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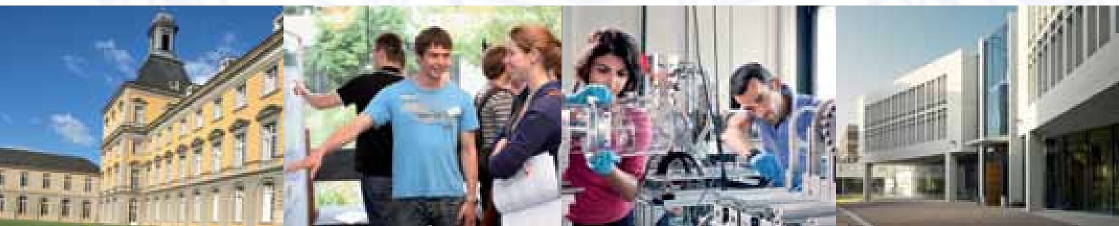

Poster 1

Identification of Protohalos with Deep Learning

Toka Alodka
University of Bonn

Abstract

Cosmological structure formation is the gravitational collapse of complex structures such as halos, filaments, and sheets from initially small density perturbations. This process is highly non-linear, and the best approximation we have for it are numerical N-body simulations, which are computationally expensive and time consuming. In this work we use deep neural networks to classify the particles in the initial conditions which will end up in halos at redshift z=0, binned according to the final halo masses, through a semantic segmentation approach. Our models only take the initial density field at z=99 as an input. This can be useful for the fast generation of mock halo catalogs for precision cosmology, making fast estimates of the Lagrangian bias, or getting some insights on the factors impacting structure formation. We compare the performance of a convolutional neural network and a vision transformer neural network for this task, and we find that vision transformer models are significantly more capable of making accurate predictions of the particles that will belong to a halo at z=0. This shows great promise for vision transformers in extracting useful information from simulation boxes, subsequently giving them great potential for being used in the development of faster tools.

Poster 2

Testing dynamic source models of a repeating Fast Radio Burst

Suryarao BETHAPUDI
Max Planck Institute for Radio Astronomy

Abstract

Fast Radio Bursts (FRBs) are milli-second radio transients that originate from outside of our galaxy. The first FRB was discovered in 2007, but even then, FRBs have opened up several new avenues in time-domain transient astronomy. The focus of the poster is on one such FRB - FRB 20180916B. This FRB was realized to be a repeating FRB with an activity period of 16.33 days and an active window lasting 1.6 days at 600 MHz. Rigorous follow-up of the source helped in uncovering multiple characteristic features, such as the frequency dependency of the activity period, Rotation Measure evolution with time, and the unique local environment of the source in its host galaxy. Still, the source of the FRB is not known. There are multiple plausible models to explain the periodicity, chromaticity, and burst activity. In this work, we limit ourselves to dynamic models of magnetars to explain the FRB. We test the models using the polarimetric measurements of the bursts observed using the upgraded Giant Metrewave Radio Telescope (uGMRT) and 100-meter Effelsberg Radio Telescope at different frequency ranges. Each dynamic model predicts Position Angle variation with time; which we use to constrain the model. We employ Bayesian Nested Sampling code to (1) acquire the maximum posterior likelihood parameters, and (2) use Bayesian Evidence to compare different models. Lastly, we also present simulation results where we apply the same model testing to simulated data to determine the capability of such model testing.

Poster 3

Approximate N-body Simulations using Generative AI

Devika BHATNAGAR
University of Bonn

Abstract

The large-scale structure of the Universe showcases an intricate system of voids, filaments, and halos, known as the cosmic web. Observations from sky surveys are compared with numerical predictions to obtain information about this structure and the constituents of the Universe. Conventional methods of modeling this structure are N-body simulations, that evolve billions of particles in a box under the laws of gravity. However, these simulations are computationally expensive. This has prompted recent developments in the application of deep learning techniques as an efficient substitute for the former method. In our work, we treat the evolution of particles from a high redshift ($z = 127$) to today ($z = 0$) as an image-to-image translation problem. We adopt the machine learning pipeline 'pix2pix' to generate 3D dark matter overdensity fields from their initial conditions. Further, we explore the reconstruction of initial conditions from present-day fields via the same pipeline. We train our model using density fields in boxes of size 1 Gpc from the Quijote simulations suite. We evaluate the performance of the model through summary statistics such as the density power spectrum. Lastly, we present the applications of this method as a faster and computationally cheaper alternative to model the large-scale structure going forward as well as backward in time.

Poster 4

Investigating Chlorine chemistry with observations of HCl in star-forming regions

Lennart BÖHM
University of Bonn

Abstract

In interstellar space, despite its low solar abundance relative to atomic hydrogen, chlorine has a propensity to form hydrides due to its unique thermochemistry. This is facilitated by its lower first ionization potential compared to hydrogen, leading to the dominance of Cl+ in atomic clouds, initiating chlorine chemistry through exothermic reactions with H_2. As a result, HCl becomes the most abundant chlorine-bearing molecule in regions with significant visual extinction. Astrochemically, elemental chlorine, primarily produced by core-collapse supernovae, exhibits stable isotopes Cl-35 and Cl-37, with their ratio expected to vary due to differing metallicities of chlorine sources. Chlorine-bearing molecules might serve as a tool to constrain galactic chemical evolution models. While various chlorine-bearing species have been detected in the interstellar medium, our observations of HCl toward 28 Milky Way star-forming regions reveal a mean Cl-35/Cl-37 isotopic ratio of 3.2 across galactocentric radii. Our detection of HCl in NGC 4945, the first detection in a nearby galaxy, further underscores its ubiquity across galaxies.

