Re[incontri] di Fisica Partenopea

Tuesday 19 December 2023 - Thursday 21 December 2023

Dipartimento di Fisica ”Ettore Pancini”

Book of Abstracts

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3D Morphing of Azopolymer-based Microstructures: In Between Top-Down and Bottom-Up Approach

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Surfaces endowed with three-dimensional (3D) microstructures have captured the interest of the scientific community because of the possibility to introduce intriguing properties that are not present in their planar counterparts. They are extensively used in various fields such as photonics, surface wettability, bio-interfaces, and energy harvesting and storage [1]. Generally, there are two types of techniques for 3D microfabrication: the top-down and the bottom-up approach. On one hand, the top-down approach, such as the conventional photolithography and the imprinting lithography, is well-known for its fast and large-scale production. However, these methods require post processing steps, and often result in 3D structures with limited complexity. On the other hand, while the bottom-up approaches such as direct laser writing and 3D printing bring complexity and accuracy to the 3D structures, they suffer from the slow speed, high-cost procedure, and sophisticated tools. Recently, the direct and reversible light-induced mass-transport in azomaterials has been explored as a very powerful alternative. To create unique and complex 3D microstructures using azopolymers, an initial 3D microstructure is usually fabricated and subsequently exposed to light in order to shape it into various 3D architectures. The photo-driven deformation of azopolymer-based microstructures exhibits a distinctive mechanism in which the initial structure morphs without requiring removal of any material, as in the top-down approach, or addition of any new material, as in the bottom-up approach. Here, we use the light-induced mass transport in azopolymer to create complex and anisotropic textures [3]. By exploiting the polarization-driven transport of the material, a 2D square array of micropillars was reshaped into a grating-like structure with a programmable amplitude, height, and orientation controlling the polarization direction and exposure dose. In addition, the approach can be generalized by using the different light penetration depth in azopolymer volume at different light wavelengths [4]. By exposing the azo microvolumes with light of different wavelengths, we fabricated different 3D microstructures from the same original with tunable structure-dependent properties, such as wettability, with a single exposure with a low-intensity light and simple set-up.

References [1] P. van Assenbergh, E. Meinders, J. Geraedts, D. Dodou, Small. 14, 1703401 (2018). [2] S. L. Oscurato, M. Salvatore, P. Maddalena, A. Ambrosio, Nanophotonics. 7, 1387–1422 (2018). [3] M. Salvatore, F. Borbone, F. Reda, P. Maddalena, S. L. Oscurato, J. Phys. Photonics. 3, 034013 (2021). [4] I. K. Januariyasa, F. Borbone, M. Salvatore, S. L. Oscurato, ACS Appl. Mater. Interfaces. 15, 43183–43192 (2023).

Cosmology & Quantum Gravity / 27

A tentative to understand Jordan and Einstein frames by the Hamiltonian analysis

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We will briefly summarize some recent results obtained in the Hamiltonian formalism for the Brans-Dicke theory. We will show that these results can be used to address equivalence (if any…) between

Jordan and Einstein Frames. Although we will show that there is a mathematical equivalence between these two frames, a pair of examples points out that the two frames do not look to be physically equivalent.

Astro Physics & Particle / 62

AGN & Euclid: a close entanglement

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Euclid has been launched in July 2023 with the first internal Data Release DR1 planned for December 2024. While Euclid has primarily been optimised for the study of dark matter and dark energy, the wealth of data it will accumulate promises groundbreaking insights into Active Galactic Nuclei (AGN), their origins, and their evolution. In this talk I will show you how Euclid will identify and characterised AGN by using spectroscopy and photometry, providing a great amount of information to investigate fundamental open issues, such as the AGN demography and AGN evolution with redshift and luminosity, tracing the growth of BHs and providing an important constraint on galaxy/AGN evolution models.

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AGN & Euclid: a close entanglement

Viola Allevato[1]

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Euclid has been launched in July 2023 with the first internal Data Release DR1 planned for December 2024. While Euclid has primarily been optimised for the study of dark matter and dark energy, the wealth of data it will accumulate promises groundbreaking insights into Active Galactic Nuclei (AGN), their origins, and their evolution. In this talk I will show you how Euclid will identify and characterised AGN by using spectroscopy and photometry, providing a great amount of information to investigate fundamental open issues, such as the AGN demography and AGN evolution with redshift and luminosity, tracing the growth of BHs and providing an important constraint on galaxy/AGN evolution models.

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Are Gaussian data all you need?

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We consider the problem of generalized linear estimation on Gaussian mixture data with labels given by a single-index model. Our first result is a sharp asymptotic expression for the test and training

errors in the high-dimensional regime. Motivated by the recent stream of results on the Gaussian universality of the test and training errors in generalized linear estimation, we ask ourselves the question: "when is a single Gaussian enough to characterize the error?". Our formulas allow us to give sharp answers to this question, both in the positive and negative directions.

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Are there critical aspects in the time, energy and angular distributions of SN1987A?

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Supernova neutrinos have enormous importance for ongoing research in astrophysics, nuclear and particle physics. However, existing simulations of this complex event, although increasingly sophisticated, still do not guarantee with sufficient confidence a reliable description of the emission. In this situation, it seems important to study as accurately as possible the only such event observed so far with neutrino telescopes: those of SN1987A. With these considerations, we are setting up a refined analysis, taking into account the many acquisitions of the past decades. In this poster we present the model describing the energy distributions, in the various phases of emission, and verify its adequacy to describe the characteristics of the neutrino emission of SN1987A, namely, the distributions in energy, time and angle.

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Ash Volcanic Measurements by Lidar near the Mount Etna

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Volcanic emissions represent a well-known hazard mainly for aviation safety that can be reduced with real time observations and characterization of eruptive activity. Lidar observations allow to perform immediate and accurate detection of volcanic plumes, quantify volcanic ash concentration in atmosphere and characterize optical and microphysical properties of volcanic particles. From 18 to 21 February 2019, Etna's activity was characterized by abundant ash emissions from the North-East Crater (NEC), accompanied by ordinary degassing activity of variable intensity from the other summit craters. LiDAR measurements of Volcanic plume were performed in Catania, in 21/02/2019. Real-time Lidar observations captured the complex dynamics of the volcanic plume and allowed to analyse the geometrical, optical and microphysical properties of the volcanic ash. The aerosol backscattering (β) profiles at 355 nm and 532 nm and the depolarization ratio (δ) were measured near the volcanic source using an Elastic Lidar system. The aerosol optical properties were used to estimate the ash concentration (γ) profiles in the volcanic plume. This is the study of optical properties of volcanic particles through Elastic measurements near volcanic summit craters and one of few studies which quantify the impact of abundant ash emissions and degassing activity in atmosphere.

