K. Borkowski, J. Quick, G. Nicolson, S. Ananthakrishnan, M. Sankararaman, I. Shmeld & E. Bervalds

## **Goals and results of ad-hoc VLBI activity with Russian antennas**

Presentation: POSTER

Russia experienced a crisis situation in the field of VLBI since the only modern VLBA recording terminal was returned to NRAO in 1994. Therefore a special program was started in 1996 in order to establish

an international VLBI cooperation including some Russian radio telescopes. This project was entitled the International Low Frequency VLBI Network. The old Mk-2 equipment from JPL and NRAO was repaired and installed at Bear Lakes, Puschino, St. Pustun and Zimenki in Russia, Evpatoria in Ukraine, GMRT and ORT in India and Ventspils in Latvia. New Canadian S2 recorders were installed at Bear Lakes and Puschino. Direct connections were established with the radio telescope stations around the world which are equipped with S2 recorders or which keep operational Mk-2 terminals. A few Mk-2 and S2 experiments were then arranged during 1997-2000 at 92-cm and 18-cm wavelengths, using various combinations of the above-mentioned antennas plus Green Bank, Arecibo, HartRAO, Shanghai, Urumqi, Noto, Medicina, Torun and Svetloe stations. The first Mk-2 session was processed on the JPL/Caltech Block II correlator. A Russian Mk-2 correlator has been developed at RRI, N. Novgorod for processing the remaining Mk-2 experiments. Four 18-cm S2 experiments were successfully correlated at Penticon, DRAO, Canada. The post-processing was carried out at ASC, Moscow, Russia. The ASC is also developing its own S2 correlator project. In this report the scientific goals of this VLBI activity, results obtained so far and further plans are presented.

I. Molotov

### **Two-year program to upgrade Bear Lakes RT-64 for EVN membership**

Presentation: POSTER

The 64-m dish radio telescope was erected at Bear Lakes near Moscow, Russia in 1979 and was fruitfully used for goals in astronomy, deep space communication and education over a very long time period. The last VLBI experiment of Bear Lakes RT-64 in a global VLBI network was in 1993, using a MARK-2 recording terminal. The idea of EVN membership for this telescope has existed practically from the time of the EVN's foundation, but it was not realized because of the lack of a modern VLBI recorder and insufficient governmental financing. Nevertheless, Bear Lakes RT-64 regularly participates in domestic VLBI activity and VSOP co-observing. There is a plan to upgrade RT-64 for EVN membership under INTAS-IA-01-02. The project supposes verification of the current condition of the antenna construction and infrastructure, its rehabilitation where necessary, equipping with modern radio astronomy apparatus (6 radio astronomy receivers, GPS-receiver, FS computer, base-band converters and MARK-5B terminal), and arranging first test VLBI co-observing with the EVN. Some recent VLBI results that were obtained with the participation of Bear Lakes RT-64 will be presented in this report.

R. Morganti, A. Peck, T. Oosterloo et al.

### **Thin disks and HI absorption in the centre of low power radio galaxies**

Presentation: ORAL

Recent results at different wavelengths have shown that the nuclei of low luminosity (i.e. Fanaroff-Riley type I) galaxies appear basically unobscured, i.e. the standard pc-scale, geometrically thick torus is not present in these objects. Optical cores are observed with HST in a high fraction of them and the fraction of these radio galaxies showing HI absorption is low.

However, some of the HI detections are intriguing; we find at least two galaxies where HI absorption is detected (on the arcsec scale) but the optical core appears also well visible (so not much obscuration is expected). These galaxies have been observed with a global VLBI experiment with the aim of finding whether the neutral gas is, as some indications suggest, in a disk-like structure (although other possibilities do exist) and, if so, whether this structure has the same characteristics (e.g. inclination, thickness) of the dusty disks observed with HST in these galaxies.

Here, the results obtained in the case of the radio galaxy NGC315 will be presented.