Poster 5

Optimizing optical potentials with physics-inspired learning algorithms

Martino CALZAVARA
University of Cologne

Abstract

We present our experimental and theoretical framework which combines a broadband superluminescent diode (SLED/SLD) with fast learning algorithms to provide speed and accuracy improvements for the optimization of 1D optical dipole potentials, here generated with a Digital Micromirror Device (DMD). Our methods provide a route to fast optimization of optical potentials which is relevant for the dynamical manipulation of ultracold gases.

Poster 6

Wide-band observations of pulsar radio emission

Jacob CARDINAL TREMBLAY
University of Bonn

Abstract

Pulsar radio emission is currently poorly understood, especially the wide-band coherent emission process. To arrive at a consistent theory which explains all observed emission features, phenomena such as moding, nulling, and profile evolution must be examined in the wide-band context. By using well-calibrated data, and studying single pulse behaviour in time, frequency and polarization, a more complete picture of pulsar emission can be obtained. The recently installed Ultra-BroadBand receiver (UBB) at the Effelsberg 100 meter radio telescope offers an opportunity to examine single pulse emission over a 1.3-6.0 GHz frequency range. While the large frequency bandwidth allows one to analyze emission properties that vary in frequency, it also presents a particularly difficult challenge in terms of removing radio frequency interference (RFI). I will present an automatic RFI-removal algorithm that I developed. After removing RFI using this algorithm, I examine the wide-band behaviour of pulsar B0355+54 in both single pulse and time-averaged emission. I will present the results of the analysis on the average emission evolution, nulling, moding, and polarization of this pulsar.

Poster 7

Constraining the primordial power spectrum using a differentiable likelihood

Subarna CHAKI
University of Bonn

Abstract

This project utilizes auto-differentiable machine learning methods to predict the primordial power spectrum in cosmology. Employing Hamiltonian Monte Carlo (HMC) sampling, it aims to constrain the spectrum's parameters from observational data. The research contributes insights into inflationary theory by exploring high-dimensional parameter spaces efficiently.

Poster 8

Energy landscapes of peptide-MHC binding

Laura COLLESANO
University of Cologne

Abstract

Molecules of the Major Histocompatibility Complex (MHC) present short protein fragments peptides on the cell surface, an important step in T cell immune recognition. MHC-I molecules process peptides from intracellular proteins; MHC-II molecules act in antigen-presenting cells and present peptides derived from extracellular proteins. Here we show that the sequence-dependent energy landscapes of MHC-peptide binding encode class-specific nonlinearities (epistasis). MHC-I has a smooth landscape with global epistasis; the binding energy is a simple deformation of an underlying linear trait. This form of epistasis enhances the discrimination between strong-binding peptides. In contrast, MHC-II has a rugged landscape with idiosyncratic epistasis: binding depends on detailed amino acid combinations at multiple positions of the peptide sequence. The form of epistasis affects the learning of energy landscapes from training data. For MHC-I, a low-complexity problem, we derive a simple matrix model of binding energies that outperforms current models trained by machine learning. For MHC-II, higher complexity prevents learning by simple regression methods. Epistasis also affects the energy and fitness effects of mutations in antigen-derived peptides (epitopes). In MHC-I, large-effect mutations occur predominantly in anchor positions of strong-binding epitopes. In MHC-II, large effects depend on the background epitope sequence but are broadly distributed over the epitope, generating a bigger target for escape mutations from T cell immunity than for MHC-I.

Poster 9

MMGPS: science from binary discoveries

Miquel COLOM I BERNADICH
Max Planck Institute for Radio Astronomy

Abstract

The MPIfR-MeerKAT Galactic Plane Survey (MMGPS) at L-band has discovered 70 new pulsars in the Galactic plane, 16 pulsars of which in binary systems. With data from dedicated follow-ups with the MeerKAT and Parkes telescopes, we measure their orbital parameters and constrain the masses of their companions, unveiling a wide range of astrophysical natures. These consist of a diverse collection of pulsar-white dwarf (WD) systems with different evolutionary histories, including two rare pulsars with light CO-WD companions and one faint pulsar with a massive WD companion, and two eccentric double neutron star (DNS) systems. We present these discoveries and their science cases, with a focus on the DNS in PSR J1208-5936. This system will merge in 7.2 Gyr due to the emission of gravitational waves, rendering it one of the few known precursors of the NS merger events seen by LIGO and Virgo, such as GW170817. With the new information provided by this discovery and the updated sky coverage offered by the sensitivity of the MMGPS, we update and constrain the NS merger rate based on known Galactic binaries to 293(+222-103) $\mathrm{Gpc}^{-3}\ \mathrm{yr}^{-1}$.

Poster 10

Unveiling Star Formation in the Milky Way: SOFIAs legacy in Cygnus X

Simon DANNHAUER
University of Cologne

Abstract

The massive Cygnus X star-forming region stands out as an active galactic laboratory, offering valuable insights into the intricate processes governing the birth of stars. We study here the DR21 ridge, a star-formation site with a massive outflow (DR21), an OB-protocluster in the making (DR21-OH) and the Diamond Ring. The Diamond Ring, which lies south-east of the ridge, is a puzzling ring-like CII structure which lacks typical signs of an expanding CII shell. Using CII 158 micron upGREAT data from the SOFIA legacy survey FEEDBACK and previously unpublished 4GREAT data (CI 1-0, CO(11-10), CO(8-7)), together with a large data set of sub-mm molecular lines, we intend to reveal the complex dynamics and the physical conditions in the Diamond and connection to the ridge. The large spectroscopic data set enables modelling of the photodissociation regions and we present here not only the data sets but also first results for the ionising source #277 (Comeron et al., 2008), within the ring.

Poster 11

Discovery of a > 13 Mpc long X-ray filament between two galaxy clusters beyond three times their virial radii

Jakob DIETL
University of Bonn

Abstract

The light curves and spectra of many Type I and Type II supernovae (SNe) are heavily influenced by the progenitor's properties and the interaction of the SN ejecta with circumstellar material (CSM) surrounding the progenitor star. The observed diversity hints at the fact that many progenitors have undergone some level of stripping and CSM pollution shortly before the explosion. The presence of a binary companion and the onset of stable or unstable mass transfer offers a mechanism that can give rise to this diversity.

