50th Young European Radio Astronomers Conference – virtual edition

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From filaments to cluster formation: California and ALMA-IMF

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In this talk I first summarize my IRAM results on California, and then briefly highlight future work on the ALMA-IMF large program (P.I. F. Motte). California (CMC) has comparable gas mass to Orion (~1e5 Msun), and is at the median mass of Milky Way clouds. Meanwhile, the CMC has only ~177 YSOs (and 1 B-star), so has been dubbed a "sleeping giant". We focus on the CMC L1482 filament. This filament is one of the most dense in the CMC. First we measure the Gaia distance, then we characterize the mass distribution, next we analyze the C18O velocity profile. Using a simple solid-body rotation toy model, we show that the centripetal force, compared to gravity, increases toward the break; when the ratio of forces approaches unity, the profile turns over. Combined, these results imply outside-in evolution on a few times 6 Myr. This filament has practically no star formation, a perpendicular Planck plane-of-the-sky (POS) magnetic field morphology, and POS "zigzag" morphology, which together with the rotation profile lead to the suggestion that the 3D shape is a corkscrew filament with a helical magnetic field. These results suggest evolution toward higher densities as magnetized rotating filaments shed angular momentum.

Exploring relativistic jets on parsec and kpc-scale with LOFAR and e-MERLIN

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Extragalactic relativistic jets offer insights into the role of radio sources in the evolution of structure and the production of most energetic photons and hadrons in the Universe. Jet powers inferred from cavities in the intergalactic medium are sufficient to reheat cooling gas on the largest scales, but questions remain about the processes involved in heating and the mechanisms of feedback. The varieties of host galaxy environment and properties complicate the study of the dynamics and kinematics of the inner parts of radio sources, with open questions on what initiates the brightening, flaring and deceleration of low-power radio jets, what are the magnetic field configurations immediately surrounding jets, and the site and nature of particle acceleration in jets. To address these questions, the e-MERLIN Jets Legacy programme has been making high-resolution maps of low-z radio sources. In this talk, I will provide a brief overview of the project and discuss some results from our ongoing multiwavelength campaign. I will explore how synchrotron spectra and Faraday rotation measure synthesis spectra provide parameter that allow us to constrain jet energetics, and offer some perspectives on how high-resolution spectral and polarimetric imaging should help us build a model of flow dynamics and energy deposition in the plumes, and so to test evolutionary models of jet propagation in the IGM.

Identifying NLS1s in a spurious source sample

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Narrow-line Seyfert 1 (NLS1) galaxies are a subclass of active galactic nuclei (AGN) with characteristically narrow emission lines and a FWHM of less than 2000 km s^{-1}. The number of confirmed NLS1s is rather low, only a few thousand or so. In my master's thesis, I studied the optical spectra of 11001 claimed NLS1 sources trying to determine if they actually were NLS1s. The hope was to be able to obtain a clean NLS1 sample, for example, for proper determination of galaxy classification factors and of new observing samples. An outdated assumption is that NLS1s do not exhibit significant radio emission, however, it has been shown that NLS1s can host relativistic jets and can thus have strong radio emission. NLS1s with relativistic jets can be observed even at high radio frequencies such as the 37 GHz band at Metsähovi Radio Observatory. Of the 11001 studied sources, 3998 sources were deemed most likely NLS1s and the remaining were deemed most likely not NLS1s. I also studied the basic parameters of the sources deemed most likely NLS1s, to explore their suitability for further (radio) observations.

The chemical nature of Orion protostars: ORANGES are different from PEACHES

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Hot corinos and Warm Carbon Chain Chemistry (WCCC) objects are two chemically distinct types of Solar-mass protostars. On the one hand, hot corinos are compact (<100 au), dense (n>107 cm-3) and hot (>100 K) regions, enriched in interstellar Complex Organic Molecules (iCOMs; e.g. CH3OH, CH3OCH3). On the other hand, WCCC protostars have an inner region deficient in iCOMs but a larger zone (~1000 au) enriched in hydrocarbons (e.g. CCH, c-C3H2). Because recent studies found correlations between iCOMs abundances in hot corinos and in comets, our Sun is thought to be an ancient hot corino. Recently, studies aiming to characterise the complex chemical content of Solar-mass protostars at small scales were performed. The most recent ones are the Perseus Alma Chemistry Survey (PEACHES) and the ORion ALMA New GEneration Survey (ORANGES). The former targeted a low-mass star-forming region. The second one targeted the Orion Molecular Cloud 2/3 filament, the closest and best known analogue of the Sun's birth environment. While the PEACHES study showed that hot corinos were likely dominant in Perseus, I will present the new results obtained from the ORANGES, which show that ORANGES are different from PEACHES.

Searching for extragalactic radio pulsars with MeerKAT

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Pulsars are the fastest spinning, smallest and densest stars, with the strongest stellar magnetic fields known. I will present our searches for new pulsars outside the Milky Way. Of the nearly 2900 known radio pulsars, only 29 are extragalactic. Observations are conducted with the new South African radio observatory MeerKAT, for which pulsar observations have started in 2020, with a revolutionary sensitivity and field of view. Pulsars can keep track of time to a precision rivaling atomic clocks. Any variations in the ticking of their pulses can be an indicator of astrophysical processes, from planets to extreme and relativistic physics. When constituting a significant sample of known extragalactic pulsars, we are effectively probing the effects of another galaxy's properties onto its neutron star population, as a valuable contrast to the Milky Way. This can give extragalactic insights into neutron star formation and merger rates, gravitational waves, and fast radio bursts.

Using Machine Learning to identify high-redshift Radio Galaxy candidates

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Recent observations of the highest redshift quasars pinpoint the early growth of supermassive black holes (SMBH) that trigger the formation of active galactic nuclei (AGN) at redshifts greater than 6. It is anticipated that radio emission can be detected from such early AGN, although its characteristics are still quite indeterminate. A relevant fraction of the more than 200 AGN at redshift higher than 6 have been initially detected from optical observations. Radio-detected AGN make up a small part of the high-redshift objects we presently know as sufficiently deep radio observations are often non-existent. Critical attention has been drawn to developing procedures to predict properties of high-redshift Radio Galaxies given previous information. In light of large-scale radio observatories and surveys and their ongoing precursors (EMU, MIGHTEE, LoTSS). Future data volumes will make applying regular AGN detection techniques an inefficient task. We have implemented a series of Machine Learning models which take photometric catalogues --in several wavelength bands-- as input and produce a list of Radio Galaxy candidates, along with their predicted redshift values. We will present early results of the use of the models with data from photometric catalogues in the HETDEX Spring Field (~400 deg2).

