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Exploring the nature of the broadband variability in the flat spectrum radio quasar 3C 273

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The detailed investigation of the broadband flux variability in the blazar 3C 273 allowed us to probe the location and size of emission regions and their physical conditions. We conducted correlation studies of the flaring activity in 3C 273, which was observed for the period between 2008 and 2012. The observed broadband variations were investigated using the structure function and the discrete correlation function methods. Starting from the commonly used power spectral density analysis (PSD) at X-ray frequencies, we extended our investigation to characterise the nature of variability at radio, optical, and -ray frequencies. The PSD analysis showed that the optical and infrared light-curve slopes are consistent with the slope of white-noise processes, while the PSD slopes at radio, Xray, and Gamma-ray energies are consistent with red-noise processes. We found that the estimated fractional variability amplitudes strongly depend on the observed frequency. The flux variations at Gamma-ray and mm-radio bands are found to be significantly correlated. Using the estimated time lag of (110±27) days between Gamma-ray and radio light-curves, where Gamma-ray variations lead the radio bands, we constrained the location of the Gamma-ray emission region at a de-projected distance of 1.2± 0.9 pc from the jet apex. Flux variations at X-ray bands were found to have a significant correlation with variations at both radio and Gamma-ray energies. The correlation between X-ray and Gamma-ray light curves indicates two possible time lags, which suggests that two components are responsible for the X-ray emission. A negative time lag of -(50±20) days, where the X-rays are leading the emission, suggests that X-rays are emitted closer to the jet apex from a compact region (0.02–0.05 pc in size), that is, they stem most likely from the corona at a distance of (0.5±0.4) pc from the jet apex. A positive time lag of (110±20) days (Gamma-rays are leading the emission) suggests a jet-base origin of the other X-ray component at 4–5 pc from the jet apex. The flux variations at radio frequencies were found to be well correlated with each other such that the variations at higher frequencies are leading the lower frequencies, which is expected from the standard shock-in-jet model.

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The earliest accreting super massive black holes : indications from models for future

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Understanding when and how the earliest super massive black holes (SMBHs) were born and grew since then is currently one of the hottest research area in science. With the latest developments in both the observational and simulation sides, it starts to be of utmost interest to compare both perspectives in order to delineate best strategy practices in searching for the first SMBHs in sky surveys underway and those planned for the near-future. In this work, we put side-to-side semi-analytic galaxy formation models results and state-of-the-art observational constrains at X-rays and radio spectral regimes, so to provide the expected number of SMBHs at z>6 in the current and upcoming sky surveys such as ASKAP, SKA, EMU and ATHENA. Furthermore, we are trying to understand how super-eddington accretion on SMBHs could help us overcome the limitations revealed by these models at the very high redshift universe.

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Radio interferometric study of the puzzling radio galaxy 3C 411

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Based on X-ray spectroscopic observations, the radio galaxy 3C 411 has recently been suggested to have a blazar-like core. The model proposed by Bostrom et al. (2014) was investigated with radio interferometric imaging, both with arcsecond resolution using archival Very Large Array (VLA) measurements, and on milliarcsecond scales using Very Long Baseline Array (VLBA) data. The source brightness distribution was characterized by fitting Gaussian model components to the visibility data in the Difmap package. The low values of the Doppler factor (between 0.14 and 0.35) found for the inner jet region of 3C 411 exclude the possibility of relativistic beaming, hence the blazar nature. Assuming typical values of the jet bulk Lorentz factor, the inclination of the approaching jet to the line of sight was estimated, suggesting an angle between -70° and -90°. Comparing it with the large-scale jet inclination (82-88°), at best a modest change in the orientation could be inferred. However, the approaching jet apparently switched from the south-eastern to the north-western side between 100 kpc and pc scales, respectively.

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A multi-frequency study of radio evolution of SN 2008iz

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A report on multi-frequency Very Large Array (VLA) and Very Long Baseline Interferometry (VLBI) radio observations for a monitoring campaign of supernova SN 2008iz in the nearby irregular galaxy M 82. We fit two models to the data, a simple time power-law, $S\propto t^{\beta}$, and a simplified Weiler model, yielding decline indices of β= -1.22±0.07 (days 100-1500) and -1.41±0.02 (days 76-2167), respectively. We also derive the spectral index, α, $S\propto \nu^{\alpha}$ for frequencies 1.4 to 43 GHz for SN 2008iz during the period from $\sim$430 to 2167 days after the supernova explosion. The value of α shows no signs of evolution and remains steep ≈ -1 throughout the period. From the 4.8 and 8.4 GHz VLBI images, the supernova expansion is seen to start with a shell-like structure that becomes increasingly more asymmetric, then breaks up in the later epochs, with bright structures dominating the southern part of the ring. The VLBI 4.8 and 8.4 GHz images are used to derive a deceleration index, m, for SN 2008iz, of 0.86 ±\,0.02, and the average expansion velocity between days 73 and 1400 as $(12.1\pm0.2)\times10^{3}$ km s^{-1}.

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Probing the Magnetized Medium of AGNs using Wideband Polarimetry

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Wideband radio polarimetry is a powerful tool to reveal magnetic fields on different scales in different environments: in galaxies and in Active Galactic Nuclei (AGNs). I will introduce RM synthesis and QU-fitting which are excellent tools to interpret wideband polarization data. The aim of my thesis is to use new polarization data with a wide frequency coverage and these tools

to map magnetic fields near and far in order to shed new light on the origin of cosmic magnetism. I observed polarized emission from unresolved point sources, selected from the NVSS catalog which seems to have very high fractional polarizations (> 30%). Except for the high degree of polarization, those sources appear to have normal AGN properties. Therefore, they could represent a class of sources with very well ordered magnetic fields. For this, I am conducting a deep, high resolution, broad band polarization survey of around 80 of those sources to make one more step towards understanding the origin of the unusual high degree of polarization. Understanding the intrinsic polarization properties of these objects are crucial since these unresolved point sources are used as background probe of intervening systems in these so-call RM grid experiments.

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Resolving the base of the relativistic jet in M87 at 6 Schwarzschild radii resolution with global mm-VLBI

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M87 is one of the nearest radio galaxies with a central SMBH and a prominent relativistic jet. Due to its close distance to the observer and the large SMBH mass, the source is one of the best laboratories to obtain strong observational constraints on the theoretical models for the formation and evolution of the AGN jets. In this talk, we present preliminary results from our ongoing observational study about the innermost jet of M87 at an ultra-high resolution of $\sim$ 50 micro-arcseconds achieved by the Global Millimeter-VLBI Array (GMVA). The data obtained between 2004 and 2015 clearly show limb-brightened jets at extreme resolution and sensitivity. Our preliminary analysis reveals that the innermost jet expands in an edge-brightened parabolic shape but with the jet expansion profile slightly different from the outer regions of the jet. Brightness temperatures of the VLBI core obtained from cm- to mm-wavelengths show a systematic evolution, which can be interpreted as the evolution as a function of distance from the BH. We also adopt a new super-resolution imaging algorithm, BSMEM, to test reliable imaging at higher angular resolutions than provided by the standard CLEAN method. A demonstration with a VLBA 7mm example data set shows consistent result with a near-in-time 3mm VLBI image. Application of the method to the 2009 GMVA data yields an image with remarkable fine-scale structures that have been never imaged before. We present a brief interpretation of the complexity in the structure.

