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Book of Abstracts

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Poster / **3**

Enhance the Esterification Reaction Rate in Producing Biodiesel by Microwave and Fe Powder

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In the biodiesel production process, esterification is an essential step, but it typically consumes a considerable amount of time before meeting the criteria for proceeding to the next phase, the transesterification reaction. Based on the previous work in our laboratory, we have demonstrated a stirring cavity utilizing a 2.45GHz microwave, which enhanced esterification reaction employing a molar ratio of 1.15 of glycerol to oleic acid to approximately 1.3 times faster than the conventional method, which typically takes over 6 hours. In this study, we demonstrate an improved esterification reaction introducing iron powder as a catalyst. As a result of these enhancements, we achieved a significant improvement, which was about 13 times faster than the conventional method.

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Structure Effect on Reflective Gyrotron Backward-Wave Oscillator

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Gyrotron devices, based on the principles of the electron cyclotron maser (ECM) instabilities, are powerful high-frequency microwave sources. In this study, we focus on specific type of reflective type gyro-BWO , which consist of several tapered section and can achieve a phenomenal output efficiency and bandwidth. This study investigates the effect of structural nonuniformities on the beam-wave interactions in the gyrotron backward-wave oscillator (gyro-BWO). Employing the effective-boundary method both upstream and downstream of the primary cavity, we examine the modulation effect resulting from end reflections. The gyrotron's beam-wave dynamics during backward wave and forward wave interactions are analyzed separately. The study reveals a significant modulation effect during the electron bunching stage of backward-wave interaction, influencing tunability positively or negatively. This modulation effect is contingent upon the acquired phase from upstream reflections. The influence of both upstream and downstream structural nonuniformities is elucidated. These findings not only provide valuable insights but also offer a clear physical understanding for optimizing current gyrotron devices.

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TE- and TM-mode Competition in Subterahertz Gyrotron Using Axis-Encircling Electron Beam

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For a long time, most gyrotron oscillators have avoided utilizing TM modes because of the concerns about strong bunching competition and relatively weak beam-wave coupling. However, this work demonstrates that an axis-encircling electron beam with high mode selectivity is adapted to preclude most parasitic modes and makes the TM12-mode oscillation in an open-cavity-type gyrotron system feasible. Considering the modes excited at the fundamental cyclotron harmonic, the TE12 mode remains the only competitor to the targeted TM12 mode, however, it will be effectively suppressed by the axial velocity spread. Operating with 70 kV beam voltage and 1 A beam current, the output power of the TM12 mode may reach the several-kilowatt level, verified by both nonlinear frequency-domain and time-domain simulations. Nonetheless, as the modes at high cyclotron harmonics are included, the second-harmonic TE24 mode and the third-harmonic TE36 mode would potentially hazard the proposed TM12-mode operation. Even so, the particle-in-cell CST simulation results still show a tunable window of the TM12 mode, where all parasitic TE-mode oscillations are fully suppressed. This work manifests the importance of considering the competition from TM modes in the designs of gyrotron devices, especially for the cases employing axis-encircling electron beams. Currently, the proposed system is being constructed at Peking University, Beijing, with preliminary tests supporting the findings of this study.

Poster / **6**

First statistical evidence of cosmological baryonic flunctuation revealed by localized fast radio burst.

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The enigma of the missing baryons poses a prominent and unresolved problem in astronomy. Dispersion measures (DM), serving as a distinctive observable of fast radio bursts (FRBs), quantify the electron column density along each line of sight, revealing the missing baryons described in the Macquart (DM-z) relation. The scatter of this relation is anticipated to be the variation of cosmic structure. However, this is not yet statistically confirmed. Here, we present the statistical evidence of the cosmological baryonic fluctuation in the intergalactic space by measuring the foreground galaxy number densities around 12 (12) localized FRBs with WISE-PS1-STRM 5 and WISE x SCOS 6 photometric redshift galaxy catalog, repectively. The foreground galaxy number densities are determined through a comparison with measuring random apertures with the radius of 1 Mpc. We found a positive correlation between the excess of DM contributed by the intergalactic medium (DMIGM) and the foreground galaxy number density. The correlation is strong and statistically significant, with a median Pearson coefficient of 0.8 (0.7) and a median p-value of 0.003 (0.012) for each catalogue calculated by Monte Carlo simulations. Our findings indicate that baryonic matters in intergalactic space exceed its cosmic average along the line of sight to high galaxy-density regions, whereas there is less amount of intergalactic baryons along the line of sight to low-density regions, presenting the first statistical evidence of the cosmological fluctuation of the missing baryons with the characteristic scale of □1.5 Mpc.