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Asymptotic Safety in Generalized Proca Theories

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We investigate the possible ultraviolet completion of a subclass of generalized Proca theories up to the second order in the vector field. Technically, this analysis involves deriving the beta functions of the theory and investigating their fixed points and corresponding stability properties.

Cosmology & Quantum Gravity / 50

Backreaction of scalar radiation on black holes

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The evolution of the trapping horizon of a black hole in the presence of infalling matter can be understood as a backreaction effect. Focusing on low-frequency scalar radiation and spherically symmetric black holes, I will show that a simple closed-form expression for the expansion rate of the horizon can be derived in terms of the initial data for the scalar field on past null infinity. This is achieved by solving the Einstein field equations to second order in perturbation theory in the vicinity of the horizon, and then using matched asymptotics expansions to compute the evolution of wave packets through the potential barrier. Applications of this framework to more general matter fields will be also discussed.

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Brownian particle in a Poisson-shot-noise active bath: exact statistics, effective temperature, and inference

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We study the dynamics of an overdamped Brownian particle in a thermal bath that contains a dilute solution of active particles. The particle moves in a harmonic potential and experiences Poisson shot-noise kicks with specified amplitude distribution due to moving active particles in the bath. From the Fokker-Planck equation for the particle dynamics we derive the stationary solution for the displacement distribution along with the moments characterising mean, variance, skewness, and kurtosis, as well as finitetime first and second moments. We also compute an effective temperature through the fluctuation-dissipation theorem and show that equipartition theorem holds for all zero-mean kick distributions, including those leading to non-Gaussian stationary statistics. For the case of Gaussian-distributed active kicks we find a re-entrant behaviour from non-Gaussian to Gaussian stationary states and a heavy-tailed leptokurtic distribution across a wide range of parameters as seen in recent experimental studies. Further analysis reveals statistical signatures of the irreversible dynamics of the particle displacement in terms of the time asymmetry of cross-correlation functions. Fruits of our work is the development of a compact inference scheme that may allow experimentalists to extract the rate and moments of underlying shot-noise solely from the statistics the particle position.

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Calibration procedures and measurement tests of a multiparametric apparatus for real-time observations of aerosol optical and microphysical properties at ETNA (Italy)

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The VULCAMED project, developed under the National Operational Programme "Research and Competitiveness" 2007–2013, aimed to increase the observative capability of strategic relevance research infrastructures in the volcanological research domain. In the frame of the VULCAMED project an innovative lidar system was developed. The lidar was firstly designed to make elastic measurements in the UV (355nm) and IR (1064/1530nm) spectral regions. Successively it has been upgraded adding the elastic channels in the visible (532nm), the N2 Raman channels at 386 nm and 607 nm and the H2O Raman channel at 407nm, with the aim to make it at the state of the art. Moreover, parallel and perpendicularly polarized components (P and S) of the elastic signals at 355 nm and 532 nm have been selected in order to retrieve information about the aerosol shape and distinguish water vapor from volcanic ash in the plumes emitted during volcanic activity. The calibration methods and results of VULCAMED have been presented, including Rayleigh fit, depolarization calibration, overlap correction, multi-wavelength channel calibration, water vapor mixing ratio test and particle size distribution. In order to verify the accuracy of the measured parameters the comparison with radiosonde and sun-photometer has been done. The results show that VULCAMED has the ability to measure real-time optical and microphysical properties of volcanic aerosol.

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Conclusions and Goodbye

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Cryogenic silicon-based modular photosensors for DarkSide-20k

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Silicon photomultipliers are a compelling alternative to PMTs in cryogenic ultra-low background applications, such as in dark matter direct search experiments: with respect to the popular photomultiplier tubes, SiPMs can exhibit better photon detection efficiency, are insensitive to magnetic fields, more compact, and low-voltage powered, cheaper and easier to produce with low radioactive contamination. Working on the next generation of dark matter direct search experiments, the Global Argon Dark Matter Collaboration has committed to this technology, starting from their next programmed experiment: DarkSide-20k. The development of a cryogenic SiPM-based photodetector has been a challenging task due to the strict radiopurity requirements and cryogenic conditions imposed by the expected signature for dark matter signals. The R&D culminated with the design of the Photon Detector Unit (PDU), a modular photon detector of 20x20 cm² with 4 readout channels, based on a SiPM technology developed by Fondazione Bruno Kessler and cryogenic front-end electronics; PDUs will be mass-produced in the following year in Nuova Officina Assergi, a 420 m² ISO-6 cleanroom located at LNGS. More than 500 PDUs will be used to construct the two ~10.5 m² optical planes for the TPC of DarkSide-20k and as photosensors for the veto systems (~5 m² total SiPM surface). All of the TPC PDUs will be tested at LN2 temperature in the Dark Matter Cryogenic Laboratory of Naples, using a dedicated system equipped with a 1000 L cryostat. The first prototypes of the PDU have already been tested in Naples and satisfy the constraints that the collaboration had defined to reach the desired level of sensitivity.

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Engineering quantum states from a spatially structured quantum eraser

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Quantum interference is a central resource in many quantum-enhanced tasks, from computation to communication protocols. While it usually occurs between identical input photons, quantum interference can be enabled by projecting the quantum state onto ambiguous properties that render the photons indistinguishable, a process known as a quantum erasing. Structured light, on the other hand, is another hallmark of photonics: it is achieved by manipulating the degrees of freedom of light at the most basic level and enables a multitude of applications in both classical and quantum regimes. By combining these ideas, here we design and experimentally demonstrate a simple and robust scheme that tailors quantum interference to engineer photonic states with spatially structured coalescence along the transverse profile, a type of quantum mode with no classical counterpart. To achieve this, we locally tune the distinguishability of a photon pair via spatial structuring of their polarisation, creating a structured quantum eraser. We believe these spatially-engineered multiphoton quantum states may be of significance in fields such as quantum metrology, microscopy, and communications.