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Initial methanol maser measurements with VIRAC RT32 Irbene radio telescope

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After finishing the infrastructure renovation and modernization program VIRAC has his 32 m radio telescope equipped among other with coolable broadband receiver with frequency range 4.5 – 8.8 GHz capable to register weak sources. One of observation programs planned is the monitoring of methanol masers type II variability at 6.7 GHz. We selected quarter hundred methanol masers and observed them with under a weak long period. Observations are still going on but we already have data from several moths long period. We present initial results of that program.

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Observation of the Sausage galaxy cluster with the Sardinia Radio Telescope

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The Square Kilometre Array (SKA) is a forthcoming world class radio interferometer and one of its key scientific goals is to understand cosmic magnetism. In order to achieve this task, it is essential to investigate large scale magnetic fields. The sensitivity, the large bandwidth and the high spatial resolution of the SKA will make possible accurate estimates of intracluster magnetic field strength and structure and therefore to shed light on the origin of cosmological magnetic fields. The most detailed investigation of magnetic fields comes from radio observations of the Faraday effect on background radio sources and of the properties of diffuse large scale synchrotron emission. The SKA is ideal to study large scale magnetic fields by using both approaches. It will perform a polarization all-sky survey that will deliver detailed Faraday Rotation Measure images of radio galaxies over all the sky. Moreover, the enhanced sensitivity will allow us to investigate faint diffuse synchrotron sources. These sources have been observed at the centre and in the outskirts of galaxy clusters and are called radio halos and relics, respectively, according to their characteristics. They are not associated with discrete radio sources of the cluster but rather with the intracluster medium, so that they indicate the existence of a non-thermal component in the cluster, made by magnetic fields and relativistic electrons. Although radio halos and relics are usually observed with radio interferometers, this class of instruments cannot detect emission on angular scales larger than the one corresponding to their minimum baseline. With single dish telescopes, we can avoid this problem and infer the real size and flux of the radio source. During my talk, I will show one of the first results of the SRT Multiwavelength Observations of Galaxy clusters (SMOG), in the context of the early science activities of the Sardinia Radio Telescope (SRT). We produced spectro-polarimetric images of the galaxy cluster CIZA J2242.8+5301 at C-Band (6-7.2 GHz) with a resolution of 2.8 arcmin. This cluster is known to host two radio relics and a radio halo. With our observations, we were able to investigate the total and polarized emission of these sources, paving the way to new and more accurate estimates of the intracluster magnetic field.

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A Magnetic Field Study of the Radio Galaxy Coma A from 1 to 4 GHz

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Having performed an in depth study of the radio galaxy Coma A, results will be presented regarding its polarization and magnetic field structure. Broadband VLA observations at L (1-2GHz) and S band (2-4GHz) were used for this study. By imaging the broadband data at discrete intervals the behavior of the Stokes Q and U with frequency can be examined. This allows for the application of RM synthesis to measure the Faraday rotation in different parts of the source along with the total polarized flux. The Q and U data can also be fit to various Faraday rotation models to study the magnetic field structure of the source and its environment in more detail. The Faraday rotation measure will also be directly compared to Hα emission associated with the radio lobes, allowing a direct estimate of the magnetic field strength in particular regions.

Having data from 1 - 4 GHz also allows to measure the depolarization in the source and how this relates to observed Hα emission.

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Unveiling the remarkable PDR of M8 and its link to Diffuse Interstellar Bands

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Photodissociation regions (PDRs) are predominantly neutral regions of the interstellar medium (ISM) in which the heating and chemistry are regulated by far UV photons emitted by near by stars. The region closest to the star is radiated with UV photons which are energetic enough to ionize the hydrogen present hence the name HII (ionized hydrogen) region while the cooler molecular clouds are shielded from the strong radiation. PDRs are at the interface between the molecular cloud and the HII region.
The study of PDRs is basically the study of the effects of stellar far-UV (6 eV < hυ <13.6 eV) photons on the structure, chemistry, thermal balance and evolution of the ISM of galaxies. PDRs are very good searching grounds for Diffuse Interstellar Bands (DIBs) as well. DIBs are weak absorption bands from the near-UV through the visible into the far-red and near-infrared regimes with typical width of 0.5 – 30 Å (much broader than Doppler width) and with a lot of variation in relative strengths. A persistent question in astronomical spectroscopy has been the nature of the carriers of the DIBs. Identification of specific DIB carriers will provide greater insight into the nature of the ISM. If the carriers are known, the variations in the DIB profiles along different lines of sight could be used to infer their physical conditions. The most suspected carriers of DIBs are the polycyclic aromatic hydrocarbons (PAHs) which are known to exist in PDRs. PAHs are suggested to undergo fragmentation to smaller hydrocarbons when exposed to high energy FUV photons which might be responsible for some of the observed DIBs.
We are carrying out a comprehensive survey in millimeter-and submillimeter regime of Messier 8 which is an emission nebula in our galaxy, with APEX, IRAM 30m and SOFIA telescopes. M8 is heated by the nearby hot star Herschel 36 towards which anomalously broad DIBs were observed (Dahlstrom et al., 2013). Also, GLIMPSE 8 µm continuum data is indicative of strong PAH emission around Herschel 36, in M8. The aims of this project are two-fold:
1) To characterize M8 as a PDR. This will include determining the column densities of various species, gas temperature and mass to understand the physical and prevailing chemical conditions and to examine the structure of the so far unexplored PDR of M8.
2) To establish an inventory of hydrocarbons. The abundances of various species will indicate their importance in the gas phase hydrocarbon chemistry dominating in M8 and in being the favorable candidates responsible for the observed DIBs along M8.
From our recent observations with the APEX telescope (done in July 2015 and July 2016) we see M8 to be one of the brightest PDRs in our galaxy. The inferred HII region from our SOFIA telescope's observations (done in May 2016) matches well with surveys done in other wavelengths such as WISE 3.4 µm, 4.6 µm data and VLA 1.3cm data. Furthermore, the hydrocarbons observed with APEX (done in July 2015) indicate their origin from a warm PDR. In this talk, I will introduce my project and will present the preliminary results obtained from APEX and SOFIA observations and the outlook of this project.