In this poster, we present a set of detailed binary evolutionary models in which the donor star, a Red Supergiant is in a wide orbit around a main-sequence companion, and undergoes mass transfer in the later stages of evolution, up until the moment of core collapse. Their resulting SN types range from H-rich Type IIP to H-deficient IIb and H-free Ib. The material lost during the pre-SN mass transfer may form a dense CSM that surrounds the system by the time of core collapse which can give rise to significant interaction effects in the SN light-curve and spectra. If the mass transfer turns unstable, the progenitor may show significant variability in the last few thousand years before core collapse, and the following SN will likely exhibit strong interaction effects.

Poster 12

A study of the exotic pulsars in the Globular Cluster NGC 1851

Arunima DUTTA
Max Planck Institute for Radio Astronomy

Abstract

The exceptionally high stellar densities in the cores of globular clusters (GCs) makes them remarkable hosts for an exotic binary pulsar population. In this work, I will discuss a pair of massive binary pulsars in the dense globular cluster NGC 1851, observed with the MeerKAT as a part of the TRAPUM (TRAnsients and PUlsars with MeerKAT) GC Survey. Both systems consist of millisecond pulsars in eccentric orbits with massive companions, suggesting that they are the likely products of secondary exchange encounters. The first one is the second most eccentric binary pulsar in a GC and the mass of the companion suggests that it is a very massive carbon-oxygen white dwarf. The total mass of the second binary exceeds the heaviest double neutron star known in our Galaxy. It is also heavier than the most massive NS-NS merger candidate in LIGO/Virgo data. The derived companion mass places it as a compact object mass-gap candidate, with a mass larger than the largest precisely measured pulsars and smaller than the lightest known stellar-mass black holes (BHs). If the companion is identified as a massive neutron star, it would provide valuable insights into the equation of state of dense nuclear matter, leading to new constraints. On the other hand, if it is identified as a black hole, it would signify the discovery of the first millisecond pulsar-BH system. This would offer a unique opportunity to test the properties and formation mechanisms of black holes.

Poster 13

Interacting supernovae from wide massive binary systems

Andrea ERCOLINO
University of Bonn

Abstract

The light curves and spectra of many Type I and Type II supernovae (SNe) are heavily influenced by the progenitor's properties and the interaction of the SN ejecta with circumstellar material (CSM) surrounding the progenitor star. The observed diversity hints at the fact that many progenitors have undergone some level of stripping and CSM pollution shortly before the explosion. The presence of a binary companion and the onset of stable or unstable mass transfer offers a mechanism that can give rise to this diversity.

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Poster 14

Understanding the molecular gas properties of galaxy mergers with little to no star formation

Lina GERLACH
University of Bonn

Abstract

Galaxy mergers are widely recognized to radially alter their constituents, often connected to both extreme bursts of star formation activity and a rapid cessation of star formation. These changes in star formation activity vary from merger to merger, and the factors underlying that diversity are yet to be understood. While we know the reasons for starbursts in mergers, we cannot explain the variations in the strength and the existence of cases lacking a strong burst of star formation activity. This study delves into potential causes, with a particular focus on why some mergers have suppressed star formation. We examine two key factors that impact the formation of stars: the availability of fuel in the form of molecular gas, and the efficiency at which that gas is converted into stars. The research is based on a sample of 31 mergers, encompassing a wide range of star formation rates (SFR) and varying interaction stages. Among these, 20 were selected from spatially resolved measurements of CO emission obtained using the Atacama Large Millimeter Array (ALMA) and sourced from the Mapping Nearby Galaxies at Apache Point Observatory (MaNGA) survey. The remaining 11 merging galaxies were drawn from the ALMA MaNGA Quenching and Star Formation (ALMaQUEST) survey. The investigation begins by examining variations in the resolved star-forming scaling relations on an individual basis to understand how mergers diverge from an expected behaviour. Specifically, the study analyzes the resolved star-forming main sequence (rSFMS: $\Sigma*$ versus ΣSF R), the resolved KennicuttSchmidt relation (rKS: ΣH2 versus ΣSF R), and the resolved molecular gas main sequence (rMGMS: $\Sigma*$ versus ΣH2). Measuring deviations from these specific relations quantifies the enhancement and reduction of SFR, molecular gas fraction, and star formation efficiency in different regions within individual galaxies. Comparing these three variables allows us to not only distinguish areas of enhanced or suppressed star formation, but also to determine whether the gas fraction or star formation efficiency is the primary driver of those variations in star formation. Our findings suggest that the mechanisms driving merger-induced and merger-reduced star formation are diverse, with no consistent, universal cause. Nevertheless, for most individual mergers, the mechanism which boosts star formation is the opposite of that suppressing star formation in the same galaxy. Furthermore, we investigate potential correlations with global properties such as merger stage, mass, SFR, and the presence of an AGN are explored.

Poster 15

The overlap gap property limits limit swapping in QAOA

Mark GOH
University of Cologne

Abstract

The Quantum Approximate Optimization Algorithm (QAOA) is a quantum algorithm designed for combinatorial optimization problem. We show that under the assumption that the Overlap Gap Property (OGP) is present for the Max-q-XORSAT, the swapping of limits in QAOA leads to suboptimal results. Furthermore, since the performance of QAOA for the pure q-spin model matches asymptotically for Max-q-XORSAT on large-girth regular hypergraph, we show that the average-case value obtained by QAOA for the pure q-spin model for even $q \geq 4$ is bounded away from optimality even when the algorithm runs indefinitely. This suggests that a necessary condition for the validity of limit swapping in QAOA is the absence of OGP in a given combinatorial optimization problem.

