Young European Radio Astronomers Conference 2019
Participant abstracts

1 Monday 26th August - Extragalactic Studies

1.1 The 2017 observations of the Event Horizon Telescope - *M. Janssen*

The Event Horizon Telescope (EHT) is a global VLBI array with the capability to study millimeter wave emission from extragalactic radio sources with an unprecedented micro-arcsecond resolution. In a 2017 observing run, the EHT observed M87 and Sgr A* - the two primary EHT targets - alongside several other AGN sources. Eight telescopes participated in this observing session, including the extremely sensitive phased-up Atacama Large Millimeter/submillimeter Array (ALMA). A first result from this observing session has been revealed on 10 April 2019 in six simultaneous press conferences around the world: The first image of a black hole.

In this talk, I will discuss how the EHT is able to resolve the innermost regions of active galactic nuclei, focusing on the preceding technical developments, the coordination of the 2017 observing run, and the correlation process of $\sim$4 petabytes of raw data. I will conclude with an overview of the next scientific results which can be anticipated from the EHT consortium in the near future.

1.2 Calibration and imaging of the supermassive black hole in M87 with the EHT - *S. Issaoun*

The EHT collaboration released the first results of its 2017 observing run on April 10. The supermassive black hole in the radio galaxy M87 was imaged, showing an asymmetric ring encircling the shadow of the black hole's event horizon. The high observing frequency, array heterogeneity and susceptibility to atmospheric turbulence led to the development of three independent pipelines for phase calibration, a thorough understanding of telescope sensitivities and properties, a use of information redundancy to refine calibration, and suite of validation tests and systematic error budget estimates. In this talk, I will present the data processing and calibration from correlated data to fully vetted science-ready datasets for analysis. I will also be discussing the imaging process behind the now-famous first image of a black hole, which consists of two important stages: blind imaging and software evaluations.

1.3 Measurements of the shadow and mass of M87* with EHT 2017 data - *S-S. Zhao*

The shadow of a black hole is shaped by the photon unstable circular orbit near the event horizon, so the measurement of shadow is expected to reveal the spacetime of the black hole. The first EHT results of M87* have been published on April 10, in which the crescent diameter of the shadow is measured to be 42 ± 3 muas by using EHT 2017 data. In this talk I will show the method of fitting geometric models to the VLBI observation in the visibility domain and measure the shadow size. Additionally, I will show the crescent models are chosen in the measurement because they are overwhelmingly prefered to the other geometric models in the statistical comparison. By folding in the distance measurements, we calculate the mass of M87* is 6.5 ± 0.7 billion solar masses, which is consistent with the result of stellar dynamical mass measurements. The measurement of the shadow and mass strongly support the hypothesis that the central object in M87 is a Kerr black hole.

1.4 Comparing the EHT 2017 data to physical models of M87* - *F. Roelofs*

On 10 April 2019, the EHT Collaboration presented and published the first results of its 2017 observing run. The supermassive black hole M87* was imaged as an asymmetric ring at 230 GHz, indicative of the shadow of the black hole's event horizon. In this talk, I will present the methods and results of comparing the 2017 data to physical source models. The EHT Collaboration constructed a library of ray-traced general relativistic magnetohydrodynamics (GRMHD) simulations of M87*, which were fit to the EHT data. The fitted GRMHD model images were run through a synthetic data pipeline, which includes realistic data corruption and calibration effects based on station and weather parameters measured during the EHT campaign. The images reconstructed from these show remarkable similarity to the observed image of M87*.

I will also discuss the use of synthetic observations for assessing the expected image quality of an enhanced EHT array with added stations in Greenland, France, Arizona, and Namibia. On the longer term, high-frequency observations with a Space VLBI array could produce images with an angular resolution that is an order of magnitude higher.

1.5 Dust production in galaxies at z > 6 - *A. Leśniewska*

Dust production is a very important issue in galaxy evolution. Unfortunately, we are still unable to determine its formation mechanism. I will present the investigation of dust production in nine galaxies at the redshift of $z > 6$, for which dust emission has been detected. In recent years, more accurate measurements were made using the most powerful instruments, e.g. ALMA, which contributed to better estimates of luminosities and sizes, and thus to determine the masses of gas, dust and stars in the studied galaxies. I conclude that asymptotic giant branch (AGB) stars did not contribute to the dust formation significantly in these Early Universe galaxies, and that supernovae are unlikely to produce the bulk of the dust mass.