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Broadband and Molecular Dynamics Analysis of Propylene Carbonate and its Binary Mixtures with Alcohols

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This study explores the dielectric properties and relaxation behaviors of propylene carbonate (PC) and its binary blends with methanol and ethanol. Utilizing a coaxial-circular cutoff waveguide junction, broadband dielectric spectra (0.1 GHz to 18 GHz) were characterized, employing a two-group Debye model to extract relaxation parameters. Analysis of excess thermodynamic parameters, Kirkwood orientational correlation factors, and Bruggeman factors for PC-alcohol mixtures was conducted. The data offer insights into microscopic processes, such as the disassociation of alcohol hydrogen-bond networks, formation of new PC-alcohol networks, parallel alignment of dipoles, and enhanced dielectric effects with increasing PC concentration. Molecular dynamics simulations using the TraPPE-UA forcefield exhibited good agreement with experimental results, highlighting the gradual formation of PC-cage and alcohol-cluster microstructures in PC-rich mixtures. These findings hold potential practical applications in high-energy batteries and the pharmaceutical industry.

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Type Ia Supernovae Induced by Primordial Black Holes from Dark First-Order Phase Transition

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We applied a novel scenario to impose constraints on the relic abundance f_{PBH} of primordial black holes (PBHs) in the mass range $10^{-14} \leq M_{\mathrm{PBH}}/M_{\odot} \leq 10^{-11}$ which cannot be probed by microlensing or evaporation methods: When a PBH with the aforementioned mass transits through a white dwarf (WD) made up of carbon and oxygen, Bondi-Hoyle-Lyttleton (BHL) accretion in a reactive medium creates a shock wave, which generates direct detonation ignition in the WD core and then leads to Type Ia supernovae (SNe Ia) whose event rate is to be compared with the observational data. PBHs in the constrained region can be produced by a cosmological first-order phase transition (FOPT) in the dark sector which associates with $\mathcal{O}(\mathrm{MeV})$ energy scale and thus gives rise to complementary signals of stochastic gravitational waves (GWs) from 10^{-6} Hz to 10^{-5} Hz peak frequency which can be probed by future μAres GW interferometer.

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A Search for Planet Nine with Far-Infrared All-Sky Surveys Data

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Various recent data analyses and modeling simulations provide strong evidence of a giant distant planet in the outer region of the solar system, which is also known as Plane Nine or Planet X. However, the existence of this planet has not been demonstrated by observations. Since it is more difficult to detect the reflected sunlight from Planet Nine than its thermal radiation, infrared surveys using space telescopes are ideal for finding this mysterious planet. In this study, we conduct a search for Planet Nine by analyzing the data from two far-infrared all-sky surveys such as Infrared Astronomical Satellite (IRAS) and AKARI Space Telescope, whose operating times are separated by 23.4

years. The internal thermal emission at 90 μm and proper motion of Planet Nine are estimated in a mass range of 5 - 17 M_{Earth}. Our work covers the distance range of 300 - 1000 AU between Sun and Planet Nine. A set of criteria is listed for position and flux selection after eliminating all non-moving sources between catalogues. We finally obtained a shortlist of potential candidates including 166 IRAS sources and 1028 AKARI sources. Then, we started to evaluate their cutout images.

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Finding Planet 9 In the AKARI Image

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The N-body simulation of asteroids outside the Neptune shows there could be a massive object there, called Planet 9. We assume Planet 9 emit grey body radiation and try to find it in the space telescope AKATI's image.

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Quantum many-body scars as protected subgraph in the Fock space lattice: A study in 2D constraint system

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Understanding the fundamental theory of preventing thermalization is crucial for practical quantum device development. In this study, we delve into prior research on quantum many-body scars in the U(1) lattice gauge theory. By interpreting the Hamiltonian as the adjacency matrix defining an undirected graph, we pinpoint these scars as subgraphs exhibiting perfect destructive interference at the boundaries. Consequently, they are confined from exploring the entire graph, thereby violating the Eigenstate Thermalization Hypothesis (ETH). Remarkably, the Cauchy interlacing theorem ensures that these subgraphs can still share identical eigenpairs with the entire graph, even in the absence of any associated global symmetries. Leveraging this insight, we devise an efficient algorithm for scar detection. Furthermore, we assess the dynamics of these scars through numerical tests, evaluating their robustness against noise and exploring other aspects of long-time physics.