History of Physics / 30

Exchange interactions between Europe and Japan in the 1930s: Yukawa, Tomonaga and nuclear theory

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Exchange interactions were introduced by W. Heisenberg in 1926 in the context of the quantum mechanics of systems of identical particles, and soon allowed to successfully address numerous problems in atomic, molecular, and condensed matter physics, such as multi-electron atomic spectra, chemical bonds, ferromagnetism, and electron-electron collisions. After the discovery of the neutron in 1932, this concept allowed the systematic application of quantum mechanics to nuclear physics, being the basis of theories of nuclear structure developed, among others, by Heisenberg and E. Majorana. Over the subsequent decades, this idea morphed into the modern understanding of fundamental forces as mediated by virtual particle exchange, in the context of quantum field theory. In this long story, a crucial role was played by two Japanese physicists, H. Yukawa and S. Tomonaga, who were among the first Japanese to be exposed to the principles of the new quantum mechanics, and were strongly influenced by the above mentioned work. Within a few years, Yukawa conceived his decisive idea of a nuclear interaction mediated by virtual mesons, acknowledging crucial input by Tomonaga, who in the same period was investigating the range of proton-neutron interactions. In this contribution, we reconstruct the role played by Japanese physicists in the 1930s, towards the modern understanding of fundamental forces. A clear picture emerges also of the influence of European scientists in shaping the development of quantum concepts in Japan.

Quantum Technology / 56

Increasing the brightness of site controlled QDs with chip scale processing

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Increasing the brightness of site controlled QDs with chip scale processing

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Quantum dots (QDs) are a valuable technology to produce single photon as well as entangled photon pairs with immediate application in quantum technology. Site-controlled quantum dots grown in pyramidal patterned substrates give access to hundreds of thousand of single photon emitters, with highly uniform emission wavelength on a single sample. Here, we demonstrate a process to increases

the extraction efficiency from these sources and improve their emission profile. The method does not require any direct writing step and is broadband so it can be efficiently applied to all the QDs on the sample.

Firstly, we produce a regular array of sub-micron triangular pillars with a self-aligned process that ensures a single QD inside each pillar, positioned along its axis. Subsequently, multiple cycles of chemical vapor deposition are used to create quasi-conformal dielectric shells that encapsulate the pillar. While the emitted light is guided by the GaAs pillar, the dielectric layers reduce the internal reflection at the pillar end, and create a convex surface that partially focus the output beam, acting as a lens. We succeed in increasing the extraction efficiency as measured through a NA=0.42 objective by obtaining a raw single photon count rate ≥1MHz, under continuous wave excitation. The dielectric coating also induces a shift of the emitted wavelength possibly due to materials strain that will be further investigated.

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Indirect measurement of 22Ne(α,γ)26Mg via 7Li(22Ne,t)26Mg in inverse kinematics

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The reaction 22Ne(α,γ)26Mg is associated with several open questions in nuclear astrophysics and plays a crucial role in constraining stellar models. Among other scenarios, it plays a critical role in the creation of elements heavier than iron. A reliable evaluation of the stellar reaction rate at the energy of astrophysical interest must consider all the possible excited states of the compound nucleus 26Mg in order to reliably predict the reaction cross section, and hence the stellar rate. Due to very low stellar energies and therefore very low cross sections, direct experiments in the laboratory have so far only provided highly uncertain data.

This poster focuses on a forthcoming indirect measurement of the 22Ne(α,γ)26Mg reaction, aiming at providing information on the excited states of 26Mg in the astrophysically important energy range, such as spectroscopic factors and decay widths. The 26Mg states will be selectively populated via the alpha-transfer reaction in inverse kinematics 7Li(22Ne, t)26Mg. The combined use of the recoil mass separator EMMA coupled with the highly segmented tracking gamma-ray spectrometer TIGRESS and silicon detectors allows for the reconstruction of the outgoing kinematics and extraction of the properties of the populated excited level of 26Mg. The measurements will be performed at the TRIUMF laboratory in Vancouver, Canada and represent a first step for the evaluation of the cross-section measurements for 22Ne(α,γ)26Mg, followed by a direct measurement in the of reduced background environment provided by the Bellotti Ion Beam Facility at LNGS, Italy.

Astro Physics & Particle / 13

Inferring the composition of Ultra High Energy Cosmic Rays

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In this talk, I will present a novel method for inferring the mass composition of Ultra High Energy Cosmic Rays (UHECR) from the electromagnetic profile of their air showers. By capturing the main features of the profile in few moments of the distribution, we can use nested sampling algorithms to probe the full shape of the likelihood. Furthermore, I will explore opportunities for enhancing the statistical significance of this dataset by exploiting its correlation with other shower observables.

Astro Physics & Particle / 63

JWST 2nd birthday: what we have learned so far

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In this talk I will present some of the results from the first 2 years of JWST data. In particular, I will talk about the results from the MIRI GTO high-z team, that I am a part of, concerning intermediate to high redshift galaxies. The results I will present have been obtained using the combination of several instruments on board of JWST: NIRCam, MIRI, NIRISS, in both imaging and spectroscopic mode. Moreover, I will talk about what are the scientific challenges we hope to overcome with the next round of data.

Astro Physics & Particle / 57

JWST 2nd birthday: what we have learned so far

Corresponding Author(s): marianna.annunziatella@gmail.com

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Astro Physics & Particle / 3

JWST 2nd birthday: what we have learned so far

Marianna Annunziatella[1]

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History of Physics / 38

La spettroscopia nucleare in Italia: una nascita partenopea all'ombra del cervo di Rodi

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La spettroscopia nucleare in Italia è nata agli inizi degli anni '60 a Napoli, con l'arrivo di Renato Angelo Ricci. Essa ebbe inizio con una intensa attività sperimentale presso il padiglione 19 della Mostra d'Oltremare, mirata alla determinazione di nuovi schemi di decadimento nucleari. La produzione di specie nucleari radioattive veniva effettuata con un fascio di neutroni da 14 MeV, generati attraverso la reazione (d,t) con l'acceleratore HVEC da 400 kV, e misurando la radiazione gamma di decadimento tramite la tecnica di rivelazione a scintillazione. Il punto di partenza fu lo studio dello spettro dei raggi gamma emessi dal nucleo eccitato 50Ti, formato nel decadimento beta del nucleo 50Sc prodotto dalla reazione 50Ti(n,p)50Sc. Nel presente contributo verranno illustrate le tappe più significative dell'inizio di questo nuovo campo di ricerca unitamente al ruolo che esso ha avuto nella nascita della Sezione INFN di Napoli nel 1963, e nel susseguente sviluppo delle numerose attività di ricerca che oggi vedono impegnati la Sezione INFN e il Dipartimento di Fisica 'Ettore Pancini' dell'Università Federico II. A fronte dell'alto valore storico, scientifico e culturale del padiglione 19 e di altri luoghi della Mostra d'Oltremare, dove si sono svolte negli anni le attività di indagine e di formazione delle ricercatrici e dei ricercatori in fisica, essi giacciono oggi in disuso e in uno stato di completo abbandono. La seconda parte del presente contributo sarà dedicata a questo problema, ed alla presentazione dell'Associazione 'All'Ombra del Cervo di Rodi' costituita recentemente, con lo scopo di valorizzare e recuperare le aree di proprietà dell'Ente Mostra d'Oltremare di tutto il complesso costituito dai padiglioni 16 e 19, dall'Aula di Rodi e dalle altre strutture annesse, che dall'attuale stato di inattività e declino, sarebbe importante e doveroso recuperare alla comunità.