Poster 16

A new survey of the molecular gas distribution in the LMC with APEX: first results

GRISHUNIN Konstantin
Max Planck Institute for Radio Astronomy

Abstract

The Large Magellanic Cloud (LMC) is a unique laboratory for extragalactic studies of star formation owing to the proximity ($\sim$50 kpc) and nearly face-on orientation of the galaxy. Recently, using the APEX telescope, we have mapped the LMC in the 12CO(32) and 13CO(32) lines. This CO survey, with its 24 sq. deg. areal coverage and 5 pc spatial resolution, have unveiled the detailed distribution of the molecular gas in the LMC disc. In this poster, we introduce the survey and present our first results based on its data, including a catalogue of cloud properties in the LMC, scaling relations between these properties, the cloud mass spectrum in the LMC, and fingerprints of large-scale feedback in the properties of the clouds of the active star forming region 30 Doradus.

Poster 17

Sensitivity curves of Pulsar Timing Arrays

Kathrin GRUNTHAL
Max Planck Institute for Radio Astronomy

Abstract

In the gravitational wave (GW) community, so-called "sensitivity curve plots" are most common way to depict the capability of different detectors to detect gravitational waves. In these plots, the sensitivity of detectors and the strength of the sources are represented as a function of the gravitational wave frequency, such that their relative detectability is straightforward recognizable.

Opposite to earth-based and space-borne detectors, simultaneously monitoring different GW frequencies, pulsar timing arrays (PTAs) operate as time-domain observatories. Thus, translating the various noise components present in the time series into a frequency-dependent sensitivity curve requires an intricate mathematical framework. Until now, the commonly used software "HASASIA" (Hazboun et al. 2019) only integrated white and red noise components into the sensitivity curve.

In this work we developed a practical way to also include different chromatic noise processes into the computation. We present the resulting sensitivity curves for the three major regional PTAs, namely the European PTA, NANOGrav (North American) and the Parkes PTA (Australian).

Poster 18

The Nearby Evolved Stars Survey (NESS)

Manali JESTE
Max Planck Institute for Radio Astronomy

Abstract

Low-to intermediate-mass stars evolve into asymptotic giant branch (AGB) stars, and they are major contributors to the chemical enrichment of the ISM in our Galaxy. Many studies are targeting these objects to understand their mass-loss properties by studying them individually or in a small sample size. NESS is a multi-telescope observing program targeting a volume-limited sample of mass-losing AGB stars within 3 kpc. The project primarily aims to determine the total gas and dust return to the ISM by AGB stars, the gas-to-dust ratios in their outflows and to study the Galactic AGB stars as a population to perform statistical analysis. As a part of this project, I have analysed majority of stars observed from the southern hemisphere and determined their physical properties. I present here the initial results from this analysis and the statistical study performed to understand the properties as a population.

Poster 19

Boron depletion in Galactic early B-type stars reveals two different main sequence star populations

Harim JIN
University of Bonn

Abstract

Rotational mixing is a key process affecting the evolution of massive stars. The surface boron abundance is a sensitive tracer of this in hot main sequence stars. We test current models of rotational mixing through a systematic study of boron depletion in early B-type main sequence stars. We compile the stellar parameters of the 90 Galactic early B-type stars with boron abundance information. We construct a dense grid of rotating single star models using MESA and perform a Bayesian analysis to obtain the probability for each observed star that it is represented by the stellar models, as a function of the adopted rotational mixing efficiency. We find that about two thirds of the stars show good agreement with the rotating single star models, which is best for a rotational mixing efficiency which is reduced by $\sim 50\%$ with respect to the widely adopted value. The remaining stars are largely incompatible with our models, for any rotational mixing efficiency. Many of them are strongly boron depleted slow rotators, and for a significant fraction a large scale magnetic field has been detected. Our results confirm the concept of rotationally induced chemical mixing in radiative stellar envelopes, even though we find its strength to be smaller than expected. On the other side, we find that a different boron depletion mechanism, and likely a different formation path, is required to explain about one third of the stars in our sample.

Poster 20

Line intensity mapping the epoch of reionization with FYST

Christos KAROUMPIS
University of Bonn

Abstract

Poster 21

SYK model and some advancements in holography

Aditya KHALATKAR
University of Bonn

Abstract

Sachdev-Ye-Kitaev model (SYK) is a toy model with quantum many body system that is chaotic and one of the most notable model for holography. The model is described here which features Hamiltonian for N body system with a q body interaction where the couplings are drawn randomly from Gaussian distribution. Here we take a look at its large N dynamics of the theory, its symmetry breaking akin to that of Jackiw-Teitelboim theory. Notably the low energy or IR version of the SYK resemles that of JT theory which provides holographic argument. Further we take a look at its relation to chaos and highlight some advancements in the field.

Poster 22

Investigation of the Cluster A3407 and The Surrounding Large-Scale Structure Using eROSITA Data

Adhishree LAHIRI
University of Bonn

Abstract

The galaxy cluster system A3407-08 was recently observed by the eROSITA observatory. Aside from the two galaxy clusters which are very close to each other, this system consists of a number of other sources near these two clusters, which presents the system as an intriguing candidate for investigation. In this work, extensive surface brightness and spectral analysis of the cluster A3407 was done, along with investigations into the nature of the surrounding sources as well as any possible interactions with said sources. The cumulative data of all four eROSITA all-sky surveys was used in this work to examine the region around the cluster A3407. The PIB subtraction, exposure correction, galactic absorption correction and imaging enhancements were applied on the raw data. The imaging analysis reveals that the cluster A3407 is surrounded by the cluster A3408 to the east, a galaxy group to the north, and the cluster AS0601 and a galaxy group to the south-west. From surface brightness analysis of A3407 it can be seen that the cluster has higher emissions in the north and east regions, possibly due to the galaxy group and A3408, respectively. The surface brightness analysis can also be used to investigate the emission in the region between the two clusters for the detection of emission from a potential filament. The spectral analysis of the cluster A3407 was done to obtain the temperature, abundance and normalization profiles for A3407. This was also used to obtain the temperature and subsequently calculate the mass and radius of cluster A3407 and some of the surrounding sources. These values were also compared with the values obtained in previous works. The X-ray data used in this work was also compared to the Planck 2018 y-maps and the Sydney University Molonglo Sky Survey (SUMSS) radio data.