L. Mosoni, S. Frey, Z. Paragi, I. Fejes, L. Gurvits, E. Fomalont, W. Scott & P. Edwards

### **High resolution radio structure of the compact quasar 1546+027 observed with Space VLBI**

Presentation: POSTER

A 5-GHz VLBI Space Observatory Programme (VSOP) image of the quasar 1546+027 is presented with an unprecedented angular resolution at this observing frequency. The source is a very compact quasar which was unresolved in the 5-GHz VSOP/VLBA Pre-launch Survey. This quasar has been studied in almost every spectral region (radio, optical, X-rays and  $\gamma$ -rays). The observations presented here were made in August 2000, using four antennas of the European VLBI Network (EVN) and the HALCA satellite. The VSOP image shows changes in the source structure compared with earlier ground-based VLBI observations. According to total flux density monitoring data taken from the literature, 1546+027 had an outburst at the end of 1995. At

the time of our observations, the source flux density was decreasing. If we suppose that the structural changes are connected with the outburst, then 1546+027 is a good candidate for detecting apparent superluminal motion in its radio jet.

K. Murakawa, J. A. Yates & A. M. S. Richards

### **A study of OH and H<sub>2</sub>O masers in the circumstellar envelopes around Miras**

Presentation: POSTER

We have obtained OH and H<sub>2</sub>O maser emission maps of Miras (IK Tau/U Ori) using the EVN/global VLBI and MERLIN. We achieve a spatial resolution of about 10 mas for both maser emission lines. Our maps show that H<sub>2</sub>O masers are found close to the star, in a well-filled shell with an equatorial density enhancement around IK Tau. The OH mainline masers appear to spread biconically out of the water maser shell along the polar axis. It is possible that greater starlight penetration in these directions favours the OH maser population inversion.

A. Orfei, M. Morsiani, G. Zacchiroli, G. Maccaferri, J. Roda & F. Focchi (CNR - IRA, Bologna, Italy)

### **The Active Surface System of the Noto Radiotelescope**

Presentation: ORAL

The antenna efficiency of large parabolic antennas is strongly affected by the effect of gravity on the mechanical structure. The parabolic shape may be ideal at the elevation used for panel alignment but, as the antenna points at different positions on the sky, the mirror deforms, losing its ideal shape and consequently the antenna gain reduces. A way to overcome this effect is moving the panels, recovering the ideal shape at every elevation. This can be done because gravity induces repeatable deformations, so they can be measured and compensated. In this paper we describe a solution, realized on the 32m Noto radio telescope and completed at the beginning of 2002, to overcome this effect. This new setup allows an increase in the operating frequency and eliminates the elevation dependence of the antenna efficiency. The electro-mechanical actuators will be described, as well as the structure of their connecting network, together with panel alignment tools and the first results obtained.

Z. Paragi, I. Fejes, R.C. Vermeulen, R.T. Schilizzi, R.E. Spencer & A.M. Stirling

### **The Equatorial Outflow of SS433**

Presentation: ORAL

SS433 is a well-known Galactic microquasar with mildly relativistic anti-parallel radio jets. In addition there is radio emission quasi-perpendicular to the jets. This so-called Equatorial Emission Region indicates the presence of a massive outflow (also evidenced by observations at other wavelengths, from X-rays to IR) in the equatorial plane of the central binary system.

We present global VLBI images of SS433 at 1.6 GHz. The Equatorial Emission Region clearly changes with time. There are times when it is quite smooth but brighter features appear frequently. It is possible that these components are related to shocks developed by a fast disk-wind from the central binary system. In this scenario the equatorial region must change with the precession cycle of the radio beams and the disk itself.

Z. Paragi, A.M. Stirling & I. Fejes

### **The spectrum of SS433 jet components during outburst**

Presentation: POSTER

SS433 was observed in a flaring state on 18 April 1998 with the VLBA at four frequencies. We present the spectral index distribution of the ejected plasmons and compare their evolutionary state with the Van der Laan (1966) model. The components are optically thin at all frequencies. Their spectra cannot be simply interpreted, either by expanding synchrotron bubble events or by single shocks.