Modeling of 3C61.1 to improve upper limits on the 21-cm power spectrum from LOFAR

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The redshifted 21-cm line is one of the most promising probes of the intergalactic medium during the Epoch of Reionization (EoR), when formation and evolution of first galaxies occur. In recent years, several radio interferometers aimed to statistically detect the 21-cm brightness temperature fluctuations from low-frequency observations. Such experiments have to face many challenges, above all the astrophysical foregrounds, which are orders of magnitude brighter, and the instrumental systematics. Accurate modeling of sky sources is required to reduce calibration errors and contamination from the foreground subtraction. Recently, the LOFAR-EoR team published the deepest upper limits on the 21-cm power spectrum at redshift 9, extracted from LOFAR North Celestial Pole (NCP) observations. However, these results are limited by excess power. One source of excess power is the imperfect modeling of sky sources. The strongest residuals in the field are associated with the FR-II galaxy 3C61.1, the brightest and most complex source near the NCP. In this talk, I will present the process of creating a highly accurate model of 3C61.1 from new LOFAR observations, in order to improve the current 21-cm power spectrum limits from LOFAR.

Organic chemistry in the proto-solar analog OMC-2 FIR 4: environment matters

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Our Sun was born in a densely packed star cluster, near massive stars whose energetic radiation must have contributed to shaping the evolution of the surrounding environment. Moreover, the presence of products of short-lived radionuclides in meteoritic material shows that the same environment was flooded by internal energetic particles (>10 MeV) of protostellar origin. How did such harsh environmental conditions affect the chemistry of the proto-Sun and its surroundings? We will present recent results from an observational study carried out with ALMA, thanks to which it has been possible to delve into the wide diversity of organic molecules in a Solar System-like environment and use the chemical imprints detected to shed new light on the emergence and evolution of complex organic molecules in proto-solar environments.

Simultaneous radio and X-ray variability of radio-quiet Seyfert galaxies

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Timing study is an important tool to characterize the physical origin of accretion onto black holes. Radio-quiet (RQ) active galactic nuclei (AGN), in particular Seyfert galaxies, exhibit fast variability in X-ray on time scales of hours, which indicates that the X-ray emission comes from a region close to the super-massive black hole (SMBH), the so-called corona. The variation detected in radio on time scales of a few days to a month, also suggests that the radio variability in RQ AGN could be related to a variable compact core and/or a nuclear outflow affected by the change of accretion rates. If the radio and X-ray emission are physically connected, there could be a correlation between the radio and X-ray light curves. In this work, we report results of simultaneous radio and X-ray monitoring of three RQ Seyfert galaxies, Mrk 110, Mrk 766, and NGC 4593. The radio observations were carried out with the Very Large Array (VLA) in X-band. The X-ray observations were carried out with the Rossi X-ray Timing Explorer (RXTE) at 2-10 keV. We found that two Seyfert galaxies exhibited radio variability with significant amplitudes of a few percent. We performed a cross-correlation analysis and found a possible correlation between the radio and X-ray light curves with positive and negative time lags. We will discuss possible explanations of the results.

Galaxy formation, ICM heating and AGN feedback: the turbulent youth of a proto-cluster at z=1.7

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I present the physical properties of a large-scale structure at z=1.7 that is populated by star-forming galaxies and is assembling around a powerful FRII. We recently discovered three new gas-rich galaxies, in addition to a large molecular gas reservoir (M_H2~2 x 10^11 M_sun) around the FRII host galaxy. We show that the system will evolve into a ≳ 10^14 M_sun cluster at z=0 and that the FRII is the likely progenitor of the BCG. Extended X-ray emission has been detected around the FRII. Remarkably, four of the protocluster members lie at the edge of the X-ray emission, suggesting that it originates from an expanding bubble of gas shock heated by the FRII jet, that is promoting the star formation on nearby galaxies compressing their ISM. If confirmed, this would be the first evidence of positive AGN feedback on multiple galaxies on hundreds-kpc scales. I also present new LOFAR (150 MHz) and JVLA (1.4 GHz) observations of the FRII, which reveal extended radio emission around its lobes, likely linked to the diffuse X-rays. Exploiting the JVLA and LOFAR data we built the spectral index map that reveals signatures of re-acceleration of the plasma in the outskirts of the lobes, possibly induced by interactions with the ICM.

Seed Of Life in Space (SOLIS NOEMA LP): A train of shocks at 3000 au scale: the clash of an expanding bubble into the NGC 1333 IRAS 4 region

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The NGC1333 molecular cloud hosts a large number of young protostars associated with filamentary structures, probably shaped by external triggers. In order to search specific signatures of a possible clash that shaped the southern filament of this cloud, where the IRAS4 protostellar system lie, we observed SiO and CH3OH, as known tracers of violent events, with IRAM-NOEMA. We detected three parallel elongated and equispaced structures, called fingers, with narrow line profiles (FWHM~1.5km/s) peaked at the systemic velocity of the cloud. They have different chemical compositions with the northern one with a CH3OH/SiO ratio of 160-300 while the other two have CH3OH/SiO<40. Performing a non-LTE analysis on the CH3OH lines we derived that they are tracing high density (5-20x10^5 cm^(-3)) and high temperature (80-160 K) gas. Among the various possibilities, we were able to reproduce the observed conditions only with a train of consecutive shocks. We suggest that the fingers have been created by an expanding gas bubble clashing against the filament with a velocity of ~3km/s. Finally, we propose a solution to the nature and origin of the widespread narrow SiO emission observed in the south part of NGC1333, which would be unresolved trains of shocks.

Cross-Identification of a new MeerKAT catalogue to the Herschel catalogue

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Identifying radio counterparts for submillimetre sources is one of the common methods for SMG studies, for radio observations are far easier to make than far-infrared (FIR) interferometric observations due to the atmospheric transmission. We present a cross-identification of a new MeerKAT radio catalogue to the *Herschel* FIR/sub-millimetre catalogues. Our MeerKAT data cover three ~1.2deg^2 areas of sky at 1.4GHz with detection limit down to around 20μJy, centred at three candidate *Herschel* protoclusters which are the primary targets of the observations. However, the large covering areas of these images also enable us to establish a new catalogue from them, by using the source extraction tool PyBDSF. The catalogue is sufficiently large for radio investigation of the generic *Herschel* sources after matching it to the *Herschel* catalogues, in particular the radio-FIR relation of the Herschel sources will be allowed to be studied. With precise *Herschel* positions of our MeerKAT sources in this new catalogue, further unambiguous cross-identifications in the optical and near-IR bands from other datasets including SHARKS can be carried out in the following studies, potentially leading to complete SEDs for the sources and hence their physical characteristics such as photometric redshift and star-formation rate. Last but not least, this cross-matched catalogue can be used as an experiment for the coalescence of the SKA and *Herschel* data in the future.

