ICTP Sul-Americano para Pesquisa Fundamental: Um Centro Regional para Física Teórica

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Fapesp Project Number: 2021/14335-0

Project Period: 01/12/2022 - 30/11/2027

Period covered by this Report: 01/12/2023 - 30/11/2024

São Paulo

2024

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Summary of the Project's main goals

Fundamental research in theoretical physics has historically led to developments in all areas of science. In addition to producing technological applications coming from a better understanding of the physical laws of the universe, fundamental research in theoretical physics has led to new methods of problem-solving which has revolutionized areas of mathematics, biology, computer science, economics, and other areas of study.

Throughout the world, the importance of this research has led to the creation of theoretical physics institutes which focus on research, on the training of graduate students and postdocs, and on the organization of schools and workshops. Although these theoretical physics institutes have different structures and many are connected with public universities, they are all disconnected from undergraduate physics departments and have independent hiring policies and academic responsibilities from the rest of the university. Because of this autonomy, these theoretical physics institutes are able to attract the best researchers to their faculty. And because of the prestigious faculty and the organization of schools and workshops, these institutes are able to attract highly qualified graduate students and postdocs. As a result, the academic and research programs at these autonomous theoretical physics institutes increase the international impact of their host universities.

To fulfill the need for such a theoretical physics institute in South America, the ICTP South American Institute for Fundamental Research (ICTP-SAIFR) was created in 2011 in São Paulo as a collaboration between the São Paulo Research Funding Agency (FAPESP), the International Centre for Theoretical Physics (ICTP-Trieste) - a category 1 institute of UNESCO, the São Paulo State University (UNESP), and the Instituto de Física Teórica (IFT-UNESP) in whose building it is located. The ICTP-SAIFR in South America was the first regional center of ICTP created outside of Trieste, and because of its success, the ICTP-Trieste has now created regional centers in the continents of Central America (Mexico), Africa (Ruanda), and Asia (China).

In its twelve years of existence, the ICTP-SAIFR has already established itself as the premier institute for theoretical physics in South America. Its international schools and workshops for graduate students and researchers are selected from online proposals every year by the ICTP Scientific Council and attract the top students and lecturers from all over the world to São Paulo. Since the creation of ICTP-SAIFR, the graduate physics department of IFT-UNESP has been awarded the highest rating from the national agency CAPES despite its relatively small size. And with the help of a world-class scientific council and international search committee, ICTP-SAIFR has been able to reverse the brain drain and attract the top candidates to its faculty and postdoctoral positions. Its faculty currently include **Director Nathan Berkovits**, winner of the 2009 TWAS Physics Prize for his research in string theory and the 2021 John Wheatley Award for ICTP-SAIFR's role in South America, **Vice-Director Rogério Rosenfeld**, member of the Dark Energy Survey collaboration and president of the Brazilian Physical Society from 2019-2021, **Pedro Vieira**, joint professor at Perimeter Institute and winner of the 2018 Sackler Physics Prize and 2020 New Horizons in Physics Prize for his research in quantum field theory, **Ricardo Sturani**, member of the LIGO-Virgo collaboration which was recently awarded the Nobel Prize for the detection of gravitational waves, and **Ricardo Martínez-García**, winner

of a Serrapilheira grant for his research in mathematical ecology, coauthor of the December 2020 cover of Science, and elected in 2020 as an affiliated member to the Brazilian Academy of Science. Pedro Vieira is originally from Portugal and spends 6 months per year at IFT-UNESP with a FAPESP São Paulo Excellence Chair, and Riccardo Sturani and Ricardo Martinez-Garcia came to Brazil from Italy and Spain as FAPESP Young Investigator Fellows and began their permanent positions at IFT-UNESP in February 2022 as soon as the Covid-19 hiring restrictions were relaxed.

Simons-FAPESP "tenure-track" professors and FAPESP postdocs with temporary positions at ICTP-SAIFR are annually selected through an online application process involving hundreds of applicants. For the postdoctoral positions, a final short list of candidates are interviewed by the ICTP-SAIFR faculty and associated researchers in the research area of the candidates. And for the Simons-FAPESP group leader positions, the final short list of candidates are invited to present seminars and are interviewed by members of the ICTP-SAIFR Scientific Council and International Search Committee consisting of distinguished professors including Nobel Prize winners. These ICTP-SAIFR fellowships have attracted many outstanding researchers to return or to immigrate to Brazil, reversing the brain drain. In 2024, two new Simons-FAPESP "tenure-track" professors will be selected in the areas of theoretical physics and biological physics.

The main role of a theoretical physics institute is to foster the interchange of information between visiting and local researchers, and the ICTP-SAIFR has an active visiting program with over 150 visitors per year spending between one week and two months at the institute. There are weekly seminars and journal clubs in various subareas of theoretical physics, and the complete list of visitors and research seminars can be found on the ICTP-SAIFR webpage `www.ictp-saifr.org`. Research seminars are frequently recorded and made available online using equipment installed with the guidance of the Perimeter Institute and ICTP Trieste audiovisual departments.

In addition to the research conducted by its members and visitors, the ICTP-SAIFR regularly organizes schools, minicourses, workshops and programs for doctoral students and researchers in all areas related to theoretical physics. The success of these activities has allowed the IFT-UNESP masters and doctoral programs to attract the top students in theoretical physics from all of South America, and to receive the top ranking of Brazilian graduate physics programs since 2011. Over the next years, the ICTP-SAIFR intends to build on these recent accomplishments and continue to improve its research and organizational activities and consolidate its status as the premier theoretical physics institute in South America.

Accomplishments in the Period

During the second year of the grant from December 1, 2023 - November 30, 2024, ICTP-SAIFR further advanced its role as the premier hub for theoretical physics in South America. As explained below, this was achieved through the expansion into new research areas by hiring talented junior physicists from around the world, though the training of South American graduate students and postdocs with international advanced schools and workshops and new monthly research group meetings for the São Paulo physics community, and through the preparation of the next generation of scientists by organizing various types of outreach activities for high-school students and teachers, as well as the general public.

In 2022, ICTP-SAIFR was awarded a renewal for the third time of a prestigious "Targeted Grant for Institutes" from the privately funded Simons Foundation (USA). This grant finances two generous Simons fellowships which are combined with FAPESP Young Investigator fellowships to attract top researchers to ICTP-SAIFR. In 2023, the international ICTP-SAIFR search committee formed of world-leading researchers including Nobel laureate David Gross analyzed the applications of hundreds of candidates and selected the Italian physicist Dario Rosa to receive one of the two Simons-FAPESP positions.

Dario Rosa was the research team leader of the Quantum Chaos group at the University of Science and Technology in Korea and arrived in São Paulo in January 2024 as a Simons fellow together with a FAPESP Young Investigator position. Dario has already organized several activities in this new ICTP-SAIFR research area of quantum chaos and is closely linked to the new QuTIa Initiative of FAPESP in quantum technologies. In the related area of non-equilibrium quantum physics, a newly hired professor at SUNY Buffalo who was not selected for the Simons-FAPESP position, Jamir Marino, plans to visit ICTP-SAIFR for 1-2 months every year and help organize activities and supervise students. An Italian researcher at Mainz Institute in Germany, Martino Stefanini, has already agreed to come to ICTP-SAIFR in 2025 to start a joint postdoctoral position in collaboration with Prof. Marino´s group.

In 2024, the international ICTP-SAIFR search committee opened a call for the second Simons-FAPESP fellowship and selected Jaron Kent-Dobias, an American physicist at the Univ. of Rome performing research on applications of statistical mechanics to search optimizations. Before Rome, Jaron received his PhD at Cornell University in 2020 and completed in 2022 a postdoctoral position in Paris at Ecole Normale Superieure. Jaron was recently awarded a FAPESP Young Investigator Position and will arrive at ICTP-SAIFR in January 2025 where he is expected to nucleate a new group in this rapidly expanding research area related to machine learning.

Furthermore, in addition to these new junior faculty, UNESP promised in 2024 the opening of two new permanent professor positions for ICTP-SAIFR and two new permanent professor positions for IFT-UNESP. The first of these 4 positions was opened in October-November 2024 in all areas of theoretical physics and its applications, and the formal competition and selection is expected to take place in early 2025. It is expected that these permanent hirings will allow ICTP-SAIFR and IFT-UNESP both to strengthen its current research areas and expand into new areas.

During this second year of the grant, 4 new postdocs were hired in the areas of quantum information, condensed matter theory, soft matter and population dynamics, and a fifth will arrive in 2025 in the area of quantum many-body physics. Together with the 7 postdocs hired during the first year, all 12 postdoctoral positions on the initial grant have now been filled. In order to strengthen its current research areas and expand into new areas, ICTP-SAIFR will therefore be requesting additional postdoctoral fellowships at this time. As explained in subsection 4.4, these new fellowships are necessary both to extend the current 2-year positions for an additional year (as was decided by FAPESP for all fellowships starting in June 2024), and to attract talented young researchers from around the world to come to São Paulo to work with the new Simons-FAPESP fellows Dario Rosa and Jaron Kent-Dobias in the rapidly growing areas of quantum technologies and search optimizations.

To begin this second year of the grant, ICTP-SAIFR celebrated its 12th anniversary in February 2024 with the organization of an international symposium involving the participation of Nobel Prize Laureate David Gross and 75 renowned physicists from South America. One day of this symposium was devoted to stimulating the creation of South American networks in the different research areas and initiating monthly research group meetings for the São Paulo community. The first research group meetings were organized in the area of Astrophysics/Cosmology starting in April 2024, the next were organized in Soft and Biological Matter starting in May, and research group meetings in Quantum Technologies were initiated in December, These monthly or bi-monthly group meetings are day-long events with a few seminars and ample time for discussions, and are ideal for creating new collaborations. In addition to these new research group meetings, ICTP-SAIFR organized in August the third LASF4RI symposium for experiments in High-Energy, Cosmology and Astroparticle Physics, and was invited again by the American Physical Society to organize satellite sessions broadcast live at the 2024 March and April APS meetings in the areas of complex systems and cosmology.

During this period, ICTP-SAIFR continued its extensive training program of graduate students and postdoctoral researchers with the organization of 11 international schools on the subjects of data science and machine learning (Dec. 4 - 8, 2023), modeling infectious disease dynamics (May 6-12), particle physics (June 24- July 5), dark matter and neutrino detection (July 8-19), theoretical physics (July 22-28), cosmology, gravitational waves and exoplanets (July 29- August 9), water anomalies (Sept. 2 – 7), active matter (Sept. 30 – Oct. 4), quantum computing (Oct. 7 – 18), few-body physics (Oct. 21 - 25) and biological physics (Nov. 11 - 22). To encourage and motivate students, ICTP-SAIFR also organized competitions and awarded small cash prizes to the best PhD thesis in classical gravity and to the top scorers on a challenging physics exam for talented undergraduates. In addition, ICTP-SAIFR organized 11 minicourses on advanced topics including solitons, gravitational wave detectors, quantum computing, heavy ion collisions, neutrinos, quantum gravity, open quantum systems, precision gravity, early universe, Bayesian machine learning, and disorder in strongly correlated materials. And for researchers, ICTP-SAIFR organized the 14th International Workshop on Neutrino-

Nucleus Interactions (NUINT 2024), Integrability in Gauge and String Theory (IGST 2024), the 3rd Symposium on Current Topics in Molecular Biophysics (CTMB3), the Simons Collaboration Meeting on Bootstrap and Integrability, and workshops on quantum aspects of gravity in a lab and on dynamical processes in complex networks.

Finally, ICTP-SAIFR expanded its outreach programs for high-school teachers to include 16 weeks of an accredited course with the São Paulo Department of Education on cosmology, and expanded its program for high-school students with preparatory modules for the Physics Olympiad and the Physics vestibular exam in São Paulo and Campinas, as well as Saturday morning minicourses on advanced topics taught by university professors and intensive one-week schools during the summer and winter holidays involving group projects. And in 2024, ICTP-SAIFR continued its outreach program for the general public with distinguished public lectures on quantum technologies (USP research dean Paulo Nusseznzveig), accelerator physics (Sirius director Harry Westfahl) and particle physics (Nobel Prize laureate David Gross), monthly presentation of science-related films at the Belas Artes Cinema in São Paulo with discussions after the movie, monthly presentations in a downtown bar by a physicist, a cycle of lectures on cosmology, and an online book club with books selected and discussed by a physicist. Furthermore, ICTP-SAIFR greatly expanded its presence on social media with daily posts on Instagram and the production of Youtube videos at https://www.youtube.com/@SAIFRDivulga.

These accomplishments and others are all described in the bimonthly scientific bulletins at https://www.ictp-saifr.org/scientific-bulletins/.

Subsections 4.1 - 4.3 below will describe the research publications, visitors and activities during this period, and subsection 4.4 will describe the request for additional postdoctoral fellowships which is being submitted together with the report.

4.1 Research Related to Publications

The research conducted at ICTP-SAIFR during this period included various subareas of theoretical physics and its applications. The publications involved research performed by principal and associated researchers, postdoctoral and direct-doctoral fellows, and visitors of ICTP-SAIFR. Various ICTP-SAIFR researchers are also members of international experimental collaborations such as the CMS particle detector at the LHC in Switzerland, the LIGO gravitational wave detector in the USA, and the Dark Energy Survey telescope in Chile. In this period, ICTP-SAIFR researchers had a total of 164 publications and several of them will be briefly described below.

4.1.1 High Energy Physics

String Theory

Four-dimensional Chern-Simons (4DCS) theory is useful for understanding integrable sigma-models and constructing new ones. In [1] was shown how the complete pure spinor $\mathrm{AdS}5 \times \mathrm{S}^5$ superstring sigma-model can be derived from 4DCS theory with defects. The matter sector of this sigma model had been previously derived by Costello and Yamazaki, and it was proposed that the pure spinor ghosts come from gauge-fixing meromorphic transformations of 4DCS, which lead to the usual pure spinor Lax connection, including the ghost contribution.

