ASP2024 alumni online presentations (2)

Thursday 17 October 2024 - Thursday 17 October 2024

Book of Abstracts

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Swampland conjectures for higher spin AdS3 gravity

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We give Swampland constraints on the three dimensional Landscape of Anti-de Sitter higher spin gravity in the Chern-Simons formulation with connection valued in various split real forms of Lie algebras. We derive the finiteness conjecture by computing the upper bound on the rank of possible gauge groups then we refine it using the AdS distance conjecture. We discuss the implications of this Swampland constraint on the spectrum of higher spin gravity theories and we contrast it with the gravitational exclusion principle, required from BTZ black hole consideration, to excerpt a constraint on the Chern-Simons level k. The relevance and potential extensions of these results to 4D theories will be addressed as well.

Keywords: Swampland program, Quantum gravity, AdS3 Landscape, Higher spin gravity, BTZ black hole, AdS/CFT correspondence.

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COMPARING THE RESOLUTION AND SENSITIVITY OF MULTIELECTRODE HYDROGEOPHYSICAL CONFIGURATIONS USING 2D RESISTIVITY TOMOGRAPHY: A CASE STUDY AT NSAKYE IN THE EASTERN REGION OF GHANA

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Geophysical method of exploration involving 2D Electrical Resistivity Tomography was employed to compare the resolution and sensitivity of different electrode configurations in order to delineate potential drill point for groundwater at Nsakye. The 2D Electrical resistivity tomography (ERT) using the Dipole-dipole, Wenner, Schlumberger electrode array configurations was deployed along traverses within the area. The work carried out comprises desktop study, field reconnaissance survey and geophysical investigations. The 2D Electrical Resistivity Tomography technique was used for the studies to determine the lateral and vertical variations of rock resistivity with depth. The results of the geophysical investigations indicated that the study area is generally underlain by three geological strata with varying apparent resistivity values. The bedrock is fractured to facilitate groundwater development with expected satisfactory borehole yield. The results of the study confirm that the optimal electrode configuration for geophysical investigation at Nsakye is the Dipole-dipole array and 2D ERT method is also very suitable for sitting boreholes in Nsakye which is underlain by Voltain supergroup. It is suggested that, Geophysical methods should hence, form an integral part of groundwater exploration programmes in solving problems associated with groundwater prospecting to locate potential aquifers for the supply of potable water to rural communities.

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Combining Deep learning and Raman Spectroscopy for rapid pesticide screening

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Ensuring compliance with maximum residue limits (MRL) for pesticide residues in fresh produce is crucial for food safety. Traditional detection methods such as chromatography and mass spectrometry, while accurate, are often time-consuming, expensive, and require complex sample preparations. This study aimed to evaluate the effectiveness of combining Raman spectroscopy with deep learning algorithms for rapid and non-destructive pesticide screening in various vegetables. Samples of kales, spinach, tomatoes, lettuce, and Chinese cabbage were spiked with varying concentrations of Chlorothalonil pesticide, and Raman spectra were acquired. These spectra were processed to reduce noise and enhance signal quality. A convolutional neural network (CNN) was then trained to predict pesticide concentrations based on the preprocessed spectra. Additionally, an API was integrated to allow for practical deployment and interaction with the models.
The results demonstrated that the CNN model could accurately predict pesticide concentrations, significantly reducing analysis time and cost compared to conventional methods. The integration of the API facilitated real-world application, enabling easy interaction with the models. This combined approach of Raman spectroscopy and deep learning not only provided a fast, cost-effective, and non-destructive method for pesticide detection but also ensured compliance with food safety regulations. The study concludes that this innovative technique holds great promise for enhancing food safety practices by ensuring compliance with regulatory standards and enhancing consumer confidence in the quality of fresh produce.

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Deep Learning Meets Quantum Computing: Revolutionizing Brain Tumor Detection with CNNs and QNNs

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Brain tumor detection is a critical task in medical diagnostics, where early and accurate identification can significantly impact patient outcomes. This research focuses on the development and optimization of deep learning (DL) models to enhance the accuracy and efficiency of brain tumor detection from magnetic resonance imaging (MRI) scans. By leveraging Convolutional Neural Networks (CNNs), our study aims to automate the process of tumor identification, reducing the dependency on manual analysis, which is often time-consuming and prone to errors.
We have developed a CNN-based model trained on a large dataset of annotated brain MRI images, achieving promising results in differentiating between various types of brain tumors. Our approach incorporates advanced data augmentation techniques to address the challenges of data scarcity and class imbalance, which are common in medical imaging. Furthermore, we explore the integration of Quantum Neural Networks (QNNs) to potentially improve the model's performance by harnessing quantum computing's capabilities.Our ongoing research aims to refine these models further and validate their effectiveness through extensive testing on diverse datasets, ultimately paving the way for their implementation in clinical settings.