Quantum Technology / 55

Large-scale quantum walks via spin-orbit photonics

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Large-scale quantum walks via spin-orbit photonics

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We present a photonic platform capable of generating large-scale quantum walks, corresponding to ultra-long dynamics in a Hilbert space spanned by hundreds of optical modes carrying quantized transverse momentum. The platform uses only three spin-orbit optical metasurfaces, dramatically reducing optical losses and decoherence effects. We demonstrate the potential of this method by experimentally showing that in the long time limit, a quantum walk affected by dynamical disorder generates maximal entanglement between two system partitions. This platform represents a powerful resource for cutting-edge quantum optics experiments.

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Leptonic sources of (ultra)high-energy neutrinos: Key physics and a new public code

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Leptonic sources of (ultra)high-energy neutrinos: Key physics and a new public code

Statistical Physics / 39

Machine Learning and Human Genetics for Causal Inference

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Human genetics provides a robust avenue for causal inference, avoiding the pitfalls of reverse causation thanks to the stable nature of the genome. Specifically, Mendelian randomization (MR) can leverage genetic information to assess causal relationships between risk factors and disease outcomes. For example, through MR, researchers have confirmed the detrimental impact of LDL cholesterol in cardiovascular diseases and discarded the protective role of HDL in the same set of conditions. Although its generality, applications of MR have been limited to the analysis of single risk factors and outcomes in isolation.

In this talk, I will show how one can integrate machine learning and MR to train aggregate predictors of disease risk from multiple risk factors, a new framework that we call Differentiable MR (DMR). At its core, DMR aligns genetic influences of composite risk factors with those of the disease under study, bringing principles of causality in disease risk assessment. Finally, my presentation also aims to showcase how the physicists' mindset can be channeled to tackle quantitative problems in other disciplines, with guiding examples in machine learning for biomedicine.

Astro Physics & Particle / 65

Machine Learning tools for large Sky Surveys

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I will present a multiplicity of science-ready tools based on machine learning to both fast and accurately analyse the data from upcoming large sky surveys and best exploit them for science. As a science case, I'll discuss the measurement of the total mass of galaxies using strong lensing and galaxy dynamics.

Astro Physics & Particle / 28

Machine Learning tools for large Sky Surveys

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I will present a multiplicity of science-ready tools based on machine learning to both fast and accurately analyse the data from upcoming large sky surveys and best exploit them for science. As a science case, I'll discuss the measurement of the total mass of galaxies using strong lensing and galaxy dynamics.

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Measurent of PDE DUNE X-ARAPUCA

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DUNE is an ambitious experimental project with a wide physics program. Its goals include observing neutrino oscillation physics, studying CP violation in the leptonic sector, identification of neutrino mass hierarchy, detecting supernova and solar neutrinos and searching for proton decay. The experiment will use a liquid argon time projection chamber (LArTPC) detector with a total fiducial volume of 40kt of LAr in four independent modules. This detector will be irradiated by a neutrino flux produced 1300 km away, at the Long-Baseline Neutrino Facility (LBNF), hosted by Fermilab. The first two modules, one with horizontal charge drift (FD-HD) and the other with vertical charge drift (FD-VD), are currently under construction.

They will be equipped with a photon detection system based on X-ARAPUCA technology, designed to trap scintillation light from liquid argon in an box instrumented with SiPM photon detectors with a combination of a dicroic filter and two wavelength shifter materials. Different photon detectors units have been designed implementing the X-ARAPUCA concept.

Measuring the absolute Photon Detection Efficiency (PDE) of this photodevices at liquid argon temperature is essential for characterizing the photon detection system of the DUNE experiment. However, no measurements have been performed for the 60x60 cm2 X-ARAPUCA unit designed for the vertical drift module of DUNE. The Naples Cryogenic Laboratory took on his task, by planning and performing a dedicated test with ultra-pure liquid argon in a big 1000 L cryostat.

Physics of Life / **33**

Multiscale modelling of chromatin 4D organization in SARS-CoV-2 infected cells

Andrea Maria Chiariello[1]

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SARS-CoV-2 is able to re-structure chromatin organization and alters the epigenomic landscape of the host genome, though the mechanisms that produce such changes are still poorly understood. Here, we investigate with polymer physics chromatin reorganization of the host genome, in space and time upon SARS-CoV-2 viral infection. We show that re-structuring of A/B compartments is well explained by a remodulation of intra-compartment homotypic affinities, which leads to the

weakening of A-A interactions and enhances A-B mixing. At TAD level, re-arrangements are physically described by a general reduction of the loop extrusion activity coupled with an alteration of chromatin phase-separation properties, resulting in more intermingling between different TADs and spread in space of TADs themselves. In addition, the architecture of loci relevant to the antiviral interferon (IFN) response, such as DDX58 or IFIT, results more variable within the 3D single-molecule population of the infected model, suggesting that viral infection leads to a loss of chromatin structural specificity. Analysis of time trajectories of pairwise gene-enhancer and higher-order contacts reveals that such variability derives from a more fluctuating dynamics in infected case, suggesting that SARS-CoV-2 alters gene regulation by impacting the stability of the contact network in time. Overall, our study provides the first polymer-physics based 4D reconstruction of SARS-CoV-2 infected genome with mechanistic insights on the consequent gene misregulation.

Astro Physics & Particle / 6

Neutrinos from SN 1987A probing the inner properties of supernova

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The explosion of SN1987A is the only case in history in which a neutrino signal from a nearby supernova (SN) has been observed, and has shaped our understanding of the inner mechanisms of SNe. In this talk, we revisit the interpretation of SN1987A from a modern perspective. We compare up-to-date SN models with the legacy data, showing a general consistency in the time-integrated properties. The neutrino signal, both in the accretion-dominated and in the cooling-dominated phase, agrees with the observations if the central protoneutron star is light enough, allowing us to infer a range for the initial mass of the remnant. The inclusion of convection and updated neutrino-nucleon opacities in the current models, compared to the historical ones, leads to a shortened duration of the burst, in tension with the observed signal duration. This suggests a second, independent phase of emission to explain the late-time observed events.