J. M. Paredes, M. Ribó, E. Ros, J. Martí & M. Massi

### **EVN and MERLIN confirmation of the LS 5039 jets**

Presentation: POSTER

The microquasar nature of LS 5039 was revealed from May 1999 VLBA+VLA observations showing a two-sided jet at milliarcsecond scales. Follow-up interferometric observations were carried out with the EVN and MERLIN at 5 GHz in March 2000. The maps obtained with both the EVN and MERLIN show two-sided jets with a position angle similar to the previous VLBA+VLA map. The total length of the jets is  $\sim 50$  mas in the EVN map and  $\sim 300$  mas in the MERLIN map. A brightness asymmetry, compatible with the earlier observations, is also present in the maps, suggesting Doppler boosting effects. Overall, these observations confirm the existence of a two-sided jet structure in LS 5039 and seem to indicate their persistent nature.

M.A. Perez-Torres, A. Alberdi, J.M. Marcaide, J.C. Guirado, L. Lara, F. Mantovani, E. Ros & K. Weiler

### **5-GHz high-resolution imaging of SN1986J in NGC891**

Presentation: ORAL

We have obtained a VLBI image of supernova SN1986J in NGC891 at 5 GHz, about 16 yr after its explosion. The image shows a distorted shell of radio emission, indicative of a strong deformation of the shock front. The average speed of the shell has decreased from  $\sim 7400$  km s $^{-1}$  in 1988.74 down to about 6300 km s $^{-1}$  in 1999.14, indicative of a mild deceleration in the expansion of SN 1986J. Assuming a standard density profile for the progenitor wind ( $\rho_{cs} \propto r^{-s}$ ,  $s = 2$ ), the mass swept-up by the shock front is  $\sim 2.2M_{\odot}$ . This large swept-up mass, coupled with the mild deceleration suffered by the supernova, suggests that the mass of the hydrogen-rich envelope ejected at explosion was  $\geq 12M_{\odot}$ . Thus the supernova progenitor must have kept intact most of its hydrogen-rich envelope by the time of explosion, which favours a single, massive star progenitor scenario. We detect four bright knots that delineate the shell structure, and an absolute minimum of emission, which we tentatively identify with the centre of the supernova explosion. If this is the case, SN 1986J has then suffered an asymmetric expansion. We suggest that this asymmetry is due to the collision of the supernova ejecta with an anisotropic, clumpy (or filamentary) medium.

Michele Pestalozzi, Roy Booth, John Conway & Vincent Minier

### **Methanol masers at high resolution**

Presentation: ORAL

Methanol masers are known to be tracers of intense star formation activity. They are often associated with maser emission of other species e.g. H<sub>2</sub>O and OH, as well as with strong IR radiation and ultracompact (UC) HII regions. These are all signposts for massive star formation. Searches for the strong methanol maser emission at 6.7 and 12.2 GHz have been conducted using different techniques, either by selecting targets according to special criteria or by systematically surveying large regions of sky. The latter way is the one followed at the Onsala Space Observatory, where an extensive search for methanol masers in the northern hemisphere has been running since 1999. The main results are the discovery of new methanol masers at 6.7 GHz, which do not seem to be associated with the other usual observational signposts that characterise most of the known methanol maser sources. We have conducted a follow-up observational campaign towards the newly detected sources, during which we have used the EVN to map the methanol maser emission at high spatial resolution. Since these observations preceded the introduction of the 32 m antenna at Cambridge to the 6.7 GHz network, we reobserved our list of targets using the single baseline between Cambridge and Jodrell-Bank in a later run, in order to have the information from the short baseline. The analysis of the separated datasets reveals that the shortest EVN baseline (without the Cambridge antenna) is enough to resolve out a significant amount of extended emission from the methanol maser sources.

We present a collection of results from the *missing flux studies* we have conducted by comparing data from the short British single baseline observations with the "basic" EVN network observations at 6.7 GHz.