In [2] a simple fix was introduced that exploits the relation between a parity-odd conformal block in two dimensions and a parity-even conformal block in four dimensions. The resulting toolkit was then applied to a study of the paradigmatic holographic theory in two dimensions, the D1-D5 CFT. For correlators involving Kaluza-Klein modes of the tensor multiplet, this analysis reproduced results that had been previously obtained using hidden conformal symmetry.

In [3], a definition of a two-parameter family of vertices was provided, which generalizes the ideas of both hyperbolic vertices and Kaku vertices. This family was referred to as the hyperbolic Kaku vertices. It was defined in terms of hyperbolic geometries, similar to the hyperbolic vertices. However, the geometries also depended on state inputs, as is the case with lightcone and Kaku vertices. The definition was given only at tree level, *i.e.*, focusing solely on the moduli spaces of Riemann surfaces with genus zero.

A framework was developed for the systematic study of symmetry transformations of sigma-model currents in a special situation, where symmetries had a well-defined projection onto the target space. This formalism was then applied to pure spinor sigma-models, and the resulting geometric structures in the target space were described (which, in this approach, included the pure spinor ghosts) [4]. A detailed study of the transformation properties of currents was carried out, using the formalism of equivariant cohomology. The contact terms in the OPE of BRST currents were also examined, and some relations between currents and vertex operators were derived that may not have been previously acknowledged. Additionally, the geometrical meaning of the "minimalistic" BV action for pure spinors in AdS was clarified.

Other publications related to string theory in this period are [67-68,76-77,100-108,135].

Particle and Astroparticle Physics

The Standard Model (SM) of Particle Physics has been tested to great precision and searches for phenomena proposed by models beyond the SM were searched at the LHC. Also, the overwhelming astrophysical evidence for the existence of dark matter points to the incompleteness of the SM. ICTP-SAIFR researchers have been actively working on these important issues.

Results from the CMS collaboration working at the LHC were reported in [5–37]. As highlights we can list:

(i). The first measurement of the two-particle energy correlator (E2C) at a hadron colider, probing a much higher energy scale than at the e^+e^- experiments, and the first ever measurement of three-particle correlator (E3C), were reported at [18]. The analysis was based on an event sample of pp collisions at $\sqrt{s} = 13$ TeV collected by CMS detector.

(ii). In Ref. [10] search for collective effects inside jets produced in pp collisions was performed via correlation measurements of charged particles using the CMS detector at the CERN LHC. The analysis used data collected at a center-of-mass energy of $\sqrt{s} = 13$ TeV, corresponding to an integrated luminosity of 138 fb^{-1}. Jets were reconstructed with the anti-k_T algorithm and two-particle correlations among the charged particles within the jets were studied as functions of the particles' azimuthal angle and pseudo-rapidity separations.

(iii). In [24] was reported the first LHC search for the Z boson decay to two tau leptons and two muons relative to the Z boson decay to four muons. This search benefits from a partial cancellation of experimental systematic uncertainties that affect both decay modes. The two tau leptons were reconstructed via their decays to muons and neutrinos, hence the $Z \to \tau\tau\mu\mu$ decay was studied in the final state with four muons with a total electric charge of zero.

(iv). The first search for soft unclustered energy patterns (SUEPs) was performed using an integrated luminosity 138 fb^{-1} of pp collision data at $\sqrt{s} = 13$ TeV, collected in 2016–2018 by the CMS detector at the LHC, see Ref. [19].

On the other hand, in [38] was studied how the coupling between axion-like particles (ALPs) and matter be obtained at the level of on-shell scattering amplitude, and were identify three conditions that allow us to compute amplitudes that correspond to shift-symmetric Lagrangians, at the level of operators with dimension 5 or higher. As a direct application of our results, was performed a phenomenological study of the inelastic scattering $l^+l^- \to \phi h$ (with $l^\pm$ two charged leptons, ϕ the ALP and h the Higgs boson) for which, as a result of the structure of the 3-point and 4-point amplitudes, dimension-7 operators can dominate over the dimension-5 ones well before the energy reaches the cutoff of the theory.

Other publications related to particle and astroparticle physics in this period are [71-72, 83-85,87-94,95-99,119-120,131,139,152-159].

Cosmology, Astrophysics and Gravity

ICTP-SAIFR researchers are taking part in international collaborations to explore the cosmos, such as the Dark Energy Survey (DES), Dark Energy Spectroscopic Instrument (DESI), Cherenkov Telescope Array (CTA), the Rubin Observatory's Legacy Survey of Space and Time (LSST), the Javalambre Physics of the Accelerated Universe Survey (J-PAS) and the

related S-PLUS and MiniJ-PAS surveys, the Laser Interferometer Gravitational-wave Observatory (LIGO), KAGRA and Virgo Collaborations

Results from DES and LSST are described in [39–43]. As highlights we can list:

(i). The overlap of galaxy surveys and cosmic microwave background (CMB) experiments presents an ideal opportunity for joint cosmological data set analyses. In Ref. [41] was presented a halo model-based method for the first joint analysis combining these two experiments using 10 correlated two-point functions ($10 \times 2\mathrm{pt}$) derived from galaxy position, galaxy shear, CMB lensing convergence, and Compton-y fields. This method was explored using the Vera Rubin Observatory Legacy Survey of Space and Time (LSST) and the Simons Observatory (SO) as examples.

(ii). In [44] the performance of comoving Lagrangian acceleration (COLA) emulators in constraining extended models was assessed by conducting LSST-Y1 simulated cosmic shear analyses. The wCDM model was considered, where the dark energy equation of state w is a free parameter, as emulators trained on high-resolution simulations exist for this model and provide a suitable benchmark.

Results from LIGO, VIRGO and KAGRA collaborations on gravitational waves are described in [45–49]. In particular [45] presented the result of a search for $U(1)_{B-L}$ gauge boson DM using the KAGRA data from auxiliary length channels during the first joint observation run together with GEO600. By taking into account the stochastic nature of ultralight DM, upper bounds on the coupling strength between the $U(1)_{B-L}$ gauge boson and ordinary matter were obtained for a range of DM masses. A search for a waveform-independent search sensitive to eccentric black hole coalescences, covering the third observing run (O3) of the LIGO and Virgo detectors was presented at [47]. In [48] were presented Fermi Gamma-ray Burst Monitor (Fermi-GBM) and Swift Burst Alert Telescope (Swift-BAT) searches for gamma-ray/X-ray counterparts to gravitational-wave (GW) candidate events identified during the third observing run of the Advanced LIGO and Advanced Virgo detectors.

One of the most important collaborations in Astrophysics is the Cherenkov Telescope Array (CTA). Results from the CTA collaboration were reported in [50–55]. As highlights we can list:

(i). In [51] was estimated the sensitivity of the CTA to detect diffuse γ-ray emission from the Perseus galaxy cluster, was computed the expected CTA sensitivity accounting for the CTA instrument response functions, and also discussed the CTA observing strategy of the Perseus galaxy cluster.

(ii). In [55] a sky model was built and made publicly available, combining data from recent observations of known gamma-ray emitters with state-of-the-art, physically-driven models of synthetic populations from the three main classes of established Galactic VHE sources (pulsar wind nebulae, young and interacting supernova remnants, and compact binary systems), as well as interstellar emission from cosmic-ray interactions in the Milky Way.

Other publications related to cosmology and astrophysics in this period are [80-82, 86,117-118,136-138,143-151,161,163].

4.1.2 Complex Systems

Biological and Ecological Systems

Mathematical modeling has been crucial for understanding biological and ecological systems. The emergence of a spatially organized population distribution depends on the dynamics of the population and mediators of interaction (activators and inhibitors). Ref. [56] generalizes the traditional coarse-graining procedure and applies this extended formalism to new scenarios in which mediators influence individuals' reproductive success or motility. Using a spatiotemporal Bayesian model, Ref. [57] analyzes the incidence of Cutaneous Leishmaniasis (CL) in the Brazilian Amazon from 2001 to 2017. This study concluded that the risk of CL increases significantly with deforestation, particularly where forest loss interacts with livestock activities. Ref. [58] presents a spatially explicit consumer-resource model for below-ground plant competition between ecosystem engineers that is used to determine under which environmental conditions soil-resource engineering emerges as an optimal strategy. Ref. [59] uses reaction-diffusion equations to model intraguild predation (IGP) dynamics during biological invasions. The findings underscore how habitat fragmentation and species preferences shape invasion speeds and coexistence in IGP communities.

In recent years, understanding COVID-19 and its variants has been a fundamental focus of the scientific community. Ref. [60] uses cryo-electron tomography and molecular dynamics simulations to study how the SARS-CoV-2 spike protein binds to the angiotensin-converting enzyme 2 (ACE2) receptor and drives membrane fusion through the refolding of its S2 domain. This finding paves the way for new therapies and vaccines to combat a wide range of betacoronaviruses.

Other publications related to biological and ecological systems in this period are [109-116,121-130,133-134,140-142].

Condensed Matter Theory

Two-dimensional coherent terahertz spectroscopy (2DCS) emerges as a valuable tool to probe the nature, couplings, and lifetimes of excitations in quantum materials. It thus promises to identify unique signatures of spin liquid states in quantum magnets by directly probing the properties of their exotic fractionalized excitations. Ref. [61] calculated the second-order 2DCS of the Kitaev honeycomb model and demonstrated that distinct spin liquid fingerprints appear already in this lowest-order nonlinear response when using crossed light polarizations.

The optical response of layered transition metal dichalcogenides (TMDCs) exhibits remarkable excitonic properties which are important from both fundamental and device application

viewpoints. In Ref. [62] was used ab-initio many-body perturbation calculations to investigate the exciton dynamics and spectra of bulk $2\mathrm{H} - \mathrm{MX}_2$ ($\mathrm{M} = \mathrm{Mo}, \mathrm{W}$, and $\mathrm{X} = \mathrm{S}, \mathrm{Se}$). On the other hand, the optical response of quasi-one-dimensional systems is often dominated by tightly bound excitons that significantly influence their basic electronic properties. Despite their importance for device performance, accurately predicting their excitonic effects typically requires computationally demanding many-body approaches. Ref. [63] presents a simplified model to describe the static macroscopic dielectric function, which depends only on the width of the quasi-one-dimensional system and its polarizability per unit length. Other works related to solid-state physics are [64–66].

Other publications related to condensed matter theory in this period are [69-70,73, 74-75,78-79,162,164].

4.2 Research Related to Visitors

During this period, the ICTP-SAIFR hosted 17 long-term and 265 middle-term visitors whose names and affiliations are here. The research developed by some of these visitors is described below:

Fernando Albuquerque Oliveira: UFF (4/12/2023 - 15/12/2023)
During our two-week visit we presented a colloquium for a large audience and a specialized seminar on statistical mechanics. We also started a collaboration with the researchers: Márcio Sampaio-Filho, Pablo de Castro, and Danilo Liarte. The research summary is presented below The Kardar-Parisi-Zhang (KPZ) equation describes a wide range of growth-like phenomena, with applications in physics, chemistry and biology. There are three central questions in the study of KPZ growth: the determination of height probability distributions; the search for ever more precise universal growth exponents; and the apparent absence of a fluctuation-dissipation theorem (FDT) for spatial dimension $d > 1$. Notably, these questions were answered exactly only for $1 + 1$ dimensions. In this work, we propose a new FDT valid for the KPZ problem in $d + 1$ dimensions. This is done by rearranging terms and identifying a new correlated noise which we argue to be characterized by a fractal dimension d_n. We present relations between the KPZ exponents and two emergent fractal dimensions, namely d_f, of the rough interface, and d_n. Also, we simulate KPZ growth to obtain values for transient versions of the roughness exponent α, the surface fractal dimension d_f and, through our relations, the noise fractal dimension d_n. Our results indicate that KPZ may have at least two fractal dimensions and that, within this proposal, an FDT is restored. Finally, we provide new insights into the old question about the upper critical dimension of the KPZ universality class.

Urko Reinosa: Centre de Physique Théorique - Ecole Polytechnique - CNRS (25/02/2024 - 09/03/2024)

During my first week, I gave three lectures on the Curci-Ferrari model, a phenomenological model for the gauge fixing of Yang-Mills theories and Quantum Chromodynamics in the infrared. I also initiated some discussions with the group of Gastao Krein around the analyticity properties of the gluon and the quark propagators and the question of positivity violation in non-Abelian gauge theories, as well as the applications of the Curci-Ferrari model to the study of hadron properties. A potential project has emerged around the question of the analytical structure of the correlators. During my second week, we continued the above discussions and enlarged them to the problem of evaluating gauge-invariant quark correlators that enter the definition of various non-perturbative QCD form factors. A potential project has emerged around the possibility of evaluating these quantities within the Curci-Ferrari model. We also exchanged on the relevance of center-vortices in YM/QCD theories. In addition to these discussion, I gave a colloquium about my research activity and could interact with various permanent staff members and students.

Stefano Foffa: Univ. of Geneva (02/04/2024 - 08/04/2024)
During the visit I had several discussions with Riccardo Sturani and his PhD student Alan Muller about our ongoing project on the role of quadrupole-quadrupole nonlinear interactions in the gravitational waveforms and in the energy balance of the emitting system. We have regular discussions during the year in remote mode (Zoom, Skype), but being here in presence makes a qualitative and quantitative difference. During my stay we could straight on some points related to implementation of the Ward identities (some constraints that the waveform must satisfy, related to the conservation of energy-momentum tensor), and we agreed on a few points to check in the near future. This work will certainly lead to one or more publications in the near future, although it is soon to tell precisely when.