GLOSTAR view of Galactic plane supernova remnants

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The ongoing 4-8 GHz GLOSTAR (a GLObal view on STAR formation in the Milky Way) survey is a very sensitive unbiased survey of a portion of the first quadrant of the Galactic plane, covering the Galactic center, and the Cygnus X and W43 star-forming regions. In the Very Large Array (VLA) data of this survey, we had found over 150 supernova remnant (SNR) candidates, potentially increasing the number of Galactic SNRs by ~50%. This is a crucial step forward in alleviating the discrepancy in the number of oberved (~300) and predicted (~1000) SNRs in the Galaxy. While we were already able to show evidence of non-thermal emission in some SNR candidates (using polarization and spectral index), the majority are yet to be confirmed as SNRs. I will describe current efforts to complement the VLA observations with the Effelsberg 100 meter radio telescope in order to derive spectral indices of various objects, using background-filtered flux densities and also temperature-temperature plots, which can be then used to identify their emission as thermal or non-thermal.

The CO-CAVITY pilot survey: molecular gas and star formation in void galaxies

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Voids are the most under-dense large-scale regions in the universe. Galaxies inhabiting voids are key to understand the intrinsic processes of galaxy evolution, as external factors such as multiple galaxy mergers or a dense self-collapsing environment are negligible. We present the first molecular gas mass survey of void galaxies and compare their properties with those galaxies in filaments. The molecular gas mass is strongly involved in the star formation processes, so this study will carry out a better understanding of how molecular gas and star formation are related to the large-scale environment. In particular, we compare the molecular gas mass,the star formation efficiency, the atomic gas mass, the molecular-to-atomic gas mass ratio, and the specific star formation rate. We observed at the IRAM 30-m telescope the CO(1−0) and CO(2−1) emission of lines 20 void galaxies selected among the brightest galaxies in the Void Galaxy Survey (VGS), detected 14 objects in at least one CO line, and calculated upper limits for the remaining objects. We compared the results of the void galaxies with two control samples of galaxies in filaments, xCOLD GASS and EDGE-CALIFA, for different stellar mass bins and star formation properties.

The Torun maser research

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The 32 m Torun radio telescope, as part of the European VLBI Network, participates in numerous VLBI sessions - but one may wonder what it does when these are over? It mostly observes maser emission at the cm wavelength ranges towards high-mass protostars heavily embedded into dust and gas material and are hidden in the optical wavelength range. Although the formation of massive stellar objects is still not explained well, our researches may shed some light on the physical processes in the vicinity of emerging stars.
Recent researches:

- 6 GHz OH maser survey towards known 6.7 GHz methanol maser sources (Szymczak et al. 2020)
- 12 GHz methanol maser survey towards northern high-mass protostellar sources (Durjasz et al. 2021)
- Detection of maser outburst in high-mass young stellar object G24.33+0.14 (alert: Wolak et al. 2019, research paper: Kobak et al.

AGN impact on molecular gas in the galactic centers as probed by CO lines

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The molecular phase of the interstellar medium (ISM) plays a central role in the evolution of galaxies. The main contributors to its irradiation are far-ultraviolet (FUV) photons from stars and X-ray photons from the active galactic nucleus (AGN); the two different sources give rise, respectively, to photodissociation regions (PDRs) and X-ray dominated regions (XDRs). There is growing evidence that AGN radiation is especially efficient in affecting the heating of the molecular gas in the most central and densest regions of the host galaxies. Based on the best spatial resolution available, we aim to put an upper limit to the size of AGN influence on the molecular ISM. I will present, on a new sample of local active galaxies, a systematic comparison of CO spectral line energy distribution with estimates of the relative contribution of PDR and XDR heating. By comparing our results to the Schmidt-Kennicutt relation, we find no evidence of the AGN influence on the cold and rarefied gas on galactic scales. Instead, by isolating the nuclear scales, analyzing the mid-J and high-J CO line correlation with X-ray and FUV fluxes, we conclude that a mix of the two mechanisms is necessary to explain the observed CO excitation.

Determination of the suitability of Mt. Gamsberg in Namibia for millimetre wave astronomy by measurements of the precipitable water vapour

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Precipitable Water Vapour (PWV) is the amount of water vapour in the atmospheric column above a location equivalent to the amount of liquid precipitation that would result if all the water vapour in the column was condensed. Water vapour is the main source of opacity in the Earth's atmosphere at infrared and millimetre to sub-millimetre wavelengths. The Event Horizon Telescope (EHT) is a large network of millimetre to sub- millimetre telescopes across the globe that is used to image supermassive black holes. The Africa Millimetre Telescope (AMT) is planned to be built on Mt Gamsberg in Namibia and shall compliment the EHT. In this study, PWV at Mt Gamsberg was determined in order to asses its suitability to conduct millimetre wave astronomy. PWV at the H.E.S.S. Observatory was indirectly determined from data taken by radiometers, a NASA AERONET and an ATMOSCOPE. The PWV at Mt Gamsberg was determined by scaling the PWV at the H.E.S.S. Observatory to what it would be at the height of Mt Gamsberg. The computed monthly weighted mean PWV results of a minimum 3 mm and a maximum of 4.5 indicate Mt Gamsberg is a suitable site to conduct millimetre wave astronomy and to host the AMT.

Keplerian disks and outflows around binary post-AGB stars

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There is a class of binary post-AGB stars that are surrounded by Keplerian disks and that often present outflows resulting from gas escaping from the disk. To date there are seven sources that have been studied in detail through interferometric millimeter-wave maps of CO lines. For the cases of the Red Rectangle, IW Carinae, IRAS 08544-4431, and AC Herculis, it is found that 90% of the total nebular mass is located in the disk: these are the disk-dominated sources. On the contrary, our maps and modeling of 89 Herculis, IRAS 19125+0343, and R Scuti, which allowed us to study their morphology, kinematics, and mass distribution, suggest that in these sources the outflow is the dominant component of the nebula, resulting in a new subclass nebulae around binary post-AGB stars: the outflow-dominated ones. Besides CO, the molecular content of this kind of sources was barely known. We also present a very deep single-dish radio molecular survey in the 1.3, 2, 3, 7, and 13 mm bands. Our results allow us to classify our sources as O- or /C-rich. We also conclude that these sources present in general a low molecular richness, especially those that are disk-dominated, compared to circumstellar envelopes around AGB stars and other post-AGB stars.

