Astrophysics in the LOFAR era

A scientific workshop

April 23-27, 2007 in Emmen (NL)

Monday, April 23 2007

Session LOFAR

Jaap Bregman

ASTRON

Data Processing in the LOFAR Era

LOFAR's field of view in combination with it's sub arcsec resolution pose an unprecedented calibration and image processing problem. We confront the processing requirements of the various tasks with the processing power offered by the BluGene/L system available to LOFAR and indicate where compromises need to be made to provide a sustainable output.

Joesph Otieno Malo

University of Nairobi

Kenya International Radio Observatory

This paper proposes the building of a new type of versatile,multi purpose,world class radio facility for space, environmental and communication research. It will be located in northern Kenya on the geomagnetic equator and designed foremost for the study of terrestrial magnetosphere,ionosphere and neutral atmosphere using traditional as well as newly developed diagnostic techniques.

Tuesday, April 24 2007

Session: Pulsars

Andrew Lyne - ***Finding, observing and understanding RRATs***

University of Manchester

RRATs (Rotating RAdio Transients) were discovered in data taken for the Parkes multibeam survey. They typically produce one narrow pulse every few minutes, and are only radio sources for between 0.1 and 1 second a day. Finding and observing more of these ephemeral objects is a major challenge for existing radio facilities.

Ben Stappers - ***Pulsars at Low Frequencies***

ASTRON & University of Amsterdam

LOFAR will provide an excellent instrument for studying known pulsars and discovering new pulsars. I will present the results of simulations which show that LOFAR will be able to double the number of pulsars known in the Northernn sky. I will also present new results from observations of pulsars with the WSRT at low frequencies and discuss what they imply will be possible with LOFAR.

Janusz Gil - ***Drifting subpulse phenomenon in pulsars***

J. Kepler Institute of Astronomy, Zielona Gora, Poland

The phenomenon of drifting subpulses is shortly reviewed. The sensitive radio observation are proposed to reveal the nature of this phenomenon.

Oleg Ulyanov, V.V Zakharenko, V. S. Nikolaenko

- ***Subpulse structure of Pulsars radio emission in the Decameter Range***

Institute of Radio Astronomy, NAS, Ukraine

The results of the analysis of subpulse structure of pulsars radio emission in the decameter range (18-30 MHz) are presented. Subpulse structure was detected for the PSRs: B0809+74; B0950+08; B0943+10; B1133+16 and PSR B1919+21. For these pulsars the most important parameters of the subpulses, such as width of subpulses; second order periods P2 and P3 and drift velocities were determined. Spectral and correlation analyses of the subpulse structure were carried out using original technique. These analyses show characteristic times of life of the subpulse structure in the decameter range for each pulsar. The intensity of strong subpulses has strong variations in frequency and time domain. The probability of strongest subpulses does not exceed one percent. The integral probability laws for PSRs flux densities have a long tail in the high energy field. This field corresponds to very rare subpulses which have huge flux densities. Anomalous intensity subpulses were detected for all listed above pulsars, which peak flux densities exceed analogous parameter for average profiles from 20 up to 300 times. Typical values of frequency band of the subpulses detection lie in the decameter range from 0.2 to 0.5 octaves. The other properties of these subpulses will be discussed.

Session: Magnetic Fields, AGN

Wolfgang Reich - ***Galactic research with LOFAR***

Max-Planck-Institut fuer Radioastronomie

High resolution low frequency observations with LOFAR will largely contribute to the understanding of the Milky Way's structure and its components. The detection of numerous new SNRs mainly at large distances is expected, which trace the regions where cosmic-rays are injected into the Galaxy. Absorption studies towards optically thick HII-regions at known distances will provide a detailed distribution of the synchrotron emissivity within the Galaxy. High-frequency polarization observations towards depolarizing HII-regions will complement LOFAR's results and will constrain the 3D properties of the Galactic magnetic field. LOFAR will be able to trace very small RMs. This way fluctuations of the local magnetized interstellar medium can be studied with unprecedented accuracy.

Katia Ferriere - ***Galactic magnetic fields***

Laboratoire d'Astrophysique

I will give an observational overview of magnetic fields in our Galaxy. I will successively explain how they were originally detected, describe the observational methods currently used to measure them, and review what
the different methods tell us about their large-scale properties. I will then briefly discuss how the observational properties fit in with the theoretical predictions.

Rainer Beck - ***Observation of weak magnetic fields around galaxies with LOFAR***

Max-Planck Institute for Radio astronomy

Mapping polarized synchrotron emission from nearby galaxies with LOFAR can reveal weak, ordered magnetic fields in regions far away from star-forming regions, illuminated by low-energy electrons. This opens new possibilities to observe galactic halos, interactions with the intergalactic medium via compressed magnetic fields, and connections

to the cosmic web. -- Faraday rotation measures (RM) of polarized background sources are the most sensitive tool to trace magnetic fields in intervening media. RM surveys with LOFAR will allow the investigation of the so far unexplored domain of very small Faraday rotation measures, tracing weak magnetic field strengths and low densities of ionized gas at even larger distances from galaxies than synchrotron emission. For the first time we might detect magnetic fields and tenuous warm gas in the intergalactic medium.

James M Anderson - ***Low Energy Electrons in AGNs***

JIVE

Our understanding of physical processes in AGNs which lead to particle acceleration are limited. The shape of the electron energy distribution connecting the original electron population and the relativistically accelerated population can give insight into the fluid properties of AGN accretion disks and jets and the electron acceleration mechanism. Low energy electrons are best studied at low frequency radio waves, and high sensitivity and resolution observations with LOFAR will provide crucial information about the physical conditions and processes which generate highly relativistic electrons. I will focus on low energy electrons in the radio cores of AGNs, especially nearby, low-luminosity AGNs, and what can be learned through imaging, broadband spectroscopy, astrometry, and variability measurements of these objects with long-baseline LOFAR.

Session: Clusters

Matteo Murgia - ***Dying radio galaxies with LOFAR***

INAF- Osservatorio astronomico di Cagliari

Strong radio sources associated with elliptical galaxies are supplied with energy from active galactic nuclei via plasma beams. If this energy supply ceases, a source is expected to undergo a period of fading before it disappears completely. However, only a handful of radio galaxies in this evolutionary stage are known. A possible explanation for the rarity of the fading radio galaxies may be the short duration of the remnant phase of a radio source with respect to the average lifetime of the radio activity. In the absence of fresh particle injection, the high-frequency radio spectrum develops an exponential cutoff due to the radiative losses and the source will disappear quickly from the sky at frequencies > 1 GHz. On the other hand, these objects should still be visible at lower frequencies. In support of this scenario, I will present new radio observations of a sample of 14 fading radio galaxies we recently discovered in the Westerbork Northern Sky Survey at 325 MHz. Based on these findings, one can expect the existence of a large population of radio sources that are particularly bright at frequencies of 100 MHz or lower, but that have been missed from the currents surveys because of their very steep spectra. With LOFAR it will be possible to perform a complete census of these elusive radio sources and to study in detail their spectral in physical properties.

Robert Dunn - ***Radio Bubbles in Clusters: Relativistic Particle Content***

University of Southampton

In recent years the interaction of radio plasma with X-ray emitting gas at the centres of clusters of galaxies has been studied in detail. Assuming that the two plasmas are in pressure balance, the relativistic particle content of the radio plasma can be investigated without the need for equipartition. For a sample of nearby clusters we have determined k, which is the ratio of the total particle energy to that of the electrons radiating between 10 MHz and 10 GHz. Constraints on the ages of the cavities confirm that the ratio of the energy factor, k, to the volume filling factor, f, lies within the range 1 ~< k/f ~< 1000. In the assumption that the filling factor is close to unity, some extra energy, beyond that assumed to be in synchrotron electrons, is required for the bubbles to be in pressure equilibrium with their surroundings. Currently, the electron energy spectrum is simplistically assumed to have a single slope with no break. I will show how observations of the low frequency radio spectrum with LOFAR will improve estimates of the energy contained in the synchrotron electrons, and so more tightly constrain the lobe particle content.