Keywords: Quantum many-body scars, eigenstate thermalization hypothesis, graph theory

Poster / **13**

Acoustic Monitoring of the STM Tunneling Current

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The tunneling current is the only outgoing signal in scanning tunneling microscopy (STM) experiments. The current contains information about electronic states, the transition between these states, and the gap itself, which is formed between the probe and the studied system. Since its invention, the instrumental development reflects our increasing access to the different components which are contributing to the tunneling current. Central in the data analysis is the splitting of the current signal into its frequency components. Respectively, incoming signal are modulated in time and the response in the tunneling current grants the access to the properties of the studied system. For example, in simple STM imaging the current is kept constant through a z-feedback loop, and the response of the DC (or low frequency) current with the lateral motion as regulated by z is displayed. Here, we use the current signal to address gap noise. In particular, a common problem in our study of molecular systems is the unintentional capture of organic parts by the probe. This can be traced in current noise beyond 100 Hz. Monitoring externally the current response after FFT filtering is possible but also visually distracting. Instead, the human ear does inherently act as a FFT analyzer. We therefore demonstrate an Arduino project to first filter the DC signal out, realize an adjustable band pass filtering, and the conversion into an instantaneous, acoustic signal without distracting the visual supervision of the experiment by the user.

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Simulating AGN feedback in galaxy clusters with pre-existing turbulence

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Active galactic nuclei (AGN) feedback's role in suppressing cooling flows in cool-core clusters is acknowledged, but the primary heating mechanism of AGN jets is debated. One potential heating mechanism is heating caused by turbulence induced by AGN jet-inflated bubbles. However, there has been disagreement between simulation and observational studies. Therefore, the goal of our study is to elucidate this discrepancy using 3D hydrodynamic simulations including both AGN feedback and pre-existing turbulence. Our results indicate that turbulence has a limited impact on entropy. We found that the observed line-of-sight velocity dispersion (⊠⊠⊠⊠) could overestimate the true velocity dispersion (⊠⊠), thus providing an explanation for the discrepancy between the simulated and observationally inferred turbulent heating rates. Leveraging new XRISM data, our research provides key insights into the long-standing problem of AGN heating in clusters.

Poster / 15

Microwave-Based Oxidation Process for Carbon Fiber

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The conventional process of carbon fiber has several stages, including oxidation, pre-carbonization, and carbonization. The oxidation is the most time-consuming one, taking approximately 90-120 minutes at temperatures ranging from 200-300℃. According to previous research, using the properties

of microwaves can significantly reduce the oxidation process time to a total of 13 minutes (8+5 minutes) with a two-step process. The goal of this experiment is to design a small-scale yield continuous microwave system to efficiently transform the precursor, PAN fiber, into oxidation fiber. The cavity design used HFSS to simulate the electromagnetic and thermal field distributions, ensuring that the cavity parameters meet the desired specifications. Following the experiment, samples will undergo various measurements, including density and dielectric properties, among other tests, to confirm that the degree of oxidation matches the required level for oxidized fibers.

Poster / **16**

Exploring Quantum Size Effect of Antiferromagnetic 120° Néel State on Mn Nanoislands by Spin-Polarized Scanning Tunneling Microscopy

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The quantum size effect plays a crucial role in the fundamental physics as well as technological applications in the two-dimensional materials. In our studies, we have investigated the quantum size effect on the antiferromagnetic 120° Néel state of monolayer Mn on Ag(111) by utilizing spin-polarized scanning tunneling microscopy (SP-STM). The typical area sizes of Mn nanoislands under investigation are ranged from 30 to 170 nm^2. The interplay between the area size, modulation of Néel state and magnetic field dependence have been discussed as a manifestation of the quantum size effect.

Poster / **17**

Formation and mechanics of fire ant rafts as an active and self-healing membrane

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The unique ability of fire ants to form a raft to survive flooding rain has enchanted biologists as well as researchers in other disciplines. It was established during the last decade that a three-dimensional aggregation of fire ants exhibits viscoelasticity with respect to external compression and shearing among numerous unusual mechanical properties. Continuing these works, we will study the ant raft in its natural form, i.e., composing no more than two layers. This allowed us to focus on the cracks that are unique to membranes and see how their patterns are influenced by the fact that these ants are mobile and can self-repair the damage to keep their raft from disintegration. In the beginning, we show that vertical and horizontal shaking can also prompt fire ants to aggregate. The canonical view that the stability of ant raft relies on the Cheerios effect and a combination of other parameters is tested. The force-displacement experiment is performed to show that two distinct mechanical responses and fracture patterns, characteristic of ductile and brittle materials, can be elicited, depending on the magnitude of the pull speed. During the process, we counted the number of ants that actively participated in the stress-strain relation and used this information to roughly sketch out the force chain. The latter information reveals that the pull force expedites the alignment of fire ants, in analogy to the effect of an electric field on liquid crystal polymers. To highlight the self-healing nature, we employ the creep experiment to study how the length and Young's modulus of the raft change or relax with time. One major finding is that the raft can exhibit zero Poisson's

ratio without resorting to specific geometry structures. This is enabled by the active recruitment of ants from the top layer to the bottom layer to keep the raft from disintegrating.