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Detecting the Magnetic Cosmic Web through Deep Radio Polarization Imaging

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Magnetic fields are present throughout the Universe and many astrophysical processes are influenced by their presence. Due to the indirect nature of the detection of these fields, it is difficult to determine much about the origin and evolution of magnetic fields. One method of detection is to measure how the polarisation angle of light is rotated in the presence of electrons and magnetic field. In this project, we simulate the Rotation Measure (RM) experienced by radio emission as it travels from an extragalactic source to observer in large-scale simulations. Our aim is to investigate the effect of extragalactic magnetic fields on the spatial distribution of RM. This project aims to produce RM maps of the simulated universe and use these to inform upcoming radio surveys.

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What Can Spectral Ageing Tell Us About Recent Star Formation?

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Radio Continuum (RC) emission in normal galaxies originates from massive star feedback: thermal RC is directly related to their ionising flux which creates the surrounding HII region that gives rise to free-free emission; non-thermal RC is generated by Cosmic Ray electrons (CRe) accelerated in the shocks resulting from core-collapse supernovae. The almost extinction-free RC can potentially provide an ideal tracer for recent star-formation, valid out to high redshifts. This fact is illustrated by the existence of the Radio-FIR correlation, a tight relationship that links RC emission to FIR emission over an astonishing 5 orders of magnitude in luminosity. Current Radio-SFR relations are calibrated to this relationship, yet many independent factors need to delicately balance to maintain this trend over such a large range of luminosity. In order to fully calibrate a radio star-formation relation, insights into the fundamental physics behind the Radio-FIR correlation need to be gained by pushing observations to extreme environments, for example, that provided by low mass, low-density dwarf galaxies that have recently been shown to deviate from the correlation. The source of this deviation is believed to be due to CRe escaping the low gravitational potential of these systems without radiating a substantial amount of their injected energy via the synchrotron emission process. The actual fraction of energy that is radiated inside the disks of dwarf galaxies is currently unknown and is key to understanding how other factors "conspire" to maintain the relation. We present the theory behind CRe ageing analysis and outline a pilot project to construct resolved CRe "age" maps for the star-bursting Dwarf Irregular galaxy NGC 1569. These maps will offer a unique opportunity to study CRe energy loss as a function of environment and analyse to what extent CRe "age" analysis can be used to recover galaxy-wide spatially resolved recent star-formation histories.

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A new relativistic binary pulsar discovered in the HTRU-S Low Latitude pulsar survey.

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Here we present some of the latest results from HTRU-S Low Latitude pulsar survey, including the discovery of the most relativistic binary pulsar found to date. Pulsars, rapidly rotating neutron stars whose beams of electromagnetic emission sweep through space like cosmic lighthouses, can serve as tools in a wide variety of scientific applications. The study of their regular clock-like pulsations can provide insight into the structure of the Interstellar Medium, help to constrain the equation of state of neutron star interiors, and can inform our understanding of the processes of stellar evolution. Of particular interest are pulsars in binary systems. These systems provide unique laboratories for testing General Relativity and other theories of gravity in the strong-field regime. These tests were first performed with the so-called Hulse-Taylor pulsar PSR B1913+16, and studies of the Double Pulsar PSR J0737−3039A&B (which until recently was the most relativistic binary pulsar known) have allowed for five independent tests of General Relativity (which passed the most stringent of them to within an error of only 0.05%).
The High Time Resolution Universe South (HTRU-S) Low Latitude pulsar survey represents the most sensitive pulsar survey taken of the Galactic Plane to date. One of the primary goals of this survey is to discover new, ultra-compact relativistic binary pulsars. The Galactic Plane is considered to have the highest likelihood of containing such systems, as due to their higher total masses they are unlikely to have moved far from their point of origin. The partially-coherent segmented acceleration search employed by our pulsar search pipeline is designed to ensure a high sensitivity to binary pulsars with orbital periods as short as 90 minutes. This presentation will outline the structure of this pipeline, as well as to highlight some of the most exciting discoveries to emerge from the survey. This includes the a new relativistic binary system which, with an orbital period of 4.4 hours and an eccentricity of 0.606, sets a new record as the most relativistic binary pulsar found to date, exceeding the relativistic properties of the Double Pulsar and opening the door for yet-more stringent tests of theories of gravity.

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Milliarcsecond VLBI Maser Astrometry

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Interstellar masers are excellent signposts of high-mass star formation. They are intense (up to >1000 Jy) and are not significantly absorbed by intervening clouds of gas and dust. I have been using sub-milliarcsecond (mas) resolution VLBI measurements of masers, to conduct research into high-mass star formation. Using multi-epoch observations over the course of ˜1 year, my collaborators and I are measuring the parallax and proper motions of masers associated with Galactic high-mass star formation regions (HMSFRs). These results are being used to determine the spiral structure of the fourth quadrant of the Milky Way and to probe the gas dynamics of the stellar core at 10 - 1000 AU scales.
There currently exists much ambiguity in our knowledge of the Milky Way's structural and orbital properties. No consensus exists as to the number of spiral arms, their positions or rotational attributes. The most direct and accurate method to determine the distance to our Galaxy's spiral arms is by making measurements of the parallax angle to the HMSFRs which constitute the bulk of their matter. Reid et al. have been undertaking astrometric parallax measurements of methanol and water maser emission from HMSFRs as a part of the Bar and Spiral Structure Legacy (BeSSeL) survey. Their findings to date from over 100 measurements gives the distance to the Galactic centre as 8.34 ± 0.16 kpc and circular rotation speed as 240 ± 8 km s^{-1}. However, all the data have been acquired from the northern hemisphere, and these need to be supplemented with southern hemisphere measurements. This is because observations of the fourth Galactic quadrant, corresponding to at least 30% in azimuth, can only be obtained from southern hemisphere instruments. The updated circular rotation speed is significantly different from the accepted value of 220 km s^{-1} by the IAU, and implies that the Milky Way is of similar size and mass to its companion Andromeda Galaxy. Since 2012 I have been measuring parallaxes to southern hemisphere 6.7 GHz maser sources with the Australian Long Baseline Array (LBA).

These are currently the only measurements from the southern hemisphere, and I will be presenting the first methanol maser parallax results in my talk.
Despite the prominence of high-mass stars in the field of astrophysics, the details of the processes which lead to their formation are not well understood. This is because these objects tend to be located far away from the solar system (typically >2 kpc) and are deeply embedded in thick obscuring dust clouds during the early stages of their evolution. In addition to the parallax, the multi-epoch maser observations with respect to a "fixed" background quasar also allow us to determine the mas yr^{-1} proper motion of individual maser features associated with HMSFRs. When the proper motions in the plane of the sky are combined with the observed line-of-sight velocity of the HMSFRs, the complete 3D gas kinematics of the region can be determined to an accuracy of ~1 km s^{-1}. We are currently analysing the gas kinematics in 40 high-mass young stellar sources at scales of 10 - 1000 AU from the young stellar core, and I will be discussing our preliminary results.