R.B. Phillips, A.N. Straughn, C.J. Lonsdale & S.S. Doeleman

### **Simultaneous 3mm and 7mm Observations of SiO Masers Around R Cassiopeiae: The Maser Line Ratios**

Presentation: ORAL

We have carried out simultaneous 3mm and 7mm VLBI observations of the SiO masers surrounding the long-period variable red giant R Cassiopeiae (R Cas). Both the  $v = 1$ ,  $J = 2 \rightarrow 1$  (3mm) and  $J = 1 \rightarrow 0$  (7mm) transitions appear as incomplete rings. For the first time, the bright masers at 3mm and 7mm from an evolved star could be spatially registered on the sky. We derive line ratios for the first two rotational transitions of the  $v = 1$  state. Line ratios vary by more than two orders of magnitude, depending on location in the ring.

The overall attributes of the two  $v = 1$  rings are consistent with the current model of Humphreys et al (2002), which combines a stellar pulsation model with a realistic SiO maser model, leaving the radiative part of the pump constant. We confirm a number of properties predicted by Humphreys et al, including a lone maser isolated over the disk of the underlying star. Finally, in this image made near minimum maser light, an arc-like ‘cap’ of masers shows highly ordered radial velocities which suggests rotation of the maser shell. This contrasts with recent 3mm VLBI images of R Cas showing only localized or chaotic velocity structure near maximum maser light.

A.G. Polatidis

### **Expansion velocities in Compact Symmetric Objects**

Presentation: ORAL

We will report on recent global VLBI observations which measured new, and refined previously known, expansion velocities and will summarize the implied kinematic ages in Compact Symmetric Objects (and “double-double” radio galaxies). We will also present other age estimates, measuring the spectral ageing of electrons in the lobes from recent multi-frequency VLBI observations. A short discussion will be given on limits on side-to-side motions of hotspots and the implications for evolution models of CSOs.

A.G. Polatidis & S. Aalto

### **MERLIN observations of atomic and molecular gas in starburst galaxies**

Presentation: POSTER

We present MERLIN observations with a linear resolution 30-100 pc of the radio continuum, HI absorption and the OH megamaser emission or OH absorption of 4 starburst/AGN galaxies. In all cases the radio continuum arises in a disc-like structure, thought to be synchrotron emission from electrons accelerated by supernovae, and elongated along the major axis of the optical image. This continuum provides an ideal background for the HI absorption which, along with the 1667 OH megamaser emission, arises in rotating structures with diameters of a few tens to a few hundred parsecs. The OH emission region has, on average, a size smaller than the HI absorbing region. These observations enable us to constrain the dynamics of these objects on <500 pc scales and to study the physical conditions of the circumnuclear atomic and molecular gas.

R. W. Porcas, M. A. Garrett & S. Nair

### **EVN+MERLIN/Global observations of the gravitational lens 2016+112**

Presentation: POSTER

The gravitational lens system 2016+112 is something of a puzzle. It seems to be “almost a quad”; the 3 image regions contain 2 clear images of a single, 2-component radio source, and an elongated structure which is best interpreted as 2 further (partial) images of the same source. The exact details of the relationship between the full and partial images, however, remain obscure. We will present results from recent EVN+MERLIN/Global observations at 1.6 and 5 GHz, designed to explore the image structures.

R.W. Porcas & M.J.Rioja

### **VLBI phase-reference investigations at 90 GHz**

Presentation: POSTER

We describe the results of a 90 GHz phase-reference investigation using observations made with the (dynamically scheduled) VLBA. We attempted rapid switching between the two strong, flat-spectrum sources 1308+326 and 1308+328, using cycle times from 20 to 40 s to try and follow the rapid temporal fluctuations of the atmospheric phase. Both sources were detected in longer, 2-minute scans, and the stronger (1308+326) was detected in some of the short, rapidly-switched scans, in a way that allows the phase to be followed between scans. We investigate the transfer of the interpolated 1308+326 phase to the weaker source, 1308+328.