Michael Wise - ***Tracing AGN Heating in Clusters with Low Frequency Radio Observations***

API, University of Amsterdam

Recent X-ray and radio data on clusters of galaxies clearly demonstrate the profound impact of AGN in cluster cores on the surrounding intracluster medium (ICM). The realization that powerful outbursts from AGN can release upwards of 10^61 erg into the ICM suggests a common solution to several cooling related issues long associated with clusters and groups of galaxies. AGN feedback has emerged as the most likely mechanism for regulating not only the cooling of the hot gas in clusters, but also the growth of the central cD galaxies themselves and their attendant super-massive black holes. The combination of deep X-ray imaging and low frequency radio data provide some of the most reliable and accurate diagnostics of AGN in clusters. Using results from a recent sample of clusters with both X-ray and low frequency radio data, we discuss here the limits we can place on the age, total energy output, and duty-cycle of activity for the central AGN in these systems. As we show, low frequency radio emission appears to be an excellent proxy for the integrated energy output of the central AGN over the last several 100 Myr. We will discuss the possibilities for studying these systems in greater number and detail with emerging low frequency instruments such as LOFAR. Finally, we will also discuss the implications these data have for the growth of super-massive black holes and models of galaxy formation.

Rossella Cassano - ***Statistics of Radio Halos and Future Low Frequency Observations***

Dipartimento di Astronomia Univ. Bologna & Istituto di Radioastronomia-INAF, Bologna

Radio Halos (RH) are the most spectacular examples of non-thermal emission from the Intra Cluster Medium (ICM). The study of their statistical properties (occurrence, correlations with thermal ICM) is a powerful tool to constrain the origin of the emitting particles.

Present observations suggest that these RH are "transient" (life-time <= 1 Gyr) and that they are associated with powerful merging events in massive clusters. This is interpreted in favour of a scenario in which particles are re-accelerated in the ICM by shocks and MHD turbulence. Still present observations may suffer from observational biases due to the brightness limits of present radio surveys.

In a couple of recent papers (Cassano & Brunetti 2005; Cassano, Brunetti, Setti 2006) we have calculated the statistical expectations of RH in the framework of the re-acceleration model. In this scenario RH are preferentially expected in massive and merging clusters, and their occurrence in the Universe should increase at lower observing frequencies. This is not only because RH have steep spectra, but also because particles emitting at lower frequencies are less energetics and can be re-accelerated also in less massive merging clusters. This is a unique prediction of the re-acceleration scenario: it seems that present observations can only pick-up the "tip of the iceberg" so that future radio surveys at low frequencies are expected to catch the bulk of RH and to provide a real breakthrough in our understanding of the origin of these phenomena.

In this contribution I will start discussing an unbiased and "revised occurrence" of RH in galaxy clusters in the redshift bin 0-0.35. This is obtained by combining the VLA-NVSS radio survey with deep pointed observations of 50 X-ray selected galaxy clusters carried out at the GMRT; the results are then compared with theoretical expectations. Then I will present the "theoretical predictions" of RH occurrence in the Universe at LOFAR observing frequencies based on the re-acceleration model. Our study is the first theoretical effort in this direction, it is aimed at deriving predicted luminosity functions and number counts of RH at different observing frequencies and different redshifts, and I will discuss several observational tests with future LOFAR surveys. Statistics of Radio Halos and Future Low Frequency Observations.

Daniele Dallacasa - ***Perspectives in the low frequency study of diffuse cluster radio sources***

Astronomy Department - Bologna University

In massive galaxy clusters with high X-ray luminosities and with substantial dynamical activity to be classified in a merging process with other massive galaxy groups or clusters, there is a high incidence of extended, diffuse radio emission not associated with any particular galaxy. Such extended structures are known either as "halos" if found at the cluster centre, or as "relics" if located at the outskirts. Current models interpret such structures as originated by the reacceleration of aged relativistic electrons as a consequence of the merger capable to dump substantial amount of energy for this purpose.

Using the GMRT at 610/325 and 235 MHz, we are investigating a sample of about 50 luminous and then massive galaxy clusters in the redshift range 0.2 - 0.4 searching for halos, relics and signatures of cluster mergers. According to present models explaining the formation of such structures, the selected redshift interval has the highest fraction (~0.3) of luminous clusters with possible presence of radio halos.

Given the steep radio spectrum of these diffuse radio sources, their large angular size and relatively low surface brightness, radio halos and relics are quite difficult to study with current instrumentation. In particular, the low frequency end (below 200 MHz) is very important for studying the acceleration mechanism and LOFAR is expected to play a very relevant role in this respect. Sub-mJy sensitivity and arcsecond scale resolution are ideal tools to investigate the nature of the relativistic particles, their origin and the total energetic content associated with them.

Roberto Pizzo

- The diffuse extended emission and the first polarimetric results at low frequency for Abell 2255

Kapteyn Institute, University of Groningen

The existence of diffuse radio sources in clusters of galaxies demonstrates the presence of cluster-wide magnetic fields and relativistic particles on physical scales up to a few Mpc. The importance of this relativistic component for the energy balance in the central parts of clusters has been highlighted by the Chandra X-ray images of clusters. The cavities visible in those maps are created by the pressure of relativistic bubbles of plasma, that reveal the dynamical effect of powerful cluster radio sources on the surrounding gaseous medium.

A2255, a nearby (z=0.08) rich cluster which shows signs of undergoing a merger event, is an ideal target for such investigations. Through WSRT observations at high (18 and 21 cm) and at low frequency (1 meter band) we show that the cluster has quite an extended emission in the centre (Halo), a peripherical one (Relic) and a very numerous galaxy population. The physical properties and the morphologies of these radio galaxies demonstrates that A2255 has a very dense ICM even at very big distances from the centre (>= 3Mpc).

The last analysis of the cluster through the RM synthesis technique revealed a lot of extended polarized emission in the field of A2255; further investigations will point out how much of this emission is intrinsic of A2255 and how much belongs to our galaxy.

Federica Govoni - ***Polarization of cluster radio sources with LOFAR***

INAF - OAC

The existence of magnetic fields associated with the intra-cluster medium in clusters of galaxies is now well established through different methods of analysis (e.g. diffuse radio emission, rotation measure of radio galaxies). The high resolution and superb sensitivity reached by LOFAR will permit to study in detail the polarization properties of cluster radio sources in a spectral window that still remain to be explored. I will show, through numerical simulations, how these low frequency observations can be used to provide a unique possibility to constrain the strength and structure of cluster magnetic fields.

Gianfranco Brunetti - ***Constraining cosmic rays in Galaxy Clusters***

INAF- Istituto di Radioastronomia

Cosmic ray hadrons are believed to be injected and to remain confined in galaxy clusters. The confinement implies that the rate of proton-proton collisions in the ICM is enhanced and thus that a population of secondary electrons and positrons should be continuously injected in the cluster volume. In principle, secondary particles should emit diffuse and steep-spectrum synchrotron radiation and this may give the possibility to constrain the content of cosmic ray protons in the ICM from deep radio observations; still it might be difficult to clearly disentangle between this emission and that coming from re-accelerated electrons in merging clusters. If these protons store a significant energy budget it is expected that future LOFAR surveys should detect diffuse synchrotron emission resembling Radio Halos and/or Radio mini-Halos from several thousands galaxy clusters and GLAST should detect gamma rays from a large number of these clusters. Thus providing first constraints on the energy budget in terms of cosmic ray protons in the ICM is extremely important. I will discuss on deep upper limits on the synchrotron emissivity at 604 MHz that we obtained with GMRT observations of X-ray luminous clusters. The bulk of these clusters is "radio quiet" and from the corresponding upper limits to the synchrotron emissivity we put unprecedented constraints on the energy density and spectrum of the cosmic ray protons in the ICM. I will show that these findings are potentially very important to understand the origin of the relativistic electrons emitting the presently-known Radio Halos and how these limits can be used to plan future studies at lower frequencies with LOFAR.

Judith Croston - ***Constraining the energy budget of radio galaxies with LOFAR***

University of Hertfordshire

Recent X-ray observations of inverse Compton emission from the lobes of radio galaxies and quasars have enabled us to probe the energetically dominant low-energy electron population of radio galaxies, suggesting that radio galaxies are close to equipartition. These constraints are essential in order to understand the energetic impact of radio galaxies on their surroundings, and hence their feedback role. However, to reach these conclusions it is necessary to make assumptions about the shape of the low-frequency spectrum, which is unobservable with current facilities. I will discuss how LOFAR constraints on the low-frequency spectra of radio-galaxy lobes and hotspots will improve our understanding of radio-galaxy energetics.