Nickolas Kokron: Institute for Advanced Study (15/04/2024 - 26/04/2024)
Collaborated with IFT-UNESP PhD student Abdias Aires on a publication related to his Master's thesis, carried out under the supervision of Professor Rogerio Rosenfeld. The project concerns itself with a pressing challenge in statistical analysis of cosmological datasets, and the fact that their complexity has increased significantly with the advent of so-called "Stage IV" cosmological surveys. The aim of the publication we are working on is to introduce an alternative method, known as the "theoretical error covariance", to the modelling of the relationship between galaxies and the underlying dark matter distribution, which retains the same statistical information but has lower dimensionality. The project is at an advanced stage but some non-intuitive results were recently observed. Understanding these non-intuitive results led to the construction of toy models for what the "signal-to-noise ratio" of a cosmic survey is in the presence of uncertainty in your theory – the main result obtained during the visit. These results show that caution must be taken when constructing models for this theoretical error, or else spurious cosmological information could be introduced in datasets. This effect was previously

missed in the literature on “theoretical error covariances”.

M. Lisa Manning: Syracuse University (13/05/2024 - 18/05/2024)
During my visit, I discussed research with Prof. Danilo Liarte, postdoc Pablo de Castro, numerous students, and other visitors. I was there for a week, and we discussed problems related to active solids, including physical learning in active matter, and how some concepts from physical learning might apply to some active matter models we were all interested in. I also discussed how clustering of active agents might impact epidemiological models, and I participated and gave a talk at a soft matter and biological physics workshop.

Simona Procacci: Universite de Geneve (02/09/2024 - 20/09/2024)
During my visit to the ICTP-SAIFR, I had the chance to interact with the group of Prof. Riccardo Sturani and exchange different perspectives on gravitational wave developments in theory and experiments. In particular, I have learned about ongoing efforts and methods to disentangle different signals using waveform properties, and about the capabilities and operational features of upcoming experiments other than LISA. Also giving a mini-course on the role of gravitational waves in early-universe cosmology to an audience specialized in waveforms and late-universe predictions was a rich learning opportunity I am very grateful for. Moreover, interacting with the postdoc Duifje M. van Egmond I have learned how the Curci-Ferrari model could provide new results for the comparison of non-perturbative observables in pure Yang-Mills theories. These studies are still at the explorative stage, but I hope I could communicate the great interest there is for them in the cosmology community. Being in S.Paulo I also had the opportunity to visit Prof. Giorgio Torrieri in Campinas for a seminar and discuss some open questions in the thermalization dynamics that might have characterized the reheating period after inflation. His perspective from heavy-ions studies yields many hints to techniques new to me that might help shed light on this yet hard topic. Finally, a brief visit for a seminar at USP was the occasion to interact with the group of Prof. Gustavo Burdman, who pointed me to some glueballs mixed portal interactions I was not aware of and might be relevant for the analysis of the relic abundance of glueballs dark matter we did in a recent work with H. Kolesova and S. Biondini. To draw a balance, my visit is probably not directly connected with an advanced draft within a direct collaboration. However, I go home with many new ideas and homework that will be useful in several ongoing projects.

Ezequiel Alvarez: ICAS-UNSAM (19/10/2024 - 02/11/2024)
There has been a very rich interaction with ICTP-SAIFR researchers such as Profs. Rosenfald, Matheus, among others. I have given a special seminar which has raised a number of points that have deserved further discussion, in particular we have discussed using Bayesian techniques in pp -¿ ttHH, and how to remove the ttZZ background. I have also given a mini-course on Bayesian Machine Learning which was attended by about 30 participants, including professors,

graduates and undergraduates. The course has led us to discuss different fields of research with participants an din many of them we have made it to provide some clues on how they can apply the taught techniques in their specific problems. It has been a very productive week, my impression of ICTP-SAIFR, its researchers, its staff, and its direction is outstanding. I am very happy to have participated, and I expect to come back soon.

Marcia Rodrigues Tenser: São Paulo University (13/04/2024 - 27/04/2024)
"I discussed with Pedro Vieira about bootstrap techniques applied to 3d gauge theories and, in particular, to ABJM theory. We agreed on pursuing computations of loop diagrams up to two-loops, extending the approach that so far has been mostly explored in $4d$ $N = 4$ SYM theory." Note that $\mathcal{N} = 4$ SYM is a special four dimensional theory that showed up a few times above; ABJM is a three dimensional cousin of it, dual to quantum gravity in four space-time dimensions. It seems to be only every so slightly more complicated than $\mathcal{N} = 4$ SYM and we should thus push further the study of this theory to make sure we accomplish as much there as in $\mathcal{N} = 4$ SYM.

4.3 Organization of Activities

Between December 2023 – November 2024, ICTP-SAIFR organized eleven São Paulo International Schools for Theoretical Physics, eleven minicourses, five workshops, three symposiums, five meetings, and weekly outreach events, seminars, colloquia, and journal clubs. The complete list of 2024 activities is on the website https://www.ictp-saifr.org/2024-activities/, the list of weekly seminars, colloquia, and journal clubs is on the website https://www.ictp-saifr.org/2024-research-seminars-and-activities/. Most of the activities were recorded and the videos are available online on the associated websites.

4.3.1 São Paulo International Schools

The eleven São Paulo International Schools were on the subjects of data science and machine learning (December 4 - 8, 2023), modeling infectious disease dynamics (May 6-12), particle physics (June 24- July 5), dark matter and neutrino detection (July 8-19), theoretical physics (July 22-28), cosmology, gravitational waves and exoplanets (July 29- August 9), water anomalies: biological and technological applications (September 2 – 7), active matter (September 30 – October 4), quantum computing (October 7 – 18), few-body physics, nuclear physics and QCD (October 21 - 25) and biological physics and pattern formation (November 11 - 22). The schools were for mostly master's and PhD students, and those students not from São Paulo were housed in a hotel in shared rooms. The students were asked to anonymously evaluate the schools, and the links to view their evaluations are:

- Second School on Data Science and Machine Learning
- School on Modelling Infectious Disease Dynamics
- III Joint ICTP-SAIFR/ICTP-Trieste School on Particle Physics
- Second School on Dark Matter and Neutrino Detection
- Cosmological History: from Gravitational Waves to Exoplanets
- School on Water: From the Anomalies to the Biological and Technological Applications
- School on Active Matter
- Second Quantum Computing School
- ICTP-SAIFR/ExoHad School on Few-Body Physics: Nuclear Physics from QCD
- School on Biological Physics across Scales: Pattern Formation

All lectures of the schools were filmed and the videos are available online on the school websites.

Second School on Data Science and Machine Learning (December 4-8, 2023)

The Second School on Data Science and Machine Learning (December 4-8, 2023) is described on the website https://www.ictp-saifr.org/dsml2023/ and involved 5 lecturers and 47 participants. This school focused on training PhD students, postdocs, and outstanding master's students in machine learning, neural networks, convolutional neural networks, generative models, reinforcement learning and natural language processing.

Lecturers and Topics:

- Raphael Mendes de Oliveira Cóbe (NCC – Unesp, Brazil): *Introduction to Machine Learning Models and Neural Networks.*
- Alexandre Xavier Falcão (IC – Unicamp, Brazil): *Convolutional Neural Networks.*
- Luciano Oliveira (UFBA, Brazil): *Generative Models.*
- Marcelo Finger (IME-USP, Brazil): *Natural Language Processing.*
- Felipe Fernandes Fanchini (FC-Bauru-Unesp, Brazil): *Quantum Machine Learning.*

School on Modelling Infectious Disease Dynamics (May 6-12)

The School on Modelling Infectious Disease Dynamics (May 6-12) is described on the webpage https://www.ictp-saifr.org/smidd2024/ and involved 4 lecturers and 44 participants. At the school, students were familiarized with epidemic models and numerical treatment of epidemiological data. The school had lectures on the following topics: models for infectious disease dynamics, epidemiological data analysis, numerical methods and complexity in epidemiological model.

Lecturers and Topics:

- Roberto Kraenkel (IFT-UNESP): *Compartmental Models for Infectious Disease Dynamics.*
- Marcelo Ferreira da Costa Gomes (Fiocruz/RJ): *Epidemiological Data Analysis.*
- Renato Coutinho (UFABC): *Numerical Methods.*
- Guillaume Le Treut (Chan Zuckerberg Biohub, San Francisco): *Dealing with Complexity in Epidemiological Models.*

III Joint ICTP-SAIFR/ICTP-Trieste School on Particle Physics (June 24 - July 5)

This two-week school organized from June 24 to July 5 provided lectures on Standard Model and beyond, cosmology, particle physics, collider physics, amplitudes and applications, and dark matter. The school involved 6 lecturers and 57 participants. For a more detailed description see the website https://www.ictp-saifr.org/sspp2024/

Lecturers and Topics:

- Christophe Grojean (DESY, Germany): *Standard Model and Beyond.*
- Kfir Blum (Weizmann Institute, Israel): *Cosmology and Particle Physics.*
- Laura Reina (Florida State University, USA): *Collider Physics.*
- Yu-tin Huang (National Taiwan University, Taiwan): *Amplitudes and applications.*
- Markus Luty (University of California at Davis, USA): *Formal developments in Beyond Standard Models.*
- Nicolás Bernal (New York University Abu Dhabi, United Arab Emirates): *Dark Matter.*

Second School on Dark Matter and Neutrino Detection (July 8-19)

The first week of this school took place in the IFT-UNESP auditorium and provided a theoretical introduction to Dark Matter and neutrino physics. The second week was at the Principia Institute and focused on detection techniques, with the afternoons devoted to experimental work in small groups. The school involved 8 lecturers, 13 professors leading the projects in the laboratories and 75 participants. For a more detailed description see the website https://www.ictp-saifr.org/ssdmnd2024/

Lecturers and Topics:

1st week

- Graciela Gelmini (UCLA, USA): *Dark Matter*.
- Pedro Machado (FNAL, USA): *Neutrino physics*.
- Nicolás Bernal (New York University Abu Dhabi, UAE): *Dark Matter beyond WIMPs*.
- Matheus Hostert (Harvard): *Neutrinos Beyond the Standard Model*.

2nd week

- Daniel Pershey (FSU, USA): *Neutrino detection*.
- Javier Tiffenberg (Fermilab, USA & UBA, Argentina): *Dark Matter Detection*.
- Luca Marsicano (INFN, Italy): *Accelerator Dark Matter detection*.
- Dario Rodrigues (UBA, Argentina): *Neutrino detection with CCDs*.

Laboratory and hands-on activities:

At Principia Institute:

- Dario Rodrigues (UBA, Argentina): *Sensitivity and exclusion limits for DM & Nu experiments*.
- Laura Paulucci (UFABC, Brazil) & Franciole Marinho (ITA, Brazil): *LAr experiment design using Monte Carlo simulations*
- Ana Botti (Fermilab, USA): *Particle detection with a CMOS camera*.
- Matias Rolf Hampel (ITeDA, Argentina): *Muon veto systems based on plastic scintillators*.
- Vinicius Franco Lima & Irina Nasteva (UFRJ, Brazil): *Particle detection using a silicon pixel detector*.

At Universidade de São Paulo (USP):

- Simone Sanfilippo (INFN, Italy): *Characterization of Silicon PhotoMultipliers for astroparticle physics applications*.
- Edivaldo Moura Santo & Nikolas Kemmerich (USP, Brazil): *Pulse-shape discrimination for gamma-neutron separation*.
- Edivaldo Moura Santos & Nikolas Kemmerich (USP, Brazil): *Compton edge-based energy resolution measurements with a coincidence setup*.
- Guilherme S. Zahn, Paulo Sérgio C. da Silva & Frederico A. Genezini (IPEN-CNEN/SP, Brazil): *Gamma Spectrometry using Semiconductor Detectors*.

7th Perimeter-SAIFR-IFT Journeys in Theoretical Physics (July 22-28)

The 7th edition of this school is described on the website https://journeys.ictp-saifr.org/ and involved 4 lecturers and 84 participants. The top students from this school were invited to a joint Master's program at Perimeter and either IFT-UNESP or USP. The students accepted to the joint program include Bruno Sivilotti (Univ. de Buenos Aires), Rennan Gomes de Albuquerque (UFPB), and Diana Cruz Pestana (USP São Paulo).

Lecturers and Topics:

- L. Raul Abramo (IF-USP, Brazil): *Cosmology and structure formation in the era of Machine Learning*.
- Dario Rosa (ICTP-SAIFR & IFT-UNESP, Brazil): *An introduction to quantum computing.*
- Pedro Vieira (Perimeter Institute, Canada & ICTP-SAIFR, Brazil): *Anti de Sitter*.
- Tim Hsieh (Perimeter Institute, Canada): *From pure to mixed quantum phases of matter.*

Cosmological History: from Gravitational Waves to Exoplanets (July 29 – August 9)

This school organized from July 29 – August 9 provided lectures on star evolution, planet formation, gravitational waves, astrophysics, exoplanets, galaxy formations in cosmic ecosystem, dynamics of collisional stellar systems and applications to gravitational waves astronomy. The school involved 10 lecturers and 42 participants. For a more detailed description see the website https://www.ictp-saifr.org/chgwe2024/

Lecturers and Topics:

- Sydney Barnes (Leibniz Institute for Astrophysics Potsdam (AIP), Germany): *Star evolution*.
- Wladimir Lyra (New Mexico State U., USA): *Planet formation*.
- Filippo Santoliquido (GSSI, L'Aquila, Italy): *Gravitational Wave Astrophysics* .
- Cristina Chiappini (Leibniz Institute for Astrophysics Potsdam, Germany): *Galactic Archeology in the Gaia era.*
- Camilla Danielski (INAF Arcetri, Italy): *Exoplanets beyond the Main sequence*.
- Romeel Davé (U. of Edinburgh, UK): *Galaxy Formation in the Cosmic Ecosystem*.
- Alessandro Trani (U. de Tokyo, Japan): *Introduction to dynamics of collisional stellar systems and applications to gravitational wave astronomy*.