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Study of a proposed new solar to electricity converter based on electron-photon interaction, a theoretical study

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This work is a theoretical study of a proposed novel system whose purpose is to convert solar radiation to electrical energy. The study proposed an electron chamber with trapped electrons inside it. The trapped electrons were then excited by photons of specific frequency. The excited electrons were allowed to escape the chamber across a circular boundary to an evacuated coil-shaped path. The radius of the boundary was constrained to vary periodically with time. The movement of the electron within the system under the influence of light was modeled and the resultant equation simulated in MATLAB software with a test charged-particles with each particle having a radius of 2.38 ⊠⊠ which was basically clumped-up electrons to form a test particle. The simulation results showed that the proposed system would generate D.C voltage and current with profile similar to that of D.C generator. The results further showed that resultant voltage was directly proportional to frequency and intensity of the photons. The results suggested that the proposed system had the potential of attaining efficiencies as high as 90% since it was not affected by the electron-hole recombination problem. The results also suggested that the efficiencies are strongly
dependent on the frequency of the incident photons, hence best suitable for space explorations.

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Modified Alfvén wave of multi-ion species in the upper ionosphere of Mars

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Cold-modified Alfven waves of multi-ion species propagating perpendicular to an ambient magnetic field have been investigated. We derive the linear dispersion relation for any number of species. In addition to the conduction current density, we consider the displacement current density. The derived dispersion relation suggests a magnetized plasma mode to propagate at the long-wavelength for every ion species. At the short-wavelength, the propagating mode for every ion species saturates at a resonance frequency equal to the cyclotron frequency of that ion. The Alfven wave mode is shown to be the long-wavelength mode for the heaviest ion species, while the Whistler wave mode corresponds to the less massive ion species. It is found that the displacement current density excites another mode to exist in the electron fluid, which is known as the magnetized plasma analog of Langmuir mode. The consequences of varying the magnetic field, and the total plasma density and the mixing ratios of the ion species on the resonance, the cutoff frequencies, and the propagating modes are inspected. Investigation of this model on the observed linear ULF waves on the upper ionosphere of Mars is introduced.

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COMPARATIVE STUDY OF INTERNAL DOSE CALCULATION: MONTE CARLO VERSUS MIRD METHOD

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The Monte Carlo method and the method proposed by the Medical Internal Radiation Dose (MIRD) committee are among the most widely used methods for estimating absorbed dose in nuclear medicine. In fact, The MIRD committee is a committee of the Society of Nuclear Medicine, set up in 1965 to develop methods, models, assumptions and a standard mathematical scheme for assessing the internal radiation doses of administered radiopharmaceuticals.

The Monte Carlo method is very useful as it takes into account the complexity of to take into geometric models and the different radionuclide emissions.

In what follows, we compare the two, focusing on the calculation of absorbed doses to target organs.

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Thermodynamics of Nuclear Matter at High-Energy Nuclear Reactions.

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The experimental data from various hadronic and heavy-ion collisions have been studied to investigate nuclear matter under extreme temperature and pressure. Under such conditions, the nuclear matter undergoes different phase transitions from the hadronic matter to the quark-gluon plasma (QGP) matter. Also, there are several experimental indicators that allow studying different regions of the quantum chromodynamics (QCD) phase diagram through the hadron and ion collisions. Therefore, the phase transition mechanism was investigated using thermo-statistical models based on the correlation between the distribution of measurable experimental quantities, such as the transverse momentum and multiplicity of the produced charged particles, and the microscopic hypotheses of the transition mechanism. The used analysis tools could describe the experimental data over the considered energies and rapidity intervals. Moreover, the analysis of the experimental data in view of Tsallis'statistics has enabled me to obtain the values of the temperature, chemical potential, and non-equilibrium index (q) at the kinetic freeze-out stage, which reveals the possible mechanism of particle production through proton-proton and heavy ion collisions at the center of mass energy in the GeV and TeV regions.