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Using Matrix Product State to Solve Scale Invariant Hamiltonian in Efimov Physic

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Matrix Product State (MPS) and Density Matrix Renormalization Group (DMRG) serve as effective variational techniques for investigating the low-energy states within quantum many-body systems, utilizing the underlying entanglement structures. By broadening the scope of MPS as a data representation framework, it becomes more adept at capturing intricate correlations within the system. Recent advancements have expanded the utility of this approach to efficiently address hydrodynamic equations, including the complex dynamics of phenomena like turbulence, and can compress data well. This study endeavors to adapt these methodologies to Efimov physics, which is characterized by unique universal properties and discrete scale invariance. Within this context, two new distinct approaches for generating the inverse of the required $\frac{1}{R^2}$ potential into MPS, thereby reproducing discrete scaling behavior, have been identified, alongside a detailed exploration of associated numerical challenges.

Poster / 19

Dual residence time for droplet to coalesce with liquid surface

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When approaching a liquid surface, droplets have a tendency to merge in order to minimize the surface energy. However, they can exhibit a phenomenon called coalescence delay in most cases that keeps them floating for tens of milliseconds. The duration is known as the residence time or the non-coalescence time. Surprisingly, under identical parameters and initial conditions, the residence time for water droplets is not a constant value but exhibits dual peaks in its distribution. In this poster, we present the observation of the dual residence times through rigorous statistical analysis and investigate the quantitative variations in residence time by manipulating parameters such as the droplet height, radius, and viscosity. Theoretical models and physical arguments are provided to explain their effects, particularly why a large viscosity or/and a small radius is detrimental to the appearance of the longer residence time peak.

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Spectropolarization of Synchrotron Radiation in Astrophysics

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The ratio of the polarized synchrotron emission to the total emission, i.e., the polarization degree, is known to be (p+1)/(p+7/3) or (α +1)/(α +5/3), for electrons with a power-law energy distribution of index p, where α = (p − 1)/2 is the spectral index. In this article, we first show the limitation of the formula, and then we propose a generalized version of this formula which could serve as a universally applicable formula for estimating the polarization degree.

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Raman Scattering Approach to the $\mathbb{Z}_2$ Gauge Theory in the Kitaev Model

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The Kitaev honeycomb model can be viewed as a system consisting of Majorana fermions coupled to a $\mathbb{Z}_2$ gauge field, for which the accompanied $\mathbb{Z}_2$ vortex is called the vison. Recently, a study introduced a Green's function approach to analytically compute the energy cost of generating a vison in the Kitaev honeycomb model. On the other hand, some studies proposed that the Raman scattering method can be applied to investigate the Kitaev spin liquid. Based on These approaches, we can delve deeper into the system's characteristics when two visons recombine through the formation of a loop, which may reflect the information about the self statistics of visons in the Kitaev model. This study offers further insights into the $\mathbb{Z}_2$ gauge theory within the Kitaev spin liquid.

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The Magnetic Field in Star-Forming Regions of Perseus Molecular Cloud

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We present magnetic field strength maps in the star-forming regions, including IC348, L1448, L1455, NGC1333, and PerB1, of the Perseus molecular cloud. The angular dispersion is calculated from the 850 μm linear polarization maps as part of B-fields In STar-forming Region Observations (BISTRO) survey. The velocity dispersion is estimated from spectral lines of $C^{18}O$ and N_2H^+. The result shows that the magnetic field strength is higher at the core regions. Furthermore, we compare the magnetic field strength with volume density and find that they follow the expected power law. The mass-to-flux ratio in most of the regions is found to be less than 1, suggesting magnetically supercritical.

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Characterization of dynamical phases for periodic-driven systems on the Poincar\'e disk

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In conformal invariant $(1+1)$-dimensional systems subjected to periodic driving,
there are heating and non-heating phases characterized by linear growth and oscillation of the entanglement entropy respectively [arXiv preprint arXiv:1805.00031]. In this work, we explore different setups without conformal symmetry by employing Poincar\'e disk realizations for periodic driven systems with $SU(1,1)$ symmetry.
We demonstrate these realizations by two examples: (a) Bose-Einstein condensates (BEC) quenching dynamics and (b) periodic-driven oscillators, both of which are experimentally accessible.
For BEC quenching dynamics, the heating and non-heating phases can be determined by both excitations and entanglement entropy. On the other hand, for the driven coupled oscillators, the phase diagram is enriched.
We observed there are distinct phases inside the heating phase which can only be captured by the entanglement measures.

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Searching for the Missing Puzzle Pieces of the Early Universe with JWST in the COSMOS Field —3μm Dropout Galaxies

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The quest to comprehend the origin and evolution of the cosmos stands as one of the most profound enigmas in the realm of science. It encompasses the birth of fundamental elements, the intricate process of star and galaxy formation, and the dawn of the first galaxies in our ever-expanding universe. At the heart of this quest lies the imperative task of identifying the most remote galaxies, whose study yields critical insights into the primitive conditions of the universe during the Epoch of Reionization.