E. Preuss

### **The beginnings of VLBI in Effelsberg**

Presentation: ORAL (in Effelsberg)

This will be an informal review of the beginnings of VLBI at the 100m telescope in Effelsberg. It will include short remarks on the technical, instrumental and scientific aspects, the people involved and the prime motivations arising from AGN and molecular maser research.

M. Ribó, E. Ros, J. M. Paredes, M. Massi & J. Martí

### **EVN+MERLIN observations of microquasar candidates**

Presentation: ORAL

In an attempt to increase the number of known microquasars we have carried out a search for new Radio Emitting X-ray Binaries (REXBs), which are the sources to be inspected later with VLBI techniques to unveil their possible microquasar nature. For this purpose we have performed a cross-identification between the X-ray ROSAT all sky survey Bright Source Catalog (RBSC) and the radio NRAO VLA Sky Survey (NVSS) catalogs under very restrictive selection criteria for sources with  $|b| < 5^\circ$ . We have also conducted deep optical, and multifrequency VLA, studies of 6 of the selected candidates. VLBI observations of these sources were also carried out in February 2000 with the EVN+MERLIN at 5 GHz. Five of the six observed objects have been detected, presenting different morphologies: one source with two-sided jets, three sources having a one-sided jet and one point-like source. With all the available information up to now, we conclude that two of the sources are good microquasar candidates in our Galaxy.

M.J. Rioja, R.W. Porcas, J.F. Desmurs, W. Alef, L.I. Gurvits & R.T. Schilizzi

### **VLBI observations in Cluster-Cluster mode at L-band**

Presentation: ORAL

We present the results of joint observations in “cluster-cluster” mode at L band between subgroups of antennas from WSRT, VLA and MERLIN arrays. The observations consisted of 6-hours, on two consecutive days, of simultaneous monitoring of 4 sources with angular separations ranging from  $\sim 1$  to 9 degrees. The processing was successfully done using the MK3 correlator at MPIfR. We investigate the potential of observations in cluster-cluster mode applied to phase-referencing and astrometric projects.

A.E.Rodin

### **Pulsar VLBI observations**

Presentation: ORAL

Pulsar VLBI coordinates, when combined with timing coordinates based on the analysis of time of arrival of pulsar pulses, provide a link between quasars, and other AGNs, and the planetary ephemeris dynamical reference frames. Pulsar parallaxes gives distances to pulsars directly. Pulsar proper motions, along with pulsar ages, help to determine the birth places of pulsars.

The main limiting factors in obtaining maximal accuracy of pulsar positions are:

- 1) low signal to noise ratios (SNR) caused by pulsar weakness and short integration times
- 2) fluctuations of electron density in the Earth ionosphere, which affects the propagation time of pulsar signals.

It is possible to increase the SNR by extending the coherence time to a few hours, using the phase-reference technique, which excludes the bulk of the phase variations due to clock and atmospheric instabilities (Lestrade, 1993). Another way to increase the SNR in pulsar VLBI is to use the pulsating property of pulsar signals (Sekido, 1994). It is possible to correlate only when the pulse is “on”. This approach increases the SNR  $\propto \sqrt{P/w}$ , where  $P$  = pulsar period,  $w$  = pulse width, and requires prediction of the pulsar phase and period (Rodin).

This paper presents the results of processing Japan – Russia pulsar VLBI observations.

E. Ros, K.I. Kellermann, M.L. Lister, J.A. Zensus, M.H. Cohen, R.C. Vermeulen, M. Kadler & D.C. Homan

### **Kinematics of parsec-scale structure in AGN: the VLBA 2cm Survey**

Presentation: POSTER

We are investigating the kinematics of the jets in AGNs (QSOs, BL Lacs, Radio Galaxies, Empty Field objects) on parsec scales by studying a representative population of sources, rather than following a few individual sources or a specific class of source. This study is being carried out using the Very Long Baseline Array at 15 GHz, with more than 800 images taken since 1994. We present an overview of the diversity of kinematics

including the distribution of Lorentz factors, the jet bending, pattern motion and other complexities. Our goal is to compare the kinematical results with other source properties, such as multiwavelength luminosity, variability, or radio morphology.