Physical and chemical structure of high-mass star-forming regions

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During high-mass star formation, fragmentation takes place on various spatial scales from giant molecular clouds down to disk scales. At the earliest evolutionary stages, high-mass protostars are still deeply embedded within their parental molecular cloud and can be studied best at high spatial resolution with interferometers at mm wavelengths. The IRAM/NOEMA large program "CORE" allows us to analyze the physical and chemical properties of 18 luminous high-mass star-forming regions. The 1.4 mm continuum of the sample shows a large diversity of fragmentation properties. Using the spectral line emission, we are able to determine the physical structure and molecular content of individual fragmented cores. Even though all regions are classified to harbor high-mass protostellar objects, the molecular content shows a high degree of complexity. By combining the observed core properties, we are able to constrain chemical timescales with the physical-chemical model MUSCLE. We find well-constrained density and temperature profiles. The molecular complexity can be explained by an age spread that is then confirmed by our physical-chemical modeling. The hot molecular cores show the greatest number of emission lines, but we also find evolved cores in which most molecules are destroyed and, thus, the spectra appear line-poor once again.

Methanimine Megamasers Discovered Towards Compact Obscure Nuclei

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We have discovered 5.29 GHz methanimine (CH_2NH) 1_{10}-1_{11} megamasers toward a six compact obscured nuclei. These galaxies contain a Compton thick nucleus. Using the Very Large Array, the brightness temperatures measured towards the most luminous of the six galaxies (Arp 220) indicates superthermal emission. The emitting region is measured to be less than 100 pc in diameter and the masers exceed luminosities of 1Lจ□ toward all six nuclei. Our results indicate a strong correlation with OH megamasers. Our study suggests that CH_2NH megamasers are linked to the nuclear processes within 100 pc of the Compton Thick nucleus within CONs, potentially providing a window into the compton thick environment.

Millimeter-wave observations of cometary rotation

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Comets are excellent probes to study the formation and evolution of the early Solar System as they carry a plethora of different molecules including water and complex organics. While approaching the Sun, cometary ices start sublimating, often creating torques, which drive the angular acceleration and/or complex rotation of a nucleus. The acceleration can eventually result in rotational disruption, when the nucleus reaches the critical rotation period of ~ 3 h. One of the best rotation-period tracers available for active comets is the HCN molecule, which can be conveniently observed with millimeter-wave telescopes via rotational transitions. During my talk I will show how an analysis of velocity-resolved spectral time series of cometary volatiles, obtained with millimeter-wave telescopes such as IRAM 30m and APEX, can uncover the secrets of nucleus rotation.

ALMA observations of methanol masers in NGC 253

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Context. Class I and II methanol masers are found in a variety of astrophysical environments in our Galaxy, however, the study of methanol masers in external galaxies is still in its infancy.
Aims. We search for methanol masers in the central molecular zone (CMZ) of the starburst galaxy NGC 253.
Methods. Covering a frequency range between 84 and 373 GHz (λ= 3.6 to 0.8 mm), we have probed its CMZ by studying 10 regions at the positions of giant molecular clouds. In order to look for maser candidates, we employed the rotation diagram method along with radiative transfer models.
Results. In LTE, E–CH3OH traces preferentially colder environments than A–CH3OH. We detect for the first time maser emission above 84 GHz in NGC 253, covering an ample portion of the J_(−1)→(J_(−1))_0−E line series (at 84, 132,229, and 278 GHz). We observe a lack of methanol Class I maser in the very central region of the CMZ.
Conclusions. The physical conditions needed to show maser action can be explained by shocks, cloud-cloud collisions, and Lindblad resonances. The presence of photodissociation regions due to a high star-forming rate may explain the lack of maser emission in the very central regions.

Exploring the environmental effects of the companion sources of massive galaxies at high redshift using [CII] emission

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The rapid build-up of stellar mass during intense starbursts at high redshifts represents an important evolutionary state for massive galaxies. Many questions remain open about this extreme phase, for example: what is the role of and impact on the environment of companion sources around these galaxies, and how does feedback affect their starburst phase? We present deep, high-resolution ALMA band 7 [CII] observations of BRI0952-0115, a lensed quasar at z~4.4, and AzTEC-3, a submillimeter galaxy (SMG) at z~5.3. We detect companion sources bright in [CII] emission surrounding both objects within a radius of 3 arcseconds (~19 kpc) of the central sources. The [CII] line structure for both sources exhibit complex broad emission line profiles, indicating the possible presence of outflows. Additionally, we present evidence of a 'gas bridge' between the SMG and a companion source. Extrapolated star-formation rates from the central sources suggest both contain maximum starbursts of a few 1000 solar masses per year. These results provide additional evidence in support of the hypothesis that massive galaxies form in over-dense regions, growing through minor or major mergers with companion sources.

Pioneering the study of Lunar radio environment for future low-frequency radio science using NCLE

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The Netherlands-China Low Frequency Explorer (NCLE, PI KleinWolt/Falcke/Ping) is a low-frequency radio instrument on board the Chinese Chang'e 4 relay satellite (Queqiao) that is currently being commissioned by the joint Chinese and Dutch research teams. NCLE will have its optimal sensitivity in the frequency range between 1 and 80 MHz where the highest priority science signals are expected. These include a wide range of topics, such as determining the radio background spectrum at the Earth-Moon L2 point, studying the Solar activity and space weather at low frequencies, creation of a new low-frequency map of the radio sky, studying the Earth's ionosphere, and possibly constraining the 21-cm line Dark Ages and Cosmic Dawn signal. The NCLE system design involves 3 co-located, orthogonal, monopole antenna elements, each of ~5 meters in length. Importance of radio instruments in space for low frequency radio astronomy is well known. I shall discuss the design of such a radio instrument - NCLE and present an overview of commissioning the instrument and some challenges in the course of commissioning

Milliarcsecond analysis of the 6.7 GHz methanol maser outburst in HMYSO G24.33

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The outburst was detected in the high-mass star-forming region G24.329+0.145 at the 6.7 GHz methanol maser line under the monitoring program with the 32m Torun dish (Wolak et al. 2019). The M2O collaboration has started multi-frequency and multi-epoch studies to analyze this rare episode, which can be provide a rapid increase a gas accretion on the disc. Using VLBA and EVN methanol maser lines (6.7 and 12.2 GHz) and water maser (22 GHz). We present detailed studies of variability of single maser cloudlets and their distributions. These help to derive the physical conditions and kinematics in the target.