One of the instrumental endeavors in this cosmic exploration is the Cosmic Evolution Survey (COSMOS) project, which includes the "Search of 3μm Dropouts in JWST COSMOS field." Under the broader COSMOS initiative, the COSMOS-Web project embarks on a contiguous 0.54 $\deg^2$ NIRCam imaging survey employing multiple filters, thus pushing the boundaries of observational depth. The primary objective of this endeavor is to identify dropout sources from JWST data, with a specific focus on Lyman break galaxies. I analyzed COSMOS data, using crude selection to find z~7.88 galaxy candidates.

Lyman break galaxies are of particular interest due to their distinctive "Lyman break" phenomenon. This effect arises from the shift of the Lyman limit into observable wavelengths, a consequence of the cosmic expansion. The resulting shift enables telescopes to capture this characteristic spectral feature in various wavelength bands, leading to the identification of "dropouts" in specific spectral regions, such as "H-dropouts" within the near-infrared range. These dropout galaxies provide a unique window into the early universe, offering valuable insights into its most distant realms.

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Multi-User Quantum Key Distribution with 148 Times Improvement in Key Rate

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We present an enhanced quantum network communication protocol, building upon the standard MDI-QKD framework. This method achieves a 148 times improvement in the key rate and effectively mitigates quantum bit error rate from asymmetric channels. We demonstrate the new protocol in the laboratory and its progress towards commercial viability. Our aim is to develop practical quantum communication solutions for diverse users across various locations.

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Shaping Single Photons By Fiber Bragg Gratings

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Fiber Bragg gratings (FBGs) are distributed reflectors realized by periodic or aperiodic variation of refractive in optical fibers. In this work, we explore the waveform shaping of a phase-modulated optical pulse at the single photon level in a FBG. We describe the theory, simulation, techniques and provide anovel approach to control waveform.

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Vertical Electronic Interaction in DB6P on Ag(111)

Author: Abhishek Singh[1]

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[n]Phenacene [1] have gained significant attention for their potential application in organic field-effect transistors (OFET) [2,3]. They are stable under ambient conditions, demonstrate high charge mobility, and are chemically easily tailorable for the design of desired electronic, optical, or mechanical properties.
We investigate the growth and electronic properties of DiBenzo[6]Phenacene (DB6P) adsorbed on a Ag (111) surface using scanning tunneling microscopy and spectroscopy. DB6P is a [6]Phenacene derivative with the phenacene structure extended by a benzene ring (Benzo) at each of the two (Di) ends. In the first layer, DB6P forms a regular, rows-wise network with the molecular plane parallel to the surface. In the second layer, the growth continues row-wise with dimerized but unequally tilted DB6Ps. This growth is corresponding previous observations on [n]Phenacenes with

the exception that for DB6P, the rows in the first and second layer are rotated against each other. This rotation is manifested in a respective modulation of the molecular electronic states. Moreover and in difference to [n]Phenacenes, the experimental results indicate a pinning of molecular states through the vertical electronic interaction. We will present the experimental findings and discuss our interpretation.

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Entanglement renormalization of non-Hermitian critical systems and emergent dS space

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One of the most important development in AdS/CFT correspondence is the RT formula[1]. This formula states that entanglement entropy of boundary CFT will equal to bulk AdS minimum surface
\begin{equation}
S(V) = min[\frac{A(m)}{4G_N}]
\end{equation}
Which gives a big convenience to calculate entanglement entropy in CFT.
Later research[2] shows that this conjecture becomes obvious in the AdS/MERA.
Since our universe is a dS space, so people have a big interest in dS/CFT. Research[3] shows that here the dual CFT will be a non-unitary one with negative/complex central charge. Recent research[4] shows that non-Hermitian system can have a negative central charge. Therefore, to push the understanding of RT formula in dS/CFT case and learn more about dS/CFT, we study the cMERA of non-Hermitian system.

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Growth of lead and gold layers on top of new quasi-freestanding phase germanene

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Using low-energy electron diffraction (LEED) and angle-resolved photoemission spectroscopy (ARPES) techniques, we studied germanene on Ag(111) and divided our results into three parts:
1.At higher annealing temperatures, two new quasi-freestanding phases (QP) germanene, referred to as new QP1 and new QP2, were grown and compared with the QP R30° prevoously discovered.
2.Growth of two different monolayer Pb layers on the two new QP phases.
3.Au atoms infiltrate the Pb layer to form a special Au layer on new QP1 with the same lattice constant, 3.5Å, of the Pb layer, rather than the pristine one, 2.89Å.