Emmanouel Rovilos

### **OH Megamasers**

Presentation: ORAL

Recent results from MERLIN observations of the OH maser and continuum emission of Arp 220 will be presented, which show the correlation between the continuum and the maser peaks. Recently reduced VLBA data on two southern OH Megamaser galaxies, IRAS 10039-3338 and IRAS 20100-4156, will also be presented.

R.T. Schilizzi (JIVE)

### **Fibres and Disks: the eEVN and PC-EVN projects**

Presentation: ORAL

I will present the current status of two development projects being pursued within the EVN:

(i) eEVN - the connection of the EVN telescopes and Data Processor by commercially operated, optical fibre networks. The first tests are expected to take place later this year, initially involving Jodrell Bank, Westerbork, and the EVN Data Processor at JIVE.

(ii) PC-EVN - a project led by JIVE and Metsahovi to replace current MkIV and VLBA tape recorders with a true COTS PC disk-based recording system. This PC-EVN system will form an integral part of the eEVN data acquisition system.

Both developments are expected to result in significant improvements to the EVN, permitting GHz of bandwidth to be employed, thus increasing continuum sensitivity and enhancing uv-coverage. In the case of the eEVN, real-time observations will also be possible.

K. V. Semenov, M. V. Popov & V. A. Soglasnov

### **A search for interstellar scattering of pulsar B0329+54 with VLBI**

Presentation: ORAL

The talk deals with the data reduction and interpretation of results from SVLBI observations of pulsar B0329+54 at 1.6 GHz. The purpose of these observations was to measure the scattering angle. Additional steps for amplitude calibration of pulsar data (bandpass correction, correction for incommensurability of pulsar period and correlator integration time, correction for intrinsic pulsar variability) are described. Software implementing these techniques has been developed. The estimated size of the scattering angle is less than 1.6 mas. An attempt to trace apparent source position changes induced by scattering has been made.

Mosalam Shaltout (Menofia University, Egypt)

### **A 32 meter Radio Telescope in the Arabian Region**

Presentation: ORAL

The building of a Radio Telescope at Abu Simbel in the South of Egypt as part of the European VLBI Network (EVN), to cover the gap between the radio telescopes in western Europe and the radio telescope at Hartbeesthoek in South Africa, is very important. The telescope can be used for solar and stellar observations at wavelengths ranging from centimeters to millimeters, and for geodetic VLBI studies. The suggested diameter of the telescope is 32 meters and it is expected to work at frequencies from 1.4 to 43 GHz. Abu Simbel is characterised by excellent atmospheric transparency, dry climate, and low population without any artificial interference. The cooperation of interested international institutions is being explored, as Menofia University offers encouragement for building this telescope through international collaboration, specially with the EVN.

The author was invited as consultant to an astronomical meeting for building the Associated Gulf Observatory, which was held in Kuwait from 16 to 18 April 2002. A similar 32 meter Radio Telescope was suggested by the author for the Gulf Observatory, for six countries: Saudi Arabia, Kuwait, Qatar, Bahrain, Emirate and Oman since the western region of Saudi Arabia and the South of Oman contain mountains more than 2500 meters above sea level, and are very dry. The suggested telescope was included in the recommendation of the meeting, which will be raised at the Council of the Gulf for kings and princes, to confirm it in the next meeting, and consider financing it.