School on Water: From the Anomalies to the Biological and Technological Applications (September 2 – 7)

The School on Water: From the Anomalies to the Biological and Technological Applications (September 2 – 7) is described on the webpage https://www.ictp-saifr.org/sw2024/ and involved 5 lecturers and 31 participants. This school, dedicated to studying water anomalies, included lectures on hydrophobic and hydrophilic surfaces and interfaces, nanoconfined water, supercooled water, and scattering and structural factors.

Lecturers and Topics:

- Gustavo Appignanesi (Universidad Nacional del Sur, Argentina): *Hydrophobic and Hydrophilic Surfaces and Interfaces.*
- Marcia Barbosa (UFRGS, Brazil): *Nanoconfined Water.*
- Paola Gallo (Roma Tre University, Italy): *Dynamics and Supercooled Water.*
- Enrique Lomba (CSIC, Spain): *Scattering and Structural Factor.*
- J. Rafael Bordin (UFPel, Brazil): *Anomalies and poly(a)morphism in (some) core-softened models.*

School on Active Matter (September 30 – October 4)

The School on Active Matter (September 30 – October 4) is described on the website https://www.ictp-saifr.org/sam2024/ and involved 4 lecturers and 75 participants. The school was aimed at PhD students, postdocs and outstanding Master's students and lecture topics included active nematics and mechanobiology, computational models of active systems, theoretical foundations of active matter, and the physics of flocking.

Lecturers and Topics:

- Julia M Yeomans (University of Oxford, UK): *From Active Nematics to Mechanobiology.*
- Rodrigo Soto (Universidad de Chile, Chile): *Computational Modeling of Active Systems.*
- Aparna Baskaran (Brandeis University, USA): *Theoretical Foundations of Active Matter: Lessons from Ideal Microscopic Models.*
- Francesco Ginelli (University of Insubria, Italy): *Physics of Flocking.*

Special Presentation:

- Antonio Romaguera (Universidade Federal Rural de Pernambuco, Brazil): *Active matter with Hexbugs robot toys: Experimental demonstration.*

Second Quantum Computing School (October 7 -18)

The Second Quantum Computing School (October 7 -18) is described on the website https://www.ictp-saifr.org/sqcs2024/ and involved 7 lecturers and 95 participants. Topics discussed in the lectures included quantum communication with structured light, quantum computing and quantum chemistry, technological applications of Bose-Einstein condensation, quantum networks, quantum machine learning and trapped ion quantum processors.

Lecturers and Topics:

- Antonio Zelaquett (UFF-Niteroi, Brazil): *High Dimensional Quantum Communication with Structured Light.*
- Daniel Nino (Xanadu, Canada): *Introduction to Applications of Quantum Computing to Quantum Chemistry (with hands-on – PennyLane).*
- Emanuel Henn (USP, Brazil): *Bose-Einstein Condensates and the Involvement in Advances for New Technologies.*
- Juan José García Ripoll (QUINFOG-CSIC, Spain): *Quantum Networks for Quantum Computers.*
- Marco Cerezo (Los Alamos National Laboratory, USA): *Prospects and Challenges for Quantum Machine Learning.*
- Markus Hennrich (Stockholm University, Sweden): *Trapped ion quantum processors.*
- Miroslav Ježek (Palacky University Olomouc, Czech Republic): *Application of Machine Learning for Advanced Quantum Detection.*

Invited Speaker:

- Victoria Porozova (Centro de Pesquisas Avançadas Wernher von Braun, Brazil): *Quantum Gravity meets Quantum Computing*.

ICTP-SAIFR/ExoHad School on Few-Body Physics (October 16 – 25)

This school organized from October 16 - 25 provided lectures on non-relativistic quantum scattering, particle Physics, Lagrangians, & Feynman rules, relativistic scattering theory, lattice QCD, effective field theory, and finite-volume physics. The school involved 6 lecturers and 51 participants. For a more detailed description see the website https://www.ictp-saifr.org/sfbp2024/.

Lecturers and Topics:

- Lucas Madeira (USP São Carlos, Brazil): *Non-relativistic Quantum Scattering*.

- Felipe Ortega-Gama (Lawrence Berkeley Lab, USA): *Basic Particle Physics, Lagrangians, & Feynman Rules*.
- Sebastian Dawid (University of Washington, USA): *Relativistic Scattering Theory*.
- Amy Nicholson (University of North Carolina at Chapel Hill, USA): *Lattice QCD*.
- André Walker-Loud (Lawrence Berkeley Lab, USA): *Effective Field Theory*.
- Andrew Jackura (William & Mary, USA) and Raúl Briceño (U.C. Berkeley, USA): *Finite-Volume physics*.

School on Biological Physics across Scales: Pattern Formation (November 11 – 22)

The School on Biological Physics across Scales: Platter Formation is described on the website https://www.ictp-saifr.org/sbpspf2024/ and involved 6 lecturers and 57 participants. The school included lectures on stochastic pattern formation, spatial ecology, self-organization, and pattern formation in living and synthetic cells.

Lecturers and Topics:

- Nigel Goldenfeld (University of California San Diego, USA): *Stochastic pattern formation in space and time: from the brain to the biosphere.*
- Johan van de Koppel (Royal Netherlands Institute for Sea Research, Netherlands): *The Physics of spatial ecology.*
- Erwin Frey (Ludwig-Maximilians-Universität München, Germany): *Self-organisation and pattern formation in living and synthetic cells.*
- Veronica Grieneisen (Cardiff University, UK): *Integrating the different levels of pattern formation, from sub-cellular to cellular and finally, multi-cellular structures.*

4.3.2 Workshops

ICTP-SAIFR organized workshops on the subjects neutrino-nucleus interactions, dynamical processes on complex networks, integrability in gauge and string theory, and quantum aspects of gravity in a lab. The purpose of these workshops was to discuss the status, recent progress and perspectives in each of the fields mentioned.

14th International Workshop on Neutrino-Nucleus Interactions (NUINT 2024) (April 15-20)

This workshop took place at Instituto Princípia and the topics discussed included neutrino flux predictions and measurements, neutrino interaction generators, $\mathrm{QE} + 2\mathrm{p2h}/0 - \pi$ production, pion production/SIS/DIS, low-energy neutrino scattering, charged lepton and pion scattering,

and impact of scattering uncertainties on measurements. The website of the workshop is https://www.ictp-saifr.org/nuint2024/ and the speakers included:

Session-1: Neutrino flux predictions and measurements:

- Katsuya Yonehara (Fermilab).
- Laura Fields (Notre Dame University).
- Megan Friend (KEK).

Session-2: Neutrino interaction generators:

- Yoshinari Hayato (ICRR, The University of Tokyo).
- Julia Tena-Vidal (Tel Aviv University).
- Pedro Machado (Fermilab).

Session-3: $\mathrm{QE} + \mathrm{2p2h}/0 - \pi$ **production:**

- Stephen Dolan (CERN).
- Joanna Sobczyk (Johannes Gutenberg University).
- Saori Pastore (Washington University in Saint Louis).
- Richard Gran (University of Minnesota Duluth).

Session-4: Pion Production/SIS/DIS:

- Minoo Kabirnezhad (Imperial College London).
- Mohammad Sajjad Athar (Aligarh Muslim University).
- Laura Munteanu (CERN).
- Kirk Bays (Minnesota).

Session-5: Low-energy neutrino scattering:

- Bryce Littlejohn (Illinois Institute of Technology).
- Maria Cristina Volpe (APC/CNRS).
- Claudia Nones (CEA/IRFU).
- Raimund Strauss (TUM).

Session-6: Charged lepton and pion scattering:

- Adi Ashkenazi (Tel Aviv University).
- Camilo Mariani (Virginia Tech).
- Artur Ankowski (Wroclaw).

Session-7: Impact of scattering uncertainties on measurement:

- Callum Wilkinson (Lawrence Berkeley National Laboratory).
- Linda Cremonesi (Queen Mary University of London).
- Luke Pickering (STFC UKRI).

Workshop on Dynamical Processes on Complex Networks (May 13-17)

This workshop was held from May 13 to 17 and included 59 participants and 20 international speakers from nine different countries. The event covered a range of topics, including dynamics in complex networks, contagion models on higher-order networks, chimera states in neuronal networks, public transport networks, and nonlocally coupled oscillators. The website of the conference is https://www.ictp-saifr.org/wdpcn2024/ and the speakers included:

Confirmed Speakers:

- Marco Ajelli (Indiana University Bloomington, USA): *Computational tools to respond to health emergencies*.
- Celia Anteneodo (PUC – Rio de Janeiro, Brazil): *Opinion dynamics in complex networks*.
- Guilherme Ferraz de Arruda (CENTAI Institute, Italy): *Contagion models on higher-order networks*.
- Marcelo Avila (Universidad Mayor de San Andrés, Bolivia): *Firefly flashing behavior as a paradigmatic example of synchronization in complex networks: from simple inevitable sync to mobile oscillators*.
- Antonio Batista (Universidade Estadual de Ponta Grossa, Brazil): *Chimera states in neuronal networks*.
- Jose Antonio Mendez-Bermúdez (Universidad Autónoma de Puebla, Mexico): *Scaling properties of directed multilayer random networks: A Random Matrix Theory approach*.
- Stefano Boccaletti (CNR- Institute for Complex Systems, Italy): *Describing the transition to synchronization of networked systems: revealing (and controlling) clusters and modular behavior*.
- Timoteo Carletti (Namur Institute for Complex Systems, Belgium): *Global Synchronization on networks and beyond*.
- Gabriela Castellano (Universidade Estadual de Campinas, Brazil): *Complex networks to understand brain re/organization in motor rehabilitation and brain-computer interfaces*.
- Fernando Ferreira Fagundes (USP, Brazil): *Exploring Networks in Modeling Complex Systems: Examples in Economic and Agricultural Systems*.
- Kelly Iarosz (Centro Universitário de Tel. Borba, Brazil): *Plasticity: an incredible brain capacity*.

- Sarika Jalan (Indian Institule of Technology, India): *Phase oscillators with higher order interactions: rotating clusters*.
- Alberto Aleta (University of Zaragoza, Spain): *The unequal effects of the health-economy tradeoff during the COVID-19 pandemic*.
- Andre Martins (USP Leste, Brazil): *The coevolution of opinions and networks*.
- Adilson Motter (Northwesten University, USA): *Complex Contagion: Unfolding and Control*.
- Camilo Neto (USP Leste, Brazil): *Structure and robustness of São Paulo public transport network*.
- Tiago Pereira (Universidade de Sao Paulo, Brazil): *Emergent chaos in the Turing-Smale problem*.
- Gaël Rosain Simo (University of Ebolowa, Cameroon): *Collective behaviors in neuronal networks under the actions of electric and magnetic fields*.
- Ricardo Viana (Universidade Federal do Parana, Brazil): *Phase and frequency synchronization of nonlocally coupled oscillators*
- Jean-Gabriel Young (University of Vermont, USA): *Complex or simple? Determining a contagion's type from observational data.*

Bootstrap meets Integrability (June 10-14)

This workshop was held from June 10 to 14 at the Principia Institute. During the workshop, several areas like bootstrap and integrability in defect CFTs, light-ray operators, integrability in Fishnet CFTs, Regge trajectories, higher twist and complex spin, and quantum spectral curve were covered. The website of the workshop is https://exact.ictp-saifr.org/workshop-2024/ and the speakers included:

Speakers:

- C. Meneghelli (INFN Milano Bicocca and Universita di Parma, Italy) & M. Preti (Nordita, Sweden): *Bootstrap + integrability in defect CFTs*.
- Caron Huot (McGill University, Canada): *Light-ray operators*.
- E. Olivucci (Perimeter Institute, Canada): *Integrability in Fishnet CFTs*.
- P. Kravchuk (King's College London, UK): *Regge trajectories, higher twist and complex spin*.
- Z. Zahree (CERN, Switzerland): *Bootstrap+Integrability for* $N = 4$ *SYM correlators*.
- P. Vieira (Perimeter Institute, Canada & ICTP-SAIFR, Brazil): *Challenges in Integrability*.
- N. Gromov (King's College London, UK): *Quantum Spectral Curve (QSC)*.

Integrability in Gauge and String Theory (June 17-21)

The workshop's main topics discussed by the 102 participants were recent advances in studying non-perturbative physics and strongly interacting models. This activity was a natural continuation of workshop Bootstrap meets Integrability. The website is https://www.ictp-saifr.org/qm2023/ and the speakers included:

Speakers:

- F. Ambrosino (DESY Hamburg, Germany): *Exploring 2d QCD with Integrability*.
- Z. Bajnok (HUN-REN Wigner Research Centre for Physics, Hungary): *Octagon resurgence*.
- B. Basso (Ecole Normale Superieure, France): *OPE and Wilson loops for form factors of local operators*.
- N. Berkovits (ICTP-SAIFR/IFT-UNESP, Brazil): *On the equivalence of the RNS and Pure Spinor Superstring*.
- M. Bianchi (Universidad San Sebastián, Spain): *Uniform transcendentality and correlation functions in* $N = 4$ *SYM*.
- B. Carneiro (Universidade Federal de Pernambuco, Brazil): *Semiclassical conformal blocks and black hole scattering*.
- D. Correa (Instituto de Fisica de La Plata, Argentina): *Is the bosonic* $1/6$ *BPS Wilson loop in ABJM integrable?*
- S. Ekhammar (King's College London, UK): *New Approach to Strongly Coupled N=4 SYM via Integrability*.
- M. Gaberdiel (ETH Zurich, Switzerland): *Integrability in the Symmetric Orbifold*.
- T. Hansen (Durham University, UK) *The AdS Veneziano amplitude*.
- V. Kazakov (Ecole Normale Superieure, France): *Matrix model and Riemann-Hopf hydrodynamics for structure constants of huge* $1/2$ *BPS operators of* $N = 4$ *SYM*.
- S. Komatsu (CERN, Switzerland): *Non-invertible Symmetries, Scattering Amplitudes and Integrability*.
- C. Kristjansen (Niels Bohr Institute, U. Copenhagen, Denmark): *Integrable Holographic defect CFTs*.
- J. H. Lee (Perimeter Institute, Canada): *On Branes and Trace Relations*.
- E. Mazenc (ETH Zurich, Switzerland): *Strings from Feynman Diagrams*.
- J. Minahan (Uppsala University, Sweden): *The Hagedorn temperature from integrability*.
- V. Mishnyakov (Nordita, Sweden): $N = 4$ *SYM on the Coulomb branch: holography, OPE and large charges*.
- C. Paletta (Trinity College Dublin, Ireland): *Integrability of open quantum circuits*.
- M. Preti (Nordita, Sweden): *ABBA - solving the BFKL regime*.