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Polarisation Measurements of Soft Gamma Rays from the Crab and Cygnus X-1 using a Small Compton Polarimeter to Fly on a Cubesat

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Measurement of polarization is important in understanding radiation mechanisms of pulsars and coronal geometry of X-ray binaries. In this study, we propose to implement a small Compton Polarimeter on-board a 6U Cubesat to study the gamma ray polarization of the Crab and Cygnus X-1. The instrument is based on Gadolinium Aluminum Gallium Garnet (GAGG, chemical formula: $Gd_3Al_2Ga_3O_{12}$) scintillator arrays and silicon photomultipliers (SiPM) to convert the scintillation light to electric signals. In this paper, we estimate the Minimum Detectable Polarization (MDP) using the MEGAlib package for certain variations of the instrument models, including different configurations, energy threshold and read-out size of detectors. We will discuss the results for four energy ranges: 80-160 keV, 160-250 keV, 250-400 keV, and 400-2000 keV and try to obtain the optimised criteria for the lowest MDP, thus estimating the most sensitive instrument configuration to detect useful polarization information in the soft gamma-ray regime.

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Topological phases of antiferromagnetic insulator

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We explore the topological phases of a three dimensional canted antiferromagnetic insulator featuring Dresselhaus and Rashba spin-orbit couplings. In contrast to previous studies that rely on assumed Néel order to classify topological properties, we acknowledge the potential impact of spin-orbit interactions on the Néel orde. Employing self-consistent magnetic order calculations, we observe distinctive spin arrangements under Dresselhaus and Rashba couplings. Under Dresselhaus spin-orbit coupling, the spin configuration exhibits antiferromagnetic order with spins pointing in arbitrary directions. On the other hand, Rashba interaction results in spins antiferromagnetically aligning in the xy-plane. Additionally, a small interaction controlled by hopping parameter induces spin tilting, causing antiferromagnetic alignment in the xy-plane but ferromagnetic alignment in the z-direction.

We categorize the topological properties of these phases: for pure antiferromagnetic order, the system possesses a modified time-reversal symmetry, characterized by Z2. In contrast, tilted antiferromagnetic orders are characterized by glide-mirror symmetry and inversion symmetry, described by a Z4 index. Moreover, we scrutinize the bulk-edge correspondence, revealing that the surface state becomes gapless when the surface symmetry aligns with that of the bulk state; otherwise, the surface state exhibits a gap. Our findings offer a comprehensive topological characterization for canted antiferromagnetic insulators with spin-orbit couplings, providing valuable insights into the interplay between spin arrangements, symmetries, and topological properties in these systems.

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Reversible Switching of Single FePc Molecule Structure on Giant Rashba Surface

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The Rashba system, originated from strong spin-orbit coupling induces energy band splitting for electrons of opposite spins, exhibit distinctive interactions when coupled with a magnetic impurity. Previous STM/STS studies have demonstrated that the antiphase boundary of the Rashba system BiAg2 stabilizes an alternative structure for manganese phthalocyanine (MnPc) molecules, resulting in a reversible magnetic switching system. In our research, we replaced MnPc with Iron phthalocyanine (FePc) and observed its ability to sustain two switchable phases. Notably, one of these phases manifests as a six-lobes pattern in STM topography in contrast with the previously observed four lobes, deviating from the typical molecular shape. This discovery highlights the potential unique electronic behavior of magnetic impurities within the Rashba system and may have far-reaching implications.

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Growing quasi-freestanding phase germanene on Ag2Bi alloy surface

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In this work,we study the growth of germanene on Ag111 basis that depositing Bi atom.Bi will form three structures on Ag111 according to different deposition amounts: Ag2Bi-Root3 X Root3 R30, Bi/Ag111-(p x root3), and Bi(110)/Ag(111).We use LEED(low energy electron diffraction) to investigate the germanene lattice structures formed by depositing Ge on two different Bi/Ag111 surfaces :
1. Ag2Bi-Root3 X Root3 R30 alloy structure
2. Coexistence structure of Ag2Bi-Root3 X Root3 R30 with Bi/Ag111-(p x root3)
Using ARPES to measure the surface band structure and core-level variations in two distinct regions can be employed to compare with LEED results and draw conclusions.Finally,We constructed lattice models of the coexistence of Ag2Bi surface alloy - Root3 X Root3 R30 on Ag111 substrate and Bi/Ag111-(p x root3) in order to explain the interesting structures observed in the second part of the experiments

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Pioneering All-copropagating Scheme for Biphoton Source in Hot atomic System