Poster 23

FRB-Pulsar connection through energy distribution study

Pranav LIMAYE
University of Bonn

Abstract

Fast Radio Bursts (FRBs) are bright millisecond pulses of unknown origin seen only at radio frequencies. Most of these bursts are detected as one-off events while there are a handful of 'active' repeaters. The closest progenitor models that can describe FRBs are Pulsating neutron stars called 'Pulsars'. Both pulsars and FRBs are coherent synchrotron emitters. The pulsar emission has been well established to be of magnetospheric origin and can be described by the famous 'lighthouse model'. My work with Dr. Marilyn Cruces tried to probe the connection between FRB single pulses and pulsar single pulses. We work on single pulses from Pulsars and try to characterize their energy distribution in a similar way as is done for FRBs to investigate this connection and try to understand the emission mechanisms of both these exotic objects in detail.

Poster 24

Tracing the Full Length of the A3391/95 Intergalactic Medium Emission Filament

Caroline MANNES
University of Bonn

Abstract

Filaments form connections between galaxy clusters, the nodes of the cosmic web. Studying filaments can improve our understanding of the growth of structure in the universe and might help solve the missing baryon problem. The eROSITA X-ray telescope opened up the possibilities for the detection of new filaments owing to its unique soft response and large field of view (FOV). A search for filaments was conducted in a $\sim$216 square degree field around the A3391/95 galaxy cluster system using data from the first four eROSITA all-sky scans (eRASS:4), expanding the investigated area by a factor of 14 compared to previous works. Corrected and wavelet-filtered RGB images were created and combined with multi-wavelength data, such as a Planck SZ map and an optical galaxy density map. We found that for fractions of the FOV, a significant amount of contamination by foreground emission is present. Keeping the constraints by the foreground emission in mind, hints for possible filament-like structures were found in the East ($\sim$10 Mpc) of the A3391/95 system, as well as towards the North ($\sim$11 Mpc) and South ($\sim$9 Mpc). In the inner region close to the main cluster system, results from previous works could be mostly confirmed.

Poster 25

Fragility of surface states for in Non-Wigner-Dyson Topological Insulators

Mateo MORENO
University of Cologne

Abstract

Topological insulators and superconductors support extended surface states protected against the otherwise localizing effects of static disorder. Specifically, in the Wigner-Dyson insulators belonging to the symmetry classes A, AI, and AII, a band of extended surface states is continuously connected to a likewise extended set of bulk states forming a bridge between different surfaces via the mechanism of spectral flow. In this work we show that this mechanism is absent in the majority of non-Wigner-Dyson topological superconductors and chiral topological insulators. In these systems, there is precisely one point with granted extended states, the center of the band, E=0. Away from it, states are spatially localized, or can be made so by the addition of spatially local potentials. Considering the three-dimensional insulator in class AIII and winding number =1 as a paradigmatic case study, we discuss the physical principles behind this phenomenon, and its methodological and applied consequences.

Poster 26

Resurgence in topological field theories

Oguz ÖNER
University of Bonn

Abstract

Most problems in theoretical physics are only solvable via approximation schemes, often leading to formal power series that are factorially divergent. Resurgence is a framework to capture non-perturbative physics from perturbative data by making sense of divergent series. My poster presentation will be about how resurgent analysis sheds light on the "hidden information" in topological quantum field theories by focusing on a relevant example, (complex) Chern-Simons theory for hyperbolic knots. Based on the references, I will describe the process for the simplest hyperbolic knot, the figure eight knot. The poster will end by describing a recent advancement in using resurgent analysis, a mathematical perspective on a bijective operation with many potential applications, including q-series invariants that arise from non-perturbative completion of complex Chern-Simons theory.

Poster 27

Examining cosmic (an)isotropy using velocity dispersion scaling relations of galaxy clusters

Aditya PANDYA
University of Bonn

Abstract

The late universe is assumed to be homogeneous and isotropic and according to this assumption, the expansion rate of the universe or the Hubble parameter should be the same in all directions. Galaxy cluster scaling relations provide an excellent tool to test this hypothesis by pairing one cosmology-dependent quantity and one independent quantity. For this work, velocity dispersion of galaxy clusters (σ_{v}) are used as the cosmology independent quantity since their measurement does not involve cosmological assumptions. This quantity is paired with Cluster X-ray luminosity (Lx) and the total integrated Compton parameter (Ysz) which are both dependent on cosmological parameters such as the Hubble parameter (H0). By examining the scaling relations Lx - σ_{v} and Ysz - σ_{v} in different parts of the sky, any variations observed in the scaling relations can be attributed to variations in H0. From the joint analysis of the two relations, maximum H0 variation is found in the direction of (l,b) = (280°, -35°) with statistical significance of $> 3.4\sigma$ obtained from isotropic Monte Carlo simulations.

Poster 28

MPIfR-MeerKAT Galactic Plane Survey (MMGPS) I: System setup and early results

Denisha PILLAY
Max Planck Institute for Radio Astronomy

Abstract

Pulsars are highly magnetised, rapidly rotating neutron stars that emit beams of electromagnetic radiation from their magnetic poles and are remarkable laboratories for testing theories of gravity, studying neutron star interiors, and constraining equations of state. Previous surveys searching for such intriguing objects have provided high-impact science results, and new-generation radio telescope sensitivities enable more intriguing discoveries.