1.6 Jet Feedback in a new sample of Galaxy Scale Jets from the LOFAR Two Metre Sky Survey - *B. Webster*

Using the unparalleled sensitivity and high angular resolution of the LOFAR Two-Metre Sky Survey (LoTSS), we are now able, for the first time, to conduct a systematic study of low-luminosity radio AGN within the local universe. The recent first data release from the LoTSS project contains ~300,000 sources in an area of sky covering 424 square degrees which represents 2% of the final survey area. The LoTSS survey is more than an order of magnitude more sensitive than FIRST whilst being sensitive to emission at the same resolution on both small and extended scales. Dubbed Galaxy Scale Jets (GSJ), I will present my discovery from amongst the LoTSS DR1 dataset of a substantial population of physically small, low luminosity radio-loud AGN. Small, low-luminosity sources such as these are important because they are far more numerous than the large, powerful radio sources typically studied and their cumulative effects upon cosmic evolution is much less well-understood. The few existing studies of sources similar in size to GSJ have revealed X-ray detected shocks, providing some of the only known evidence for the direct effects of feedback on galaxy scales (as opposed to cluster scales in the larger sources). I will describe the methods used to find these objects along with their typical radio and host properties. I will also present the first study of the energetic impact of feedback from this previously unknown galaxy-scale jet population and their implications for galaxy evolution.

1.7 Cosmic evolution of radio loud AGN in ultra-deep LOFAR observations - *R. Kondapally*

Over the past two decades, it has become evident that AGN can have a significant effect on their host galaxies, suppressing star formation and regulating the growth of the galaxies (known as AGN feedback). It is now known that there is a strong correlation between the growth rate of the black hole and that of the host galaxy, a relation that seems to have been in place for billions of years. One of the most striking examples of AGN feedback in action comes from detailed local studies of radio-loud AGN, which exhibit powerful jet outflows that can deposit significant energy into the galaxy halo. This project will study how and why radio-loud AGN activity evolves across cosmic time and study the properties of the host galaxies. To achieve this goal it is essential to carry out deep radio observations over large areas and to identify and characterise the multiwavelength counterparts of the sources.

LOFAR is undertaking deep observations in the ELAIS-N1, Lockman Hole and Bootes fields, achieving a sensitivity of $\sim 20\mu$Jy/beam over 10s of square degrees. In this talk I will present the work (using both statistical and visual techniques) to cross-match radio sources to their optical/IR counterparts, incorporating both colour and magnitude information to greatly increase the robustness of the cross-matching, and to extract the physical properties of the host galaxies. The unprecedented depth of both the radio and other multiwavelength data allows us to achieve a cross-match fraction > 95%.

1.8 Detection possibility of low mass galaxy clusters and groups - *P. Gupta*

Low mass galaxy cluster and groups ($\leq 10^{14}$M$_\odot$) are unlikely to be detected following the prevailing mass scaling of radio power from massive galaxy clusters. But, reported observations and simulations of thermal emissions suggest that low mass galaxy clusters are merger prone and non-virialised, indicating more non-thermal energy budget. Detection of non-thermal radio emissions from them would help us to understand the particle acceleration mechanisms better, as well as, being younger and cooler, they can be the unique laboratory to test the models of cosmic magnetism. In this work, we present simple models for computing magnetic field and radio synchrotron emission combining the particle acceleration mechanism: the diffusive shock acceleration (DSA) and Turbulent Reconnection Acceleration (TRA) with numerical modeling on cosmological simulations. From a sample of more than 600 simulated objects (Mass$\geq 10^{13}$ to 2×10^{15} M$_\odot$), we found that the combined radio power from both TRA and DSA electrons fit reasonably well to the observed 'radio halos' at high masses ($> 3\times10^{14}$M$_\odot$). This improves our understanding of radio halo emission and allows us to extend the results to further smaller masses. We obtain an indicative new mass scaling of $P_{1.4\text{GHz}} \propto M_{500}^{2.50\pm0.06}$ and correlation scale of $P_{1.4\mathrm{GHz}} \propto Lx^{1.29\pm0.03}$ from the simulation. Significantly, groups below 10^{14} $M_{\odot}$ reveal the existence of 10s of nano-Gauss to a sub-μG magnetic field and radio power of about 10^{19-23}W/Hz, noticeably higher than what existing mass scaling predicts. Finally, we obtain that the computed radio flux from simulated objects indicates possible detection of low mass objects by existing and aplenty with the future radio telescopes.