Wednesday, April 25 2007

Session: Stellar Sources & Transients

Jochen Eislöffel - ***Investigating the launching mechanism of young stellar jets with LOFAR***

Thüringer Landessternwarte

The accretion/ejection mechanism is one of the most universal astrophysical processes - operating in sources over 10 orders of magnitude of mass of the central object. Jets from young stars are the nearest such sources and therefore allow us investigations at the highest spatial resolution. In this talk I will present the great potential that LOFAR offers to test the current paradigm for the jet launching mechanism.

Stephane Corbel - ***Jets from X-ray binary: LOFAR contributions***

CEA Saclay & University Paris

Black holes and neutron stars in compact Galactic X-ray binaries are variable on many timescales ranging from ms to years and have proven to be ideal targets to investigate the accretion â€“ ejection coupling in accreting compact objects. Their transient X-ray outbursts are usually associated with synchrotron radio emission, originating from high energy particles interacting with the magnetic field of relativistic jets. With a factor 100-1000 improvement in sensitivity and spatial resolution, LOFAR can achieve major advancements in understanding the violent nature of these cosmic explosions. In this review, I will outline the major contributions of LOFAR to the study of these cosmic accelerators.

Christian Kaiser - ***Radio lobes of microquasars***

University of Southampton

Only a few microquasars are known to inflate radio synchrotron lobes comparable to those seen around radio galaxies. While it can be shown that the conditions for the formation of bright synchrotron emitting lobes are not favourable for microquasars, we can still detect them because of the radio bremsstrahlung emission of the compressed and partially ionised ISM surrounding them. I will outline a model for this emission and review the prospects of observing these objects with LOFAR.

Sera Markoff - ***LOFAR constraints on weakly accreting black hole jets***

API, University of Amsterdam

Black holes accreting at significantly below their Eddington limits show similar behaviours across over 8 orders of magnitude in mass. Such sources include X-ray binaries (XRBs) in their low/hard accretion state, and classes of Active Galactic Nuclei (AGN) such as low-luminosity AGN and like FR Is and BL Lacs as well. The much shorter timescales found in XRBs compared to AGN for the same physical processes make these often transient sources valuable targets for monitoring campaigns. I will discuss how the addition of LOFAR (and its Radio Sky Monitor mode) to such campaigns will provide new information on the physics of these compact jets, in particular helping constrain their internal energetics and particle distributions. By nature of the "fundamental plane" linking the stellar sources to the galactic, we can also learn more about AGN jet physics. LOFAR will also be key for exploring the possible link between other XRB states and AGN classes.

James Miller-Jones - ***Low-frequency radio observations of Galactic X-ray binary systems***

University of Amsterdam

LOFAR will open up new areas of parameter space for exploration. With the wide field of view available at low frequencies, we will, for the first time, be able to perform sensitive all-sky monitoring for radio transient detection. One class of sources known to be highly variable at GHz frequencies are the so-called `microquasars' (binary systems producing relativistic jets). To date however, their low-frequency behaviour has not been well constrained by observations. I will present our initial investigations of their low-frequency properties, showing wide-field images made from data taken with the LFFEs, the new suite of low-frequency receivers on the WSRT, and also the 74-MHz system on the VLA. These data were taken as preliminary science observations on behalf of the LOFAR Transients Key Science Project team. I will briefly discuss their implications for our monitoring strategy with LOFAR.

Catherine Brocksopp - ***A Highly Polarised Jet in XTE J1748-288***

UCL/MSSL

XTE J1748-288 is a black hole X-ray transient which went into outburst in June 1998. The X-ray lightcurves showed fairly canonical morphologies with minor variations on the "Fast Rise Exponential Decay" profile. The radio source, however, reached an unusually high flux density of over 600 mJy. This high radio flux was accompanied by a high (>20%) fractional linear polarisation, the variability of which was anti-correlated with the flux density. We use this variability to discuss possible depolarisation mechanisms and to predict the underlying behaviour of the (unresolved) core/jet components.

Subhashis Roy - ***New Results on emission from the Transient Bursting Source GCRT J1745-3009***

ASTRON

GCRT J1745-3009 is a transient bursting radio source located about a degree away from Galactic centre, discovered by Hyman et al. (2005, 2006) from 330 MHz VLA and GMRT observations in 2002 and 2003. We have made a new serendipitous detection of this source from GMRT observations in March 2004. From the single burst detected, lasting only 2 minutes, the spectral index is found to be extremely steep (-13 +/-3). In addition, from a re-analysis of the September 2003 GMRT observation, we have detected significant circularly polarised emission from this source. Since the emission is likely to be coherent, the emission mechanism is possibly electron cyclotron maser. The magnetic field required to produce such emission at 330 MHz is ~120 Gauss, which is expected near stellar or planetary surfaces. Its non-detection in other wavebands, however, tends to preclude emission from any nearby magnetically dominated star. We consider different emission mechanisms and possible sources of emission including an extrasolar planet.

Jean-Mathias Grießmeier (1), P. Zarka (1), H. Spreeuw (2)

- The search for radio emission from extrasolar planets with LOFAR

(1) LESIA, CNRS-Observatoire de Paris, (2) Astronomical Institute "Anton Pannekoek"

All strongly magnetized planets of the solar system are known to be sources of intense nonthermal radio emission. For close-in giant exoplanets ("Hot Jupiters"), the interaction of the planet with the stellar wind is believed to be much stronger than for planets at larger orbital distances. This should result in radio emission much more intense than that of Jupiter, which is nearly as bright as the Sun at decameter wavelengths. We present theoretical results concerning the detectability of such radio emission for all currently known extrasolar planets. In particular, we show estimates for the expected maximum emission frequency and for the radio flux, for which the four existing theoretical models are compared. Based on these characteristics, we discuss whether (and for which planets) the conditions are expected to be favorable enough to allow for detection with LOFAR.

Claudio Maccone - *Innovative SETI by the KLT*

SETI - International Academy of Astronautics

SETI searches are, by definition, the extraction of very weak radio signals out of the cosmic background noise. When SETI was born in 1959, it was “natural” to attempt this extraction by virtue of the only detection algorithm well known at the time: the Fourier Transform (FT). In fact:

1) SETI radio astronomers had adopted the viewpoint that a candidate ET signal would necessarily be a sinusoidal carrier, i.e. a very narrow-band signal. Over such a narrow band, the background noise is necessarily white. And so, the basic mathematical assumption behind the FT that the background noise must be white was “perfectly matched” to SETI for the next fifty years!

2) In addition, the Americans J. W. Cooley and J. W. Tukey discovered in April, 1965 that all FT computations could be speeded up by a factor of N*ln(N) (N is the number of numbers to be processed) by replacing the old FT with their own Fast Fourier Transform (FFT) algorithm. Then, SETI radio astronomers all over the world gladly, and unquestioningly, adopted the new FFT.

In 1983, the French SETI radio astronomer, François Biraud, dared to challenge this view. He argued that we only can make guesses about ET's telecommunication systems, and that the shifting trend on Earth was from narrow-band to wide-band telecommunications. Thus, a new transform was needed that could detect signals over both narrow and wide bands, regardless of the colored noise distribution over this finite bandwidth. Such a transform had actually been pointed out as early as 1946 by the Finnish mathematician, Kari Karhunen and the French mathematician, Michel Loève, and is thus named KLT for them. In conclusion, François Biraud suggested to “look for the unknown in SETI” by adopting the KLT rather than the FFT.

Starting 1987, this author also was “preaching the KLT”: first at the SETI Institute, then (since 1990) at the Italian CNR SETI facilities at Medicina, near Bologna. Their director, Stelio Montebugnoli, was willing to pay attention to him. Little by little, bright students succeeded in programming the KLT algorithm for the Medicina radio telescopes. Finally, by the year 2000, the advent of programmable cards, mastered by Montebugnoli, made the “miracle” happen. The KLT for SETI is now a reality at the SETI-Italia facilities and for the first time in history.