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Biphoton generation has emerged as a pivotal tool in quantum research, offering the capability to produce heralded single photons. Leveraging the strong temporal correlation between two photons, one photon can be used as a trigger, and we can effectively use the second photon to conduct research in quantum information, quantum simulation and communication. Biphotons generated via the four-wave mixing process in hot atomic systems exhibit distinctive characteristics, including stable high detection rates, adjustable frequency as well as linewidth. These traits are particularly advantageous for applications in quantum communication. However, the previous generation rate per linewidth (known as spectral brightness) of hot atom SFWM biphoton sources lagged significantly behind those produced via spontaneous parametric down-conversion processes. This disparity primarily stems from the necessity of phase matching for maximizing the generation rate in the four-wave mixing process, which requires all light to propagate in the same direction. Nevertheless, the presence of background light in experiments compromises the purity and characteristics of single photons, emphasizing the critical need to identify the sources of background light and develop appropriate solutions. Presently, we have achieved a significant milestone by generating the world's brightest biphoton source in a hot atomic system, achieving a generation rate of 3.8×10^6 pairs/s and a spectral linewidth of 3.4 MHz. This groundbreaking research not only signifies a pioneering accomplishment in the realm of All-copropagating scheme biphoton sources but also establishes a fundamental groundwork for advancing biphoton generation. Importantly, this method has been successfully applied to generate biphoton sources in cold atom systems and even directly within optical fibers, showcasing its versatility and potential impact across various platforms.

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Machine-Learning enhanced Quantum State Tomography: Covariance matrix approach

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Machine learning (ML) has emerged as a powerful tool in quantum state tomography (QST), facilitating the extraction of comprehensive information about quantum states. Leveraging ML architectures such as convolutional neural networks, we present a rapid and robust QST approach for continuous variables using experimentally measured data from balanced homodyne detectors. Our method offers significant and alternative points of view to the traditional maximum likelihood estimation or the reconstruction model, avoiding truncation problems and focusing on the statistical measurement of the uncertainties. Through ML-enhanced QST, we retrieve the Wigner function for quadrature data of the validation set, showing that the performance in order to describe the squeezed state and its squeezing angle was accurate. Furthermore, we introduce a model generating target matrix components to bypass complexities associated with large Hilbert spaces while preserving high-precision feature extraction. Covariance matrix method demonstrates consistency, affirming the diagnostic utility of ML-QST for diverse applications ranging from quantum information processing to macroscopic quantum state generation and advanced gravitational wave detectors.

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A Framework For Rapid Parameter Inference of Kilonova Light Curves: Bayesian-Machine Learning Approach

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The coalescence of binary neutron star (BNS) in the event GW170817, leading to the generation of gravitational waves (GW) and accompanied by kilonova (KNe), the electromagnetic (EM) counterpart, has been a prime topic of interest for the Astronomy community in recent times as it provided much insight into multi-messenger astronomy. Since its discovery in 2017, several research teams have put forward models to describe the light curves and the parameters of the observed KNe. Here we propose a technique for parameter estimation where we utilize the strength and flexibility of conditional variational autoencoder (CVAE). Publicly available physical parameters corresponding to single light curves are used as training data. Once the training has concluded, we are able to perform parameter inferences with accuracy. Since this approach is likelihood-free, it provides relatively quicker results. We have demonstrated that the total time, from training until the parameter inference, is under 3 hours. In this work, we show that for a given KNe light curve, we can rapidly perform parameter inference based on the required model.

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Investigating Magnetic Properties of Mn-Deposited Bi/Ag(111) with Spin-polarized Scanning Tunneling Microscopy

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The emergence of two-dimensional topological materials and spontaneous magnetization holds the potential for the realization of the quantum anomalous Hall effect. In this research, we employ spin-polarized scanning tunneling microscopy (SP-STM) to investigate the structural and magnetic characteristics of manganese (Mn) deposition on the Bi/Ag(111) surface. The deposition of Mn on Bi/Ag(111) gives rise to the formation of a remarkable honeycomb lattice structure. Field-dependent SP-STM measurements have unveiled magnetic signals exhibiting a 2×2 periodicity. We propose that these magnetic signals originate from close-packed Mn beneath the Bi honeycomb layer. Our SP-STM simulations reveal that the magnetic contrast pattern closely resembles the triple-q spin state, and we can reproduce this pattern in simulation by adjusting the orientation of the tip to a specific angle.