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2 Tuesday 27th August 2019 - Solar, Instrumentation and Pulsar Studies

2.1 The effect of scattering on split-band Type II solar radio bursts - *N. Chrysaphi*

Shocks driven by coronal mass ejections (CMEs) can accelerate electrons which through the plasma emission mechanism can produce radio signatures known as Type II solar radio bursts. A characteristic of some Type II bursts is the splitting of a harmonic band into thinner lanes, a phenomenon known as band splitting. We present a detailed imaging and spectroscopic observation of a split-band Type II burst recorded with the LOw-Frequency ARray (LOFAR). We show, for the first time, simultaneous images of the higher- and lower-frequency sub-band sources and find that they experience a large separation. The effect of radio-wave scattering—the dominant process affecting radio waves—is taken into account. We find that the amount by which scattering shifts the true location of a lower-frequency source is larger than the shift of a higher-frequency source such that two sources originating from virtually co-spatial regions will appear to be significantly separated. This provides supporting evidence for band-splitting models that require the emission sources of a split-band Type II burst to originate from nearly the same spatial location, like the model attributing band splitting to radiation emitted from the upstream and downstream regions of a shock front.

2.2 Insights into Coronal Mass Ejection Shocks with the Irish Low Frequency Array (I-LOFAR) - *C. Maguire*

The Sun can produce large-scale energetic events such as solar flares and coronal mass ejections (CMEs) which can excite shock waves that propagate through the corona. To date, the shock kinematics responsible for particle acceleration and emission at radio wavelengths are not well understood. Here, we investigate these phenomena using radio observations of the 2017 September 2, C7.7 solar flare at 10-240 MHz from Irish Low Frequency Array (I-LOFAR, www.lofar.ie). We investigate the relationship between the features in I-LOFAR's dynamics spectra and the shock kinematics as derived from imaging observations using the GOES/SUVI and SOHO/LASCO C2. We calculated the shock Mach number from both shock geometry in SUVI and modelling of coronal Alfvén speed. The relationship between shock characteristics from SUVI and data driven modelling are compared to shock characteristics from radio in order to determine the plausibility of shock accelerated electron release into the solar corona.

2.3 Imaging the Solar Corona during the 2015 March 20 Eclipse using LOFAR - *A. Ryan*

The solar corona is a highly-structured plasma which reaches temperatures of more than $\sim$2MK. At low radio frequencies (≤ 400 MHz), scattering and refraction of electromagnetic waves are thought to broaden sources to several arcminutes. However, exactly how source size relates to scattering due to turbulence is still subject to investigation. This is mainly due to the lack of high spatial resolution observations of the solar corona at low frequencies. Here, we use the LOw Frequency ARray (LOFAR) to observe the solar corona at 120-180 MHz using baselines of up to ~ 3.5 km ($\sim 1-2'$) during a partial solar eclipse of 2015 March 20. We use a lunar de-occultation technique to achieve higher spatial resolution than that attainable via traditional interferometric imaging. This provides a means of studying source sizes in the corona that are smaller than the angular width of the interferometric point spread function.

2.4 Interferometric imaging of Type III bursts in the solar corona - *P. Murphy*

The size of radio emission sources in the solar corona is thought to be fundamentally limited by scattering off of random density inhomogeneities, most prominently at the plasma frequency. Radio interferometers such as the LOw Frequency ARray (LOFAR) have been increasingly used to study radio bursts in the solar corona over the last number of decades.