Condensed Matter / 52

New pathways to tailor the properties of carbon nanotubes

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New pathways to tailor the properties of carbon nanotubes

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Among the various nano-carbon allotropes, single-walled carbon nanotubes (SWNTs) step up for their mechanical endurance and their optical and electronic properties, trademarks of their quantum nature. SWNTs come in different chiral species, each of them with their distinctive electronic character, providing a rich field to compare theoretical predictions and experimental validations. Despite their structure-properties features have been thoroughly investigated, their customization is still actively under development. Straightforward, reliable, and reproducible protocols to adapt their

properties to targeted applications are still missing. Here we focus on the approach we developed to control the amount of charges injected in each SWNTs at the single nanotube level and how to exploit this for targeted applications.

Astro Physics & Particle / 23

Novel probes of sub-GeV dark matter

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Although Dark matter (DM) is one of the cornerstones of fundamental physics and cosmology, so far it has evaded all the attempts to unveil its nature. A standard way to directly probe DM particles is to search for their scatterings with nucleons in underground detectors. However, in case of DM particles with sub-GeV masses, the direct-detection technique is hampered by the low nucleon recoil energies which are typically below the experimental sensitivity. In this talk, I will discuss a novel idea to probe sub-GeV DM particles. In particular, I will investigate the effects of the possible scatterings between cosmic-ray protons and sub-GeV DM particles in star-forming and starburst galaxies, which are well-motivated astrophysical emitters of high-energy neutrinos and gamma-rays through hadronic collisions. For this scenario, I will explore the phenomenological implications and discuss new constraints on the DM parameter space.

Physics of Life / 32

Polymer physics modeling can uncover the mechanisms underlying DNA folding

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Quick advances in molecular biology have shed light on the three-dimensional structure of DNA in the cell nucleus, exposing its complex, non-random nature, and its connection to gene regulation. Our challenge is to comprehend the mechanics behind such an intricate genomic architecture and how two or more genomic regions may physically connect with one another. Experiments have shown certain preferred patterns of interactions that go beyond random contacts associated with the polymeric structure of the DNA chain and imply the presence of fundamental organizing principles of folding. Polymer physics and Monte Carlo-based computational approaches are proving to be excellent tools for investigating these phenomena. Here we describe the details of the simple, yet powerful "String and Binders Switch" (SBS) polymer physics model, and its computational implementation (PRISMR). We additionally discuss some of the uses of this framework, including the prediction of chromatin structural rearrangements upon disease-associated mutations and the investigation of gene-enhancer dynamics and their connection to epigenetics.

Refs:

-Bianco S. et al. Polymer physics predicts the effects of structural variants on chromatin architecture. Nature Genetics, 2018 -Esposito A. et al. Polymer physics reveals a combinatorial code linking 3D chromatin architecture to 1D chromatin states. Cell Reports, 2022.

Physics of Life / 46

Polymer physics reveals a combinatorial code linking 3D chromatin architecture to 1D chromatin states

Andrea Esposito[None]

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Recent technologies, such as Hi-C [1], have revealed that the mammalian genome has a complex, far from random three-dimensional (3D) organization, intimately linked to vital biological processes. To rationalize the complexity of experimental data, polymer models from Statistical Physics and a variety of computational methods have been developed [2,3]. However, they typically cannot explain data at the scale of the full genome. In this talk, I will present the first genome-wide extension of PRISMR [4], our approach that combines Machine Learning and Polymer Physics to infer the different types of DNA binding sites determining genome 3D structure. The genome-wide study allowed us to develop a code linking chromosome 3D structure to chromatin states through our inferred binding domains. Interestingly, they have an overlapping, combinatorial organization along chromosomes necessary to accurately explain contact specificity. The binding domains and the associated architectural code were tested by making predictions on the changes of the 3D structure caused by a set of genomic mutations at the Sox9 locus linked to human diseases and our predictions were confirmed by independent data from cells carrying such mutations. Finally, in a reverse approach based on the discovered code, we predicted de novo the 3D structure of an independent set of chromosomes from only their 1D chromatin marks, thus validating the inferred epigenetic-architecture code [4]. Overall, our results shed light on how 3D information is encrypted in 1D chromatin via the specific combinatorial arrangement of binding sites.

References

[1] R. Kempfer, A. Pombo, Nature reviews Genetics 21 (2020) [2] Barbieri et al. Proc. Natl. Acad. Sci. USA 109 (2012) [3] Bianco et al. Nat. Genet. 50 (2018) [4] Esposito et al. Cell Reports 38 (2022)

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Primordial black hole dark matter evaporating on the neutrino floor

Roberta Calabrese[None] ; GENNARO MIELE[None] ; STEFANO MORISI[None] ; Damiano Fiorillo[None] ; Antonio Palazzo[None]

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Primordial black holes are hypothetical Black Holes generated in the first instants of the Universe life. Focusing on Primordial Black Hole masses in the range $[5 \times 10^{14} - 5 \times 10^{15}]$ g, we point out that the neutrinos emitted by PBHs evaporation can interact through the coherent elastic neutrino-nucleus scattering producing an observable signal in multi-ton Dark Matter direct detection experiments. The envisaged high exposures for the next-generation facilities allow us to limit Primordial Black Hole abundance today, improving the existing neutrino limits obtained with Super-Kamiokande. We also quantify how Primordial Black Holes would modify the "neutrino floor".

Quantum Technology / 54

Pseudomagic quantum states: when computer science meets physics.

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Pseudomagic quantum states: when computer science meets physics.

Lorenzo Leone[1]

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The delicate and elusive boundary between quantum and classical computation is a central question in current research, with a focus on identifying uniquely quantum resources that contribute to a quantum advantage. One such resource is so-called magic, which is a measure of the non-Clifford resources needed to prepare a quantum state. Among other relations, it has been shown that the amount of magic is directly connected to the hardness of classically simulating a quantum state, the overhead required for fault-tolerant quantum computation and is directly proportional to the degree of chaos in a system.

Given this multitude of interpretations, one might naturally expect that quantum states with high magic are inherently different, and operationally more non-classical, than states with low magic. This work challenges that intuition. Indeed, we find that the situation can be more intricate than that. Through the concept of computational indistinguishability borrowed from computer science, we demonstrate the existence of families of states with actually small values of magic while they operationally appear as states with maximum values of magic. We call this phenomenon pseudomagic. In our work, we make a number of contributions that comprehensively elucidate the implications of this phenomenon. Our pseudomagic ensembles force us to reconsider quantum chaos, give rise to a fundamental cryptographic primitive and allow us to prove bounds on testing stabilizerness and certain forms of magic-state distillation.

Yet, the significance of computational indistinguishability extends beyond investigating quantum resource theories such as magic and entanglement. From the physics perspective, it advocates the mindset that the only physical properties that can be measured in a laboratory are those that are efficiently computationally detectable. It introduces a unique perspective into the quantum realm of many particles, transforming the laboratory from a mere verifier of quantum theories into an integral part of the theory itself, where the limitations of observers assume a central role.