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Directly observing continuum emission from self-gravitating spiral waves

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We use a simple, self-consistent, self-gravitating semi-analytic disc model to conduct an examination of the parameter space in which self-gravitating discs may exist. We then use Monte Carlo radiative transfer to generate synthetic Atacama Large Millimeter/submillimeter Array (ALMA) images of these self-gravitating discs to determine the subset of this parameter space in which they generate non-axisymmetric structure that is potentially detectable by ALMA. Recently, several transition discs have been observed to have non-axisymmetric structure that extends out to large radii. It has been suggested that one possible origin of these asymmetries could be spiral density waves induced by disc self-gravity. We use our simple model to see if these discs exist in the region of parameter space where self-gravity could feasibly explain these spiral features. We find that for self-gravity to play a role in these systems typically requires a disc mass around an order of magnitude higher than the observed disc masses for the systems. The spiral amplitudes produced by self-gravity in the local approximation are relatively weak when compared to amplitudes produced by tidal interactions, or spirals launched at Lindblad resonances due to embedded planets in the disc. As such, we ultimately caution against diagnosing spiral features as being due to self-gravity, unless the disc exists in the very narrow region of parameter space where the spiral wave amplitudes are large enough to produce detectable features, but not so large as to cause the disc to fragment

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AGN and parsec-scale jets in the LeMMINGs survey

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The Legacy e-MERLIN Multi-band Imaging of Nearby Galaxies survey (LeMMINGs) will perform a complete census of radio emission in nearby - upto 125Mpc - galaxies. Optically-selected from the Palomar spectroscopic bright galaxy survey, the 280 LeMMINGs galaxies form a statistically-complete legacy dataset for investigations into low-luminosity active galactic nuclei, star formation rates and cosmology. A complimentary deep sample of 41 galaxies allows for more direct study of individual galaxies and their radio emission. e-MERLIN observations probe intermediary scales between VLA and VLBI to a sensitivity level of 8 micro Janskys per beam at L band giving an unprecedented view on the radio sky with the goal of identifying and classifying radio sources.
Of the pressing issues in AGN research is finding out how optical spectroscopic classifications compare with the likelihood of an AGN at the core. Seyfert galaxies are known to harbour AGN

in the cores and several LINERs have now been shown to have hidden AGN behind star forming regions. However, due to low accretion rates in local, low-z galaxies and contamination from star formation, it has yet to be shown whether star-forming galaxies have AGN at their cores. Moreover, even if star-forming galaxies are partially AGN powered, what form of accretion onto the AGN is unknown and whether these models can be unified into existing theories.
Here, I present the preliminary results of a subset of the LeMMINGs statistical survey in L-band, the state of data reduction and how this affects our understanding of the fundamental plane of black hole activity. I also show some LeMMINGs deep sample data of NGC 4151, NGC 5322 and NGC 6217 showing their small, sub-parsec-scale jets and radio cores.

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Short-term radio variability from the gamma-ray emitting X-ray binary LS I +61d303

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The high-mass X-ray binary LS I +61d303 is detected from radio up to very high energy gamma-rays. The source consists of a Be star and a compact object in an eccentric orbit. Observations have shown evidence for radio microflares superimposed on larger outbursts. We observed the decaying phase of one large radio outburst with the 100-m telescope in Effelsberg at 5, 8, and 10 GHz. We observed microflaring activity with a periodicity of 10 hours. We discuss the possible physical processes behind these quasi-periodic oscillations and implications for gamma-ray emission.

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Tracing Molecular Oxygen Using Nitric Oxide as a Tracer Species

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Molecular oxygen is difficult to detect in the interstellar medium and the few observations so far indicate a rather low abundance for this species, which is a surprise since chemical models predict that it should be present at high abundances. With possibilities for directly detecting molecular oxygen limited to space telescopes such as Herschel, it is desireable to identify alternative tracer species that can be more readily observed. On chemical grounds, nitric oxide appears to be such a species. It is detectable with ground based millimetre telescopes but, perhaps due to a complex spectrum, is not routinely observed.
A full non-LTE radiative transfer implementation of nitric oxide in conditions appropriate for star forming clouds is presented. The major lines between J = 1/2 to 15/2 levels of the first and second manifolds are modeled and fit the data satisfactorily. The simulated hyperfine line

profile patterns produced by the code are compared to theoretical calculations and laboratory spectra. Additionally IRAM observations of L1544 are modelled using abundances predicted from chemical models. It is concluded that in molecular clouds at temperatures below around 100K, nitric oxide is a useful detectable tracer for molecular oxygen.

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What we have learned so far about compact AGNs

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The evolution of extragalactic radio sources has been a fundamental question in the study of active galactic nuclei for several decades. However a clear picture of the evolution of AGN as radio sources has only just begun to emerge.
In the general scenario of the evolution of powerful radio loud AGN, the younger and smaller sources (Gigahertz-Peaked Spectrum and Compact Steep Spectrum) become a large-scale FRI and FRII objects. However the growing number of observations of low power radio sources and results of their analysis suggest that not just one, but at least two evolutionary paths exist. During their evolution, the radio jests traverse the ISM and try to leave the host galaxy. The jet-ISM interaction can be very strong and it appears to be a crucial scenario in the evolution of radio sources. On the other hand, the studies of the optical properties of radio-loud AGN suggest the existence of two radio source populations where the main discriminant is the accretion rate onto the central black hole. According to these studies, high excitation galaxies are distinctive in strong evolution while the low excitation galaxies are either slowly-evolving or not-evolving group of sources. There is also a suggestion that young radio-loud AGN can be short-live objects.
The analysis of the radio, optical and X-ray properties of a sample of low-luminosity compact objects carried out by our group over the last few years suggests that much larger population of short-lived low-power radio sources exist, and needs to be explored. Moreover, these sources present an unique opportunity to study fast-evolving and intermittent AGN jets. The Caltech-NRAO Stripe 82 Survey (CNSS), a multi-epoch radio transient survey carried out recently with the Jansky VLA, has facilitated an unbiased study of these sources for the first time.
In my presentation I would like to discuss the results of CNSS survey, our earlier studies of observations carried out with VLBI network, Keck telescopes and Chandra X-ray observatory as well as the future possibilities of low-frequency observations with LOFAR.