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Analysis of Alpha and Lithium-7 Particle Energy Deposition in BNCT using Geant4 Simulation

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This study investigates the microdosimetry of Boron Neutron Capture Therapy (BNCT) using high-fidelity Monte Carlo simulations to quantify the energy deposition distributions from alpha and lithium-7 particles in cellular structures.
We employ Geant4 to model various physics lists and water representations, aiming to optimize the accuracy of BNCT simulations. Dosimetry and microdosimetry studies using these Monte Carlo

techniques examined the behavior of the produced alpha and lithium-7 particles and their energy deposition in different cellular compartments. Our findings contribute to the understanding of BNCT' s effects at the cellular level, which is crucial for advancing treatment planning and minimizing side effects.

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Weak/strong gauge duality in M-Theory on K3xK3

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Testing the Swampland conjectures in the context of string theory on Calabi-Yau threefolds has led to interesting results,both mathematically and physically. We generalize results of fibration structure of Calabi-Yau fourfold with finite volume in infinite distances in the moduli space. By applying these results to compactifications of M-theory on K3xK3 we relate weak coupling and strong coupling regimes to each other, which allows for non perturbative treatement of the three dimensional Effective field theory. This allows testing the Asymptotic Weak Gravity Conjecture in three dimensions.

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Gravitational fine-grained entropy enhancements.

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Entanglement entropy can be computed directly by describing the density matrix of the associated system. For gravitational systems such as black holes, the radiation entropy has a geometrical construction given by extremal surfaces. However, due to the quantum characteristics of black holes, this surface can be generalized to quantum extremal surfaces. We outline the derivation of gravitational fine-grained entropy using the quantum version of extreme surfaces. We provide evidence about a new method to compute von Neumann entropy.

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Performance of the Missing transverse energy triggers for the ATLAS detector.

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The ATLAS detector is one of the two general-purpose detectors at the Large Hadron Collider (LHC) at CERN, designed to explore a wide range of physics, including the discovery of new particles, precision measurements of known particles, and searches for signs of new physics beyond the Standard Model. One of the essential parts of the ATLAS experiment is the trigger system, which manages large amounts of data generated by particle collisions and subsequently identifies the most interesting events, such as the presence of energetic leptons, photons, hadronic jets, τ lep, or large amounts of missing energy for further analysis. Only a small fraction of the events can be kept due to limitations in storage and processing. This means that a large number of events are discarded and are not available for future analysis. Where the ATLAS physics program uses trigger selection for events containing invisible particles. However, selecting these events is challenging as they don't register in the detector. The strategy used is to deduce the presence of these invisible particles from the apparent imbalance of the momentum calculated from the visible particles. In practice, the imbalance in the direction parallel to the proton beams is not sensitive since the fraction of each proton's momentum that participates in the collision is unknown, and much of the outgoing momentum in the beam direction is not observed. Rather, the quantity of most significance is the imbalance in momentum in the plane perpendicular to the proton beams; this is referred to as the missing transverse momentum, and its value is commonly represented by E_T^{miss} (MET). The E_T^{miss} used in the wide range of physics processes, like searches for supersymmetry, searches for final states with stable long-lived particles, and searches for dark matter condidate that is not predicted by the Standard Model (SM), but many theories beyond the Standard Model (BSM) offer the study of DM, such as 2HDM with a pseudo-scalar mediator (2HDM+a) and a simplified model for dark matter production.

The MET trigger relies on data from calorimeters, which measure the energy deposited by particles in the transverse plane. The ATLAS trigger system has been significantly upgraded during LS2 (2019–2022). The performance of Missing Transverse Energy (MET) triggers is a crucial aspect of ensuring the efficiency and accuracy of data collection. For that, we will study the performance of the MET trigger by using data collected during 2023 and 2024. Performance in terms of efficiency, trigger stability, background rejection, etc. studied as a function of several quantities, including run conditions and pile-up. One of the major challenges is pile-up. This can complicate the accurate measurement of MET. The particles from pile-up collisions can contribute to the overall energy detected in the event, artificially inflating the measured MET. This makes it difficult to distinguish the true missing energy associated with the particles of interest from spurious contributions.

In the future, the HL-LHC phase will witness an increase in luminisity and thus an increase in pile-up events. One of the efforts made to reduce the pil-up event is the HGTD detector. The HGTD will provide the timing information to reduce the density of vertices for a given track, so that will provide a good distinction of pile-up events.