Cosmology & Quantum Gravity / 16

Quantization and Reduction

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In this talk we will discuss the theory of reduction of phase space, in terms of Poisson geometry, and the open problem of the diagram reductio-quantization in the setting of deformation quantization.

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Quantum Black Hole Physics from the Event Horizon

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Quantum gravity theories predict deformations of black hole solutions relative to their classical counterparts. A model-independent approach was advocated in our work that uses metric deformations parametrised in terms of physical quantities, such as the proper distance. While such a description manifestly preserves the invariance of the space-time under coordinate transformations, concrete computations are hard to tackle since the distance is defined in terms of the deformed metric itself. In this work, for spherically symmetric and static metrics, we provide a self-consistent framework allowing us to compute the distance function in close vicinity to the event horizon of a black hole. By assuming a minimal degree of regularity at the horizon, we provide explicit (series) expansions of the metric. This allows us to compute important thermodynamical quantities of the black hole, such as the Hawking temperature and entropy, for which we provide model-independent expressions, beyond a large mass expansion. Moreover, imposing for example the absence of curvature singularities at the event horizon leads to non-trivial consistency conditions for the metric deformations themselves, which we find to be violated by some models in the literature.

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Quantum Euler angles and agency-dependent spacetime

Domenico Frattulillo[1] ; Giuseppe Fabiano[1]

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Quantum gravity is expected to introduce quantum aspects into the description of reference frames. Here we set the stage for exploring how quantum gravity induced deformations of classical symmetries could modify the transformation laws among reference frames in an effective regime. We invoke the quantum group SUq(2) as a description of deformed spatial rotations and interpret states of a representation of its algebra as describing the relative orientation between two reference frames. This leads to a quantization of one of the Euler angles and to the new paradigm of agency-dependence: space is reconstructed as a collection of fuzzy points, exclusive to each agent, which depends on their choice of reference frame. Each agent can choose only one direction in which points can be sharp, while points in all other directions become fuzzy in a way that depends on this choice. Two agents making different choices will thus observe the same points with different degrees of fuzziness.

https://arxiv.org/pdf/2211.11347.pdf

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Quantum Euler angles and agency-dependent spacetime

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Astro Physics & Particle / 40

Searching for ultra-high-energy cosmic rays and events related to atmospheric electricity at the Pierre Auger Observatory

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The Pierre Auger Observatory is the largest facility in the world for studying ultra-high-energy cosmic rays. The Observatory is located in Argentina and consists of more than 1600 water Cherenkov detectors spread over an area of 3000 km^2 overlooked by Fluorescence detectors. The first phase of the Observatory's data-taking began in 2004 and continued until the end of 2021. Now a new phase is starting with the upgraded AugerPrime detector. The Auger Observatory was designed to investigate the composition, energy and arrival directions of ultra-high-energy cosmic rays studying the extensive air showers produced in the Earth atmosphere, but has proven to be also a unique instrument to detect in unprecedented detail phenomena related to atmospheric electricity, as ELVES and downward TGFs. I will describe the work I carried out as a member of the Auger Collaboration starting from composition studies, passing through the optimization of AugerPrime, up to atmospheric electricity studies.

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Spacetime fuzziness and parity symmetry breaking: unveiling the Universe's secrets

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The National Doctorate in Space Science and Technology is a doctoral program spanning across Italy with seven different curricula that cover various scientific fields related to space, ranging from Early

Universe Cosmology to medical sciences applied to astronaut health, and even space diplomacy. The DN-SST program began last year with the XXXVIII cycle and up to this point, I am the only student from Naples involved in this program. Within this framework, I'm involved with a scholarship in Cosmology with the name "Constraints from space borne observations of the cosmic microwave background and of the large scale structure of the Universe", with operational site in the Cosmology group of the University of Ferrara.

Naples is my hometown, and the University of Naples Federico II has been my alma mater, where I acquired the knowledge and skills necessary to be a part of the scientific community. For this reason I would like here to show you the research which still links me with Naples, about Quantum Gravity and Noncommutative Geometry, which I started during my master's thesis work. Defining the fuzziness of the spacetime structure, is it possible to have a macroscopic evidence of it in relativistic compact objects? If so, how?

Nevertheless, I also would like to talk about my current research in Cosmology: what happens when a scalar field, which once it has filled the spacetime up to a certain point in the Universe history, couples with the electromagnetic field breaking the latter's parity symmetry? Have we observed evidence of this in recent precision experiments? How would it impact our understanding of the standard model of physics if we found it?

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Studio e ottimizzazione della linea di iniezione del ciclotrone del progetto SPES presso i Laboratori Nazionali di Legnaro

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Presso i Laboratori Nazionali di Legnaro dell'Istituto Nazionale di Fisica Nucleare è in corso di realizzazione un'innovativa infrastruttura per la fisica nucleare. Il progetto, sotto la sigla SPES (Selective Production of Exotic Species), mira a fornire fasci di isotopi radioattivi esotici per studi di fisica nucleare e relative applicazioni. Un'altra parte del progetto, denominata LARAMED (Laboratorio di RADionuclidi per la MEDicina), riguarda la produzione di isotopi radioattivi di interesse medicale. Il cuore del progetto è il ciclotrone realizzato dall'azienda canadese Best Theratronics in collaborazione con i Laboratori di Legnaro. L'acceleratore è stato installato e collaudato nel 2017. Si tratta di una macchina piuttosto compatta in grado di fornire contemporaneamente due fasci di protoni con energia variabile tra 30 e 70 MeV e intensità di corrente complessiva fino a 700 uA. Come studente di dottorato presso l'Università di Ferrara sto lavorando nel gruppo ciclotrone all'ottimizzazione della linea di trasporto per l'iniezione degli ioni H- all'ingresso del ciclotrone in modo da studiare i limiti di corrente raggiungibili con il sistema a disposizione. L'attività prevede di realizzare anche un componente denominato "buncher a radiofrequenza", necessario per trasformare il fascio continuo fornito dalla sorgente di ioni in un fascio composto da pacchetti di ioni entro l'intervallo di tempo di pochi ns in cui il campo elettrico oscillante del ciclotrone è in grado di accelerarli fino all'estrazione. Lo sviluppo per il momento riguarda lo studio della dinamica delle particelle per mezzo di simulazioni al computer del sistema di iniezione e della fase di prima accelerazione fino all'energia di 1 MeV all'interno della macchina. Seguiranno la realizzazione del buncher e la verifica sperimentale del modello simulato sull'acceleratore in funzione.