This presentation describes the KLT and how the KLT breakthrough for SETI was finally achieved.

Thursday, April 26 2007

Session: EOR

Saleem Zaroubi - ***The Epoch of Reionization with LOFAR***

Kapteyn Astronomical Institute, University of Groningen

I will give an overview on the simulation of the LOFAR-EoR project data-cube and what we can learn from it. These simulation include the cosmological signal, galactic and extra galactic foreground, ionospheric distortions and the instrumental response and noise. Estimates on the accuracy of recovering the underlying cosmological signal will be discussed.

Rajat Thomas - ***Reionization Simulation for LOFAR***

Kapteyn Astronomical Institute, University of Groningen

Beginning with the simulation of the true underlying 21cm signal at the epoch of reionization using N-body simulations and radiative transfer, we try to follow its path through the intergalactic medium all the way through the ionosphere into the instrument. We also model the influence of the instrument on this signal. This is done in order to create a mock dataset that could be used to test several of the inversion algorithms under development.

Garrelt Mellema - ***Simulating the redshifted 21cm signal from Reionization***

Stockholm Observatory

Using the results of large-scale radiative transfer simulations of reionization, we calculated the redshifted 21cm emission for fields of 1 by 1 degree over the redshift range of reionization. These simulated redshifted 21cm results show how the signal is changing with frequency, and I present simulated observables relevant for the LOFAR EoR experiment, such as the change of RMS signal with frequency, power spectra, and image cubes. Results based on the 3year WMAP cosmological parameters show that the outlook for success of the LOFAR EoR experiment has substantially increased.

Vibor Jelic - ***Foregrounds Simulation for the LOFAR EOR Experiment***

Kapteyn Institute

One of the main difficulties in observing EOR signal is the existence of very prominent foregrounds sources of emission over which is the desired signal overlaid. The foregrounds have four main components: galactic synchrotron emission (~70%), galactic thermal (free-free) emission (~1%), the integrated emission from extragalactic unresolved sources (~27%, radio sources/AGNs, clusters) and the microwave cosmic background itself. We need to simulate the above mentioned foregorunds in order to create a mock dataset for the LOFAR EOR experiment.

Benedetta Ciardi - ***21cm views of the high-z universe***

Max-Planck-Institute for Astrophysics

In this presentation I will talk about the possibility of observing the high-z universe through the 21cm line from neutral hydrogen, with particular emphasis on the reionization process. Among others, I will also discuss about possible sources of IGM heating and how 21cm measurements can be used in combination with different observations, e.g. CMB anisotropies.

Xuelei Chen - ***21cm signature of first stars***

National Astronomical Observatory of China

I will describe our research on the theory of 21cm signal produced by the Lyman alpha sphere around first stars

Panos Labropoulos - ***Extracting the EoR signal from LOFAR data***

Kapteyn Institute

The EoR is a challenging experiment and the name of the game is calibration. We present a sketch out of the basic LOFAR data inversion algorithm that the EoR group will follow to analyze the data and extract teh cosmological parameters.

Avery Meiksin - *The Wouthuysen-Field mechanism revisited*

Institute for Astronomy, University of Edinburgh

The relaxation of the radiation colour temperature produced by sources at the End of the Dark Ages to the matter temperature is computed as the radiation field approaches statistical equilibrium through scattering. The results are discussed in the context of the Wouthuysen-Field mechanism for coupling the 21cm spin temperature of neutral hydrogen to the kinetic temperature of the gas through Lyman-alpha scattering. The evolution of the heating rate is also computed, and shown to diminish as the gas approaches statistical equilibrium, but recent results suggest it may not vanish.

Session: Surveys

Thomas Jones - *Astrophysical Particle Acceleration*

University of Minnesota

I will review the current status of our understanding of the acceleration of cosmic ray particles in diffuse matter environments, including galaxy clusters, radio galaxies and supernova remnants.

Timothy Garn - *610 MHz radio surveys using the GMRT*

University of Cambridge

I describe four wide-field radio surveys that have been created at 610 MHz with the Giant Metrewave Radio Telescope. We have observed the Spitzer First Look Survey field, and three of the SWIRE fields with 6" resolution. Our image of the First Look field covers about 4 square degrees, and reaches a noise level of 30 microJy in the centre of each pointing. Using the knowledge that has been gained from these surveys, we aim to carry out further large field 610-MHz surveys with the GMRT, with a sensitivity of about 100 microJy/beam. I discuss the details of these future surveys, and describe some of the expected results.

Valeriy Shepelyev - Extragalactic Radio Sources at Low Frequencies

IRA NAS Ukraine

The world biggest decameter radio telescope UTR-2 and four smaller arrays form the Ukrainian VLBI network URAN with an angular resolution up to 1" operating at decameter wavelengths. A few tens of extragalactic radio sources have been observed with the URAN interferometers to date. The low frequency structure of the studied radio sources differs from their centimeter wavelengths images noticeably. The main peculiarities of the brightness distribution in the range are:

- The compact details (hot spots and sources associated with AGN) in radio galaxies and quasars are less prominent or entirely disappeared at the decameter wavelengths. Their angular diameters are equal to those at higher frequencies or enlarged by the interstellar scattering.
- Dimensions of lobes are enlarged and their spectral indexes are smaller than those measured at higher frequencies.
- A characteristic feature of the quasar structure at low frequencies is extended components with steep spectra and low surface brightness that contribute essentially to the source flux at the decameter wavelengths. Their angular diameters appreciably exceed the total sizes of the sources measured at higher frequencies. Such halos have been revealed in some radio galaxies too. The reason of the changes usually is a combination of various phenomena of radio wave generation and propagation which prove themselves particularly brightly at longer wavelengths. To clarify the question, the maps with high resolution in a wide frequency range are required to determine continuum spectra of the components of the sources. The data are scarce at meter wavelengths. Mapping with the LOFAR will allow to fill the gap and thus determine jointly with the centimeter and decameter data:
    - the spectra of the source components in the widest frequency range;
    - the physical mechanisms that distort the spectra of hot spots and lobes of the sources
    - images of the extended halos (high dynamic mapping is needed) and their connection with the sources and/or their environment;
    - physical conditions in the source component and in the environment.

Mykhailo Sydorchuk, K.M. Sidorchuk, N.M. Vasilenko, E.A. Abramenkov, D.V. Mukha, S.M. Zakharenko

- Decametric continuum investigations at UTR-2

IRA NAS Ukraine

We present the continuum radiation investigations carrying out at the largest till nowadays decameter band (8 - 30 MHz) radio telescope UTR-2 having an angular resolution ~ 70' - 25' respectively in this band and the effective area 150 000 m2 (Braude at al., 1978).

The survey of the Northern Sky is the main program of observations at UTR-2 for more than 30 years. The catalogues of discrete sources are published for the declinations -12° - 20° and 30° - 60° (last publication Braude at al., 2002), the observations for the strip 20° - 30Â° are finished and they begun for declinations > 60°. About 2300 discrete sources are detected and their coordinates and fluxes are determined mainly at five frequencies - 12.6, 14.7, 16.7, 20 and 25 MHz. In addition to the amount of so low frequency catalogue by itself, the sources count in dependence on a flux (the so-called N(S) dependence) found out the deficit of sources with small and large fluxes, that testifies the strong evolutional effects. Such an important cosmological effect must become apparent just at low frequencies and so, LOFAR with his great resolution and sensitivity can essentially specifies the N(S) dependence especially for the sources with small fluxes.

The imaging of Northern Sky is conducted jointly with the program of the discrete source survey at UTR-2. Now we construct the maps of the sky area 29° - 55° at frequencies 14.7, 20 and 25 MHz with a middle fluctuation sensitivities ~ 3.5, 1.5 and 1.1 kK respectively. To date it is the maps with the best resolution and sensitivities at low frequencies, the detailed analysis of which coming yet, and they can serve as a good test for LOFAR.

The character and important feature of low frequencies is that an ionized matter appears in absorption against an intensive background nonthermal emission. When investigating more than 20 extended HII regions (last publication Abramenkov & Krymkin, 1992), such specific character of decameter range allowed us not only to define their electron temperatures with an independent method and thermal structure of the nebulas jointly with high-frequency data but also to get volume density distribution of radio background emission towards the Galaxy anticenter, to reveal the anisotropy of this value, to do the estimation of the local magnetic field direction, to estimate the metagalactic component of space radio emission.