The Max-Planck-Institut fur Radioastronomie (MPIfR) MeerKAT galactic plane survey (MMGPS) is an ongoing commensal survey that aims to maximise the scientific return per unit of MeerKAT observing time by covering multiple science cases (pulsars, fast transients, Galactic and extragalactic magnetism and Galactic star formation) simultaneously. The primary science objective of the MMGPS is to find previously undetected compact relativistic binary pulsars along the Galactic plane and use such systems to probe general relativity in the strong field regime. The MMGPS has been partitioned into three parts: the MMGPS-L band (1.4 GHz observations of the Galactic plane), MMGPS-S band ($\sim$2.4 GHz observations close to the Galactic plane) and MMGPS-SgrA* (high-frequency end of S-Band ($\sim$3 GHz) observations centred on Sagittarius A*). The L-band portion of the survey has been completed, yielding 74 pulsar discoveries (16 binary systems and 2 double neutron star systems) and the S-band portion of the survey is currently underway.

Poster 29

Learning of highly resolved particle positions by Neural-network

Fahad PUTHALATH
University of Cologne

Abstract

Machine learning tools is used to track particles in the images captured from micro-gravity experiment of dilute granular system. Final aim is to track the particles in 3D using images captured from three axes, and get look at their statistical properties like decay of mean kinetic energy in the system, velocity distribution and compare it with the theory namely Kinetic theory of granular gas and Haff's law. Some technical limitations during the training of neural network lead to some bias in the predictions which gave us some interesting insights, which is included in the poster.

Poster 30

Investigating the Galactic latitude dependency of Faraday complexity

Shilpa RANCHOD
Max Planck Institute for Radio Astronomy

Abstract

Magnetic fields are an essential component of the interstellar medium, and measuring their structure and scale in the Milky Way is imperative for a holistic understanding of Galactic astrophysics. The observations of complex Stokes Q and U spectra with modern broadband interferometers can reveal rich properties of the magneto-ionic medium. Large area legacy surveys of polarised extragalactic sources have provided an understanding of the large scale Galactic Faraday screen. With more sensitive follow-up observations of such catalogues, e.g SPASS/ATCA RM catalogue (Schnitzeler et al., 2019), we can fully understand their systematics to ensure continued legacy value into the SKA era. In this poster, I present the results of our investigation into the increase of Faraday complexity towards the Galactic plane in the SPASS/ATCA RM catalogue. With a complexity fraction of 42%, we establish that the majority of the complexity in the SPASS/ATCA sample is due to the mixing in of diffuse Galactic emission at scales $> 2.8'$. Furthermore, we find a correlation between our observed small-scale complexity $\theta < 2.8'$ and the Galactic spiral arms, which we interpret to be due to Galactic turbulence or small-scale polarised emission. This work illustrates how observations at various angular scales are necessary to fully interpret the physical scale and structure of the Galactic magnetic field.

Poster 31

Evolution of tolerance in Neisseria gonorrhoeae under intermittent antibiotic exposure

Mahak SADWHANI
University of Cologne

Abstract

Neisseria gonorrhoeae is a multiresistant human pathogen responsible for the world's second most sexually transmitted disease gonorrhea. Gonococci possess multifunctional surface-exposed polymers - type IV pili. These are involved in surface motility, aggregation, force generation and also act as major antigens. They undergo antigenic and phase variations which lead to modified bacterial surfaces and can cause a switch between planktonic and aggregative phenotypes. Aggregation leads to biofilm formation which protects from external stresses and leads to increased tolerance under antibiotic treatment. The evolution of tolerance mechanisms is not fully understood. Therefore, we designed an experiment in biofilm-promoting conditions with intermittent exposure to ceftriaxone to understand how N. gonorrhoeae evolves tolerance mechanisms. After an initial loss in biofilm formation, we see that the tolerance drops but then it increases till it reaches the initial level and beyond. Concluding that biofilm formation is not the only mechanism of tolerance. We further inspect the reasons behind this observation at the molecular level by whole genome sequencing to identify genes involved in tolerance.

Poster 32

Implementing a two-level AI-enhanced particle detector trigger on a single chip

Patrick SCHWÄBIG
University of Bonn

Abstract

For years, data rates generated by modern particle detectors and the corresponding readout electronics exceeded by far the limits of data storage space and bandwidth available in many experiments in particle physics. The solution of using fast triggers to discard uninteresting and irrelevant data is a solution used to this day. Using Field Programmable Gate Arrays (FPGAs), Application-Specific Integrated Circuits (ASICs) or directly the readout chip, a fixed set of rules based on low level parameters is applied as a pre-selection. Only a few years ago, live track reconstruction for triggering was rarely possible. With the emergence of highly parallelized processors for AI inference, attempts to sufficiently accelerate tracking algorithms become viable. The Xilinx Versal Adaptive Compute Acceleration Platform (ACAP) is one such technology and combines FPGA and CPU resources with dedicated AI cores. My approach is to implement a two-level trigger on a single chip by utilizing the tightly integrated combination of FPGA and AI cores to profit from their individual strengths. I will show a concept for a two-level trigger setup, implemented on a Xilinx ACAP, including AI algorithms, high-speed Ethernet connection and detector read-out. An implementation of this setup will be used in an envisioned mid-size ultra-high rate fixed-target dark matter experiment (Lohengrin) at the ELSA particle accelerator.

Poster 33

Prospective motion correction with 3D Orbital Navigators for robust and rapid susceptibility weighted imaging

Matthias SERGER

Abstract

The quality of susceptibility weighted images (SWI) may deteriorate under subject motion, especially at high magnetic fields, impairing further data analysis. In this work, Orbital Navigators were integrated into a 3D EPI gradient echo sequence (0.6 mm^3 resolution) for SWI at 7T. A linear perturbation model was implemented to prospectively correct head motions to mitigate artifacts. The SWI image quality under a large instructed subject motion was preserved in contrast to a scan without correction, demonstrating the high potential of this method to provide precise motion estimates for motion-robust high-resolution imaging.