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Extragalactic Hydrogen Millimeter Recombination Lines as Star Formation Tracers

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Hydrogen recombination lines at radio and millimeter frequencies are emitted by high-n transitions of the Hydrogen atom. At the sub-mm and mm wavelengths, recombination lines come from transitions involving Hydrogen levels n ˜ 20-50. This excited hydrogen gas exists in HII regions around young massive stars, thus Hydrogen recombination could be used to trace sites of massive star formation. Energetic hydrogen lines, like Lyman-alpha, are unfortunately blocked by dust which is usually abundant in younger galaxies with high star formation rates (SFR). Millimiter hydrogen recombination lines (mm-RL) are not affected by dust extinction. Far infrared observations of dust emission are tipycally used as indirect tracers of star foramtion activity. By observing extragalactic sources of mm-RL we aim find the instantaneous star formation rate in those galaxies, and determine if mm-RL can be used as a direct tracer of SFR.

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Kinematics of Class 0 protostellar envelopes from the CALYPSO survey: the L1527 case study

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One of the main challenges to the formation of stars is the "angular momentum problem": the gas contained in a typical star-forming core envelope needs to loose most of its angular momentum or the angular momentum of the gas transfers to the star which can not be stable. Understanding how the initial angular momentum is being distributed during the main accretion, Class 0 phase is of uttermost importance to address directly the angular momentum problem and test possible solutions to it. However the spatial distribution and properties of angular momentum in Class 0 envelopes is still very little investigated, mostly because of the lack of complete observations covering the whole spatial dynamic ranges of low-mass protostellar envelopes (10 - 10 000 AU).
In order to tackle this issue, The CALYPSO (Continuum and Lines in Young Protostellar Objects) IRAM large program provides observations with Plateau de Bure Interferometer (hereafter PdBI) and the IRAM 30m telescope (hereafter 30m) of the dust continuum and dozen molecular lines emission from a large sample of 17 Class 0 protostars. The high spatial resolution (0.5") and the high dynamic range achieved with the combining of the PdBI and the 30m allow to study envelope kinematics at all relevant scales, and therefore shed light on the real angular momentum behavior in the youngest accreting protostars.
We used a sample of molecular lines tracing envelope's kinematics: SO(6-5), C18O(2-1), and N2H+(1-0). We chose L1527 IRS, a borderline Class 0/I object located in the Taurus molecular cloud at 140 pc, as a pilot source to ensure our methods are reliably reproducing results from the literature, abundant for this source.
We are now ready to implement our methodology at larger scales and a similar analysis is being carried out towards the 17 Class 0 protostars from the CALYPSO sample.

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A connection between gamma-ray and parsec-scale radio flares in the blazar 3C273

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In late 2009 quasar 3C273 experienced a series of strong gamma-ray flares which triggered our 6 cm - 7 mm VLBA follow up observations. We added to our 4 multifrequency epochs four years of 7 mm data in order to trace kinematics of newborn components.
The connection between gamma-ray and mm-wavelength variability is complex in 3C273 and there is no one-to-one correspondence in the lightcurves. If one connects the most prominent peaks in gamma-ray and in 7 mm VLBI core lightcurves, the latter lags by ˜112 days. This implies that the site of gamma-ray emission is located several parsecs upstream of the apparent jet base at 7 mm, close to the apex of the jet. This is consistent with the distance from the jet apex to the 7 mm core derived using the core shift analysis and is supported by the small time scale variability of the gamma-ray emission and absence of gamma-ray photons above 15 GeV. We found several components ejected during the active gamma-ray state and tie up one of them with the most prominent gamma-ray flare.

Magnetic field strength in the 7 mm VLBI core turns out to be almost constant while the core flux density increases by a factor of 20 during the flare. This implies that the particle density changes by 3 orders of magnitude. Changing opacity induces the movement of the core, as a tau = 1 surface, along the jet, which is detected with cluster kinematics analysis.

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The outflow content towards ATLASGAL-selected high-mass clumps in the inner Galaxy

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Molecular outflows are ubiquitous phenomena associated with both low- and high-mass star-forming regions. These structures are directly linked to the accretion process ongoing on their driving sources and they play a significant role on the ISM evolution, through the clearing of gas and the injection of momentum and energy at distances up to a few parsecs. By taking advantage of the unbiased nature of the ATLASGAL 870 micron survey of the inner Galaxy to select a statistical sample of 100 sources, representative of the proto-cluster Galactic population, we have characterized their outflow properties through their mid-J CO emission. Based on the detection rates and the energetics of the outflows, we found that a) 82% of the sample is likely to display outflow activity; b) the frequency of outflows is larger towards later pre-Main Sequence evolutionary phases; c) the outflow energetics scale reasonably well with the clump properties (bolometric luminosities and clump masses); d) mid-J CO transitions separate the environment and the entrained gas much better than low-J CO with an average temperature of approx. 65 K and are likely associated with warmer gas closer to the primary jet/UV heated walls; and e) the comparison between different luminosity ranges also supports that the entrainment mechanism of outflows associated with high-mass clumps are scaled-up versions of those driven by their low-mass counterparts.

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Discovery of extreme brightness temperatures in AGN cores by RadioAstron

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The space element of the ground-space very long baseline interferometer RadioAstron is a 10-meter radio telescope on board the dedicated Spektr-R spacecraft which was successfully launched in 2011. The largest key science program of the RadioAstron mission is the survey of strong active galactic nuclei (AGN) at the highest angular resolution. The main goal of the survey is to study physics of AGN cores by observing AGN up to the longest RadioAstron projected baselines and measuring the geometry and brightness temperature of the cores. To date radio emission is successfully detected from more than 160 sources at SVLBI baselines up to 350 000 km (27 Earth diameters) at 18, 6, and/or 1.3 cm. Formal resolution as high as 14 microarcseconds has been achieved. Results indicate that many AGN cores are significantly brighter than what was known before. In the same time, brightness temperature values about or greater than 10ˆ15 K were not observed. Current status and results of the RadioAstron AGN survey will be summarized including statistics of measurements of very high brightness temperatures in AGN cores and physical implications of these findings.