Ray-Tracing in Relativistic Magnetohydrodynamic Jet Simulations:

A Polarimetric Study

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Investigations on how the morphology of the jet's synchrotron emission depends on the magnetic nature of the jet's relativistic plasma are fundamental to the comparison between numerical simulations and the observed polarization of the jet. Through the use of 3D relativistic magnetohydrodynamic (RMHD) jet simulations (computed using the PLUTO code) we study how the jet's synchrotron emission depends upon the morphology of the jet's magnetic field structure. Through the application of polarized radiative transfer and ray-tracing (via the RADMC-3D code) we create Full Stokes synthetic radio maps for each magnetic field jet simulation, i.e., when the jet carries a predominantly poloidal, helical, and toroidal magnetic field. We also explore several scaling relations in which the underlying electron power-law distribution is set proportional to the jet's: (i) thermal plasma density, (ii) internal energy density, and (iii) magnetic energy density. Magnetic field morphology within the jet has a clear effect on the jet's synchrotron emission: a toroidal field results in an edge- brightened jet whereas a poloidal field highlights the jet's central recollimation shock. The circularly polarized emission clearly exhibits two signs in the toroidal field case whereas only one sign is visible in the poloidal jet.

An extended sample of high-redshift radio quasars imaged with e-EVN

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High-redshift radio quasars can reveal essential information about early galaxy formation and supermassive black hole evolution. However, the list of radio-loud quasars with redshift above 4 is still limited. In addition to this, it seems the number of radio-loud quasars at z>4 with jets misaligned with respect to the line of sight is much smaller than expected from the known highly-beamed jetted sources, blazars. Previous studies also showed that with high-resolution VLBI observations several of the radio sources among blazar candidates show unbeamed radio emission on milliarcsec scales. In this work, we conducted a sample of 13 radio quasars to increase the number of the VLBI imaged high- redshift sources. The observations were carried out with the European VLBI Network at two different central frequencies, 1.7 and 5 GHz. The main goal of the study is to decide whether the radio sources have blazar characteristics or they are misaligned sources. In addition to the VLBI data we also use the Gaia EDR3 optical positions of these sources and the available spectral informations found in the literature. We found that roughly half of the sample are misaligned sources, while the others are blazars

Mrk 273 : A LOFAR and APERTIF view

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Over the last few decades, low surface brightness extended radio emission has been seen in some Ultra Luminous Infrared Galaxies (ULIRGs). However, the high sensitivity required to recover this emission meant that till date, only a handful of such objects are known. The origin of this emission - whether from the intense star formation or the AGN activity in the centre - is also still under debate. We present such a study of an ULIRG Mrk273, where we observe large scale radio emission at 144 MHz with LOFAR and 1400 MHz with APERTIF. We study the spectral properties up to GHz frequencies at both high and low spatial resolution. We further explore the possible scenarios of origin of the extended radio emission in this galaxy and highlight the possibility of using the synergy between LOFAR and APERTIF to extend this to a sample of ULIRGs.

Multi-epoch observations of Black Holes

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The Event Horizon Telescope (EHT) is a very long baseline interferometry (VLBI) array consisting of a number of millimeter- and submillimeter-wavelength telescopes around the globe to form an Earth-sized virtual telescope. The high resolution of 25 micro-arcsec was able to resolve for the first time the black hole (BH) shadow in the center of the giant elliptical galaxy M87. Compared to the successful 2017 observations, more radio telescopes were involved in the 2018 and 2021 campaigns. In the future, the African Millimiter Telescope on the Gamsberg in Namibia will contribute to producing more robust images. In this talk, I will describe how additional telescopes can improve the quality of synthetic images and how repeated observations will allow us to better constrain BH parameters. New reconstructions will be presented using variable weather data collected and monitored with a web server developed by the Radboud RadioLab, named VLBI Monitor, and that plays an important role in the EHT observations.

The interstellar medium in the environment of the supernova-less long-duration GRB 111005A

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There exists two classes of gamma ray bursts (GRBs), which are distinguished by the duration of the prompt high-energy emission. Long GRBs, with durations larger than 2 s, are firmly associated with the explosions of massive stars, although in three instances, luminous supernovae (SNe) have not been detected, despite deep observations. The nature of these bursts is unclear. Our aim is to establish the properties of the interstellar medium (ISM) of the host galaxy of one of these events, GRB 111005A, in order to shed light on the nature of these peculiar objects. We used new HI line measurements and previously published optical integral field spectroscopy in order to analyze the environment in which the GRB was located. We studied the distribution of the host properties e.g. atomic gas mass, star formation rate (SFR), and kinematics. The host galaxy of GRB 111005A turned out to be characterized by regular largely symmetrical atomic gas, radio continuum distribution, and rotational patterns. This is different from the irregular ISM distributions seen in the hosts of long GRBs and type Ic SN.

Modelling annual scintillation arc variations in PSR J1643-1224 using the Large European Array for Pulsars

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Scintillation is caused by multi-path propagation of pulsar signals through the interstellar medium producing interference patterns in time and frequency. The additional time delays induce pulse broadening when observed on Earth, which can contribute significantly to the noise in high-precision pulsar timing, a technique which helps to test theories of gravity, and potentially detect gravitational waves. LEAP, which comprises five European radio telescopes, aims to increase pulsar timing sensitivity. We present five years of LEAP data for PSR J1643-1224, which lies directly behind a close (~148pc) HII region, making it an interesting source for determining scintillation and scattering effects on precision timing. Despite an environment conducive to large amounts of scattering, we see clear, time-varying parabolic scintillation arcs for PSR J1643-1224. We hypothesise that a thin scattering screen within the intervening HII region leads to these arcs. We fit the observed arc curvature variations, measure the screen's distance and orientation, and obtain an orbital constraint for the pulsar's binary system. We find that our calculated screen distance is consistent with the known HII region distance. We also investigate an unusual timing event seen for this pulsar during 2015 by multiple telescopes and measure scattering time delays during this period.

Chemical complexity in pre-stellar cores

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Observations carried out toward starless and pre-stellar cores have revealed that complex organic molecules are prevalent in these objects, but it is unclear what chemical processes are involved in their formation. In 2016, Jiménez-Serra *et al.* observed the L1544 pre-stellar core and found that complex organic molecules are preferentially produced at an intermediate-density shell at radial distances of several 1000 astronomical units with respect to the core center [1]. Later, in 2021, Jiménez-Serra *et al.* performed similar observations toward the L1498 starless core, believed to be at an earlier stage of evolution than L1544 [2]. In this talk, I will present a related study toward another starless core, L1517B, which is even younger than L1498 and L1544. L1517B has been observed in the 3 mm atmospheric window using the 30-meter telescope of IRAM at Pico Veleta (Spain), with the aim of determining its level of chemical complexity and to compare it with that of L1544 and L1498. We suggest that the differences between these three cores are due to their evolutionary stage, where the nitrogen-bearing organics are formed first followed by the oxygen-bearing organics once the catastrophic depletion of CO sets in.