Supernova remnants (SNR) investigations also showed up the specific features of a decameter range. The spectrums of all 15 the individually studied remnants have a low frequency drop, which we associate with the ionized matter distributed in an source or on the line of sight. There are evidences of finding out the relict HII shell around SNR's HB3, HB9, HB21 and possibly Cygnus Loop. Some remnants (especially HB3, CTA1, PKS0607+17 – Krymkin & Sidorchuk, 1988) at low frequencies have a larger angular size that is possibly due to existence of a steep spectrum emission on periphery of shell.

Similarly, substantially larger angular sizes have the clusters of galaxies (for example, Coma and A2255) as compared to high frequencies. The reason is that at low frequencies we see the halo of these objects having a steep spectral index ~ 2 practically in pure form. This fact provides a possibility of investigating the incompletely clear nature of such formations as haloes and relicts in clusters only at low frequencies.

And that is far from being the complete list of features and possibilities of low frequency radio astronomy for continuum investigations in particular for a telescope with such excellent resolution and sensitivity as LOFAR that we will mention in our talk.

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Isabella Prandoni - ***Modelling the sub-mJy radio sky, implications for LOFAR and SKA***

Istituto di Radioastronomia – INAF

I will present a view of the mJy and sub-mJy radio population and I will discuss possible implications for deep surveys with LOFAR and SKA, taking into account the radio spectral behaviour of the various source components.

Olaf Wucknitz - *Finding gravitational lenses with LOFAR*

JIVE

The planned LOFAR surveys provide completely new opportunities for gravitational lens searches. For the first time do large-scale surveys reach the resolution required for a direct selection of lens candidates using morphological criteria.

I describe strategies that will be used to exploit this potential. Long baselines are essential for this project.

Mike Garrett - *E-LOFAR & Cluster Lensing - a peek at the high-z radio Universe*

ASTRON

I will present some recent results of the detection of intrinsically faint, low-luminosity star forming galaxies in the distant Universe. These background sources are only detectable because of the large magnification provided by the effect of massive, foreground cluster lensing. In addition, to boosting the measured flux density of these faint sources, lensing also enhances the effective resolution of the observations. The detection by LOFAR of lensed radio sources will be discussed, an extended LOFAR (E-LOFAR) with baselines on scales of at least 1000km will be required in order to resolve the extended, low frequency emission often associated with massive clusters.

Neal Jackson - *After CLASS: LOFAR and future lens surveys*

University of Manchester, Jodrell Bank

Radio-loud gravitational lens systems are important in the study of CDM substructure in lens galaxies and as probes of the central potentials. The impact of existing surveys is discussed, and the future impact that long-baseline LOFAR will have is considered - either as a standalone instrument or for generation of source catalogues that will vastly improve the efficiency of future surveys.

Polychronis Papaderos - *New insights into dwarf galaxy evolution with LOFAR*

Max-Planck-Institut fuer Radioastronomie

Gas-rich dwarf galaxies (DGs) can undergo violent bursts of star formation separated by long (~1 Gyr) quiescent phases. During such starburst episodes they develop large-scale galactic winds which are able to drive hot, chemically enriched X-ray emitting plasma into their halos or even into the intergalactic space. Therefore, the understanding of the origin and implications of the recurrent starburst phenomenon in late-type DGs is central to the understanding of dwarf galaxy evolution in the nearby Universe and at high redshift.

Starburst activity in DGs also manifests itself in strong synchrotron radiation from relativistic electrons ejected into their halos. Low-energy cosmic electrons suffer less from synchrotron energy losses, hence they have the longest visibility time scale. Their low-frequency radio emission "memorizes" starburst activity up to ~1 Gyr after its termination, i.e. on a much longer time scale than any other integral property of galaxies (for example, the Halpha and Far-Infrared luminosity or colors). Studies of the low-frequency radio halos of DGs at meter wavelengths with LOFAR will therefore offer new powerful tools to search for post-starburst galaxies and to explore the star formation history of late-type DGs.
In my talk, I will briefly discuss some of the expected contribution s of LOFAR to dwarf galaxy research.

Sergiy Stepkin

- Extremely low frequency radio spectroscopy of the interstellar medium as important instrument of studies of the tenuous, cold, and partially ionized objects

Institute of Radio Astronomy, NAS of Ukraine

Radio spectroscopy at extremely low frequencies provides unique opportunities for studies of the cold low-density partially ionized interstellar medium. The radio recombination lines (RRL) of carbon are observed in many galactic directions up to the middle decametric waves. The biggest atoms which have been detected in space with RRL correspond to quantum numbers as big as 1009. Such atoms have a classical diameter of about 108 m (~0.1 mm) and they are larger by a factor of ~ 106 compared to the ground state atom. The partially ionized and cold interstellar plasma can play significant role in many astrophysical phenomena (among them, for example, are processes of star formation). The experience obtained with the biggest low frequency instruments such as UTR-2 (Ukraine) shows that the low frequency carbon RRL can be observed not only against strong background source like Cassiopeia A but also against non thermal background galactic radio emission. It is confirmed by the detection of absorption carbon RRL in the direction of galactic plane at frequencies near 25 - 26 MHz. Low intensity of such features causes the necessity of really big instruments in order to carry out these investigations and LOFAR can open new spectrum of opportunities in the field.

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Dmytro Mukha

- Observations of carbon radio recombination lines near Galactic plane at decameter wavelengths

Institute of Radio Astronomy NAS Ukraine

We present the attempt to carry out a large scale survey of the Galactic plane in carbon radio recombination lines (RRLs) at frequencies near 25-26 MHz as well as the observations against several adjacent to the Galactic plane objects (among them are 3C144, DR-21, GSH139-03-69, HB21, IC443, L1407, and S140). Space atoms producing these RRL are excited up to the levels corresponding to principal quantum numbers more than 600 and are concentrated around the Galactic plane. The features are strongly broadened mostly due to Doppler processes. The Galactic plane was scanned using West-East arm of the decameter wavelength radio telescope UTR-2 (spatial resolution was 40°x10°) in the range of galactic longitude from 30° to 180° with the step of 10°. Unexpectedly, the features were detected in all measured directions. The distribution of RRLs radial velocities was in good correspondence with the standard model of the Galactic rotation. Low frequency spectroscopy provides effective ways of diagnostic of the cold low density and partially ionized interstellar plasma, but the achievable at the moment spatial resolution limits the possibilities of mapping using this kind of spectral lines. LOFAR characteristics make this instrument very suitable for carrying out such investigations.

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Friday, April 27 2007

Session: Solar System

Gottfried Mann - ***Monitoring the Solar Activity by LOFAR***

Astrophysical Institute Potsdam

The Sun is an active star, which not only expresses in the occurrence of Sun spots with an 11-year cycle but also in flares, at which a large amount of energy is suddenly released within few seconds until few hours. These flares are accompanied with an enhanced level of non-thermal radio radiation. Since LOFAR is designed for observing the extraterrestrial radio radiation in the frequency range 30-240 MHz, LOFAR will be able to observe the solar corona, which is the host of flares. The study of solar flare phenomena, e. g. generation of highly energetic electrons, is of general astrophysical interest. Furthermore, flare related phenomena like coronal mass ejections influence our Earth's environment and our technical civilization. Thus, the monitoring of solar activity is not only in the interest of solar physics but also relevant for Space Weather and, consequently, of social interest.

K.-L. Klein and C. Mercier - ***Solar radio physics with LOFAR - constraints and perspectives***

Observatoire de Paris, LESIA, 92195 Meudon

Solar radio emissions are produced in the corona over wide frequency and altitude ranges. Radio spectroscopy and imaging are powerful diagnostic tools for a variety of coronal phenomena. LOFAR represents a remarkable step in the observational technique. Its frequency range corresponds to the middle and upper corona (0.2 Ð 2 solar radii) and to the basis of solar wind. We first note that the high angular resolution that justifies LOFAR in other domains of astrophysics is not a key advantage for solar observations. Due to the intrinsic broadening of coronal radio sources and ionospheric effects, the resolution will be limited, and imaging the sun below 80 MHz with correction of ionospheric distortion remains an open problem.