Observations with LOFAR's tied-array imaging technique suggest that the source sizes of Type III radio burst emission is limited by coronal scattering. However, it has yet to be determined whether source sizes observed with tied-array imaging are a result of this fundamental limit or an effect due to the unique nature of that imaging mode, i.e forming beams at different locations on the Sun and creating an image.

LOFAR interferometric imaging gives an alternative measure of source sizes with higher spatial resolution than tied-array imaging. Here, a Type III burst was imaged with LOFAR core and remote stations with baselines extending to 86 km ($\sim 22''$). We show that despite a sub-arcminute resolution, coronal source sizes are of the order of $\sim$10 of arcminutes, significantly larger than would be suggested from the spectral fine structure. This further supports the theory of scattering being the limiting factor in coronal radio observations.

2.5 Remote sensing the coronal magnetic field using Solar S-bursts - *B. Clarke*

Solar activity is often accompanied by solar radio emission, consisting of numerous types of solar radio bursts. At low frequencies, a class of radio bursts with short durations of milliseconds, known as solar S-bursts, have been identified. To date, their origin and many of their characteristics remain unclear. In this talk, observations from the Ukrainian T-shaped Radio telescope (UTR-2) and the LOw Frequency ARray (LOFAR) will be presented which give us new insight into their nature. Properties of S-bursts such as duration, drift rate, source velocity and bandwidth were measured. Leading models of S-burst generation were tested by analysing the spectral properties of S-bursts. Using various electron density models, S-burst source heights were found to range from 1.3-2 R. It will be shown that the study of S-bursts can provide a new method for measuring the coronal magnetic field. The coronal magnetic field strengths at the source heights of S-bursts were estimated to range from 0.9-5.8 G. Within error, these values are comparable to those predicted by various relations between magnetic field strength and height in the corona.

2.6 Statistical approach to frequency rising submillimeter emission from solar flares - *G. Motorina*

Sub-terahertz (sub-THz) radio observations made it possible to diagnose the region of the Sun that is the most difficult to access for researchers - flare chromospheric plasma. Recently, solar flares with an increase of the spectral flux density with frequency at the sub-THz frequency range have been of great interest. In this work, a statistical study of such events in the 200-400 GHz range has been conducted for the first time. Assuming that thermal free-free emission is responsible for the sub-THz rising component, 17 solar flares with a growing spectrum have been considered in detail. Taking into account the effect of signal saturation, based on data from TRACE and SDO/AIA (1600Å), estimates on the areas of flare ribbons have been obtained. The results demonstrate that large fluxes of sub-THz emission correspond to large areas of flare ribbons. We conclude that the optically thick thermal plasma of the transition region makes the determining contribution to the rising sub-THz component. Finally, we show that the radiation losses of the heated dense plasma can provide the observed sub-second pulsations of the sub-THz emission.

2.7 Impact of planetary ephemerides on gravitational wave searches with Pulsar Timing Arrays - *A. Chalumeau*

Pulsar Timing Array (PTA) projects intend to detect low-frequency gravitational waves (GWs) by probing their imprints on times of arrival (TOAs) of pulsar radio signals. PTAs are sensitive to nanohertz GWs, corresponding for instance to the emission from inspiralling super-massive black hole binaries (SMBHBs). One expects to measure the superposition of continuous GWs originating from the cosmic population of such objects as a stochastic signal. Individual nearby massive systems could also produce a detectable GW signal that rises above the gravitational wave background. Precise and high cadenced pulsar timing observations are carried out over a long period in order to obtain highly accurate (sub mu-s) pulsar TOA residuals. The timing process involves a transformation of the topocentric TOAs to the solar system barycenter frame. It is therefore crucial for PTA analyses that the motions of Solar System bodies be calculated by planetary ephemerides with the highest possible precision.

I will present preliminary results about the effects of imperfect planetary ephemerides on PTA analyses. This work is performed by using INPOP (Intégrateur Numérique Planétaire de l'Observatoire de Paris) data produced by IMCCE (Institut de mécanique céleste et de calcul des éphémérides).