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Finding dusty AGNs from the JWST CEERS survey with mid-infrared photometry

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The nature of the interaction between active galactic nuclei (AGNs) and their host galaxies remains an unsolved question. Therefore, conducting an AGN census is valuable to AGN research. Nevertheless, a significant fraction of AGNs are obscured by their environment, which blocks UV and optical emissions due to the dusty torus surrounding the central supermassive black hole (SMBH). To overcome this challenge, mid-infrared (IR) surveys have emerged as a valuable tool for identifying obscured AGNs, as the obscured light is re-emitted in this range. With its high sensitivity, the James Webb Space Telescope (JWST) can uncover more fainter objects than previous telescopes. In this work, we investigate the properties of AGN contribution (f_{AGN}) to the total infrared luminosity and the population of AGN, which is the AGN number fraction (f_{num}) in total sources. We discovered 42 candidates for 30 composites ($0.2 \leq f_{AGN} \leq 0.5$) and 12 AGNs ($f_{AGN} \geq 0.5$). We report that AGN contribution might increase as the redshift grows. Moreover, we found out that most of our composite and AGN candidates have lower luminosity than previous studies with Spitzer/AKARI, showing the advantage of using the JWST to search fainter objects.

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An interesting ordered phase of germanene on Ag(111) with several repeating motifs and a sharp Fourier transform spectrum, and yet no translational symmetry.

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While the family of 2D materials under active study has exploded over the last decade or two (Xenes, TMDs and others) They are usually studied experimentally in their simplest and most pristine (ordered, crystalline) state, which is what theoretical models based on unit cells model (e.g. DFT). But unusual and interesting behaviors can arise in materials which deviate from their perfectly ordered “ideal” forms (e.g. high entropy alloys and quasicrystals).
Here we examine in detail a particularly interesting ordered honeycomb phase of germanene formed on Ag(111) made of a mixture of 5, 6, and 7 sided rings with several repeating local motifs, and surprisingly sharp Fourier transforms which differ for different height cuts, and yet no obvious translational symmetry! We leverage pattern recognition techniques to search a large area, atomic resolution scan to find all instances of each motif and map their distribution.
A final comparison of these results to published, mathematically proven 2D quasicrystals is included.

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Realization of Precise Heating Stage for On-Surface Synthesis

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The synthesis of covalently coupled extended molecular structures in On-Surface Synthesis is a new, rapidly developing field of research and extends beyond the knowledge of classical chemistry. Organic molecules are chemically designed to host a reactive group. In contact with a catalytic surface, a chemical reaction of the reactive group is activated by an external stimuli and a new product by coupling is formed. External stimuli can be the local current in STM experiments, light, or, as most intensively studied, thermal excitation. The last decade has seen a tremendous development in the understanding of the physical processes, coupling processes, role of the catalyst, side products, selectivity, yield among others. Thereby, a precise temperature control is required.
We are studying such coupling reactions in a STM system. A direct measurement of low temperatures (50 –350C) in a permanent installation is critical but not available and we rely on initial temperature calibration experiments (delta T > ±20C). Therefore, we designed a precise heating stage (delta T < ±5C) for mobile samples. The stage can be operated in ultra high vacuum (UHV) and

covers a temperature range from 30C to 500C. During heating, samples are entirely covered in an UHV oven and the stage can be easily maintained. We will discuss the design, installation, and operation.

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Tuneable Complex Permittivity and Permeability of Silver-Epoxy Nano-Composite by Percolation Effect Over a Wide Bandwidth

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The percolation theory has garnered extensive attention over the last four decades in the context of permittivity and conductivity, with a noticeable gap in the exploration of permeability. This research delves into the percolation phenomena's impact on the permittivity, permeability, and conductivity of a silver-epoxy nano-composite. The identified percolation threshold falls within the range of 26.3% to 26.4%. At this threshold, the dielectric constant exhibits a remarkable increase, reaching up to 390, accompanied by a permeability of 0.31 in close proximity to the threshold.

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Study of PbAu alloy on different substrates

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Abstract :
When the system have time-reversal symmetry and inversion symmetry, the energy band of the system is not allowed to split. When one of the symmetries is breaking, the energy band is allowed to split.
The model of PbAu alloy has a special configuration that induce inversion symmetry breaking then Rashba effect.
Even under the same substrate, Different growth methods will also produce different rotation angles of alloy with substrate.

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Dropout Galaxies in JWST COSMOS Field

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Finding protoclusters in the epoch of reionization plays an essential role in understanding the evolution of galaxies and the early ionized universe. With this aim, we turn our attention to the COSMOS-Web field (α=10:00:27.92, δ=+02:12:03.5), spanning 41'.5 by 46'.5. At the present time, the lack of open

access to reduced data triggered us to develop our own image reduction techniques utilize a blend of modified methodologies from previous studies to address challenges such as cosmic-ray artifacts, wisp, and readout noise. Following image reduction, we crossmatch with COSMOS-2020 catalog, resulting in a preliminary multi-broadband imaging catalog. Our approach integrates photometric redshifts and color-color selections. Moreover, this catalog is not only designed for identifying high-redshift dropout galaxies but also potential protoclusters. Additionally, the photometric redshift determinations benefited from the exceptional angular resolution provided by JWST in near-/mid-IR imaging, further enhancing the accuracy and reliability of our results.