- D. Serban (IPhT Saclay, France): *Twisting the pants: integrability and the $Z2$ orbifold of $N = 4$ SYM.*
- A. Sfondrini (Universita di Padova and INFN, Italy): *Understanding AdS3/CFT2 with mixed background fluxes.*
- I. Szécsényi (University of Modena and Reggio Emilia, Italy): *Regge spectroscopy of higher twist states in $N = 4$ supersymmetric Yang-Mills theory*
- B. Vicedo (University of York, Canada): *$3d$ integrable field theories from $5d$ 2-Chern-Simons theory.*
- K. Zarembo (Nordita, Sweden): *Chiral transition in the Gross-Neveu model from Bethe Ansatz.*
- D. Zhong (Imperial College London, UK): *Bootstrapping Smooth Line Operators in Chern-Simons-Matter CFTs.*

Short Talks:

- R. Pitombo (ICTP-SAIFR/IFT-UNESP, Brazil): *$4D$ Chern-Simons and the pure spinor $\mathrm{AdS5} \times \mathrm{S5}$ superstring.*
- A. L. Retore (Durham University, UK): *Elliptic deformations of $\mathrm{AdS3} \times \mathrm{S3}$ S-matrices.*
- L. Martins (IIP-UFRN, Brazil): *$\mathrm{SU}(2,2) \times \mathrm{SU}(4)$ covariance in $\mathrm{AdS5} \times \mathrm{S5}$ pure spinor formalism.*
- M. Tenser (University of Milano Bicocca, Italy): *ABJM theory and defect RG flows.*
- N. Sokolova (King's College London, UK): *Exploring Excited Strings in $\mathrm{AdS5/CFT4}$.*
- H. Murali (Perimeter Institute, Canada): *Huge $1/2$ BPS structure constants as fluids - solution methods and numerics*

Witnessing Quantum Aspects of Gravity in a Lab (September 23 – 27)

The workshop Witnessing Quantum Aspects of Gravity in a Lab (September 23 – 27) involved 35 speakers from eight different countries and 43 participants. In the workshop were discussed various topics related to potential quantum experiments on gravity and theoretical aspects of general relativity. The website of the workshop is https://www.ictp-saifr.org/wqag2024/ and the speakers included:

Speakers:

- Alessandro Codello (Universidad de la Republica, Uruguay): *Asymptotic Safety and/or EFT of Quantum Gravity.*
- André Landulfo (UFABC, Brazil): *Quantum Communication in Curved Spacetimes.*
- Antonio D. Pereira (UFF, Brazil): *The predictive power of Asymptotically Safe Quantum Gravity: Can we test it?*

- Barbara Amaral (USP São Paulo, Brazil): *How can we define and quantify non-classicality?*
- Carlo Cepollaro (Austrian Academy of Sciences and University of Vienna, Austria): *Towards an experimental test for a quantum extension of Einstein's equivalence principle*.
- Daine Danielson (University of Chicago, USA): *Black Holes and Cosmological Horizons Decohere Quantum Superpositions*.
- Dave Moore (Yale University, USA): *Optically levitated nanogram-scale masses for precision tests of gravity*.
- Gautam Satishchandran (Princeton University, USA): *Gravitationally Mediated Entanglement: Newtonian Fields, Gravitons and Black Holes*.
- Gavin Morley (University of Warwick, UK): *Levitating Diamonds Containing Nitrogen-Vacancy Centres*.
- Hendrik Ulbricht (Southampton University, USA): *Large-mass quantum systems for testing the overlap between quantum mechanics and gravity*.
- Iarley Lobo (Federal University of Paraíba and Federal University of Lavras, Brazil): *Quantum-spacetime effects on nonrelativistic Schrödinger evolution*.
- Jack Harris (Yale University, USA): *Testing quantum mechanics by measuring the high-amplitude motion of a massive oscillator*.
- John F. Donoghue (UMass Amherst, USA): *General Relativity and Quantum Field Theory*.
- Jonathan Oppenheim (University College London, UK): *A postquantum theory of classical gravity?*
- Kristian Piscicchia (INFN-LNF and Centro Ricerche Enrico Fermi, Italy): *Highly sensitive X-ray measurements to investigate the interplay between quantum mechanics and gravity*.
- Luca Apadula (Austrian Academy of Sciences and University of Vienna, Austria): *Dentification is Pointless: Quantum Reference Frames, Localization of Events, and the Quantum Hole Argument*.
- Marko Toros (University College London, UK): *Searching for signatures of quantum gravity in the laboratory*.
- Markus Arndt (University of Vienna, Austria): *Universal matter-wave interferometry across the mass & complexity scales*.
- Markus Aspelmeyer (University of Vienna, Austria): *Quantum Soucers of Gravity*.
- Massimo Blasone (University of Salerno, Italy): *Weak equivalence principle violation for flavor neutrinos states*.
- Maurício Richartz (UFABC, Brazil): *Superradiance and ergoregion instabilities in vortices*.
- Nami Svaiter (CBPF, Brazil): *Analog Model for Euclidean Wormholes Effects*.

- Oriol Romero-Isart (University of Innsbruck, Austria): *Towards the gravitational quantum regime*.
- Peter Barker (University College London, UK): *Characterising and calibrating levitated nano-mechanical systems for sensing*.
- Philip Stamp (University of British Colombia, Canada): *The CWL theory of Quantum Gravity*.
- Robert Mann (Perimeter Institute and University of Waterloo, Canada): *Spacetime in Superposition*.
- Roldão da Rocha (UFABC, Brazil): *Deformations of AdS(5)-Schwarzschild black branes: constraints from the viscosities of the quark-gluon plasma at LHC and RHIC*.
- Ron Folman (Ben Gurion University, Israel): *Can a Rock be a Wave? From 100 years of De-Broglie's Wave-Particle Duality, to Quantum-Gravity*.
- Sandro Donadi (Queens University, UK): *Underground test of gravity-related wave function collapse*.
- Thiago Guerreiro (PUC-Rio, Brazil): *Structured light levitation of nanoparticles for fundamental physics experiments*.
- Timothy Light Kovachy (Northwestern University, USA): *Exploring Connections Between Large-Scale Atom Interferometry and High-Mass Matter Wave Interferometry*.
- Tong Cang Li (Purdue University, USA): *Levitated Optomechanics with Internal Quantum States*.
- Vivishek Sudhir (MIT, USA): *Precision mechanical tests of gravity's quantumness?*
- Yanbei Chen (Caltech, USA): *Testing Quantum Nature of Gravity*.

4.3.3 Symposiums

ICTP-SAIFR organized three symposiums on 2024, the ICTP-SAIFR 12th Anniversary Symposium: Physics for South America, III LASF4RI for HECAP Symposium: Update of the Strategic Plan, and 3rd Symposium on Current Topics in Molecular Biophysics (CTMB3). The purpose of these symposiums was to discuss the status, recent progress and perspectives in each of the fields mentioned.

ICTP-SAIFR 12th Anniversary Symposium: Physics for South America (February 18-20)

From February 18-20, ICTP-SAIFR celebrated this symposium. The commemoration included public talks, research seminars, round-table discussions, and several invited speakers including Nobel Laureate David Gross. This symposium was part of the ICTP 60th anniversary celebration. For a more detailed description see the website https://www.ictp-saifr.org/symposium12/.

Public Lectures:

- Paulo Nussenzveig (USP research dean): *A nova onda de tecnologias quânticas e o Brasil*.
- Harry Westfahl Jr. (Sirius-LNLS director): *Sirius – Acelerando o futuro da ciência brasileira*.
- David Gross (KITP ex-director, 2004 Nobel Prize in Physics): *My bucket list (Minha lista de desejos)*.

Parallel Sessions:

Complex systems & Biophysics

- Pablo de Castro (ICTP-SAIFR/IFT-UNESP, Brazil): *Collective dynamics of self-propelled agents from active matter to ecology*.
- Roberto Kraenkel (IFT-UNESP, Brazil): *Modelling an ongoing epidemic: Covid-19 and Brazilian data*.
- Danilo Liarte (ICTP-SAIFR/IFT-UNESP, Brazil): *The ubiquitous criticality of disordered solids*.
- Marcia Barbosa (MCTI secretary of strategic projects, Brazil): *Atmospheric water harvesting using functionalized carbon nanocones structure*.
- Silvina Ponce Dawson (Univ. Buenos Aires, IUPAP president-designate. Argentina): *The use of dynamics to enhance the signaling capabilities of cells*.
- Marcus Aguiar (Unicamp, Brazil): *Generalized frustration in the multidimensional Kuramoto model*.
- Jose Onuchic (Rice University, USA): *Modeling the Genome: a view by a physicist*.
- Giovani L. Vasconcelos (UFPR, Brazil): *Turbulence as a platform to study quantum and classical complex systems*.
- Adilton Carneiro (USP Ribeirão Preto, Brazil): *Medical Physics beyond ionizing radiation: theranostic platforms*.
- Antonio Costa (USP Ribeirão Preto, Brazil): *Biomolecular condensates as organizers of the intracellular milieu*.
- William Bialek (Princeton Univ., USA): *Searching for scale invariance in animal behavior*.

Particle physics & Field theory

- Jorge Zanelli (CECs Valdivia, Chile): *BPS conical excesses in AdS3 supergravity*.
- Gerardo Aldazabal (Balseiro Institute, Argentina): *A field theory with "stringy effects"*.

- Horatiu Nastase (IFT-UNESP, Brazil): *Monopole problem and monopole non-gaussianities in holographic cosmology*.
- Gustavo Burdman (USP, Brazil): *Momentum dependence in Higgs couplings and physics beyond the Standard Model*.
- Matthias Neubert (Mainz ITP director, Germany): *Flavor probes of axion-like particles*.
- Oscar Eboli (USP, Brazil): *Effective theories at the LHC*.
- Diego Restrepo (Univ. Antioquia, Colombia): *Abelian gauge theories*.
- Gastao Krein (IFT-UNESP, Brazil): *Mechanisms of quark confinement*.
- Ilya Shapiro (UFJF, Brazil): *New results on the conformal anomaly and anomaly-induced effective action of gravity*.
- Pedro Vieira (Perimeter-SAIFR Coordinator, Brazil): *One open problem in AdS/CFT*.
- Andrei Mikhailov (IFT-UNESP, Brazil): *Yang-Mills algebra and symmetry transformations of vertex operators*.

Cosmology & Astrophysics

- Raul Abramo (IF-USP, Brazil): *Cosmology in the era of machine learning*.
- Martin Makler (ICAS, Brazil): *A new lensing landscape in the era of time-domain, multi-wavelength, multimessenger astrophysics*.
- Oscar Reula (Univ. Nac. Córdoba, Brazil): *What are we doing at Córdoba?*
- Riccardo Sturani (IFT-UNESP, Brasil): *Gravitational wave astronomy*.
- Débora Peres Menezes CNPq DASD director, Brazil): *Gravitational waves as a tool to probe hybrid stars and the QCD phase transition*.
- Gustavo E. Romero (Argentinian Radioastronomy director, Argentina): *Electromagnetic signatures of imminent supermassive black hole merger*.
- Marek Nowakowski (IFT-UNESP, Brazil): *Aspects of quantum gravity in gravitational collapse*.
- Rogerio Rosenfeld (ICTP-SAIFR vice-director, Brazil): *The Brazilian participation in Rubin Observatory's Legacy Survey of Space and Time project*.
- Chee Sheng Fong (UFABC, Brazil): *Sphaleron portal baryogenesis*.
- Luiz Vitor de Souza Filho (USP São Carlos, Brazil): *Astroparticle physics: the energetic elite of the Universe*.
- Ivone Albuquerque (IF-USP, Brazil): *Search for light dark matter with LAr targets*.

Condensed Matter & Quantum systems

- Rodrigo Capaz (Brazilian Physical Society president, Brazilian Nanotechnology Lab director, Brazil): *Formation and rupture of ultrathin ionic wires*.

- Eduardo C. Marino (UFRJ, Brazil): *A successful theory for high-Tc superconductivity in cuprates*.
- Gustavo Dalpian (USP, Brazil): *Data science in the context of condensed matter physics*.
- Adalberto Fazzio (CNPEM-Ilum school director, Brazilian Nanotechnology Lab ex-director, Brazil): *Topological insulating phase arising in Jacutingaite-family ordered and random alloys*.
- Eduardo Fradkin (Univ. of Illinois, USA): *The uses of duality*.
- Eduardo Miranda (Unicamp, Brazil): *Achievements and challenges in the field of disordered interacting electrons*.
- Victor Luiz Quito (USP São Carlos, Brazil): *Exploring quantum materials: novel insights through multidimensional spectroscopy*.
- Gustavo Wiederhecker (Unicamp, Brazil): *Harnessing light and sound interaction in photonic chips*.
- Marcelo Martinelli (USP, Brazil): *Building quantum machines with light*.
- Dario Rosa (IFT-UNESP, Brazil): *Shallow quantum circuits are robust hunters for quantum many-body scars*.
- Alvaro Ferraz (IIP-UFRN director, Brazil): *Topological effects in strongly correlated systems*.