The Dissipation of Protoplanetary Disks

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The aim of this project is to study and understand the dissipation mechanisms in protoplanetary disks around low-mass stars. For this we look for faint disk whose faintness can be a sign that they are in the dissipation phase. As a first step, our study was focused on one particular object, GO Tau, where it was studied in all its aspects; chemical compositions, dust to gas ratio and other physical parameters. Then, we looked at 3 sources with a small continuum disk: BP Tau, CX Tau and DE Tau. These 3 sources were observed with the NOEMA telescope during 2021. We looked for the same molecules that are present in large discs and we detected them all. We see a diversity of molecular abundances among these 3 sources. Now the next step is to compare the chemistry aspect (line ratio) of these disks to the large disks. Existing ALMA and NOEMA data will be used to compare disk properties with current dissipation models.

Chemical survey of Class I protostars with the IRAM-30m

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Class I protostars, represent a bridge between Class 0 protostars, where the bulk of the material that eventually form the protostar is still in the envelope, and the Class II protoplanetary disks. The importance of Class I stage has been recently strengthened by ALMA images showing that planet formation occurs already in disks with ages < 1 Myr. We present a chemical census of 4 Class I sources: L1551-IRS5, L1489-IRS, B5-IRS1, L1455-IRS1. We used IRAM-30m observations at 1.3 mm. Our observations show a chemical differentiation: All the sources have an extended envelope characterized, well traced by narrow lines due to C-chains. L1551-IRS5 has a hot corino, traced by iCOMs with broad lines. H_2S and OCS trace the circumbinary disk. CH_3OH shows a narrow line component, plausibly due to an extended UV illuminated structure. CH_3CN, CH_3CHO, $HCOOCH_3$ abundance ratios with respect to CH_3OH in L1551-IRS5 are consistent with what has been measured in earlier stages and more in evolved disks and in comets. This suggests that the molecular composition of the latest stages of the Sun-like star forming process is inherited from the earlier phases.

The Role of Molecular Gas in Quasar Feedback

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Galactic feedback processes are thought to regulate the observed co-evolution of accreting black holes and their host galaxy that is observed across cosmic time, but our understanding is still in its infancy. Molecular gas in these galaxies seems to play a significant role in this picture and so characterising this gas and analysing its relation to jets and outflows is an important avenue of research. I will present analysis of the molecular gas properties of an unbiased sample of 17 Type 2 quasars at z<0.2, which are part of the Quasar Feedback Survey. To carry out this research we have observed the three lowest CO transitions using the ALMA Compact Array and APEX. We analysed the impact of AGN feedback on the molecular gas properties such as molecular gas content, excitation and temperature in these quasar host galaxies. Such an impact could include depleting the gas reservoir or a decrease in star formation efficiency, which could also relate to the observed radio jets and outflows. I will also present evidence of molecular gas outflows in these sources and potential interaction between the molecular gas and observed radio emission for which scheduled NOEMA observations will expand upon.

Molecular gas reservoirs associated with z~3 quasars and their link to the extended Lyα emission on halo scales

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Optical surveys are now routinely reporting the detection of cool gas reservoirs (as traced mainly by Lyman-alpha (Lyα) emission) extending on halo scales around z~3 quasars, but little or nothing is known about the molecular gas reservoir surrounding the targeted objects. In this contribution I will present an APEX/SEPIA180 spectroscopic survey (~200 hours) of the CO(6-5), CO(7-6) and [CI](2-1) emission lines for a sample of nine z~3 quasars, already observed with MUSE/VLT for the large-scale Lyα emission (QSO MUSEUM) and spanning the whole range of Lyα properties in that sample (extent, surface brightness, etc.). I will show the obtained constraints on the molecular gas masses for these systems using these CO and [CI] observations, and discuss their link with the Lyα properties on larger scales. In particular, I will present (i) an analysis of the velocity shifts of the Lyα nebulae with respect to the now available molecular redshifts in the framework of turbulent inflow/outflows around these quasars and (ii) the trends between molecular reservoirs and large-scale Lyα properties. I will conclude by discussing these findings in the framework of the quasar photons radiative transfer from galaxy to halo scales.

CON-quest: dense molecular gas properties in moderately luminous infrared galaxies

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The growing phase of supermassive black holes (SMBHs) in galaxies is one of the debated topics in modern astronomy. Recent observations reveal that a fraction of (ultra) luminous infrared galaxies; (U)LIRGs host extremely compact and dusty nuclei. Such compact obscured nuclei (CONs) are only realised in an environment with extremely high column density of materials surrounding the SMBH, and thus suggests rapid evolution. A systematic search for CONs (CON-quest) evidently detected CONs in 20-25% of (U)LIRGs, and 0% in its less luminous sample (subLIRGs). We present ALMA band 6 ~100pc resolution observations of 15 subLIRGs, that are a complete sample of galaxies within 15Mpc distance with their FIR luminosity of 10^10 L_solar, FIR<L_FIR<10^11 L_solar. The spectral range covers the HCN and HCO+ emission line that allows us to estimate the dense molecular gas structure and its kinematic properties. We compare the dense gas properties to the estimated SMBH mass and X-ray luminosity to see the correlation, and also discuss the existence of inflow that will possibly build up CON-like environment in the future.

Analysis of full disk solar observations from ALMA

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The Sun, being the nearest star, can be observed well resolved, and thus be used as a reference case for solar-like stars. ALMA is a new set of eyes to look at the stars including our Sun. Specifically, the brightness temperatures provided by ALMA shed light on the activity and the thermal structure of stellar atmospheres. The global aim of the presented study is to establish more robust solar/stellar activity indicators using ALMA observations in comparison with classical diagnostics. Here, full disk solar maps from ALMA are analysed in combination with SDO-AIA and HMI maps and, with full disk H-alpha and Ca II maps to understand the correlation between them, which also imposes constraints for the height range mapped by ALMA. The centre to limb variation in temperature observed for ALMA maps shows limb brightening which is in line with the expectation that the radiation observed with ALMA originates from the chromosphere. In order to transfer the insights gained from solar ALMA observations to other stars, the full disk solar maps are converted into a corresponding stellar signal. Here we present the first results.Analysis of ALMA full disk maps of the Sun.

Where is the black hole in 3C 84 located?