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STATISTICAL EVALUATION OF SOLAR INDICES USING PRINCIPAL COMPONENT ANALYSIS

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Space weather, defined as the variable conditions in space driven by the sun, significantly impacts the performance of both terrestrial and space-based technologies. To mitigate these adverse effects, it is essential to develop accurate storm-time space weather models. Since the sun is the primary driver of these models, solar indices like SSN and F10.7 are crucial for creating these models. However, different solar indices can lead to varying predictions. This study conducted a statistical evaluation using three metrics to determine which solar index among F10.7, F10.781, F10.7p, SSN and R12, best represents solar activity. The evaluation's core principle was to correlate these indices with the ionospheric TEC and then compare the model predictions with actual observations. PCA was utilized to perform this task and the results of the study has revealed that the F10.7p index is a

superior indicator of ionospheric conditions compared to other indices. This finding is crucial for enhancing the accuracy of the space weather predictions, thereby helping to protect and optimize the functionality of technological systems affected by solar activities.

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Development and Implementation of Physics Informed Neural Network for Nuclear Magnetic Resonance-guided Clinical Hyperthermia

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The management of human diseases is transitioning from traditional methods toward personalized medicine, with thermal therapy—comprising clinical hyperthermia and therapeutic hypothermia—becoming a focal point of research. However, both therapies face challenges in clinical trials due to difficulties in monitoring temperature and delivering precise heat to targeted tissue areas. This thesis aims to address these issues by integrating the principles of magnetic resonance relaxation with the Bioheat transfer phenomenon using Physics-Informed Neural Networks (PINN) for Nuclear Magnetic Resonance (NMR)-guided clinical hyperthermia. NMR-guided hyperthermia is a non-invasive technique that leverages MRI to guide the heating process and monitor body temperature distribution.

PINN is a type of neural network that incorporates model equations, such as partial differential equations (PDEs), into its structure, enabling it to learn from limited data while adhering to the underlying physics of the problem. In this work, a deep learning-based PINN was developed using the 1D Pennes'Heat Equation to train an AI model that respects the physical laws governing heat diffusion in tissues. The model, implemented using Python 3.8 on a 64-bit operating system with Jupyter Notebook, is designed to enhance the precision, safety, and efficiency of clinical hyperthermia when integrated into clinical RF devices.

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The effect of noncommutativity on the charged 4D-EGB black hole in AdS space–time

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In this paper, we obtain a solution of a static spherically symmetric charged black hole inspired by noncommutative geometry in the context of the regularized 4D-Einstein–Gauss–Bonnet theory in AdS space. The derived metric recovers the standard solutions'limits. It tends to the commutative case solution found in [P. G. S. Fernandes, Phys. Lett. B 805, 135468 (2020)] at large distance $r+\theta\longrightarrow\infty$ and the general relativity solution with smeared mass and charge as $\alpha\longrightarrow 0$. The charged solution obtained is singular at the origin in contrast to its neutral version, which is regular. The thermodynamic quantities have been modified due to the influence of noncommutativity. The heat capacity was used to investigate the local thermal stability. The black hole has been discovered to be locally stable for small and large radii, but unstable for middle radii.

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Impact of Magnetohydrodynamic (MHD) Instabilities on Beam Dynamics in High-Energy Particle Accelerators.

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Abstract: The research will combine theoretical analysis, numerical simulations, and experimental validations to provide a comprehensive evaluation of significantly affect the stability and performance of plasma in accelerators. In high-energy particle MHD effects on beam dynamics.
This study explores the influence of magnetohydrodynamic (MHD) instabilities on beam dynamics within high-energy particle accelerators. MHD instabilities, which arise due to the interaction between magnetic fields and conductive fluids, can accelerators, these instabilities have the potential to distort magnetic confinement, induce beam loss, and reduce the efficiency of particle acceleration. This research examines key MHD phenomena, including kink modes, tearing modes, and resistive instabilities, and analyzes their impact on beam trajectory, coherence, and overall accelerator performance. By simulating various accelerator configurations and plasma parameters, we aim to quantify the thresholds for instability growth and develop strategies for mitigating their adverse effects. These findings could lead to improved control mechanisms in next-generation accelerators, enhancing both precision and reliability in experimental outcomes.