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Testing dark energy in gravitationally bound systems: The case of Non-local Gravity

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The forthcoming generation of astrophysical and cosmological surveys are expected to generate an extensive and groundbreaking collection of data. The unmatched quantity and quality of these observations should boost our knowledge of the Universe, especially in regards to the dark sector. The true nature of the dark energy, either gravitational or related to fundamental fields, may therefore be unveiled in the next decades.

A complementary approach for delving into the zoo of dark energy models relies on the analysis of the impact within the non-linear regime resulting from the introduction of extra degrees of freedom in the theory. Therefore, the investigation of the dynamics of gravitationally bound systems emerges as the ideal framework to explore the feasibility of any modification of the standard ΛCDM paradigm.

In this poster, we investigate a dark energy model based upon a non-local extension of General Relativity and its main astrophysical features.

Astro Physics & Particle / 64

Testing dark energy through quasar cosmology

In the current era of precision cosmology, there is a growing interest in using new probes to explore the evolution of the universe and extend the mapping of its expansion to include currently uncovered redshift ranges. In this talk, I will introduce the possibility of using Quasars as cosmological probes, which have the potential to expand the Hubble diagram of Supernovae to z = 2.4 - 7.5, allowing us to distinguish between predictions of different cosmological models. Additionally, I will test several dark energy models using Quasar data and investigate their possible incompatibilities with measurements from Baryonic Acoustic Oscillations, Dark Energy Survey and Cosmic Microwave Background radiation.

Astro Physics & Particle / 8

Testing dark energy through quasar cosmology

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Astro Physics & Particle / 47

The COHERENT experiment and LAr for the CEvNS study

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The process of coherent elastic neutrino nucleus scattering (CEvNS) was predicted more than 45 years ago within the Standard Model of elementary particles. The cross section of this process depends quadratically on the number of neutrons in the nuclei and thus prevails over all other known neutrino interactions. Therefore, this process is very interesting as a possible tool for nuclear reactor monitoring and nonproliferation tasks, and as a probe for the physics beyond the Standard Model. However, due to very low recoil energy, this process was not observed until recently. The first measurement was provided by the COHERENT experiment in 2017 with the CsI detector. In this talk, an overview of the COHERENT experiment will be presented with a main focus on the liquid argon (LAr) program.

Astro Physics & Particle / 49

The DarkSide-20k experiment

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This talk will provide an overview of the DarkSide-20k experiment by the Global Argon Dark Matter Collaboration. This experiment aims to explore the WIMP hypothesis by detecting WIMP-nucleon elastic scattering with a dual-phase time projection chamber (TPC) detector filled with low-radioactivity underground liquid argon. We will discuss the current status of the experiment, as well as the involvement of the Cryogenic Laboratory of our department in the testing of photo-detection systems with a dedicated cryogenic testing facility and R&D with Proto-0, a small-scale prototype of DarkSide-20k.

Astro Physics & Particle / 1

The Milky Way and its structure

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I will give an overview of the work carried on over the last years to determine the gravitational structure of our Mother Galaxy, the Milky Way, especially in relation to its most prominent component, the Dark Matter. I will also briefly show some examples on how astrophysical uncertainties that hinder such determination affect interpretation of particle dark matter searches, and Beyond the Standard Model physics.

Astro Physics & Particle / 58

The Milky Way density structure and why should we care about it

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Statistical Physics / 14

The Unreasonable Growth of Network Platforms

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In an era dominated by the digital landscape, the ascent of network platforms defies traditional expectations, exhibiting an "unreasonable" growth that demands exploration. This presentation delves into the enigmatic forces propelling the explosive expansion of network platforms, ranging from social media giants to emerging digital ecosystems. As we dissect the unconventional strategies and dynamics fueling their meteoric rise, we challenge conventional notions of scalability and influence. Through unraveling the mysteries behind their extraordinary growth, this presentation aims to provide valuable insights for industry professionals, researchers, and enthusiasts seeking to navigate and understand the ever-evolving realm of network platforms. I will accompany you on a journey to decode the seemingly irrational trajectories of these platforms and explore the implications for technology, business, and society as a whole.seeking to navigate and understand the ever-evolving realm of network platforms. Join us on a journey to decode the seemingly irrational trajectories of these platforms and explore the implications for technology, business, and society as a whole.

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The direct measurement of the C12+C12 cross section at astrophysical energies at LUNA

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Carbon burning is the third stage of stellar evolution determining the final destiny of massive stars and of low-mass stars in close binary systems. Only stars with a mass larger than a critical value $M^*_{up} \sim 10M_\odot$, can ignite C in non-degenerate conditions and proceed to the next advanced burning stages up to the formation of a gravitationally unstable iron core. Various final destinies are possible, among which a direct collapse into a black hole or the formation of a neutron star followed by the

violent ejection of the external layers (type II SN). Less massive stars $M < M_{up} \sim 7M_{\odot}$, never attain the conditions for C ignition and will evolve into CO White Dwarfs. The values of M^*_{up} and M_{up} are linked to the $^{12}C +^{12} C$ reaction rate: the little knowledge we have of it at astrophysical energies is the greater contribution to the uncertainty of these masses.

Stellar C burning proceeds mainly through the $^{12}C(^{12}C, \alpha)^{20}Ne$ and $^{12}C(^{12}C, p)^{23}Na$ channels. The cross-sections can be measured either detecting the emitted charged particles or the γ-rays produced by the decay of the excited states of ^{20}Ne and ^{23}Na.

$^{12}C +^{12} C$ fusion reactions were investigated in a wide energy range, down to 2.2 MeV, still above the astrophysical energies. A direct measurement is necessary for both stellar evolution models and the correct analysis of indirect data.

The aim of my PhD project is the direct determination of the cross section of the $^{12}C +^{12} C$ reaction at astrophysical energies through γ spectroscopy at LNGS. Here a devoted setup is being developed to reach an extremely low background condition. The project will also make use of the new MV accelerator available at the Bellotti Ion Beam Facility at LNGS, in the context of the LUNA MV research project. This accelerator is capable of producing a high intensity carbon beam (~ 0.15 mA) with great energy resolution and stability: as of our knowledge this is the highest C beam intensity available in the world. The detection setup will be made of several NaI scintillators and an HpGe. NaI detectors will be placed in a compact arrangement around the HpGe, covering a 2π angle: such a configuration guarantees a high detection efficiency, while preserving the excellent HpGe resolution (1.2 keV at $1.33\,\mathrm{MeV}$). The NaI configuration will also function as an active veto for beam-induced background.

In this contribution I will present details of recent results in setup development.