Keynote Talks:

- William Bialek (Princeton Univ., USA): *Ambitions for theory in the physics of life.*
- Gabriela González (Louisiana State Univ., USA): *Gravitational waves astronomy*.
- Rosario Fazio (ICTP Trieste, Italy): *Non-equilibrium quantum many-body systems and quantum simulators*.

III LASF4RI for HECAP Symposium: Update of the Strategic Plan (August 26-29)

From August 26-29, the third edition of Latin American Strategic Forum for Research Infrastructure (LASF4RI) took place at Instituto Principia. The Symposium included presentations by representatives of various funding agencies including the president of the Brazilian agency CNPq, Ricardo Galvão, as well as talks on the 34 white papers submitted by the Latin American community of high-energy, cosmology and astroparticle physicists. The website of the symposium is https://www.ictp-saifr.org/hecap2024/ and the invited speakers included:

Invited Speakers:

- Luciano Maiani – chair of the LASF4RI High Level Strategy Group
- Ricardo Galvão – Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq, Brazil)
- Sylvio Canuto – Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP, Brazil)
- Rafael Anta – Banco Interamericano de Desenvolvimento (BID)
- Sharapyia Kakimova – Agencia Nacional de Investigación y Desarrollo (ANID, Chile)
- Ana Patricia Torres – Consejo Nacional de Humanidades, Ciencias y Tecnología (CONAHCYT, Mexico)
- Federico Sanchez – Comisión Nacional de Energía Atómica (CNEA, Argentina)
- Enrique Pazos – Secretaría Nacional de Ciencia y Tecnologia (SENACYT, Guatemala)
- Martijn Mulders (CERN)
- Yifang Wang (Institute of High Energy Physics – Beijing)
- Christophe Grojean (DESY & CERN)
- Hitoshi Murayama (University of Caligfornia – Berkeley)
- Paris Sphicas – chair of European Committee for Future Accelerators
- Kétévi Assamagan (Brookhaven National Laboratory)
- Marta Losada (New York University Abu Dhabi)

3rd Symposium on Current Topics in Molecular Biophysics (CTMB3) (October 7-9)

The Symposium on Current Topics in Molecular Biophysics (October 7-9) is described on the webpage `https://www.ictp-saifr.org/ctmb32024/` and involve 19 speaker of nine different countries and 68 participants. Topics discussed in the symposium included protein dynamics, modeling the genome, simulations at life processes and complex molecular assemblies. Invited speakers included:

Keynote Speakers:

- Peter Wolynes (Rice University, USA): *Protein Dynamics and the Brain*.
- José Onuchic (Rice University, USA): *Modeling the Genome: a View by a Physicist*.

Invited Speakers:

- Ben Schuler (University of Zurich, Switzerland): *Probing the rapid chain dynamics of disordered proteins and nucleic acids*.

- Kingshuk Gosh (University of Denver, USA): *Sequence patterning and charge regulation dictate conformation in IDPs*.
- Joan-Emma Shea (University of California, Santa Barbara, USA): *Self-Assembly of the Tau Protein: Liquid-Liquid Phase Separation and Fibrillization*.
- Guilherme Volpe Bossa (Southern University of Chile/ Racah Institute of Physics, The Hebrew University of Jerusalem): *Optimal antimicrobial response to a changing microbial background at a mucus interface*
- Roberto K. Salinas (IQUSP): *Uncovering the association mechanism between two intrinsically flexible proteins*
- Vitor Leite (Universidade Estadual Paulista, Brazil): *Unraveling the Functional Mechanisms of Intrinsically Disordered Proteins Through Energy Landscape Visualization*.
- Garegin Papoian (University of Maryland, USA): *Simulating Life Processes Across Scale*.
- Serdal Kirmizialtin (NYU Abu Dhabi, UAE): *RNA Structural Dynamics Revealed by Experimentally Guided Simulations*.
- Olga Dudchenko (Baylor College of Medicine, USA): *Three-Dimensional Genome Architecture Persists in a 52,000-Year-Old Woolly Mammoth Skin Sample*.
- Antonio B. Oliveira Jr (Rice University, USA): *Modeling Genome Organization from an "Agnostic" Point of View*.
- Vittore Scolari (Institut Curie, France): *A mean-field theory for predicting single polymer collapse induced by neutral crowders*.
- Amanda Souza Câmara (IPK, Germany): *Different ways of compacting holocentric chromosomes*.
- Shaker Chuck Farah (São Paulo University, Brazil): *Bacteria Wars: Structural and functional studies on a bactericidal type IV secretion system*.
- Rafael Bernardi (Auburn University, USA): *Computational Biophysics Approaches to Mechanosensing*.
- Miguel Machuqueiro (Universidade de Lisboa, Portugal): *Constant-pH MD simulations as a tool to unveil the pH effects on biomolecules*.
- Monica Pickholz (Universidade de Buenos Aires): *Exploring the Mechanical Properties of Polymerosomes through Molecular Dynamics Simulations*.
- Paul Whitford (Northeastern University, USA): *Quantifying large-scale dynamics of complex molecular assemblies*.

4.3.4 Minicourses

The ICTP-SAIFR organized eleven minicourses in 2024, on holography of solitons, gravitational waves detectors and sources, quantum computing, fluid-dynamical models of heavy ion collisions, light from the neutrinos, perturbative and non-perturbative treatment of quantum

gravity problems, open quantum systems, precision gravity, gravitational waves probes of the early universe, Bayesian machine learning for scientific research, and disorder and dynamics in strongly correlated materials. The topics, lecturers and websites for these minicourses are:

1) March 4-7 – **The Holography of Solitons** – Andres Anabalon (Universidad de Concepción, Chile & IFT-UNESP, Brazil):
   This minicourse provided an introduction to non-perturbative aspects of gauge theories in Minkowski spacetime using holography. The website of the minicourse is https://www.ictp-saifr.org/solitons2024/.

2) April 4-8 – **Minicourse on Gravitational Wave Detectors and Sources** – Stefano Foffa (Univ. of Geneva, Switzerland):
   This minicourse provided students lectures on gravitational wave detectors and sources including current plans for the next generation of Earth-based gravitational wave detectors with emphasis on the Einstein Telescope (ET). The website of the minicourse is https://www.ictp-saifr.org/gwdetectors/.

3) April 8-10 – **Minicourse on Quantum Computing** – Stefano Carrazza & Matteo Robbiati (University of Milan, Italy & CERN, Switzerland):
   In this minicourse, quantum algorithms, NISQ devices, quantum noise, and quantum hardware limitations were introduced. The minicourse involved 37 participants was divided into lectures and hands-on tutorials led by the lecturers. The website is https://www.ictp-saifr.org/mqc2024/.

4) April 15-16 – **Minicourse on fluid-dynamical models of heavy ion collisions** – Gabriel Denicol (Fluminense Federal University, Brazil):
   This minicourse discussed the fundamental assumptions and ingredients used in fluid-dynamical models of heavy ion collisions and the role that relativistic hydrodynamics plays in future challenges in this field. The website is https://www.ictp-saifr.org/heavy-ion-collisions/.

5) May 9-14 – **Minicourse on Light from the Neutrinos** – Sudip Jana (Max-Planck-Institut für Kernphysik, Heidelberg, Germany):
   This minicourse was held at Principia Institute and discussed how neutrinos can develop electromagnetic interactions with light through its magnetic moment. The website is https://www.ictp-saifr.org/lfn2024/.

6) May 20-24 – **Minicourse on perturbative and nonperturbative treatment of quantum gravity problems** – Manuel Asorey (University of Zaragoza, Spain), Gabriel Menezes (UFRRJ & IFT-UNESP, Brazil), Ilya L. Shapiro (UFJF, Brazil), and Gastao Krein (IFT-UNESP, Brazil):

This minicourse discussed specific problems of quantum gravity, with a focus on non-traditional approaches. Topics discussed included higher-derivative quantum field theories, effective quantum gravity, and complex-mass particles and their bound states. The minicourse involved 33 participants and the website is https://www.ictp-saifr.org/mqgp2024/.

7) July 1 – 5 – **Minicourse on open quantum systems: fundamentals, collisional models, and path integrals** – Jamir Marino (JGU/Mainz, Germany), Aleksandr Mikheev (JGU/Mainz, Germany), Dario Rosa (ICTP-SAIFR, Brazil), and Aleksandra Ziolkowska (JGU/Mainz Germany):
The minicourse involved 27 participants and the website is https://www.ictp-saifr.org/toqs2024/. Topics discussed included Lindblad equation and Keldysh formalism, 2PI and the Dicke model, and collisional models.

8) August 13-22 – **Minicourse on precision gravity: from the LHC to LISA and ET** – Rafael Porto (DESY, Germany):
The minicourse involved 33 participants and the website is https://www.ictp-saifr.org/mpglle2024/. Topics discussed included recent advances in solving the two-body problem in general relativity by borrowing ideas from particle physics such as effective field theory and state-of-the-art tools used in quantum field theory calculations for collider physics.

9) September 3-10 – **Minicourse on Gravitational Wave Probes of the Early Universe)** – Simona Procacci (U. of Geneva, Switzerland):
In this minicurse was derived the basic formalism to compute the gravitational wave spectrum, and discussed sources coming from inflation, reheating, and first-order phase transitions in the early universe. The website is https://www.ictp-saifr.org/gwpeu2024/.

10) October 28 – November 1 – **Minicourse on Bayesian Machine Learning for Scientific Research** – Ezequiel Alvarez (ICAS-UNSAM, Argentina):
The minicourse involved 42 participants and the website is https://www.ictp-saifr.org/mbmlsr2024/. The objective was to introduce participants to Bayesian Machine Learning for scientific applications, and lecture topics included Bayes' theorem in research, Bayesian machine learning and workflows, and non-parametric distributions using mixture models.

11) November 4-8 – **Minicourse on disorder and dynamics in strongly correlated materials** – José Hoyos (IFSC-USP, Brazil), W. Joe Meese (University of Illinois at Urbana-Champaign, USA), Victor Luiz Quito (IFSC-USP, Brazil) and Fernando Iemini (UFF, Brazil):

The minicourse involved 54 participants and the website is https://www.ictp-saifr.org/ddscm2024/. Topics discussed included phase transitions in disordered quantum systems, Floquet engineering quantum systems, and dynamics in quantum many-body systems.

4.3.5 Meetings

APS-SAIFR Satellite March Meeting (March 5)

As part of the March Virtual Meeting on March 5, 2024, ICTP-SAIFR hosted a 2-hour session broadcast live to all participants, as well as a session for student presentations and postdocs. Graduate students and postdocs gave oral and/or poster presentations at the student-postdoc session. The website of the meeting is https://www.ictp-saifr.org/apsmarch2024/.

APS/ICTP-SAIFR Satellite Session on Complex Systems:

- 14:30-14:50 – Marcus Aguiar (UNICAMP): *Generalized frustration in multi-dimensional Kuramoto models*.
- 14:50-15:10 – Hilda Cerdeira (ICTP-SAIFR/IFT-UNESP): *Phase Transitions in Swarmalators*.
- 15:10-15:30 – Pablo de Castro (ICTP-SAIFR/IFT-UNESP): *Random searches with chemotaxis: Optimal strategy transitions induced by target scent*.
- 15:30-15:50 – Silvio Salinas (USP): *Modulated structures in a nematic model with chiral interactions*.
- 15:50-16:10 – Alexandre Souto Martinez (USP, Ribeirão Preto): *Solutions of simple systems of the deformed quantum mechanics based on a new extended uncertainty principle*.
- 16:10-16:30 – Maurice de Koning (UNICAMP): *Phase transitions involving superionic ice XVIII*.

ICTP-SAIFR Student-Postdoc Session:

- 17:00-17:20 – Masayuki Hase (USP): *Dynamics of degree attainment in growing networks*.
- 17:20-17:40 – Guilherme Costa (ICTP-SAIFR / IFT-UNESP): *Dynamic of frustrated Kuramoto oscillators with modular connections*.
- 17:40-18:00 – André Timpanaro (UFABC): *Social fragmentation in an adaptive voter model*.
- 18:00-18:20 – Carlos Fiore (USP): *General features of collective engines*.

APS-SAIFR Satellite April Meeting (April 5)

As part of the April Meeting, ICTP-SAIFR hosted a 2-hour session on Cosmology and related topics broadcast live to all participants, as well as a session for student/postdoc presentations on cosmology/astrophysics/particle physics. The website of the meeting is https://www.ictp-saifr.org/apsapril2024/.

APS/ICTP-SAIFR Satellite Session on Cosmology and related topics:

- 15:00-15:30 – Raul Abramo (IF-USP): *Cosmology in the era of Machine Learning*.
- 15:30 - 16:00 – Riccardo Sturani (IFT-UNESP/ICTP-SAIFR): *Ward identities in Gravitational Wave Astronomy*.
- 16:00-16:30 – Chee Sheng Fong (UFABC): *How to verify high scale baryogenesis models?*
- 16:30-17:00 – Edivaldo Moura Santos (IF-USP): *Towards AGN population studies at the TeV energy scale*.