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A jet-cloud interaction in radio galaxy NGC 7385

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Radio/optical interactions can provide a better insight into the physical conditions within radio sources and in their environment than radio data alone. The detection of an optical object with emission lines and an underlying continuum in the outer region of a radio galaxy is relatively rare. Although significant jet deflection as a result of an optical/radio interaction has been reported for a few objects, NGC 7385 is the first radio source for which such an interaction causes a turn of the jet through 180 degrees. This extreme distortion is unusual and interesting.
NGC 7385 is a low-redshift (z=0.024) FRI-type elliptical galaxy located in a poor cluster and is also part of the 3CRR sample of radio sources published by Laing, Riley & Longair (1983). Optical observations of the source carried out using the Palomar telescope by Simkin and Ekers (1979) revealed a bright knot NE of the core. They interpreted this as the signature of a jet interacting with a dense intergalactic cloud.
Here I present new JVLA radio observations of the radio galaxy NGC 7385, along with HST and Chandra observations. The observations demonstrate morphological and polarimetric relationships between the radio plasma and the optical emission line gas in the NE of the radio counter-jet. The jet and cloud are found to be in pressure equilibrium, with an equipartition magnetic field strength 15 μG and a gas density n_e=16 cm^{-3}.
We use this source to address key questions concerning radio galaxies and their interaction with the intergalactic medium. Firstly, what are the radio morphologies of the emission in the jet bends, where existing data show strong distortions? We use measurements of spectral indices and rotation measure structure in these regions to address this question. Secondly, what is the magnetic field configuration in the jet bend regions, where we see complete jet reversals? And finally, what processes could contribute to the ionisation of the line emitting gas, and where does this gas originate? Other sources have been found to exhibit extreme jet deflections, although in these cases no optical line emitting regions are found to be associated with the deflection.
Laing R. A., Riley J. M., Longair M. S., 1983, MNRAS, 204, 151
Simkin S. M., Ekers R. D., 1979, AJ, 84, 56

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Low-frequency radio astronomy study of planetary lightning

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For more than 30 years lightning at the atmospheres of Saturn, Jupiter and Uranus have been studied. The discovery of the phenomena was made by spacecrafts but at the present time ground-based facilities could also provide an effective study. Moreover ground-based radio telescopes commonly with space missions can provide a detailed research to check the controversial facts about lightning on Venus, Mars and Titan. To the date the most studied is lightning in the atmosphere of Saturn specifically the radio emission that is called Saturn Electrostatic Discharges (SED). SED signals are sporadic and wide-band pulse radio emission observed in the frequency range from 1 MHz to 40 MHz. Duration of individual bursts stays between 30 ms and 400 ms. We conducted data processing of radio observations of the Solar system planets, which were carried out on the world's largest radio telescope in the decameter range UTR-2 [1]. According to the receiver [2] that has a maximum time resolution of 15 ns there were found intervals of intense radio emission of lightning on Saturn in the records made in 2010. For each burst duration and frequency width were estimated. We found that every lightning's burst is characterized by an inner time structure with different scale factors. To accurately determine the energy one is needed new data of calibrations, currently being hold. But our estimations have shown that SED energy

which also were found to be comparable to the Earth's one. This result is in a good agreement with [3]. In the paper authors declare that the visible energy of a single flash is comparable to that on Earth and Jupiter. For all data volume the statistical analysis was provided. Operating by the new knowledge about energy and time characteristics we could conduct some investigation of planetary lightning as a cosmic phenomenon. UTR-2 SED detections confirm the phenomena is ubiquitous [4] and thereby open a new field of planetary radio emission accessible from the Earth. We have been carrying out observations of Venus and Uranus from 2011. Observations of Uranus and Venus were a part of the program of searching and investigating of electrostatic discharges in the atmospheres of planets. The observations were carried out at the time when radio telescope was operated in five-beam mode. For the observations we used two recording modes: Mode waveform and cross-spectrum modes. The time resolution for observations of Uranus and Venus was chosen equal to 40 ms. Because of the proximity of Venus to the Sun the most appropriate periods of time for ground-based observation equal to 3 hours a day (morning or evening) when terrestrial interference are less intense. For data analysis we used developed the program of automatic search of electrostatic discharges and visual control. For automatic multichannel detection the criteria were the presence (level 4σ) of signal at least in one channel 1 MHz width, i.e. signal with flux density equal or more than 3.5 Jy. For more than 200 hours of observations of Uranus and 100 hours – Venus there was no confident registered electrostatic discharge. Despite the negative results we could not state the absence of the lightning on the Venus. So we are forced to conduct our research in the future. In February-March 2017 we planned to observe Venus simultaneously with the spacecraft "Akatsuki" (PLANET-C).

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Star Formation in the outer parts of M83 one XUV disk galaxy

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The spatially resolved star formation law has been studied in great detail in galaxies in recent years and it has been established at high surface density, when most of the gas is molecular, that the Kenniicutty-Schmidt law is almost linear providing a constant gas consumption time-scale of about 3Gyr (e.g Bigiel et al. 2011, Saintonge et al 2011). However the star formation efficiency (SFE) falls very quickly as soon the surface density drops below ˜$10M_{\odot}/pc^2$, and the gas is mainly atomic. The star formation rate (SFR) law is then highly non-linear, and the gas consumption time-scale several Gyrs up to Hubble time. This is just the case for several dwarfs galaxies and the most external parts of disk galaxies (Bigiel et al 2010), where the environments make star formation more difficult due to the low gas density, low temperature and low metallicity conditions, resembling an earlier stage of the universe.
Recent star formation within such environments was detect in H_α (the principal star formation trace over the years). However, the Galaxy Evolution Explorer (GALEX) data demonstrate that H_α observations still fail to detect a significant population of moderate-age stars in the outermost disks of spiral galaxies, since H_α traces more recent star formation episodes. Our aim is to detect the molecular gas expected in the outskirt of spiral galaxies. One remarkable example is M83, a nearby galaxy with an extend XUV disk reaching 2 times the optical major radius (Gil da Paz et al. 2007).
However, our progress in understanding these XUV disks has been halted by the difficulty of detecting molecular gas via CO emission. In particular, no highly significant ($> 5\sigma$) CO was detect in ALMA maps of the XUV disk of M83 when we expected to detect 20-30 molecular clouds with $SNR > 17$. We hypothesize that the molecular clouds in the ALMA data are CO-dark,

caused by the strong UV radiation field, which dissociates CO preferentially, due to small size of the star forming clumps in the outer regions of galaxies.

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The molecular gas content of star-forming galaxies in a z˜2 cluster as seen by JVLA and ALMA

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My talk will focus on understanding the formation of the first massive, passive galaxies in clusters, as a first step to the development of environmental trends such as the morphology-density relation that we see at low redshift. CL J1449+0856 is an especially good case for this study - a galaxy cluster at redshift z˜2 that shows evidence of a virialised atmosphere, as seen in the X-ray continuum. Unlike the proto-clusters more commonly found at this redshift, CL J1449+0856 already contains a large fraction of passive galaxies at its core, as well as evidence of widespread massive star-formation and stellar mass assembly. Using JVLA and ALMA, direct observation of such active galaxies in a crucial phase of their evolution offers insight into the relevance of (and link between) star-formation, AGN activity and mergers in overdense regions.
I will present the preliminary results of CO [1-0] measurements on the star-forming cluster members, tracing the cold gas reservoirs fuelling the star-formation. This is combined with supporting datasets to calculate the star-formation efficiencies and gas depletion timescales of the cluster members, and place them on the Kennicutt-Schmidt plane. These results can be compared with analogous measurements of non-cluster galaxies at similar redshifts, in order to assess the environmental effect on gas reservoirs and the enhancement/suppression of star-formation. To further this, the obscured star-formation rate and AGN activity will also be studied at sub-arcsecond resolution using radio continuum data. This study will provide a high-density, early-epoch environment for comparison with field galaxies, allowing us to place better constraints on theoretical models of galaxy evolution in cluster progenitors.