2.8 On X-ray emission of radio pulsars - *M. Timirkeeva*

One of the problems in investigations of radio pulsars is the understanding of the nature of their X-ray emission. To solve this problem we must first of all compare their measured and calculated parameters with parameters of radio pulsars. An analysis of distributions of some parameters of radio pulsars emitting X-ray radiation was carried out. The distribution of magnetic fields near the light cylinder shows the median value of log $B_{lc} = 4.43$ which is almost three orders of magnitude higher compared with that for radio pulsars without a registered X-ray emission ($<$ log $B_{lc} \geq 1.75$). The median value of the loss of rotational energy ($<$ log $dE/dt \geq 35.24$) is also three orders of magnitude higher than the corresponding value for X-ray quiet radio pulsars. There is the expected strong correlation (the correlation coefficient is 0.97) between X-ray luminosity and loss of rotational energy, which is believed to be the main source of all processes in pulsar magnetospheres. Dependence of X-ray luminosity on the magnetic field at the light cylinder has been detected. It supports the hypothesis that generation of non-thermal X-ray emission takes place at the periphery of the magnetosphere and is caused by the synchrotron mechanism. We detected positive correlations between luminosities in X-ray and gamma-ray ranges. Our results show that a purposeful search for pulsars in the hard electromagnetic ranges can be carried out for radio pulsars with high values of dE/dt and B_{lc}.

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3 Wednesday 28th August 2019 - Star Formation, Evolved Stars and Instrumentation

3.1 Overview of VLBI observations in Irbene – Torun baseline - *J. Steinbergs*

Ventspils International Radio Astronomy Centre (VIRAC, Latvia) operates two radio telescopes RT-16 and RT-32, accordingly with 16 and 32 m fully steerable Cassegrain type antennas. The main instruments of both telescopes are cryogenic $4.5 - 8.8$ GHz receivers, additionally radio telescope RT-32 is equipped with "warm" 1.6 GHz band receiver. Data registration units are suitable for interferometric observations on the both antennas. VIRAC also has a high-performance computer cluster with SFXC software correlator developed by JIVE. The Nicolaus Copernicus University Department of Radio Astronomy in Torun, Poland, operates a 32 m radio telescope, which also works in similar frequency bands and regularly is participating in VLBI observations. Since March 2018 VLBI team have realized several successful VLIB observation sessions in the baseline Irbene - Torun at 1.6 and 6.7 GHz. These experiments show that VIRAC is capable to conduct VLBI observations starting with planning of observation, correlation, post-correlation and data processing using astronomical software packages like AIPS or CASA. In year 2019 VLBI experiments of Galactic maser observations are planned also for short baseline Irbene16 - Irbene32 (between the two VIRAC radio telescopes). Results of these experiments and overview of VIRAC current level in the software developments in field of VLBI data processing will be presented in the talk. The possible scientific use of interferometric maser observations in the baseline Irbene – Torun will be discussed.

3.2 Real-Time Radio Imaging through the EPIC Correlator - *J. Kent*

Modern and planned instruments promise to push back the boundaries of radio science, from uncovering the Epoch of Reionisation, to transient phenomena such as Fast Radio Bursts. However, the technological challenges in building these instruments are great, and serve as fertile ground for new techniques and instrumentation methods. I'll talk about the first successful deployment of a novel radio correlator technology, the E-Field Parallel Imaging Correlator (EPIC), on the Long Wavelength Array (LWA) in New Mexico, USA. EPIC images the voltages from each antenna of an interferometer directly, without cross-multiplication which scales as O(n_a^2), where n_a is the number of antennas in the array. By directly imaging, we reduce the scaling to O$(n_a$ log$(n_a))$. This allows a significant benefit in building high density arrays with large numbers of elements, saving on the computational cost associated with a traditional FX correlator. An added benefit is that it is able to easily produce high time resolution images in real-time, unlocking a window into the transient radio universe. The details of the implementation are discussed, along with a transient detection of a meteor striking the atmosphere to demonstrate the high time resolution imaging capability. I will also discuss the key differences with this correlation technique when it comes to calibration, non-coplanarity/wide-field correction, and current work on techniques that deal with these important issues in interfereometers in the context of EPIC.