ICTP-SAIFR Student-Postdoc Sessions:

- 17:30-17:50 – João Victor Silva Rebouças (Insituto de Física Teórica – UNESP): *Modelling the Nonlinear Power Spectrum with COLA Simulations*.
- 17:50-18:10 – Walter Riquelme (Instituto de Física Teórica – UAM/CSIC): *Primordial non-Gaussianity with the Dark Energy Survey*.
- 18:10-18:20 – Rodrigo Voivodic (Donotia International Physics Center): *The Hybrid Lagrangian Bias Expansion*.
- 18:20-18:30 – Lucas James Faga (Institute of Physics – University of São Paulo): *Dark Energy Survey Year 3 Results: Cosmology from galaxy clustering and galaxy-galaxy lensing in harmonic space*.

São Paulo Research Group meetings in Astro & Cosmo

ICTP-SAIFR organizes monthly one-day meetings at Principia Institute of the São Paulo community working in astrophysics, astroparticles, gravity, and cosmology. The website of the meeting is https://www.ictp-saifr.org/astrocosmomeeting/. The meetings organized in 2024 were:

November 8, 2024:

- 10:00 – Abdias Aires (IFT-UNESP): *Mitigation of nonlinear galaxy bias with theoretical-error likelihood*.
- 11:00 – Giorgio Torrieri (Unicamp): *Non-local effective field theory in general relativity*.

- 14:00 – Daniel Lopez-Cano (IF-USP): *Machine Learning Applications in Cosmology: Past, Present, and Future*.

October 11, 2024:

- 10:00 – Abdias Aires (IFT-UNESP): *Walter Riquelme (IFT/UNESP): Unveiling the initial conditions of the universe with galaxy surveys*.
- 11:00 – Yago Porto (UFABC): *Flavor Matters, but Matter Flavors: Matter Effects on Flavor Composition of Astrophysical Neutrinos.*
- 14:00 – Lilianne Nakazono (USP): *Searching for quasars in the era of large multi-wavelength datasets.*

September 13, 2024:

- 10:00 – João Victor Silva (IFT UNESP): *Dynamical Dark Energy and Massive Neutrinos in Light of DESI 2024 BAO.*
- 11:00 – Lia Doubrawa (IAG USP): *Galaxy clusters in photometric surveys: detection and analysis.*

August 16, 2024:

- 10:00 – Edivaldo Moura Santos (USP): *The ultra-high energy cosmic ray sky*.
- 11:00 – João Vitor Dinarte Ferri (USP): *A cosmic standard ruler from the cross-correlations of galaxies and dark sirens*.
- 14:00 – Natali de Santi (USP São Carlos): *Cosmology with graph neural networks*.

June 14, 2024:

- 10:00 – Nickolas de Aguiar Alves (UFABC): *Don't forget about the memory*.
- 11:00 – Reinaldo de Carvalho (UNICID): *Studies on Galaxy Morphology: Diving into the Primordial Era*.
- 14:00 – Isabela Santiago de Matos (IFT-UNESP): *Cosmological tests with bright and dark standard sirens*.

May 10, 2024:

- 10:00 – Lucas Gabriel Silva (IAG USP): *Galaxy cluster mass estimation using the splash-back radius*.
- 11:00 – Adriana Valio (Mackenzie): *Exoplanetas: atmosferas e habitabilidade*.
- 14:00 – Carol Guandalin (Institute for Astronomy (IfA), University of Edinburgh): *I see bispectrum everywhere*.

April 12, 2024:

- 10:00 – Rodrigo Voivodic (Donostia Intl. Phys. Ctr., San Sebastian): T*he Hybrid Lagrangian Perturbation Theory.*
- 11:00 – Louis Legrand (ICTP-SAIFR): *Next generation galaxy and CMB surveys: optimal estimators and cross-correlations.*
- 14:00 – Chee Sheng Fong (UFABC): *How much baryon asymmetry and dark matter can be generated from primordial black holes?*

São Paulo Meeting on Soft and Biological Matter (May 17)

This meeting was organized in May 17 by ICTP-SAIFR. The main topics discussed were thermodynamics and transport across cell membranes, biophysics of the Golgi reassembly and stacking proteins, structural investigations of soft matter systems, computational simulations of bacterial membranes, and predicting the mechanics of 3D epithelia in vertebrate embryonic development. The website is https://www.ictp-saifr.org/softbiologicalmatter/.

Keynote Speaker:

- M. Lisa Manning (Syracuse University, USA): *Predicting mechanics of 3D epithelia in vertebrate embryonic development*.

Invited Speakers:

- Adriano Alencar (IFUSP, Brazil): *Thermodynamics and transport across cells membranes.*
- Antônio J. Costa-Filho (FFCLRP-USP, Brazil): *To be or not to be: what is the function? The exquisite biophysics of the Golgi Reassembly and Stacking Proteins*.
- Cristiano L. P. de Oliveira (IFUSP, Brazil: *Structural Investigations of Soft Matter Systems*.
- Thereza Soares (FFCLRP-USP, Brazil): *Computational Simulations of Bacterial Membranes across Scales*.

Third Brazilian Meeting of Science Communicators (November 15-17)

This meeting took place from November 15-17 at Instituto Principia and the website is https://www.ictp-saifr.org/ebdc2024/. It was organized by ICTP-SAIFR in collaboration with Blogs de Ciência da Unicamp, a science outreach project from the University of Campinas (Unicamp), Instituto Principia, an institution that promotes various science popularization activities, and external collaborators.

4.3.6 Outreach Events

The ICTP-SAIFR organized 15 different types of online outreach activities in 2024 aiming at high-school teachers, high-school students and the general public. The format, topics and websites for these events are:

Modern Physics for High-School Teachers - Portuguese

In this online course with accreditation by the Secretary of Education of the State of São Paulo, pedagogical material developed by Perimeter Institute and translated by ICTP-SAIFR was presented to high-school teachers using a Zoom platform with breakout rooms. From August 3 - September 28 and from October 5 - December 7, this course of 8 lectures was given twice to groups of 75 public high-school teachers from the state of São Paulo. The topic of the course in 2024 was chosen to be cosmology, and topics of the course in future years will include particle physics and quantum mechanics. The webpage of the program is https://outreach.ictp-saifr.org/ensino-medio/professores/fisica-moderna-para-sala-de-aula/.

Modern Physics for High-School Teachers - Spanish

In this online course taught in Spanish, pedagogical material developed by Perimeter Institute and translated by ICTP-SAIFR was presented to high-school teachers from across Latin America using a Zoom platform with breakout rooms. The webpage of the program is https://outreach.ictp-saifr.org/ensino-medio/professores/fisica-de-fronteira-para-a-sala-de-aula-online/espanol/ and presentations were given from March - December on topics in particle physics and cosmology.

IV ICTP-SAIFR Summer Course for High School Physics Teachers

From January 22-26, 2024, ICTP-SAIFR organized a one-week online summer course in Portuguese and Spanish on Particle Physics. The activities include seminars based on Perimeter material translated into Portuguese and Spanish by ICTP-SAIFR and discussion sessions with different researchers. Participants also attended a virtual visit to CERN. The website of the summer course is https://outreach.ictp-saifr.org/cursoveraoprofessores/.

Lecturers:

- Ana Cecília Soja (IFF – Bom Jesus do Itabapoana – RJ, Brazil).
- Cintia Cirillo (E.E. PEI Álvaro de Souza Vieira, Ribeirão Pires – SP & ICTP-SAIFR – SP, Brazil).
- Fátima Araújo Machado (UFSC – Campus Joinville – SC, Brazil).

- Felipe Novaes (E.E. PEI Dr. Antonio Ablas , Santos – SP & ICTP-SAIFR – SP, Brazil).
- Gabriela Conde Saavedra (Voluntario en Planetario Max Schreier – Universidad Mayor de San Andrés – La Paz, Bolivia).
- Luis Ivan Morales Bautista (Peru).
- Marcelo Munhoz (USP, Brazil).
- Martín Monteiro (Universidad ORT Uruguay y Sociedad Uruguaya de Física, Uruguay)
- Reina Camacho Toro (ATLAS – CERN).
- Ricardo Meloni Rosado (IFSP – Sertãozinho – SP, Brazil).
- Zui Oporto Almaraz (Planetario Max Schreier – Universidad Mayor de San Andrés – La Paz, Bolivia)

Physics Games for High-School Teachers

In this activity, organized by ICTP-SAIFR outreach coordinator Ana Luiza Sério, designed as a board-based escape room, teachers will tackle various challenges or physics missions aimed at teaching students scientific knowledge about different topics of General Physics. From December 2023 to November 2024 this activity included:

Physics Missions:

- On December 2, 2023 the *Particle Physics Mission* included topics such as moment conservation, vectors, Lorentz law, uniform circular motion, special relativity, among others.
- On March 16, 2024 the *Black Holes Mission* included topics such as Doppler effect, Kepler's readings and Newton's reading of universal gravitation.

The website of this activity is https://outreach.ictp-saifr.org/jogos-de-fisica/.

Modern Physics for the Classroom – Brasilia

From August 24-25, ICTP-SAIFR organized a minicourse for high school teachers based on classroom material developed by Perimeter and translated and adapted by ICTP-SAIFR. The minicourse was held in Brasilia and covered topics such as dark matter, SM, scientific models of gravity, exoplanets, and climate change. The website is https://outreach.ictp-saifr.org/ensino-medio/professores/brasilia24/.

Minicourses for High-School Students

This program involves several minicourses on modern physics for high-school students held online every Saturday morning. The website for the minicourses is http://outreach.ictp-saifr.org/ensino-medio/minicurso/ and topics covered include:

- Roberto Costa (IAG – USP, Brazil): *The stars, the periodic table and us: the origin of the chemical elements* (March 9-23).
- Ramachrisna Teixeira (IAG – USP, Brazil): *Observing the sky and building knowledge: an introduction to astronomy* (April 6-13).
- Pedro Vieira (ICTP-SAFR, Brazil & Perimeter Institute, Canada): *Introduction to quantum mechanics* (May 4-25).
- Patricia Magalhães (IFGW – Unicamp, Brazil): *Introduction to particle physics: from the origin of the universe to matter-antimatter asymmetry* (June 8-15).
- Cecília Chirenti (Universidade de Maryland, NASA Goddard Space Flight Center, USA & UFABC, Brazil): *Relativistic Astrophysics: An Overview of Neutron Stars* (June 29).
- Nathan Berkovits (ICTP-SAIFR & IFT-Unesp, Brazil): *Introduction to special relativity* (August 10-24).

4rd Summer School for Young Physicists

U. Porto and ICTP-SAIFR jointly organized the 4rd Summer School for Young Physicists from January 15-20, 2024. During this school, 44 talented high school students were selected to develop research projects created and supervised by 12 graduate students. Participants also attended three seminars and one minicourse:

Projects:

1) *Investigating phase transitions with the Ising model and the Monte Carlo method* – Arthur Almeida Frazon (IFT-Unesp).
2) *Black buracos and Rindler observers* – Marcelo Augusto Ferreira dos Santos (IFT-Unesp).
3) *Introduction to restricted relativity and particle-wave duality* – Eric Lobato Graef (IFT-Unesp) and Marcelo Rezende Barbosa (IFT-Unesp).
4) *Periodic strings: a mechanical analogy for photonic crystals* – Rodrigo Schmidt Pitombo (IFT-Unesp).
5) *A study of the main nuclear interactions in low-energy particle accelerators* – Jessica Kerollayne Lemos Chaves (IFUSP).
6) *Introduction to quantum cryptography* – Alisson Matheus Araújo Silva (IFT-Unesp).
7) *Cálculo da massa invariante em processos eletrofracos no LHC* – Isabela Maietto (IFT-Unesp).
8) *Medindo a expansão do universo através de supernovas* – Otávio Alves (University of Michigan).
9) *Living organisms in motion: how to understand ecological processes using physics* – Pablo de Castro (ICTP-SAIFR & IFT-Unesp).

10) *Diseases, rumors, and fake news: mathematical modeling of propagation phenomena* – José Andrés Guzmán Morán (ICMC – USP São Carlos).
11) *Multi-messenger astrophysics: gravitational waves as a tool to calculate the Hubble constant* – Mayara Hilgert Pacheco (INPE).

Seminars:

- Isabela Santiago de Matos (ICTP-SAIFR & IFT-Unesp): *What do gravitational waves reveal about the history of the universe?*.
- Pablo de Castro (ICTP-SAIFR & IFT-Unesp): *The physics of complex systems and collective phenomena: from biology to social sciences*.
- Marcelo Martinelli (IFUSP): *Building quantum light machines*.

The school's minicourse was titled "Introduction to Special Relativity" and taught Nadja Magalhães (Unifesp). The website of this activity is https://outreach.ictp-saifr.org/edv24/. The fifth edition is planned for 2025 (see the website https://outreach.ictp-saifr.org/escolaverao/).

Classroom Modules for High School Students

This program involves several classroom modules on physics for high-school students held at the Auditorium of IFT-UNESP every Saturday afternoon. The website for the classroom is https://outreach.ictp-saifr.org/modulos-de-aulas-ift-unesp/ and topics covered include:

Modules:

- From April 6 to June 15: *Introduction to differential and integral calculus* – Lucas David Feitosa C. (Etec Albert Einstein, Colégio Santa Marcelina & ICTP-SAIFR).
- From August 10 - 24: *Elements of electrical circuits* – William G. C. Oropesa (ICTP-SAIFR).
- From September 28 to October 5: *Unveiling the invisible: a dive into the world of nanomaterials, nanoscience and quantum materials* – Washington Francisco dos Santos (Ph.D. student IFT-Unesp).
- From September 14 to October 26: *Module for "Vestibulares"* – Lucas David Feitosa C. (Etec Albert Einstein, Colégio Santa Marcelina & ICTP-SAIFR), Marcelo Cremer (Colégio Santa Marcelina), and Felipe de Novaes (E.E. Dr. Antônio Ablas & ICTP-SAIFR)

ICTP-SAIFR Preparation for Participation in Physics Olympiads

Clewton Fonseca, who is also a high-school teacher with FAPESP fellowship, teaches classes for high-school and middle-term students to prepare for the physics olympiad exams in Campinas: https://outreach.ictp-saifr.org/programa-olimpiadas-cps/, and William G C Oropesa (ICTP-SAIFR), who is a TT-5/FAPESP fellowship, does similar work with high school students, in São Paulo: https://outreach.ictp-saifr.org/programa-olimp-so-paulo/.