Within these limitations, LOFAR is a promising complement of existing and planned ground based and space borne instruments (e.g., STEREO). We emphasise that solar observations with LOFAR have special requirements : (1) long-term observations, to capture solar activity, (2) a high dynamic range (> 10^4) to map both coherent bursty emission and the background corona, (3) quasi-simultaneous multi-frequency observations with subsecond time resolution. Further supporting tools are necessary : broadband spectroscopy covering the wavelengths imaged by LOFAR, to identify the burst types, and spectroscopy and imaging at shorter wavelengths, to trace the connection of the high coronal phenomena with the underlying active region. European solar radio astronomers operate a series of instruments which provide these complementary diagnostics. Besides fundamental research, LOFAR might serve space weather applications. This is of course only possible with a dedicated solar mode.

Based on the experience of existing intruments, particularly of the Nançay Radioheliograph, we discuss some open questions concerning dynamics of the corona (energy release, suprathermal particles, shocks, ejections) and the topology and the value of the coronal magnetic field.

Valentin Mel'nik (1), A. A. Konovalenko (1), H. O. Rucker (2), A. Lecacheux (3)

- Sporadic radio emission of the Sun at frequencies 10-30MHz

(1) Institute of Radio Astronomy, National Academy of Sciences, (2) Space Research Institute, Graz, Austria, (3) Observatoire de Meudon, Paris, France

Recently observations of sporadic radio emission of the Sun were carried out at radio telescope UTR-2 with large effective square in frequency band 10-30MHz using new registered back-end facilities. New phenomena in sporadic radio emission of the Sun such as fast Type III and IIIb bursts, Jb-J harmonic pairs, bursts in absorption, bursts with reduction in radio emission were found in the result of analysis of data obtained during observation 2001-2005 campaign. Also new properties and peculiarities of well-known bursts fine structures in the form of sub-bursts of Type II and III bursts, fine structures of drift pairs, splitting U-bursts, a wave-form of backbone radio emission of Type II bursts with herringbone structure, different fine structures of Type IV bursts and so on, were revealed. In the report some prospect of conducting of radio observations at radio telescopes with large effective square with high time and frequency resolutions for studying sporadic radio emission of the Sun are discussed.

Joe Khan - ***The Glasgow and UK interest in Solar Physics with LOFAR***

University of Glasgow

The United Kingdom has formed the LOFAR:UK Consortium with a view to participating in LOFAR in the future. One of the science topics of interest in this project to the UK is solar physics. The University of Glasgow is leading efforts to promote solar physics with LOFAR in the UK. In this presentation I will describe the UK and Glasgow perspective on the unique solar physics that can be done with LOFAR. In addition, I will describe how this ties in with current UK expertise in solar physics and the efforts of German and French colleagues who are also interested in promoting solar physics with LOFAR.

Igor Falkovich

- The investigations of the outer heliosphere with the large antenna arrays of the low-frequency URAN interferometer.

Institute of Radio Astronomy, Ukraine

The sounding of the outer heliosphere using signals of cosmic radio sources is known to be important in the context of the non-regularity of space missions. These investigations are also important for the approbation of the LOFAR concepts. As the plasma effect on signal propagation increases with wavelength, the experiments are naturally to be carried out at the low frequencies (10 to 60 MHz), which suffer strong enough scattering by the low-density plasma of the outer heliosphere and are higher than the ionospheric cut-off.

The observations of the interplanetary scintillations, which have been carried out since early eighties in the Radio Astronomy Institute of the Ukrainian Academy of Sciences, have enabled one to develop and to approbate the methods and equipment required for the outer heliosphere investigations with the large antenna arrays of the low-frequency URAN interferometer. During 2005 - 2006 the authors carried out new synchronous observations with the UTR-2 and the URAN-2 radio telescopes, which are the largest arrays of the URAN interferometer. The principal parameters of these antennae are the following:

- frequency range of 9 to 32 MHz;
- interferometer base of 153.2 km;
- effective area at 20 MHz of 150000 m2 and 28000 m2, correspondingly;
- antenna pattern width at 25 MHz

It is known that synchronous observations in two points allow the distribution function of the solar wind velocity to be estimated using a dispersion analysis technique. As at the low frequencies the scattering medium is essentially expanded, the phase screen model is not correct and the dispersion analysis technique as it worked out at the high frequencies is inapplicable, the authors had to develop the dispersion analysis technique using Feynman path-integral technique. Then the method includes the model fitting of the calculated dispersion dependencies of the solar wind velocity with the experimental ones. Now we are obtaining the interesting results of the synchronous observations. For example the data processing shows that the velocity dispersion in the outer heliosphere is essentially less than in the inner heliosphere.

Richard Fallows - ***Interplanetary Scintillation Using LOFAR: Long Baseline Heliospheric Tomography***

University of Wales, Aberystwyth

The technique of interplanetary scintillation (IPS), using modulation by the solar wind of signals from astronomical radio sources to determine the density of the solar wind and its outflow velocity, has been used to study density and velocity structure of the solar wind for over 40 years. Two principle techniques have emerged: cross-correlating the signal received simultaneously by two widely-spaced antennas gives accurate velocity estimation, while the whole-heliosphere context in both density and velocity is inferred from tomographic reconstruction of many measurements taken over a whole Sun month. LOFAR will be capable of making more measurements than are currently possible to build up very detailed tomographic reconstructions of the inner heliosphere, while additional velocity calibration will be possible with widely separated LOFAR antenna groups. Multi-frequency and multi-beam capabilities also provide the potential to directly "image" the density variations giving rise to IPS, giving unprecedented insight into solar wind turbulence.

Session: Cosmic Rays

Olaf Scholten - ***The NuMoon Project, Detection of UHE Neutrinos and Cosmic Rays off the Moon.***

KVI/RUG

When high-energy cosmic rays impinge on a dense dielectric medium, radio waves are produced through the Askaryan effect. At wavelengths comparable to the typical longitudinal size of showers produced by Ultra-High Energy cosmic rays or neutrinos, i.e. in the frequency range of 100-300 MHz, radio signals are an extremely efficient means to detect these particles [1]. These radio signals can be detected with the LOFAR array and with its supreme sensitivity it offers for the realistic possibility to find cosmic rays or neutrinos at energies in excess of 10^21 eV.

The results from ongoing search at the Westerbork Synthesis Radio Telescope (WSRT) in the frequency range of 115-170~MHz will be presented as well as the prospect of future observations with LOFAR.

[1] O. Scholten etal, Astropart. Phys., 26, 219, (2006).

Andreas Horneffer - ***Air Shower Measurements with LOFAR***

RU Nijmegen

High energetic cosmic rays that hit the Earth's atmosphere undergo nuclear interactions and produce cascades of secondary particles, an air shower. These air showers emit radio pulses and with LOPES, an early LOFAR prototype, we have demonstrated that theses radio pulses can be measured by LOFAR (Nature 435, 313).

Designed primarily as a radio interferometer LOFAR will have a high density of antennas in the virtual core, which will be extremely well calibrated. This makes LOFAR and unique tool for the study of the radio properties of single air showers. We plan to use LOFAR to test and refine our theoretical understanding of the emission process. In particular I plan to study the shape of the radio pulse front which is a step to measuring the arrival direction of cosmic rays with unprecedented precision.

In addition to presenting my plans for the future I will present first air shower data from CS1.

Stijn Buitink - ***Amplified radio pulses from cosmic ray air showers in thunderstorms***

Radboud University Nijmegen

The detection of radio flashes from cosmic ray air showers is one of the key projects of LOFAR. The radio emission can be described as geosynchrotron radiation, which is emitted when the shower electrons and positrons move in the Earth's magnetic field. Although the small electric field that is present in the atmosphere under fair weather conditions is not strong enough to influence this emission mechanism, large electrified clouds such as thunderclouds contain fields large enough to change the radio pulse amplitude considerably. Presently, air shower radio pulses are being recorded by LOPES, the LOFAR Prototype Station, which is colocated with the KASCADE experiment, an array of particle detectors in Karlsruhe, Germany.

I will present LOPES data recorded during thunderstorm conditions and compare it to data sets corresponding to other weather types.