3.3 Monitoring Jupiter's stratospheric H_2O abundance with the Odin Space Telescope - *B. Benmahi*

Water vapor and CO2 have been detected in the stratospheres of the giant planets and Titan (Feuchtgruber et al. 1997, Coustenis et al. 1998, Burgdorf et al. 2006). The presence of the atmospheric cold trap implies an external origin for H_2O, and the possible sources are: interplanetary dust particles (IDP), icy rings and/or satellites, and large comet impacts. In July 1994, the Shoemaker-Levy 9 comet (SL9) spectacularly impacted Jupiter near 44°S. On the long term, Jupiter was left with a variety of new species in its stratosphere, including CO, HCN, CS, etc (Lellouch et al. 1995). Herschel observations have enabled to demonstrate that the bulk of Jupiter's stratospheric H_2O was delivered by SL9 (Cavalié et al. 2013). All these species can be used as tracers for Jupiter's stratospheric chemistry and dynamics. In this paper, we present the long term monitoring observations from 2002 to 2019 of Jupiter's stratospheric H_2O with the Odin submillimeter space telescope. We use a 1D time-dependent photochemical model combined to a radiative transfer model to constrain the temporal evolution of the H_2O emission and make a prediction of the H_2O abundance in 2030 when JUICE/SWI will use the H_2O submillimeter lines to map the Jovian stratospheric winds.

3.4 HII regions in the Ku-band Galactic Reconnaissance Survey - *M. Mutale*

Radio surveys have an important role in astronomy. Even though our understanding of star formation and stellar evolution is still poor, such surveys have significantly contributed to building our knowledge on these processes. The Ku-band Galactic Reconnaissance Survey (KuGARS) delves into an area of the radio regime previously unexplored by radio surveys - KuGARS is the first galactic plane survey to explore the sub-arcsecond and sub-mJy regime at 14 GHz. Until now, radio surveys have been carried out at low frequencies (≤ 5 GHz) because the investment time of radio surveys is dependent on frequency. In KuGARS we aim to uncover objects whose spectra rise with frequency and would thus have gone unnoticed in these surveys. These comprise the youngest and densest objects in each class: Hypercompact HII regions, YSOs, Jets, and Planetary Nebulae. In this talk, I will describe the technical aspects of KuGARS and discuss our early stage analysis of the data therein. In particular, I will focus on discussing the smallest, densest and presumably youngest HII regions as star formation tracers.

3.5 The Spectral Type of the Ionizing Stars and the Infrared Fluxes of HII Regions - *A. Topchieva*

The regions of ionized hydrogen (HII) around O-B type stars manifest themselves in the infrared spectrum as ring nebulae due to the radiation of dust around the HII region. There is a so-called photodissociation region (FDO) between the hot ionized gas and the cold molecular gas of the parent cloud, which is visible on IR images (particularly at a wavelength of 8 µm) as a ring. The morphology of the infrared ring nebulae around the HII regions indicates that the evolution of dust in these objects is determined by a complex set of processes: the dynamics of dust, its interaction with gas, and also with the powerful UV radiation of massive stars. Studies of these processes, both from a theoretical and observational point of view, are necessary for understanding the evolution of an ensemble of dust particles (size distribution and chemical composition of nuclei) and HII regions themselves (Kirsanova et al. 2009, Akimkin et al. 2015). We used radio data at 20 cm from the VLA telescope to determine the type of the ionizing star in the sample objects (see the catalog of Topchieva et al. 2017). For 42 objects out of 99, we were able to determine the class of an ionizing source, because some objects have no measured kinematic distances, which are also determined from radio data in the molecular lines (Topchieva et al. 2018, RAA). Type of the ionizing star is a key parameter determining the expansion rate of HII regions.