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The formation of powerful AGN jets and the study of BHs and their immediate environment are subject of intense modern research. To date, two basic jet launching scenarios are discussed - the one from Blandford & Payne (1982), and the one from Blandford & Znajek (1977). Owing to its proximity and brightness, 3C 84 is a prime laboratory for testing these models, as well as studying the innermost AGN structure and jet origin, paralleled only by M87. In 3C 84 two jets emanate north- and southwards, oriented at an intermediate large viewing angle with respect to the observer, leading to only moderate Doppler beaming. Thus, the absence of counter-jet emission north of the VLBI core and on sub-mas scales is both surprising and intriguing. Utilising quasi-simultaneous VLBI observations of 3C 84 at 15, 43, and 86 GHz, we determined the apparent core shift, through 2D-cross correlation and fitting of the apparent core locations. From this we derive the magnetic _eld strength and set constraints on the B-_eld topology at the jet apex. Here we will summarise our very recent results and report on ongoing efforts to determine the location of the SMBH at the jet base.

Estimating distances to G351.77 and G353.41 protoclusters from Gaia eDR3 as part of the ALMA-IMF Large program

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In this poster I present ongoing work in two regions, G351 and G357. Both are protocluster targets observed as part of the ALMA-IMF Large program (P.I. F. Motte). These two star forming regions are relatively nearby at ~ 2 kpc (but see below), and are broadly characterized by a larger-scale filamentary structure, at the end of which star cluster formation is taking place. In this sense, they both present comparatively simple morphology. However, some ambiguities exist in the distances to these regions. Hence I am developing Gaia analysis for more robust constraints, which are essential to convert projected density measurements to masses. In a second step, I will highlight some line data cube results from ALMA-IMF in the center of the protoclusters.

The early stages at substellar formation in Lupus 1 and 3

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The dominant mechanism leading to the formation of brown dwarfs remains uncertain. While the latest discoveries point towards a scaled-down version of the star formation process, other models, such as embryo ejection or stellar disk fragmentation, may not be discarded. We present ALMA cycle 3 (Band 6) along with new results (Band 3 and 7) continuum observations of Lupus 1 and 3 star formation regions based on previous ASTE/AzTEC observations. We report thirteen new candidates (eleven prestellar cores and two Class 0/I) and five previously known class II systems. We probe the turbulent fragmentation and core collapse formation scenarios for the prestellar cores and we compare the dust masses of the disk for the class II objects with previous studies. We conclude that it is highly probable that the sources in the sample are formed as a scaled-down version of low-mass star formation, although disk fragmentation may be responsible for a considerable fraction of BDs. We also present ALMA the results for Par-Lup3-4 where we witness for first time the presence of the base of a compact bipolar molecular cavity in radio in a very low mass star, suggesting a scale down version of low mass star formation.

Probing outflows in radio-quiet AGN

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The origin of radio emission in radio-quiet (RQ) AGN is poorly understood. Possible origins include: low-power radio jets, winds, star-formation and coronal emission. Our research focuses on disentangling their contributions, and determining the dominant contributor to the radio emission observed in these sources. We will present results from our multi-frequency, multi-scale radio polarization study of a radio-intermediate quasar, III Zw 2 as well as a Seyfert 1 galaxy and BALQSO, Mrk 231. These sources reveal a composite jet and "wind" outflow. We will also highlight results from our radio polarization study in conjunction with [O III] emission-line study of 5 Type 2 RQ quasars that are known to exhibit a close association between radio structures and ionized gas morphology and kinematics. An anti-correlation between radio polarized emission and [O III] emission is observed in these sources, similar to that observed in some radio-loud AGN in the literature. This suggests that the radio emission is depolarized by the emission line gas.

Multiwavelength radio analysis of 2 Mpc – size radio galaxies

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A giant radio galaxy (GRG) is an extreme type of active galaxy that has radio jets of size larger than one Mpc. Most of the known GRGs are of FRII type whose jets remain laminar and relativistic throughout its whole journey in a single phase of activity. How some radio galaxies evolve to such a large scale is still an unsolved mystery. The size of GRGs depends on mostly three factors, i.e. IGM density, jet power, and age of the source. It was believed that GRGs are born in a sparse environment. However, some GRGs were also found in clusters of galaxies. To determine the jet power and age of the largest GRGs it is crucial to analyze multi frequency radio maps of proper uv-coverage, angular resolution and sensitivity. In this poster, we present radio properties of a sample of 2 Mpc size GRGs.

Dynamics of the hub-filament complex: L1172/1174

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The LDN 1172/1174 complex represents a cometary shaped hub-filament morphology containing a number of clumps all along the filament and towards the hub around HD 200775. NGC 7023 is a well known reflection nebula in LDN 1174 which is illuminated by an intermediate mass Herbig Be (B3) star HD 200775, in the Cepheus constellation at a distance of ~ 340 pc. These clumps in the filaments might collapse into stars depending on the interplay of magnetic field, gravity and turbulence. The studies on the origin of filaments pose a crucial step in deciding the evolution of these clumps. Being a relatively isolated star forming region, L1172/L1174 gives us an opportunity to get a glimpse of filament formation. To understand the dynamics of filament and its relation with magnetic structures on the periphery of cloud, kinematical studies over the whole filament have been conducted using molecular line observations of 12CO, C18O, N2H+(1-0) and CS (2-1) that trace different density regimes of the clouds. In this talk, I will discuss the kinematics of this particular filament with respect to the magnetic field orientation.

How do Stellar Clusters Impact Cosmic Habitability?

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My thesis aims to use the newly included cold interstellar medium (ISM) in the empirically motivated physics (EMP) simulations, which better reproduce lower mass clusters, to understand how cosmologically typical environments affect the formation and evolution of protoplanetary disks. In this talk I will present the current state of my thesis work and how I plan to use radio observations to test the predictions of the simulations and understand how environments shape protoplanetary disks.

Molecular gas outflows and gas morphology in nearby main-sequence galaxies

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Molecular outflows have been proposed to modulate galaxies' global star formation rate by removing gas from the inner region of the galaxies. Outflows appear to be common in local galaxies, yet, little is known about their frequency in normal local galaxies. We search for molecular outflows from the central 2kpc in 90 nearby main-sequence galaxies in ~1'' resolution CO(2-1) data from the PHANGS-ALMA survey. Using rigorous selection criteria, we reliably identify 16-20 outflow candidates corresponding to an outflow frequency of 25% and extending previous literature samples to lower stellar masses. These candidates exhibit a higher AGN (bar) fraction of 50% (90%) compared to the full sample. Inferred mass loading factors of unity indicate that these outflows are not efficient in quenching the SFR in our galaxies. Further we are investigating the molecular gas morphologies in PHANGS-ALMA to test the predictability of the underlying gravitational potential from gas observations alone. Preliminary results suggest a pronounced variation of morphology with stellar mass, particularly for barred galaxies.