Astro Physics & Particle / 66

The evolutionary path of astronomers who study galaxy evolution

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In this chat I am going to talk about galaxy evolution in dense environments and the different techniques and equipment we use to shed light on this topic. As an example, I will mention how we use Virtual Reality (a tool developed for gaming) to visualize and analyze astronomical 3D data. In the second part of the talk I will focus on my personal “evolutionary path” as an astronomer. I will tell why I decided to move to Naples and work at the Observatory of Capodimonte. Moving from theoretical physics to astronomy and astrophysics, jumping from one country to another: the life of researchers is more complex but as exciting as galaxy evolution.

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The evolutionary path of astronomers who study galaxy evolution

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To some extent, the evolution of galaxies shows many similarities with the life of researchers. They are not smooth and linear processes as one might imagine.

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The interplay between Primordial Black Holes and Leptogenesis

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Primordial Black holes with mass of 10ˆ15 g should have been evaporated by now giving potentially access to the physics of the Early Universe. In particular, the presence of PBH could have impacted the process of leptogenesis in different ways depending on the mass and so on the temperature of the PBHs. We present the impact of the non-standard cosmology driven by the presence and the evaporation of light primordial black holes on the production of the baryon asymmetry of the Universe in different scenarios of leptogenesis.

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The interplay between Primordial Black Holes and Leptogenesis

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Primordial Black holes with mass of 10ˆ15 g should have been evaporated by now giving potentially access to the physics of the Early Universe. In particular, the presence of PBH could have impacted the process of leptogenesis in different ways depending on the mass and so on the temperature of the PBHs. We present the impact of the non-standard cosmology driven by the presence and the evaporation of light primordial black holes on the production of the baryon asymmetry of the Universe in different scenarios of leptogenesis.

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The θ-angle in QCD at finite isospin density

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We examine the influence of the θ-angle on QCD with nonzero isospin charge and as a function of the number of matter fields. Our investigation delves into the impact on vacuum properties, the pattern of chiral symmetry breaking, and the overall spectrum of the theory. Introducing the CP-violating topological operator adds complexity to the vacuum structure, leading us to unveil novel phases and scrutinize the order of transitions that characterize flavor dynamics.

Moreover, we explore the critical chemical potential, a key determinant in distinguishing between the normal and superfluid phases of the theory, as a function of the θ-angle. Our findings provide valuable insights for guiding numerical simulations and devising new tests to scrutinize the model's dynamics.

To enhance our analysis, we employ an effective approach that incorporates Goldstone and dilaton degrees of freedom, augmented by topological terms in the theory. We specifically investigate how dilaton potentials, for which a systematic counting scheme can be established, affect the results. Via state-operator correspondence we compute the corrections to the would-be conformal dimensions of the lowest large charge operators as a function of the θ-term and dilaton potential.

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Tissues as living materials

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I will briefly illustrate my research activities on the physics of two-dimensional materials, with particular emphasis on epithelial tissues which line our bodies and inner organs. Due to their non-equilibrium nature, living epithelial tissues have astonishing properties, including the ability to close wounds while under tension and to greatly stretch before fracturing.

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Towards the stabilization of infinite-layer nickelate membranes

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The recent discovery of superconductivity in hole-doped infinite-layer nickelate thin films [1] has sparkled a renewed interest in the condensed matter community. This is motivated by the possibility to add another puzzle piece to the understanding of unconventional superconductivity, a phenomenon that has not yet been observed in infinite-layer polycrystalline samples[2]. The strain state induced by the substrate is suspected to play a key role in stabilizing the phase of superconductivity. Inspired by recent advances in the epitaxial lift-off of oxide films[3], our idea is to free our nickelate thin films from substrate-induced stresses.

In this context, here, we present our preliminary results on the use of epitaxial lift-off techniques to fabricate free-standing membranes of nickelate films with the final goal to perform a topotactic reduction process and study the transport properties. By using a pulsed laser deposition technique assisted by high-energy reflection electron diffraction, we have epitaxially grown $(\mathrm{Nd,Sr})\mathrm{NiO_3}$-based heterostructures on a sacrificial layer of water-soluble $(\mathrm{Ca,Sr})_3\mathrm{Al_2O_6}$[4]. Those sacrificial

layers are particularly adapted to study the effect of the strain on the stabilization of the infinite-layer phase, since by selecting an opportune Ca/Sr ratio, they can be grown on various substrates. This allow a better integrity of the released membranes while minimizing cracks formation. We can create membranes as large as 5x5 mm^2 that can be also fully transferred on PET or PDMS supports. Structural analyses conducted via X-ray diffraction and atomic force microscopy confirm the preservation of the crystalline quality of the membranes, close to that of the seed films.

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Towards the stabilization of infinite-layer nickelate membranes

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Unsupervised-informed classification for TCR-peptide binding predictions

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T-cell receptor binding with the pMHC peptide is a fundamental step to activate the killing machinery of the adaptive immune system against pathogens. However, limited data – due to the high specificity of T-cell receptors – make the task of binding prediction very challenging. Here we propose to use Large Language Models to sample new peptide-specific T-cell receptor sequences; by leveraging the transfer-learning ability of Large Language model, we are able to generate sequences compatible with natural ones and use them to improve the predictive power of deep classifiers.

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Witnessing Environment Induced Topological Phase Transitions via Quantum Monte Carlo and Cluster Perturbation Theory Studies

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Many-body interactions play a crucial role in quantum topological systems, being able to impact or alter the topological classi- fications of non-interacting fermion systems. In open quantum systems, where interactions with the environment cause dissipation and decoherence of the fermionic dynamics, the absence of hermiticity in the subsystem Hamiltonian drastically reduces the sta- bility of the topological phases of the corresponding closed systems. Here we investigate the non-perturbative effects induced by the environment on the prototype Su-Schrieffer-Heeger chain coupled to local harmonic oscillator baths through either intra-cell or inter-cell transfer integrals. Despite the common view, this type of coupling, if suitably engineered, can even induce a transition to topological phases. By using a world-line Quantum Monte Carlo technique we determine the phase diagram of the model proving that the bimodality of the probability distribution of the polarization signals the emergence of the topological phase. We show that a qualitative description can be obtained in terms of an approach based on the Cluster Perturbation Theory providing, in particular, a non-Hermitian Hamiltonian for the fermionic subsystem and insights on the dissipative dynamics

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Working for a big astronomical mission

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I am the lead scientist for archive and data processing operations at the Chandra X-ray Center. In this talk, I will shortly describe what it is like for an astrophysicist to be working in the operations of a big mission like Chandra and will describe the main traits of my professional development that led me to my current position. I will emphasize opportunities and challenges of this career path and provide some advices I wished I had known when I was a student (or shortly thereafter) based on my experience.