3.6 CO Mapping the Milky Way using Mopra Telescope - *K. Cubuk*

CO is the second most abundant molecule in molecular clouds. While molecular hydrogen is hard to detect because of its quadrupole transition (J=2-0) requires 510K temperature, it makes CO the most important molecule to understand molecular clouds thanks to its dipole transition. CO J=1-0 has an energy 5K above ground so it easily gets excited in 10-20K temperature. Observation stage of the Mopra CO Survey is finished in last November. Data reduction processes are still ongoing. In this talk, I will be explaining the importance of CO molecule, the methods of observation and data reduction and possible future studies related with the survey.

3.7 Tracing low-mass protostars' properties with IRAM 30m submillimeter telescope - *A. Mirocha*

Protostars are surrounded by dense, collapsing envelopes at the earliest stages of star formation. Observations at long-wavelengths are required to study deep embedded low-mass YSOs due to high dust extinction in the optical range. There are many rotational lines of key molecules at submillimeter range which are needed to characterize gas temperatures, densities, the UV radiation. Especially, the molecular outflows are strongly connected with the physical and chemical processes around protostars. Here, we present maps in HCN, CN, CS and their isotopologues obtained with IRAM 30m submillimeter telescope. In this analysis, we concentrate on the Serpens Main star forming region, which contains several of YSOs with strong molecular outflows. Targeted lines trace molecular outflows as well as YSOs' closest neighborhood. Based on information from the molecular data, we are able to characterize the population of low-mass protostars. Additionally, spectral energy distribution (SED) fitting was applied in order to determine bolometric luminosities, temperatures and evolutionary stages of the studied YSOs. This way, we gain new insights into physical and chemical properties of low-mass protostars in the Serpens Main region.

3.8 Tuning in to the radio environment of HD189733b - *R. Kavanagh*

Gas giant exoplanets orbiting close to their host stars, known as hot Jupiters, are expected to be sources of strong radio emission. For the solar system planets, this arises due to the interaction of the solar wind with planetary magnetic fields. Here I will discuss stellar wind modelling we performed for the low-mass star HD189733, which is host to a hot Jupiter orbiting at just 8.8 stellar radii. We use our stellar wind models to then predict the radio emission from the planet. Our results show that the planet emits radio emission above the detection limit of LOFAR. However, due to absorption by the stellar wind, it is likely that the planetary radio emission can only be detected as it approaches and leaves primary transit of the host star. This could be useful for timing future observing campaigns in search of exoplanetary radio emission.

3.9 Molecular fractionation in the low-mass star forming regions - *E. Redaelli*

Fractionation is the substitution of an atom in a molecular compound with one of its isotopes, creating a so-called isotopologue. In the last decades, this process have raised great interest because it is considered an important diagnostic tool to follow the different phases of star formation, from its early stages up to the planetary disk formation and evolution. In my work, I focus on the fractionation of two of the most abundant atoms in the Universe, hydrogen and nitrogen. I will report observations of different isotopologues of N2H+ and HCO+ in a small sample of prestellar cores. These objects, which are cold (T$\sim$5-10K) and dense ($n > 10^5$cm^{-3}), formed through the fragmentation of molecular clouds, and they represent the very early stages of low-mass star formation. We have observed the rotational transitions of N2H+ and HCO+ using the IRAM 30m telescope. From these data, I have derived reliable values of the molecular column density of each species. I then infer the searched isotopic ratio dividing the rare isotolopogue column density by that of the corresponding main species. Concerning nitrogen fractionation, I find that all the sources present 15N/14N ratio significantly lower than the Solar System value, a result which cannot be understood in the frame of the state-of-art chemical models. On the contrary, the D/H ratios found in N2H+ and HCO+ (26% and 3.5% respectively) can be explained by the different chemistry that these two ions exhibit.

3.10 On the size of the CO-depletion radius in the IRDC G351.77-0.51 - *G. Sabatini*

We present a study of the depletion of CO in the IRDC G351.77-0.51. Knowledge of the degree of CO-depletion provides information on the physical conditions occurring in the innermost and the densest regions of molecular clouds. A key issue is the radius within which the CO is depleted (R_{dep}). To estimate the depletion map on the cloud scale, we use the dust continuum (Hi-Gal), combined with APEX $C^{18}O$(2-1) line observations. We built a simple model to investigate the size of the CO-depleted region in G351. The model suggests that $R_{dep} < 0.12$ pc where n(H_2) $> 3 \times 10^4$ cm^{-3}. These results provide crucial information on the spatial scales on which different chemical processes operate in high-mass star forming regions and also presents a warning for using CO for kinematical studies in IRDCs.