The characteristic radio variability of Active Galactic Nuclei

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Active Galactic Nuclei (AGNs) are highly luminous sources at the centers of some galaxies. Their central supermassive black hole drives the variability of the sources causing visible changes in their observed light curves in differing frequency domains. This variability is a common subject of studies as it may help in understanding the physical conditions governing AGN behavior. The variability of AGNs has been observed to be slower in radio frequencies than other frequency domains. However, the timescales of radio variability have been difficult to characterize as the data is often of limited length. In order to understand the behavior of AGNs, uniquely long data observed by the Metsähovi Radio Observatory 14-meter telescope at the 37 GHz frequency were analyzed. Different analysis methods were used to estimate the power spectra of the sources and the methods themselves were rigorously tested to reveal any issues with their outputs. Preliminary results showed that a characteristic timescale can be visible in the power spectrum of a source if sufficiently long timeseries are analyzed. However, in order to estimate the timescales accurately, bias caused by unevenly sampled data with varying cadence between observing periods will need to be addressed with e.g., improvements to the methods.

Multi-tracer analysis of straight depolarization canals in the surroundings of the 3C 196 field

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Faraday tomography of a field centered on the extragalactic point source 3C 196 with the Low Frequency Array (LOFAR) revealed an intertwined structure of diffuse polarized emission with straight depolarization canals and tracers of the magnetized and multi-phase interstellar medium (ISM), such as dust and line emission from atomic hydrogen (HI). During this talk we will present multi-tracer analysis of LOFAR data of three additional fields in the surroundings of the 3C196 field. For the first time, we study the three-dimensional structure of the LOFAR emission by determining the distance to the depolarization canals. We use the Rolling Hough Transform to compare the orientation of the depolarization canals with that of the filamentary structure seen in HI and, based on starlight and dust polarization data, with that of the plane-of-the-sky magnetic field. Stellar parallaxes from Gaia complement the starlight polarization with the corresponding distances. The depolarization canals align both with the HI filaments and with the magnetic field probed by dust. The observed alignment suggests that an ordered magnetic field organizes the multiphase ISM over a large area (~20 deg) around 3C 196 field. In one field, two groups of stars at distances below and above 200 pc, respectively, show distinct magnetic-field orientations. These are both comparable with the orientations of the depolarization canals in the same field. We conclude that the depolarization canals trace the same change of the magnetic field as probed by the stars. This unprecedented result shows that straight depolarization canals, often associated with the edges of the Local Bubble (<200 pc), can be more generic features in the ISM than previously expected.

Which molecule traces what? Chemical diagnostics of protostellar sources revealed with ALMA

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The physical and chemical conditions in Class 0/I protostars are fundamental in unlocking the protostellar accretion process and its impact on planet formation. We use a suite of Atacama Large Millimeter/submillimeter Array (ALMA) datasets in Band 6 (1 mm), Band 5 (1.8 mm) and Band 3 (3 mm) at spatial resolutions 0.5 – 3 arcsec for 16 protostellar sources. This is an effort to pinpoint chemical tracers to the physical components of the young protostellar systems at the Solar System scales (50 au). Cold gas tracers like C18O, DCO+ and N2D+, associated with the freeze-out of CO are tracing quiescent envelope material..SiO, SO and H2CO are detected in the high-velocity jet. Cavity walls show tracers of UV-irradiation such as hydrocarbons C2H and c-C3H2 as well as CN. The hot inner envelope, apart from complex organic molecules (COMs), also presents compact emission from small molecules like H2S, SO, OCS and H13CN, most likely related to thermal ice sublimation. I will put these results in the context of the upcoming James Webb Space Telescope (JWST). From our targets, 12 will be targeted with JWST in the Cycle 1.

The Orion Radio All-Stars: High-energy processes in YSOs with the VLA, ALMA and the VLBA

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We present an unprecedented radio multi-facility study of YSOs, exploring the radio time-domain at high time and spatial resolution. First, we present a follow-up of our deep VLA survey in the central part of the Orion Nebula Cluster at cm-wavelengths, now expanded to the outskirts of the cluster, revealing hundreds of young stars, proper motions, and variability. Radio variability in protostars at these wavelengths is associated with nonthermal (gyro-)synchrotron emission from magnetospheric activity and thus, together with thermal X-ray emission from heated plasma, probes the high-energy processes in YSOs. We then expand our study of nonthermal YSO radio variability using ALMA (mm-wavelengths) and the VLBA (cm-wavelengths), both with unprecedented sample sizes. With the millimeter range we can constrain the occurrence of synchrotron flares which could have implications for disk mass measurements of insufficiently resolved protoplanetary discs. Furthermore, the VLBA milli-arcsecond resolution observations allow us to filter out any thermal emission making possible the study of exclusively nonthermal emission, which can be studied without complicated time-sliced imaging. Overall, we find strong evidence in the VLA data of the effect that the high-mass stars have on the radio properties of nearby sources which most likely show free-free radio emission from external photoevaporation.

High-latitude Galactic regions studies using decameter carbon radio recombination lines

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The studies of carbon radio recombination lines at decameter wavelengths have the great importance for astrophysics. These lines serves as a sensitive probe of cold tenuous interstellar medium which lie away from powerful stars. In this report we will talk about highly sensitive broadband decameter carbon radio recombination lines observations at UTR-2 radio telescope. For the first time the lines were detected for Galactic regions lying at high galactic latitudes ($b > 10°$). Data analysis suggests that the line formation regions are associated with clouds of neutral hydrogen HI. Obtained results can be useful for further studies of ionized matter in Galaxy.

Direct measurements of carbon and sulfur isotope ratios in the Milky Way

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We present the observations of 12C32S, 12C33S, 12C34S, 12C36S, 13C32S, 13C33S, and 13C34S J = 2-1 lines as well as the J = 3-2 lines of C33S, C34S, C36S, and 13CS toward 110 high-mass star-forming regions with the IRAM 30m telescope. Among our whole sample of 110 targets, we detected the J = 2-1 line of CS toward 107 sources, which yields a detection rate of 97%. Toward 17 objects, the 13C34S J = 2-1 line were detected with 19 radial velocity components, which allow us to determine the 12C/13C and 32S/34S ratios directly with the optical thin J = 2-1 lines of C34S and 13CS. Implementing distance values from trigonometric parallax measurements for our sources, we obtain a linear fit of $12C/13C= (4.24\pm 0.73) R_{GC}+(17.81 \pm 4.16)$, with a correlation coefficient of 0.81. R_{GC} refers to Galactocentric distances. Our 12C/13C ratios agree very well with the ones deduced from CN, C18O, H2CO, and CH. A gradient of $32S/34S= (1.96\pm 0.36) R_{GC}+(6.86 \pm 2.34)$ is also derived between 3.0 kpc $<R_{GC}<$ 10.0 kpc, with a correlation coefficient of 0.81. The 32S/34S gradient is similar to the ones presented in recent publishes.