Poster 34

Effects of the Anisotropic Halo Assembly Bias on the Halo Bispectrum

Haveesh SINGIRIKONDA
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Abstract

The large-scale structure of the universe has been established as a leading avenue to probe dark energy and the primordial universe through surveys like Euclid and LSST. Controlling the systematics in these data is one of the leading challenges to making robust cosmological constraints. One of the potential systematics, which might affect Euclid, is the Anisotropic Halo Assembly Bias (AHAB). In this work, we study the AHAB using the halo bispectrum, for which the effect has not, so far, been explored in detail. Using halo catalogues of 300 realisations of the Minerva simulations, we probed the effects of anisotropic selection criteria on cosmological parameter estimation, by creating 'mock' catalogues, with halos selected according to their relative orientation to the line of sight. We estimated the halo bispectra from these catalogues to constrain cosmological parameters. With the help of extra modelling ingredients, we were able to capture these selection effects, thus obtaining unbiased estimates of the cosmological parameters.

Poster 35

Double-lens Scintillometry: The variable scintillation of pulsar B1508+55

Tim SPRENGER
Max Planck Institute for Radio Astronomy

Abstract

The study of scintillation arcs is a quickly growing field aiming at understanding the small-scale structure of the interstellar medium (ISM) and providing a natural interferometer pointed at pulsars. Scintillation is caused by interference of scattered paths through the ISM. The resulting intensity variations contain holographic information on the scattering structures, which manifests in scintillation arcs. In our observations made at the Effelsberg 100-m telescope spanning from 2020 to today, the pulsar B1508+55 goes through various phases of scintillation arcs with rich substructure. Many observables could be monitored over several years, some of which were disovered in this study with novel methods. The result is one of the most constraining data sets of pulsar scintillation, which clearly points to two scattering screens instead of one. We derived predictions of scintillation observables from such an extended model and show that it quantitatively and qualitatively fits the data.

Poster 36

High noon for cosmic giants: beacons for massive galaxy formation from South Pole Telescope protocluster cores

Nikolas SULZENAUER
Max Planck Institute for Radio Astronomy

Abstract

In the local Universe, the most massive galaxies are found in the centers of rich galaxy clusters. While these environments are well studied out to redshifts 1-2, their formation process in the first two billion years remain enshrouded in cosmic history. Contrary to the successful hierarchical structure formation scenario, giant elliptical galaxy precursors are observed to form rapidly via the monolithic collapse process, characterized by correlated star-formation fueled by vast molecular gas reservoirs. Selected from the 25000 deg^2 large South Pole Telescope (SPT-SZ) survey, we present Atacama Large Millimeter/submillimeter Array (ALMA) observations of these SPT protocluster cores. Guided by 870um APEX/LABOCA maps, the redshift determination to the eight brightest cores is now completed. Strikingly, SPT2349-56, at z=4.3, is the record holder for the highest star-formation surface density known, with 15 ULIRGs only within 50 kpc in projection. The majority of core galaxies sit on the same cluster caustic in phase space, hinting at a core-wide collapse process caught in action. A beacon of this 'mega merger' are bright tidal gas streamers, serendipitously discovered with ALMA. Clumpy ionized carbon arcs connect individual galaxies to the larger scales of the collapsing core. Numerical simulations suggest that this is a signpost event for the formation of a red giant elliptical galaxy with ten times the Milky Way's halo mass, already completed within the next few 100 million years (z>3). This poster discusses the full sample of SPT protocluster cores and how it will allow to test the paradigm of massive galaxy formation in the first two billion years of the Universe.

Poster 37

SMEFT Interpretation of the tZq Production at the ATLAS Experiment at CERN

Can SÜSLÜ
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Abstract

Although the Standard model (SM) of particle physics has been successful to explain the observed phenomena, there are indications of new physics beyond the SM, such as dark matter and neutrino oscillations and masses. The Standard Model Effective Field Theory (SMEFT) is a framework for parametrizing the phenomena occuring at the high energies, and contains additional operators in the Lagrangian with dimensions larger than the SM. These operators from a basis, describing all possible interactions and couplings where the new physics can hide. Single top quark and Z boson production is a convenient channel for EFT interpretations as it contains the couplings of the top quark and W and Z boson, and is thus quite sensitive to many SMEFT operators. In this analysis, using a kinematic distribution, the Wilson coefficients (WC) of the dimension six operators sensitive to the tZq channel have been constrained at the detector level via profile likelihood fits. The WC constraints obtained via the detector-level approach and the further plans for optimizing the EFT-sensitive regions will be presented in this talk.

Poster 38

PulsarNet: A Novel Attention-based Neural Network to discover Pulsar Binaries

Abhinav TYAGI
University of Bonn

Denisha PILLAY
Max Planck Institute for Radio Astronomy

Abstract

PulsarNet introduces a novel Machine Learning based pulsar search algorithm to speed up the discoveries of exotic pulsar binaries that are imperative to test the theories of gravity, in the strong field regime. While PulsarNet has shown promising results, challenges remain in fully optimizing its performance, but its successful application marks a significant step towards using machine learning for pulsar research.

Poster 39

Large Scale X-ray Analysis of the Centaurus Galaxy Cluster

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Abstract

The Centaurus cluster is one of the closest and brightest clusters in the sky. Early assessment of the velocity distribution of the galaxies showed that the cluster is composed of two substructures: Cen 30 and Cen 45. Due to its relatively large extent in the sky, previous X-ray studies were focused on the brightest part of the cluster ($\leq$ 30 arcmin radial distance). In this work, we utilize the combined five eROSITA All-Sky Survey data (eRASS:5) to probe the Centaurus cluster out to $\sim$180 arcmin in the imaging analyses. The results show that while the core is dynamically active, the outskirts of the Centaurus cluster are seemingly undisturbed due to the absence of influence from cosmic filaments.