3.11 A new method to measure magnetic fields in jets from young stars using LOFAR - *A. Feeney-Johansson*

Magnetic fields are believed to play an important role in the launching and collimation of jets from young stellar objects (YSOs). However, so far they are poorly understood and few measurements of the magnetic field strength in YSO jets exist. Through the detection of a low-frequency turnover with LOFAR, we were able to measure the strength of the magnetic field in the jet of the low mass YSO DG Tau A. Using LOFAR, DG Tau A was observed at 152 MHz, only the second time that a YSO has been detected at these frequencies. Synchrotron emission was detected from two emission knots in its jet. In one of the emission knots, a spectral turnover was detected, the first time such a turnover has been detected in non-thermal emission towards a YSO. This turnover was determined to be due to the Razin effect. As this effect depends on the magnetic field within the emitting source, we were able to estimate the magnetic field strength in the jet as $\sim 20\mu$G. This is the first time the magnetic field strength within a YSO jet has been measured using this method. In the future, this could be applied to other YSOs, therefore providing an important method for studying magnetic fields in YSOs. These results show that LOFAR could be very useful for studying non-thermal emission from YSOs and determining the physical properties of their jets, allowing us to constrain their launching and collimation mechanisms.

3.12 Monitoring of SiO and water masers in evolved stars - *M. Gómez-Garrido*

During the AGB phase, a circumstellar envelope (CSE) is formed around the central star due to the intense mass-loss process. That CSE is composed of dust and gas. Several maser lines are detected in CSEs (SiO, H_2O,...). In particular, SiO masers are known to be a useful tool to study the inner layers, which are crucial to understand the dust formation and mass loss processes. The SiO maser emission has been found to be strongly variable, following the IR stellar cycle with periods $\sim 200 - 400$ days. H_2O masers have not been studied with the same detail. We are conducting systematic and sensitive observations of the SiO and H_2O masers, which can help to understand the origin of both masers. For 3 years, we are performing a simultaneous monitoring of SiO (43 GHz) and H_2O (22 GHz) masers using the 40m-Yebes telescope. Our sample is composed of a total of 22 sources, which covers diverse types of objects. We are observing ^{28}SiO, ^{29}SiO and ^{30}SiO J$= 1 - 0$ lines of the vibrational states $v = 0, 1, 2, ...$ The temporal evolution of the rare isotopic species, ^{29}SiO and ^{30}SiO, was not included in previous works. We have obtained detailed variability curves of all these lines, specially relevant in the case of the weaker and less studied lines.

3.13 Interferometric observations of SiO thermal emission in the inner wind of M-type AGB stars IK Tauri and IRC+10011 - *J. Verbena*

Asymptotic giant branch (AGB) stars go through process of strong mass loss that involves pulsations of the atmosphere, which extends to a region in which the conditions are adequate for dust grains to form. Radiation pressure acts on these grains which, coupled to the gas, drive a massive outflow. The details of this process are not clear, including which molecules are involved in the condensation of dust grains. Using the IRAM NOEMA interferometer we observed the ^{28}SiO and ^{29}SiO J$= 3 - 2, v = 0$ emission from the inner circumstellar envelope of the evolved stars IK Tau and IRC+10011. We computed azimuthally averaged emission profiles to compare the observations to models using a molecular excitation and ray-tracing code for SiO thermal emission. We observe circular symmetry in the emission distribution. We also find that the source diameter varies only marginally with radial velocity, which is not the expected behaviour for envelopes expanding at an almost constant velocity. The adopted density, velocity, and abundance laws, together with the mass loss rate, which best fit the observations, give us information concerning the chemical behaviour of the SiO molecule and its role in the dust formation process. The results indicate that there is a strong coupling between the depletion of gas-phase SiO and gas acceleration in the inner envelope. This could be explained by the condensation of SiO into dust grains.