B. W. Sohn, K.-H. Mack & U. Klein

### **An SCP - $\alpha$ diagram analysis of CSS sources**

Presentation: POSTER

We present Spectral Curvature Parameter (SCP) - spectral index ( $\alpha$ ) diagrams of 47 Compact Steep Spectrum (CSS) sources. SCP quantifies any variation from the initial power law typical of synchrotron spectra. Murgia et al.(1999), who have analyzed the integrated flux densities of a sample of CSS sources in a profound synchrotron aging study, show that these sources have moderate spectral steepening, i.e. a difference of  $\delta\alpha \sim 0.5$  between low- and high-frequency spectral indices, which is predicted by the continuous injection model (CI). We have used this sample to test the SCP procedures, which provide an alternative method for a quick analysis of synchrotron spectra. The most important results are:

- All sources are best fit with the CI model. This confirms the results of Murgia et al(1999).
- A clear difference between sources with strong ( $B_{eq} > 10^3 \mu G$ ) and weak ( $B_{eq} < 5 \cdot 10^2 \mu G$ ) magnetic fields is seen. This is because sources with strong magnetic fields show low frequency ( $< 1GHz$ ) flattening due to synchrotron self-absorption, as is expected for Gigahertz Peaked Spectrum sources, GPSs.
- A similar correlation is found for the dependence of the projected linear sizes. More compact sources have higher SCP values, i.e. show low-frequency flattening.
- There is a marginal difference between lobe- and core-dominated sources. The SCP values of the latter tend to be higher.
- There is no correlation with the redshifts of the sources. This implies that the intrinsic magnetic fields dominate by far over the magnetic field equivalent of the cosmic microwave background.

The results demonstrate that the SCP provides crucial parameters on the continuum spectrum of synchrotron radiation without more complex modeling.

F. Stefanachi, T. Venturi, & D. Dallacasa

### **Radio galaxies in cooling clusters: the milliarcsecond properties of 3C317**

Presentation: POSTER

3C317 is a compact steep-spectrum, low luminosity radio galaxy, classified as FRI and associated with the cD galaxy UGC09799, located at the centre of the cooling flow galaxy cluster A2052. We observed this source with the VLBA at three different frequencies: 1.6, 5 and 8.4 GHz in polarimetric mode. With these observations we are imaging the milliarcsecond structure of the source, and carrying out a spectral study of the various components. We are also studying the magnetic field distribution and Rotation Measure. Here we present preliminary results and discussion on the nature of the radio source and its relation to the environment.

G. Tuccari, I. Molotov, S. Buttaccio, A. Kus, X. Hong & X. Liu

### **Radar VLBI activity with the participation of Noto**

Presentation: ORAL

The radar VLBI method represents potentially a powerful tool for investigating non-emitting space objects. The combination of both techniques - radar for good range and radial velocity resolution, and VLBI for angle and angular rate information - results in three dimensional measurements. Possible applications cover the fields of research of near earth asteroids, investigation of short periodic variations of Earth group planet rotations and investigation of space debris. The very special circumstance that in such observations narrow bands are involved, because of the monochromatic emission of the transmitter, permits the implementation of a link between VLBI stations using a standard internet connection. A dedicated, fully-digital acquisition terminal is being developed for such applications and includes: a narrow-band digital base-band converter whose output is recorded on disk, observation and correlation software. Such hardware includes the entire acquisition chain fed by the receiver output, and produces files for transfer through the network and correlation at a single point. A description of the activities involving the Noto station is presented. Further plans are connected with INTAS-01-0669 project.

H. J. van Langevelde & R. M. Campbell

### **Status of the EVN MkIV Data Processor at JIVE**

Presentation: ORAL

The current operational status of the EVN correlator at JIVE will be reviewed. Currently, the bulk of the EVN experiments are being processed at JIVE, and releasing the tapes in a timely fashion for new EVN observations is one of the main considerations. Processing of continuum experiments is now straightforward, and we



routinely process cross-polarization and phase-referencing experiments. Monitoring the playback performance and checking the data for a number of known problems is still a labour-intensive process. Development focuses on the special requirements for spectral line experiments. Dealing with oversampled recordings became operational in 2001. We are working to enhance the read-out capacity of the correlator in several ways.