POSTER Contributions

Shahram Amiri
Raman Research Institute

A Low Frequency Feed for GMRT:

Shahram Amiri, N. Udaya Shankar, R. Somashekar, K.S. Dwarakanath Raman Research Institute, Bangalore

A. Praveen Kumar, National Centre for Radio Astrophysics, Pune

The Giant Metrewave Radio Telescope is a national facility available for observations at meter wavelengths. It is an interferometer array consisting of thirty, 45-m diameter antennas spread over 25 km, operating in the frequency bands 151, 325, 610/235, and 1000-1420 MHz; receivers and feeds for operation at frequencies below about 100 MHz are not currently available.

Now we are in the first phase of a project developing a low frequency system for four GMRT antennas. We have designed and developed a feed and a front-end system operating in the frequency range 40-150 MHz. The receiver design is carried out taking into account the need for high dynamic range and tolerance to man-made interference at these frequencies. The key element of this design is a compact inverted V shaped broadband dipole combined with a differential amplifier in the first stage replacing a conventional passive balun. The design, development and results of preliminary tests carried out with GMRT will be discussed in the paper.

A Low Frequency RFI Monitoring System

Shahram Amiri, N. Udaya Shankar, B. S. Girish, R. Somashekar, Raman Research Institute, Bangalore,India.

Radio frequency interference (RFI) is a growing problem for research in radio astronomy particularly at wavelengths longer than 2m. For satisfactory operation of a radio telescope, several bands have been protected for radio astronomy observations by the International Telecommunication Union. Since the radiation from cosmic sources are typically 40 to 100 dB below the emission from services operating in unprotected bands, often the out-of-band emission limits the sensitivity of astronomical observations. Moreover, several radio spectral emissions from cosmic sources are present in the frequency range outside the allocated band for radio astronomy. Thus monitoring of RFI is essential before building a receiver system for low frequency radio astronomy.

This paper describes the design and development of an RFI monitoring system operating in the frequency band 30 to 100 MHz. This was designed keeping in view our proposal to extend the frequency of operation of GMRT down to 40 MHz. The monitor is a PC based spectrometer recording the voltage output of a receiver connected to an antenna, capable of digitizing the low frequency RF directly with an 8 bit ADC and sampling bandwidths up to 16 MHz. The system can operate continuously in almost real-time with a loss of only 2% of data. In this paper we will present the system design aspects and the results of RFI monitoring carried out at the Raman Research Institute, Bangalore and at the GMRT site in Khodad.

Annalisa Bonafede - ***The Coma cluster magnetic field from Faraday Rotation measures***

Dipartimento di astronomia,Bologna University

The knowledge of the magnetic field in the Coma cluster is of great importance in order to understand the non-thermal component of the intra-cluster medium, and to test in detail current models of halo formation. We present polarimetric analysis of a few sources, for which we have derived RM on arcsec scale.

Shea Brown - ***A New View of the Polarized Sky with the NVSS Survey***

University of Minnesota

We report the discovery of new populations of large, low surface brightness polarization structures. The 0.3-1.2 degree scale structures were discovered by convolving the polarized intensity from the 21cm NVSS survey to 800" and are visible only because of smaller scale polarization angle variations. This technique opens up the NVSS survey as a powerful window for examining both galactic and extragalactic synchrotron emission whose total intensity is too smooth to be picked up by an interferometer, but whose polarized emission is depolarized by the large beams of single dish experiments. These sources provide a unique target list for LOFAR, representing extragalactic sources that could probe the elusive WHIM regions, as well as galactic structures where Faraday rotation plays an important role.

Thijs Coenen - ***Automatic LOFAR Transient Classification***

API, University of Amsterdam

Gabriele Giovannini - ***Relics Radio Sources in Clusters of Galaxies***

Dipartimento di Astronomia - Bologna University

I will shortly review observational results on Relic radio sources in clusters of galaxies and I will discuss their observational properties as: radio structures, radio spectra and position with respect to the cluster centre.

I will discuss that differences in Relic properties could be related to the origin and physical properties of Relics.

Ilian Iliev - ***Large-scale simulations of EoR and their implications for the observables***

CITA

We have recently performed the first large-scale radiative transfer simulations of reionization. These are run on top of the largest and most detailed simulations of early structure formation to date which resolved halos down to dwarf galaxy scale in very large volumes, up to 100/h Mpc. We showed that the reionization process is strongly self-regulated and that it has a fairly large characteristic scales, at wavenumbers of k~1 h/Mpc, which is similar to the typical resolution of planned experiments, at arcminute scales. This allowed us for the first time to make realistic observational predictions of the Epoch of Reionization observables based on detailed radiative transfer and structure formation simulations. I would present our predictions for the progress and features of reionization under different scenarios and would discuss in detail the observability of this epoch with upcoming experiments for measuring the small-scale CMB temperature anisotropies from kinetic Sunyaev-Zeldovich effect and CMB polarization anisotropies (with ACT and SPT) and for observing high-redshift Ly-alpha sources in both emission and absorption. A companion talk by Garrelt Mellema would discuss the EoR observability at redshifted 21-cm line of hydrogen (with LOFAR, GMRT, MWA and SKA).

Nikolay Kalinichenko - ***Investigations of dynamic processes in the solar wind***

Institute of Radio Astronomy, Ukraine

High-speed streams of the solar wind from coronal holes and coronal mass ejections (CMEs) are constantly present in the interplanetary medium. Though they decay with removing from the sun, the most powerful ones are observed at the large distances (at least several a.u.). Whole-sky pictures of the interplanetary plasma, which are built using the large number of the scintillating radio sources, allow the high-speed streams to be detected and studied. As the spatial resolution of this technique depends on the number of radio sources, it is necessary to have as many of radio sources as possible. Moreover, at high frequencies IPS data are usually modelled based on the weak scattering theory. However, at the low frequencies the scattering medium is essentially expanded and the most scattering layer is situated near an observer, so use of the phase screen model is not correct. More correct ways are provided by multiple scattering methods. Also, at the low frequencies it is necessary to take into account the effect of the ionosphere on radio source scintillations to obtain the reliable parameters of the solar wind. These and some others problems are solved by us for a long time. We think the results of these investigations would be interesting as probe of LOFAR concepts.

During 2003-2004 we observed the scintillations of the small size radio sources at the large solar elongations with the largest in the world decameter radio telescope UTR-2. Simultaneously, we carried out IPS observations of eleven supernova remnants to determine if any of these remnants contain compact radio sources to compensate the lack of compact radio sources needed for building whole-sky pictures of the interplanetary plasma. In experiments we used new wide-band radiometers that allow us to obtain scintillation power spectra with dynamic range of 3 to 4 orders, unachievable before at decameter wavelengths. To derive the solar wind parameters, the observed spectra were fitted with theoretical ones which were obtained by using the multiple scattering theory. We used the width difference of the frequency correlation intervals to separate the interplanetary and ionospheric scintillations and to increase the data reliability. The data processing allows us to obtain the variations of the solar wind parameters during this time interval and to prove possibility of tracking of high-speed solar wind streams in the outer heliosphere by using IPS observations at decameter wavelengths. We managed to observe the fast stream moving from the large coronal hole in the north hemisphere of the Sun and the fast speed streams caused by the powerful solar flare 17.03.2003 and the filament outburst 18.03.2003 reached Earthâ€™s orbit on March, 20. Our results were in good agreement with SOHO and Genesis Discovery Mission data. In our opinion, the obtained results and methods are very helpful for scientific programs of LOFAR and LOFAR, with its unique and unprecedented capabilities, can provide more useful information.

Jaroslaw Kijak - ***Turn-over in pulsar radio spectra: From young pulsars to millisecond ones.***

J. Kepler Institute of Astronomy, University of Zielona Gora, PL

The evidence for turn-over in young pulsar radio spectra at high frequencies is presented. The frequency at which a spectrum shows the maximum flux density is called the peak frequency. This peak frequency appears to depend on pulsar age and dispersion measure. A possible relation with pulsar age is interesting. Millisecond pulsars, which are very old objects, may show no evidence for spectral turn-over down to 100 MHz. Some studied pulsars with turn-over at high frequencies have been shown to have very interesting interstellar environments. This could suggest that the turn-over phenomenon is associated with the environmental conditions around the neutron stars, rather than being related intrinsically with the radio emission mechanism. Although there are no earlier reports of such a connection, a more detailed study on larger sample of pulsars is needed to address this idea more quantitatively. In this context, future observations below 200 MHz using LOFAR will allow us to investigate turn-over in radio pulsar spectra.