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Radio halos in a mass-selected sample of galaxy clusters

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A fraction of galaxy clusters hosts diffuse Mpc-scale synchrotron emission, the so-called radio halos (RH). In the current theoretical picture these sources are originated from the acceleration of particles by turbulence generated during cluster mergers. This scenario has clear expectations about the statistical properties of RHs that need large mass-selected samples of galaxy clusters with adequate radio and X-ray observations to be tested. With this goal in mind, we selected a sample of 75 galaxy clusters with $M > 6x10^{14} M_{\odot}$ and z=0.08-0.33 from the Planck SZ catalogue. I will present first results based on a sub-sample of 57 clusters with available radio information (Cuciti et al. 2015). For the first time we found significant evidence for the presence of a drop in the fraction of clusters with RHs at lower masses. We used the X-ray Chandra data, available for most of the clusters, to derive information on the cluster dynamical status and we confirmed that clusters with RHs are merging systems while non-RH clusters are relaxed. This study is still limited by the incompleteness of the sample, indeed 18 high-z clusters lack radio information about the presence/absence of RHs. We are currently analysing new GMRT 610 MHz data of these 18 clusters in order to determine the presence of diffuse cluster-scale radio emission and to finally constrain the fraction of RHs as a function of the cluster mass and dynamics. In addition, we have observed 10 of these clusters with the JVLA at 1.5 GHz to have a better frequency coverage. Also, we observed, with the JVLA at 1.5 GHz, 4 low-z clusters that needed confirmation about the presence of diffuse emission. I will discuss some preliminary and interesting results obtained with these new radio data .

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The cold neutral medium probed by low frequency recombination lines

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The interstellar medium (ISM) is central to the evolution of galaxies. New stars are formed from interstellar gas, and these in turn enrich the gas with the products of nucleosynthesis. This gives rise to a recycling of matter in the ISM. One interesting aspect of this cycle is the relation between the cold neutral medium, which comprises most of the ISM mass, and other phases of the ISM, such as molecular clouds. Our understanding of the ISM has increased notoriously over the last decades, in part thanks to the opening of the radio and submillimeter windows. In these windows systematic surveys of atomic and molecular gas through surveys of the 21 cm HI line and from CO line transitions are possible. These have revealed a complex and dynamic ISM in which the different phases are related, but many questions remain open. Low frequency (<1 GHz) radio recombination lines (RRLs) offer a complementary way of studying the ISM. Carbon, having a lower ionization potential than hydrogen, is ionized throughout the ISM, which makes carbon RRL (CRRL) emission ubiquitous in our Galaxy. Given the physics of low frequency CRRL emission, the lines are good tracers of cold diffuse gas. Using the power of the low frequency array (LOFAR) our group is conducting a survey of CRRLs in the Milky Way. At low frequencies, diffuse synchrotron emission from the galaxy is a perfect background source, which enables the determination of the line optical depth and gas distribution over the Galactic disk. By studying the evolution of the CRRL properties with principal quantum number and comparing with updated models of RRL emission our group has developed, we can determine the thermodynamic properties of the gas (such as temperature and density). In this talk I will give an overview of low frequency RRL observations, introduce the LOFAR survey of low frequency RRLs and present preliminary results from the survey.

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Properties of compact HII regions and their host clumps - investigating massive star formation in the Outer Galaxy

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We aim to compile a complete list of compact and ultracompact HII regions for the Galaxy. Previous catalogues are incomplete and full of uncertainty due to similarly mid-infrared colour-selected objects (i.e. PNe, intermediate mass YSOs). However, Urquhart et al. (2013) found that data sets from mid-infrared (i.e. GLIMPSE), submillimeter (i.e. ATLASGAL), and radio (i.e. CORNISH and RMS follow-up investigations) could be employed to clearly identify compact HII regions from these mis-identifiers as well as extragalactic background sources and more evolved HII regions. Urquhart et al. (2013) used this method on a small portion of the Galaxy ($10 < l < 60$) to identify 213 compact HII regions. We use the newly completed SASSy 870 μm survey to extend these techniques into the outer Galaxy (to include $60 < l < 240$), previously unexplored in these wavelengths and adding another 337 regions to the sample. We will present the current results from the new sample and discuss the implications of the SASSy results for massive star formation in the outer Galaxy. In addition, we have found that many of the potential star forming clumps found by SASSy have no pre-existing radio counterpart due to the lack of radio surveys in this region and are exploring potential follow-up observations including a proposal for VLA.

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Molecular gas in AZTEC/C159: A a primordial disk forming 1.3Gyr after the big bang

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The nature of the star formation in high-redshift galaxies remains an open issue. Observational studies of the molecular gas, which fuels the star formation in these galaxies, are paramount to understand galaxy evolution at early cosmic times. We report the detection of CO molecular line emission from the active star forming disk galaxy AzTEC/C159 at z = 4.56702. We secured line detections for the transition levels J =2−1 and J =5−4 using the NRAO Very Large Array (VLA) and the NOEMA (NOrthern Extended Millimeter Array) interferometer, respectively. Its star formation efficiency (SFE) is at least five times higher than that of local spiral galaxies and z ∼0.4−2 Main Sequence galaxies, but similar to those observed in sub-mm selected galaxies. Its CO spectral line energy distribution suggests that this is an unusually high excited galaxy, where the CO(5−4) integrated line flux is only 12% lower than expected for thermal excitation. If, indeed, AzTEC/C159 is not a merger-driven system, our results give evidence that the cold mode accretion can drive star formation as efficiently as observed in high-z starburst galaxies.

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Determining the core shift of Sagittarius A* using VLBI observations

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The compact radio source at the center of the Milky Way, Sagittarius A* (Sgr A*), is the strongest candidate for a supermassive black hole. The origin of its emission is still unclear. Different theoretical models try to explain the emission from Sgr A*, such as jet models, radiatively inefficient accretion flow models or advection-dominated accretion flow models. An important prediction in jet models of Sgr A* is the presence of a "core shift". Here we describe how to measure the relative position of Sgr A* from VLBI observations at frequencies of 15, 22, 43 and 86 GHz using the fast frequency switching method. This method allows us to measure core shifts more robustly than traditional phase-referencing observations where calibrators can have their own core shifts and the differences in the atmosphere in front of the target and calibrators will affect the accuracy of the astrometry. Our end goal is to help discriminate between models with and without a radio jet by determining the presence or lack of a core shift in Sgr A*.