Poster 40

Testing large scale cosmology with MeerKAT

Jonah WAGENVELD
Max Planck Institute for Radio Astronomy

Abstract

The cosmic radio dipole is an anisotropy in the number counts of radio sources with respect to the cosmic background. Results have shown a tension between the radio dipole and the dipole as measured from the cosmic microwave background (CMB), presenting an intriguing puzzle as to the cause of this discrepancy. With its high sensitivity and large field of view, MeerKAT, a radio telescope located in South Africa, can yield thousands of sources per telescope pointing. We present a dipole measurement carried out on the continuum catalogue of 391 pointings of the MeerKAT Absorption Line Survey (MALS), one of the large survey projects carried out with MeerKAT. The catalogue produced from these pointings covers 1623 square degrees and contains around 800,000 sources. We present the characterisation of completeness and noise properties of the catalogue, as well as novel estimators developed for this dipole measurement. We discuss the challenges that came along with a measurement of the dipole on MALS in the form of some persistent systematics. The final results agree with the CMB dipole in terms of direction, but in terms of amplitude are three times larger, with a significance of 3-sigma. This result agrees with measurements of the cosmic radio dipole made with other radio catalogues, suggesting a large scale anisotropy present in the data that is in tension with the cosmological principle.

Poster 41

Overcoming Challenges in Finding Ultra-High-Energy Cosmic Ray Sources with a Bayesian Hierarchical Framework: Impact of the Galactic magnetic field and mass composition

Keito WATANABE
University of Cologne

Abstract

The origins of ultra-high-energy cosmic rays (UHECRs) continue to elude us due to the intricate interplay between their acceleration and escape mechanisms, propagation physics, and detection limitations. Developing a comprehensive statistical model is further complicated by the numerous parameters and uncertainties involved. In this study, we present a statistical analysis of the connection between UHECRs and astrophysical sources using a Bayesian hierarchical framework introduced in Capel & Mortlock (MNRAS 484, 2019). We expand on this framework by incorporating the effects of the Galactic magnetic field on UHECR propagation and introduce a novel method for inferring the nuclear composition at the source based on the observed composition at Earth. Our approach respects rigidity- dependent deflections and energy-loss horizons for each event, depending on its observed mass, energy and arrival direction. We apply our approach to publicly available data from the Telescope Array and Pierre Auger Observatory. Since event-by-event composition-sensitive variables are not yet available, we assume an average observed composition. By providing a more accurate understanding of the nuclear composition at the source, our approach can improve our knowledge of the processes that generate cosmic rays. Our results offer new insights into the differences between Northern and Southern skies and enhance our ability to understand the astrophysical phenomena underlying UHECR production.

Poster 42

Analysis of the 3α-decay of the 0_2^+ state in ^{12}C

David WERNER
University of Cologne

Abstract

The branching ratios of the three-particle decay of the 0_2^+ excited state in ^{12}C, the Hoyle state, are important probes for the inner structure of ^{12}C and provide insights into stellar nucleosynthesis. Two high-statistics experiments were performed at the 10 MV FN-tandem accelerator of the Institute for Nuclear Physics of the University of Cologne. A $^{12}C(\alpha,\alpha')$ reaction at a beam energy of 27 MeV was utilized to populate the state of interest. The Lund-York-Cologne-Calorimeter (LYCCA) was used to study the three-particle decay branches of the Hoyle state. The 18 segmented double-sided silicon strip detectors allowed individual detection of the reaction's four α particles with high angular precision. Results from particle spectra are compared with Geant4 Monte-Carlo simulations. Analysis results, in particular Dalitz plots, will be presented. The branching ratios of the three-particle decay of the 0_2^+ excited state in ^{12}C, the Hoyle state, are important probes for the inner structure of ^{12}C and provide insights into stellar nucleosynthesis. Two high-statistics experiments were performed at the 10 MV FN-tandem accelerator of the Institute for Nuclear Physics of the University of Cologne. A $^{12}C(\alpha,\alpha')$ reaction at a beam energy of 27 MeV was utilized to populate the state of interest. The Lund-York-Cologne-Calorimeter (LYCCA) was used to study the three-particle decay branches of the Hoyle state. The 18 segmented double-sided silicon strip detectors allowed individual detection of the reaction's four α particles with high angular precision. Results from particle spectra are compared with Geant4 Monte-Carlo simulations. Analysis results, in particular Dalitz plots, will be presented.

Poster 43

Simulation of downhill skiing areas

Buchuan ZHANG
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Abstract

Based on video analysis of downhill skiing areas a model for ski traffic is devel oped. The video analysis uses PeTrack to determine the trajectories of individual skiers which are then statistically analysed. A stochastic cellular automaton model is proposed that can reproduce the basic observed features. The empirical data are used for validation and calibration of the model. In the future, the model may help to analyse comfort and safety on skiing slopes, especially the risk of collisions.

Poster 44

Inflection point inflation and Modular invariant inflation in Supergravity

Wenbin ZHAO
University of Bonn

Abstract

We propose two different classes of inflation models based on Supergravity framework. For inflection point inflation, we use polynomial Superpotential to generate inflation potentials. We further consider the possible effects of supersymmetry breaking on the inflaton model and build a bridge between supersymmetry breaking scale and inflation scale. For modular invariant inflation, we find the modular symmetry put a strong constraint on the shape of inflation potential. In both cases, our inflation potential can not be simply approximated by renormalizable inflation models. The tensor to scalar ratio is small in our model while the running of spectral index is reachable in next generation experiments.