Alexander Konovalenko

- Astrophysics at low and very low frequencies with the existing and future radio telescopes

Institute of Radio Astronomy, NAS, Ukraine

Radio astronomical investigations at low frequencies (meter-, decameter range) are very important for the astrophysics science. Just at low frequency a lot of physical events in the Universe become most pronounced and even unique. In particular, such phenomena were described in detail in the “LOFAR scientific application” edited by M. van Haarlem. Mention above work represents a list of problems which are important for the future investigation with the new generation telescopes. In the given review we prove an availability of future research by the demonstration and generalization the results of studying solar system, galaxy and metagalaxy with the existing largest wide-band instruments (UTR-2, URAN1â€¦URAN4, NDA). We show the earlier results as well as the modern, for instance, we present the Saturn electrostatic discharges which were recently discovered by the UTR-2 telescope.

In the Ukraine begin a realization of new program for perspective development of the low frequency radio astronomy. This program includes the further modernization of UTR-2 radio telescope and also the creation of new large telescope of 10 – 70 MHz frequency range. The combination of LOFAR and already existing instruments will permit to get unexampled angular resolution due to the reaching the base in order of 2000 km.

Casey Law - ***A Survey for Transient Sources with CS1***

University of Amsterdam

LOFAR's ability to observe at low frequencies with a wide field of view makes it ideal for studying transient astrophysical phenomena. Known sources of transient low frequency radio emission include GRBs, X-ray binaries, pulsars, planets, and flare stars. Here we describe a survey for transient sources with LOFAR's first station, CS1, including a description of our transient detection scheme and preliminary results.

Wojciech Lewandowski - ***Turn-over in pulsar radio spectra: From young pulsars to millisecond ones***

J. Kepler Institute of Astronomy, University of Zielona Gora, PL

The evidence for turn-over in young pulsar radio spectra at high frequencies is presented. The frequency at which a spectrum shows the maximum flux density is called the peak frequency. This peak frequency appears to depend on pulsar age and dispersion measure. A possible relation with pulsar age is interesting. Millisecond pulsars, which are very old objects, may show no evidence for spectral turn-over down to 100 MHz. Some studied pulsars with turn-over at high frequencies have been shown to have very interesting interstellar environments. This could suggest that the turn-over phenomenon is associated with the enviromental conditions around the neutron stars, rather than being related intrinsically with the radio emission mechanism. Although there are no earlier reports of such a connection, a more detailed study on larger sample of pulsars is needed to address this idea more quantitatively. In this context, future observations below 200 MHz using LOFAR will allow us to investigate turn-over in radio pulsar spectra.

Galyna Lytvynenko

- Significant importance of the high sensitive and high resolution observations for the Jovian DAM emission investigation

Institute of Radio Astronomy, NAS, Ukraine

Jovian sporadic decameter emission represents one of the more powerful events in the radio astronomy. Thanks to this fact a lot of fundamental information has been obtained with the comparatively small antennas which have an effective area in order of the several square meters (small-size array, log-periodic array and so on.). At the same time the complete theory of the Jovian decameter emission phenomenon still doesnâ€™t exist. Thus it is obvious the importance of further developing the theory as well as further organization the new experiments. During the last years the new high sensitive recording facilities, such as the digital spectro-polarimiter (DSP) and waveform receiver (WFR) were created and installed into the largest decameter band antenna array UTR-2 (Kharkov, Ukraine). It can be noted that in the present time this combination (antenna + equipments) gives the best sensitiveness, band of analysis, dynamic range, time and frequency resolutions. The using of mentioned above technique allowed detecting new time-frequency features of the Jovian S-bursts.
With the creation of new giant low frequency antenna array (LOFAR) and low wavelength array (LWA) the new possibilities of high level study of the Jovian DAM emission will appear. For instance, the combination of LOFAR and already existing instruments (max base in order of 2000 km) will permit to determine the spatial parameters and localization of an emission source. Future results may prove useful for understanding of the still unclear origin of the sporadic Jovian decametre emission.

Karl-Heinz Mack *- Low-frequency emission from restarting radio galaxies*

INAF - Istituto di Radioastronomia

LOFAR is expected to deliver a wealth of information on the evolution of radio sources, as it is in the still poorly studied low-frequency range that the lowest energy and thus oldest emitters can be detected. The extrapolation of some of the source characteristics derived from the existing large surveys in the cm-range and a few specific observations at longer wavelengths allow us to get a glimpse on the expected results of the large-scale LOFAR surveys of the extragalactic Universe. Here we present a few examples of recent studies on the low-frequency emission in recurrent radio galaxies.

Emanuela Orru' - *Low frequency observations of radio halos*

Dipartimento di Astronomia - Bologna University - Istituto di Radioastronomia INAF Bologna

Spectral index images can be used to constraint the energy spectrum of relativistic electrons and magnetic field distribution in radio halos and relics, providing useful information to understand their formation, evolution and connection to cluster merger processes.

We will present a low-frequency study of the two clusters of galaxies: A2744 and A2219.

Observations were made with the Very Large Array at the frequency of 325 MHz. For both clusters deep Very Large Array 1.4 GHz observations are available. Combining the 325 MHz and 1.4 GHz data, we obtained the spectral index images and the brightness radial profiles of the diffuse radio emission with a resolution of ~ 1 arcmin. The spectral index maps will be compared with the X-ray and optical data. Results will be analyzed, discussed and compared with the current models.

Mamta Pandey *- Low frequency imaging*

CEA, Saclay, France

We have recently carried out very low frequency radio imaging of newly discovered high energy sources with the GMRT at 610 and 235 MHz. In this meeting I would like to present the results of our work.

Zsolt Paragi *- e-VLBI developments at JIVE*

JIVE

The European VLBI Network (EVN) routinely carries out e-VLBI science observations since 2006. The data from the radio telescopes are streamed into the correlator in realtime, and post-processed shortly after the observations. This gives a great flexibility for studying transient objects discovered by LOFAR.

Evgenii Vasiliev ***- The 21 cm power spectrum from the universe with decaying particles***

Tartu Observatory (Estonia), South Federal University (Russia)

The decaying dark matter particles heat baryons and increase spin temperature of HI, and therefore affect emission and absorption characteristics in 21 cm at redshifts z = 10-50. The power spectrum of the brightness temperature fluctuations is found to be fairly sensitive to the type of decaying dark matter. This provides possibilities to detect observational manifestations of decaying particles in 21 cm with the future radio telescopes (LOFAR, 21CMA and SKA).

Marek Wezgowiec ***- Diffuse cocoons around extended giant radio galaxies***

Obserwatorium Astronomiczne Uniwersytetu Jagiellonskiego

Galaxies with active galactic nuclei (AGN) are usually powerful radio sources producing jets and extended regions of emission. There is no doubt that weak diffuse radio cocoons should exist around powerful extragalactic sources. By observing them we may acquire important information about the nature of the central AGNs, as well as get some clues about physics of the radio structure and galaxy evolution in general. Unfortunately, steep radio spectra and low surface brightness of such sources makes them difficult to observe at higher frequencies. Existing radio interferometers provide high angular resolution but are not sensitive enough to detect extended structures and high sensitivity of single-dish telescopes is diminished by their poor angular resolution. Therefore, sensitive low-frequency observations with high angular-resolution are of fundamental importance. In this poster we show some examples of diffuse radio cocoons around extended giant radio galaxies.

Erik Zeitler

- Using stream queries to measure communication performance of a parallel computing environment

Uppsala University

We have developed a DSMS that supports declarative stream queries running over high data volumes in a supercomputing environment. To enable specification of massively parallel computations our query language provides processes as query language objects. The queries call process construction functions that execute stream sub-queries assigned to some CPU. Such queries can be used to define query functions that parallelize computations. The CPU assignment is normally automatic, but can also be influenced by the user. We show how this enables measuring the performance of different communication topologies in a heterogeneous hardware environment containing a Linux cluster and a BlueGene.