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Discussing causes of periodicity in maser emission.

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Class II methanol masers and water vapor masers are usually linked to high mass star-forming regions and they exhibit variability caused by astrophysical processes associated with protostar. Among methanol maser sources small group shows periodic bursts of activity, one of with is G107.298+5.639. Long-term monitoring of methanol and water emission done with 32m antenna in Torun revealed alternating flares of 6.7 and 22 GHz lines confirming first known periodic water maser. In my talk I will use newest spectral data, including OH maser monitoring done with the Nancay Radio Telescope, results of EVN observation and available literature to discuss probable causes of that type of behavior.

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Low frequency studies of pulsars in low frequency with NenuFAR

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Neutron stars are residual of massive stars supernova. These stars have really high magnetic fields with acceleration process.
NenuFAR (New Extension in Nançay Upgrading loFAR) is a radio-telescope built in Nancay in France, it will be operational at the end of the year with 50% of his nominal collecting surface. It is a precursor instrument for the future SKA (Square Kilometer Array) and it will allow us to study the magnetospheric emission mechanism to frequency still underexploited (10-85 MHz).
Low frequency is extremely interesting in Pulsars study for different reasons and much more difficult to observe due to the large effect of the discretion measure and the scattering.
Many things are unexplained in the process, we can observe a sudden fall in the mean flux density below 100 MHz in the majority of pulsars (Shrauner, Taylor & Woan 1998) and the polarized part of the emission is more important than in high frequency in most of cases, some pulsars present one or several orthogonal jump with an uncommon polarization shape.
The study of the pulsation shape gives use information about the structure of the emission process. Furthermore, variations of the angle of the linear polarization (Position Angle) contain information about the magnetic structure.

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A search for the molecular counterpart of high velocity ionized outflows in nearby BAL QSOs

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Feeding and feedback in Active Galactic Nuclei (AGN) play a very important role to gain a proper understanding of galaxy formation and evolution. The nature of the interaction between the activity mechanisms in the nucleus and its influence in the host galaxy are related to the physical processes involved in feedback, including star formation, energetic and chemical recycling in the interstellar (ISM) and the feeding process, which account for the gas fuelling of the black hole (BH) (Fabian, 2012; Combes, 2014). One of the problems when considering the AGN feeding is how the BH are fuelled to trigger the nuclear activity, since to drive sufficient gas towards the center requires a large removal of angular momentum from the gas. Gas inflows can trigger the BH activity but the mechanisms involved are not yet well determined. On the other hand, the mechanisms involved in feedback (radiation, winds and jets) can affect significantly the ISM of the host galaxy. Feedback processes can be the responsible to regulate the BH growth and galaxy evolution and explain the observed proportionality between the bulge and the BH masses (M_{BH}/M_{bulge} ~2×10^{-3}). The discovery of many massive molecular outflows in the last few years have been promoting the idea that winds may be major actors in galaxy evolution (Fischer et al. 2010, Feruglio et al. 2010, Alatalo et al. 2011, Sturm et al. 2011, Dasyra & Combes 2011, 2012; Aalto et al. 2012, Morganti et al. 2013, Combes et al. 2013, Cicone et al. 2013, Veilleux et al. 2013, Spoon et al. 2013; Dasyra et al. 2014, García-Burillo et al., 2014; Sakamoto et al., 2014). The widely observed winds from the central regions of AGN are promising candidates to explain the link of scaling relations under the AGN feedback scenario. Observationally, with terminal velocities of order 1000-30000 km/s, the ionized gas outflows in Broad Absorption Line (BAL) quasars could constitute a source of high ram pressure that could accelerate molecular gas to high velocities, as long as the molecular clouds have the time to (re)form in the flow. Those high-velocity ionized gas winds could transfer enough momentum to accelerate large amounts

($>10^7$\,$M_\odot$) of molecular gas. We are interested to determine the mass of their molecular gas reservoir, the velocity distribution of the accelerated molecular gas, the power and momentum of the outflow and the fraction of molecular gas escaping the galaxy for potential BAL QSOs candidates. We will present our preliminary results of new NOEMA CO(2-1) observations of PKS1532+01 at z=1.435 and PdBI observations of 3C48 at 0.367. Our aim is to test if these QSOs could be hosting outflows that are most efficient in expelling molecular gas outside of galaxies. Since the feedback is invoked to inhibit star formation in the host galaxy, outflows have to affect significantly the molecular gas where stars are formed. Mass outflows driven by stars and AGN and detected inflows are a key element in many current models of galaxy evolution. Observational constrains will help to enhance the understanding of the physical processes in galaxies as well the fundamental keys of galaxy formation and evolution. A detailed analysis of nearby BAL QSOs will also serve as a prototype for subsequent studies of high-momentum outflows in high-z QSOs at the peak of the star formation history of the Universe.

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Search for methanol maser bursts

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At the moment only a few short period CH30H maser flare sources are known from which G33.64−0.21 is very interesting source that has produced several burst activities at 6 GHz (Fujisawa et al 2011). We have identified this source in the WISE catalog. Now there is a study in progress to find a like objects that would make observational targets for VIRAC 32m radiotelescope to find new methanol maser sources with possible short period activity.

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HI in strongly barred galaxies

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Bars are found in around 30-70% disc dominated galaxies, they are thought to play an important role in secular evolution through enabling radial transfer of material. It is observed that redder, more massive disc galaxies are more likely to host strong bars. This hints at a role for bars, not only in growing central bulges, but also in moving disc galaxies out of the blue cloud. What is less clear is whether the link is casual: does the appearance of a bar help cease star formation in disc galaxies, or is it merely a side effect of other processes that cause this transition? I have been investigating some of the unusual and rare gas-rich and strongly barred systems with resolved HI observations.

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Why maser VLBI is the best

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Very long baseline interferometry (VLBI) is a technique which combines a group of distantly separated radio antennae to create a 'synthesised' telescope with very fine angular resolution. Such arrays are sensitive to bright, point-like emission such as masers which are often found near the sites of forming stars; in outflows, jets, disk, bow shocks and expanding shells. Observing the astrometry of masers in multiple epochs with VLBI enables detailed 3D analysis of the internal motions in regions of star formation and, in addition, allows measurement of the annual parallax

- giving a direct measurement of the distance to the target. In this talk I'll introduce some recent results obtained using maser VLBI, which really is an awesome technique in radio astronomy.