T. Venturi, D. Dallacasa, R. Morganti, S. Pellegrini & C. Vignali

### **The accretion process in the nucleus of the radio galaxy PKS1333-33**

Presentation: POSTER

We will present VLBA multifrequency images of the nearby radio galaxy PKS 1333-33, associated with the cluster elliptical IC 4296. Chandra X-ray data of the source will also be presented. The parsec-scale morphology of the radio source and its nuclear radio spectrum will be discussed in the light of the X-ray properties, which suggest that an ADAF could be present in the central region of the galaxy. We will discuss the derived observational properties in the attempt to throw a light on the accretion process in this source.

M.A. Voronkov, V.I. Slysh, F. Palagi & G. Tofani

### **EVN observations of 6.7 GHz methanol masers from the Medicina survey**

Presentation: POSTER

We report VLBI observations of methanol masers in the brightest  $5_1 - 6_0$  A<sup>+</sup> transition at 6.7 GHz in NGC 281W, 18151-1208 and 19388+2357. Using a fringe rate method, absolute positions were obtained for all observed sources. An ordered linear structure with a velocity gradient was revealed in NGC 281W. Under the assumption that such a structure is an edge-on Keplerian disk around the central object with a mass of  $30M_{\odot}$  located at a distance of 3.5 kpc from the Sun, we estimated that the methanol masers are situated at a distance of about 400 AU from the center of the disk. A second epoch of observations is reported for L1206, GL2789 and 20062+3550. With the accuracy achieved, no reliable proper motions have been detected.

Alan R. Whitney

### **The Mark 5 Disc-Based VLBI Data System**

Presentation: ORAL

The Mark 5 system is being developed as the first high-data-rate VLBI data system based on magnetic-disc technology. Incorporating primarily low-cost PC-based components, the Mark 5 system will support data rates up to 1024 Mbps recording/playback to an array of up to 16 inexpensive removable ATA/IDE discs. ATA/IDE discs have already fallen to <1.50/GB, below the cost of Mark 4/VLBA tape, with the expectation that prices will continue to fall and capacities continuing to expand to several hundred-GB per disc.

Besides recording and playing from disc, the Mark 5 system will be fully e-VLBI compatible, utilizing standard Gigabit Ethernet connections. For real-time e-VLBI usage, data may be either directly transmitted or received; for quasi-real-time usage, e-VLBI data may be buffered through the disc array.

A development effort is now underway at Haystack Observatory, with support from BKG, EVN, KVN, MPI, NASA, NRAO and USNO to fully develop the Mark 5 system. The development plan is highly attentive to compatibility requirements with existing Mark 4 and VLBA data-acquisition and correlator systems, with prototype deployment of ~20 systems expected in spring 2002. A fully VSI-compliant Mark 5 system will be introduced in 2003.

Jiyune Yi, R.S. Booth & J. Conway

### **Multi-epoch VLBA observations of 43 GHz SiO masers**

Presentation: ORAL

We have conducted multi-epoch, simultaneous observations of two 43 GHz SiO maser lines, towards Mira variables using the VLBA, in the hope that we can discern the spatial distribution of masers in the  $v=1$  and  $v=2$ ,  $J=1-0$  lines with sub-mas resolution. Positional coincidence of these two lines has been argued as a way to distinguish among the maser pumping models. We will also examine the phase-dependent features of these masers, such as the variation of the maser ring size and the disruption of the ring shape, predicted by Gray and Humphreys (2000). These properties were seen in our previous two epoch, simultaneous VLBA observations of the two maser lines in TX Cam (Yi et al. 2001). Our new results from three more epochs of observation,

performed at different stellar phases, will give us solid answers on the phase-dependent properties and provide more reliable constraints on pumping models.

References:

Gray, M.D. & Humphreys, E.M.L. 2000, *New Ast.*, 5, 15

Yi, Jiyune, Booth, R.S., Conway, J.E., Winnberg, A., & Diamond, P.J. in *Proc.IAU Symposium 206, Cosmic Masers: from Protostars to Black Holes*, eds. Victor Migenes et al. (in press)