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Investigating Gas Adsorption and Diffusion Dynamics in Zeolite-Based Membranes for Post-Combustion CO_2 Capture

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Abstract
One of the most important technologies for reducing greenhouse gas emissions is carbon capture and storage (CCS). CO2 is the main gas responsible for global warming. Post-combustion carbon capture is a popular method of carbon capture that is used in power plants and industrial processes to extract CO_2 from flue gases that are created during the combustion of fossil fuels. Conventional techniques, including chemical absorption using solvents like amines, are limited in their large-scale application due to issues with high energy consumption, solvent degradation, and high operating expenses. In order to get over these restrictions, this study investigates the use of zeolite-based

membranes as a CO_2 capture substitute, with an emphasis on enhancing the post-combustion capture process's effectiveness and financial sustainability.
Given their high surface area, adjustable pore sizes, and superior adsorption capabilities, zeolite-based membranes present a viable option that allows selective CO_2 separation via molecular sieving and chemical interactions. The project intends to maximize selectivity and capture efficiency while reducing the energy penalty related to regeneration by integrating these membranes into the CO_2 capture process. The process's economic viability is further enhanced by the membranes' capacity to regenerate themselves through changes in pressure or temperature, which guarantees their reuse without causing a large amount of material loss. This strategy increases the effectiveness of CO_2 capture while simultaneously adhering to the principles of the circular economy by allowing the captured CO_2 to be used in a variety of industrial processes, like enhanced oil recovery or the creation of synthetic fuel. The results of this study will address significant inefficiencies in the current approaches and progress efforts to reduce CO_2 emissions by assisting in the development of more affordable and sustainable CCS systems.
Key words: post combustion, carbon capture, zeolite based membranes

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Physical properties of Gra-doped $ZnFe_2O_4$ thin films for solar cells application

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The Zinc ferrite ($ZnFe_2O_4$) has significantly attracted many researchers due to their chemical and thermal stability [1] and their narrow band gap [2]. In this present research we successfully studied the influence of Graphene (Gra) doping on the physical properties of zinc ferrite thin films. The undoped and Gra-doped $ZnFe_2O_4$ nanofilms were grown onto glass substrates using spray pyrolysis technique at a substrate temperature of about 450℃. The elaboration process was followed by an annealing process in air at 500℃ for 2 hours. We present in this investigation the effect of graphene on the structural (by XRD), optical (by Spectrophotometry), electrical (by I-V curves and Impedance spectroscopy) and morphological (by SEM and AFM) properties of $ZnFe_2O_4$. The X-ray diffraction results comfirmed that the prepared undoped and Gra-doped $ZnFe_2O_4$ had cubic spinel crystal structure with preferentiel orientations along the (311) plan. The Transmission increase from 71 to 81% with increasing the doping concentration. For the band gap, it decreases from 2.57 to 2.31 eV as the graphene cocentration is increased. The solar cell designed with the structure $ZnO/ZnFe_2O_4/CIGS$ was optimased and tested using Silvaco software. The simulation proves that the graphene doped $ZnFe_2O_4$ used as buffer layer improve the efficiency of the solar cell.
The experimental results further revealed that Graphene doping had a considerable effect on the structural, electrical, optical and morphological properties of $ZnFe_2O_4$.

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Optimizing Quantum Network Performance: Performance Evaluation of Quantum Dijkstra's Algorithm

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Quantum communication methods are highly sensitive to variations in protocol parameters, which can affect their effectiveness. This study explores the performance of quantum communication protocols using online quantum computing platforms such as Quirk, Qiskit-IBM-Q, Rigetti Forest, and D-Wave. Despite the promising advancements over classical teleportation, many protocols fall short of their anticipated benefits. We propose a routing scheme to enhance fidelity in quantum networks by focusing on positive quantum channel capacity. The proposed Channel Selection (CS) algorithm, combined with the K-shortest path technique, is designed to optimize fidelity rates for source-destination pairs. This paper presents a detailed implementation of Quantum Dijkstra's Algorithm within a quantum circuit model, utilizing quantum gates and the IBM Qiskit framework to find the shortest path in a graph. We assess various quantum error channels, such as amplitude damping, phase flips, and bit-flip errors, to identify optimal quantum error correction methods. Through performance analyses, we evaluate the impact of noise levels, channel capacities, and the number of source-destination pairs on throughput, fidelity, and memory utilization. Our results demonstrate that the CS algorithm outperforms traditional methods like Q-PATH and Greedy by maintaining higher fidelity and throughput, optimizing memory usage, and effectively managing noise. This study highlights the advantages of the CS algorithm in enhancing quantum communication networks and its potential for practical implementation in noisy environments.

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Introduction and Welcome address