ICTP-SAIFR Workshop for Young Physicists

On June 22 and 23, a workshop for high-school students was organized by Lucas David Feitosa (Etec Albert Einstein, Colégio Santa Marcelina & ICTP-SAIFR) on the topic of the physics of climate change. The workshop included a minicourse by Marco Aurélio de Menezes Franco (IAG-USP), hands-on and computational activities, as well as data analysis and case studies. The website of the workshop is https://outreach.ictp-saifr.org/oficina/.

ICTP-SAIFR Winter Course for Young Physicists

Form July 16-20, ICTP-SAIFR organized a one-week winter school for high school students. Topics included the two minicourses "Dark Matter for High School" by Prof. Farinaldo Queiroz (IIP & UFRN) and "Introduction to Python with Physics" by IFT-UNESP physics Ph.D. students, and a lecture and visit to Second School experiments on Dark Matter and Neutrino Detection by Carla Bonifazi (ICAS-ICIFI-UNSAM, Argentina & IF-UFRJ, Brazil) and Martin Makler (ICAS-ICIFI-UNSAM, Argentina & CBPF). The winter school website is https://outreach.ictp-saifr.org/cursodeinverno/.

Book Club – Sci-SAIFR

In this outreach program, a physicist uses a science fiction book to discuss with the audience the physics concepts behind it. The webpage for the program is https://outreach.ictp-saifr.org/clube-do-livro/, and the books discussed from December 2023 to November 2024 meetings included:

- Pedro Vieira (Perimeter Institute, Canada & ICTP-SAIFR, Brazil) and Ana Rusche (USP, Brazil): *The Time Machine* (December 20, 2023).
- Thaisa Storchi Bergmann (UFRGS, Brazil): *Black Holes* (February 7).
- Marco Moriconi (IF-UFF, Brazil): *The Demon-Haunted World: Science as a Candle in the Dark* (April 17).
- Pedro Vieira (Perimeter Institute, Canada & ICTP-SAIFR, Brazil): *The Three-Body Problem* (May 22).

- Luana Pedroza (IF-USP, Brazil) and Julian Fuks (writer):*When We Cease to Understand the World* (June 20).
- Marcelo Munhoz (IF-USP, Brazil): *Project Hail Mary* (August 28).
- Gabriela Lemos (IF-UFRJ, Brazil): *The Code Breaker: Jennifer Doudna, Gene Editing, and the Future of the Human Race* (October 30).

Science in Cinema

ICTP-SAIFR and the Reag Belas Artes Cinema promoted special sessions to discuss films related to physics with a public audience. In these sessions, researchers invited by the ICTP-SAIFR answered questions from the audience after the films. The website of this activity is https://outreach.ictp-saifr.org/ciencia-no-cinema/ and the films discussed and the invited researchers from December 2023 to November 2024 included:

- *Pi* (December 12, 2023) with Rogério Rosenfeld (ICTP-SAIFR vice-director & IFT-UNESP).
- *Gravity* (January 23) with Roberto Costa (IAG-USP).
- *Proof* (February 20) with Christina Brech (IME-USP & Umalca & ASL).
- *Dune: Part Two* (March 6) with Raul Abramo (IF-USP) and Ana Rüsche (IF-USP).
- *Poor Things* (April 2) with Cláudia Fusco (ESPM-SP & Instituto Vera Cruz), João Cortese (IEA-USP), Michel Naslavsky (IB-USP) and Paula Carvalho (UFF).
- *Primer* (May 21) with Pedro Vieira (Perimeter Institute & ICTP-SAIFR).
- *2001: A Space Odyssey* (June 25) with Eduardo Cypriano (IAG-USP), Mauro Almeida (Univ. of Cambridge, USA) and Renata Wassermann (IME-USP).
- *The Martian* (July 23) with Bruno Leonardo do Nascimento (USP & Nupesc).
- *Inside Out 2* (August 4, for children) with Analía Arévalo (Hospital das Clínicas FMUSP).
- *The Theory of Everything* (August 20) with Nathan Berkovits (ICTP-SAIFR director & IFT-UNESP) and Alex Dias (UFABC).
- *Nostalgia for the Light* (September 17) with Luís Villaça (Senac) and Elisabete Dal Pino (IAG-USP).
- *The Wild Robot* (October 20) with Renata Wassermann (IME-USP).
- *Soylent Green* (October 29) with Pedro Luiz Cortes (USP).

Papos de Física

"Papos de Física" is an activity organized by ICTP-SAIFR where one or more researchers lead discussions on science with a general audience. These events are hosted at Cervejaria Nacional (Av. Pedroso de Morais, 604 – Pinheiros) in São Paulo. The official event website is https://outreach.ictp-saifr.org/papos-de-fisica/. The sessions held between December 2023 and November 2024 were:

- *The End of the Universe* (March 22) with Rogério Rosenfeld (ICTP-SAIFR vice-director & IFT-UNESP).
- *Exoplanets: distant worlds* (April 19) with Adriana Valio (CRAAM-Mackenzie).
- Pint of Science 2024:
  - *Artificial Intelligence: revolution or hype?* (May 13) with Sergio Ferraz Novaes (IF-USP) and Pedro Vieira (Perimeter Institute & ICTP-SAIFR).
  - *What is dark matter?* (May 14) with Raul Abramo (IF-USP) and Edivaldo Moura Santos (IF-USP).
  - *How to describe quantum gravity?* (May 15) with André Landulfo (UFABC) and Nathan Berkovits (ICTP-SAIFR director & IFT-UNESP).
- *Lightning in storms: much more than electricity* (June 21) with Rachel Albrecht (IAG – USP).
- *The life of a neutrino and the origin of everything* (July 12) with Pedro Machado (Fermilab, USA).
- *It's in the air: the physics of atmospheric aerosols* (August 30) with Luciana Rizzo (IF-USP).
- *The Computer and Schrödinger's Cat* (September 27) with Marcelo Martinelli (IF-USP).
- *Physics and Art: what is the relationship?* (October 25) with Marcia Rizzutto (IF-USP).
- *Patterns in nature: a beautiful coincidence or a quest for survival?* (November 21) with Ricardo Martínez-Garcia (ICTP-SAIFR & CASUS, Germany).

Second Lecture Series ICTP-SAIFR/Principia

In this series, ICTP-SAIFR and Instituto Principia organize a cycle of lectures for the general public by a distinguished researcher on a specific topic. This year, the set of lectures was presented from March 2-23 by Rogério Rosenfeld (ICTP-SAIFR & IFT-UNESP) with the title "The Science of the Cosmos: The evolution of knowledge about the Universe". This was a natural continuation of the lecture series that started last year. The website of this activity is https://outreach.ictp-saifr.org/ciclo-de-palestras/.

4.3.7 Weekly Seminars, Colloquia and Journal Clubs

In 2024, weekly seminars were regularly organized. There were 115 seminars and the complete list is on the website https://www.ictp-saifr.org/2024-research-seminars-and-activities/. There were also weekly journal club meetings in string theory, soft and biological matter, cosmology and quantum systems.

4.3.8 Annual Meeting of Steering Committee and Scientific Council:

On February 21, 2024, the ICTP-SAIFR scientific council met to discuss the activities planned for 2025. The council members are listed on the website http://www.ictp-saifr.org/steering-committee/ and http://www.ictp-saifr.org/scientific-council/. The 2025 meeting of the steering committee and scientific council will be on February 17 – 18.

4.4 Request of Additional Postdoctoral Fellowships

Together with this report of the thematic grant, a modification of the budget is being requested to increase the number of postdoctoral fellowships. This increase will allow extensions of the existing 2-year fellowships for an additional year (as was decided by FAPESP for new fellowships starting in June 2024), and will allow the expansion of ICTP-SAIFR into new research areas.

One of the main accomplishments of ICTP-SAIFR has been to help reverse the brain drain by attracting hundreds of applications every year from around the world for its postdoctoral positions. The initial grant included 12 two-year postdoctoral positions, and these positions have already all been filled by carefully selecting candidates in the 12 different areas of the initial grant. In order to continue to attract talented postdoctoral candidates, it is necessary to be able to offer three-year postdoctoral positions as was recognized by FAPESP since June 2024 when they changed the duration of the fellowship. For this reason, ICTP-SAIFR is requesting an additional 12 one-year fellowships to be able to renew the 12 original two-year fellowships for an additional year. In addition, ICTP-SAIFR is requesting two 2 1/2-year postdoctoral fellowships in the new ICTP-SAIFR research areas of statistical mechanics with applications to search optimizations, and quantum chaos with applications to quantum technologies. With the new Simons-FAPESP faculty Jaron Kent-Dobias and Dario Rosa working in these rapidly growing research areas, these additional postdoctoral positions will allow ICTP-SAIFR to attract talented researchers from around the world to come to São Paulo and work in these strategic areas.

Description of Institutional Support

The ICTP-SAIFR received support from both the Instituto de Física Teórica (IFT) and from the Universidade Estadual Paulista (UNESP). All professors and secretarial staff of the IFT have been extremely supportive of all ICTP-SAIFR activities.

The UNESP university is providing the salary for four ICTP-SAIFR secretaries including an executive secretary, an accountant, a computer systems manager and an executive manager.

Activity Plan for 2025

In 2025, the ICTP-SAIFR will continue to expand its research, outreach and training activities in all areas related to theoretical physics. Confirmed scientific activities in 2025 which will be organized by ICTP-SAIFR are listed below and include international schools and workshops and programs on several topics which will take place both at IFT-UNESP and at the new installations of Instituto Principia. The list of 2025 activities planned up to now include the activities:

São Paulo International School on Theoretical Physics

- School on Synchronization: from collective motion to brain dynamics (February 3 – 14).
- School on the Origins of Life, Behavior and Cognition (March 10 – 21).
- School and Workshop on the Physics of Life (March 24 – April 4).
- School on Biological Physics and Biomolecular Simulations in the Machine Learning Era (April 14 – 19).
- São Paulo Advanced School on Disordered Systems (April 28 – May 9).
- II School on Modeling Infectious Disease Dynamics (May 12 – 18).
- School on Multineutron Clusters in Nuclei and in Stars (May 27 – May 31).
- VI Siembra-HoLAGrav Young Frontiers Meeting at ICTP-SAIFR (June 30 – July 11).
- Perimeter-SAIFR-IFT Journeys School (July 14 – 20).
- V Joint ICTP-Trieste/ICTP-SAIFR School on Cosmology (July 28 – August 8).
- CLAF/ICTP-SAIFR Astroparticle Physics School (August 11 – 15).
- IV School on Light and Cold Atoms (October 20 – 31).
- School on Emergent Phenomena in Many-Body Systems (November 3 – 14).
- Fourth School on Data Science and Machine Learning (December 1 – 5).
- QCD meets Gravity XI School (December 8 – 13).

Minicourses

- Minicourse on Effective Field Theory in Large Scale Structure (January 6-7).
- Minicourse on Partial Differential Equations: Analytical and Numerical Tools (May 1 - June 30)

Meetings/Programs/Workshops

- Council Meeting (February 17 – 18).
- APS-SAIFR Satellite Global Physics Summit (March 16-21).
- II Brazilian Workshop on Soft Matter (April 7-11).
- Workshop on Multineutron Clusters in Nuclei and in Stars (June 2-6).
- Program on Anomalies, Topology and Quantum Information in Field Theory and Condensed Matter Physics (June 16 – 27).

- 9th Conference on Chirality, Vorticity and Magnetic Fields in Quantum Matter (July 7 – 11).
- Simons Collaboration Bootstrap 2025 (July 21 – August 8).
- Program on Fundamental Aspects of String Theory (August 4 – 15).
- Workshop on Frontiers in Quantum Materials (September 1 – 5).
- Program on Quantum Many-Body Dynamics: Thermalization and its Violations (September 8 – 19).
- TWAS Satellite Symposium (October 4-5).
- QCD meets Gravity XI Conference (December 15 – 19).

Outreach

- Escola de Verão para Estudantes de Ensino Médio (January 15-20).
- Curso de Verão para Professores de Ensino Médio (January 22-26).
- Minicursos para Estudantes de Ensino Médio (March-November).
- Física de Fronteira em Português (March-November).
- Física de Frontera en Español (March – November).
- Clube do Livro Sci-SAIFR (March – November).
- ICTP-SAIFR Módulos de Aulas (March – November).
- Preparação ICTP-SAIFR para Participação em Olimpíadas (February - November)
- Ciência no Cinema (January – December).

Data Management

The main data produced by ICTP-SAIFR activities are research articles, recorded videos and pdf files of lectures and seminars, and online material for the general public. The research articles are available online on public sites such as http://xxx.arxiv.org for preprints and on the journal sites for Open Access publications. The recorded videos and pdf files of lectures and seminars are all posted online on the ICTP-SAIFR websites of the activities and at https://www.ictp-saifr.org/2024-research-seminars-and-activities/ and https://www.ictp-saifr.org/other-years-research-seminars-and-activities/. The online material for the general public is available on the various websites of the ICTP-SAIFR website http://outreach.ictp-saifr.org/. In 2024, the creation of a joint library of videos with Perimeter Institute was initiated and it is expected that all videos of ICTP-SAIFR research activities will be available at the Perimeter Institute library in 2025.

Use of Reserva Tecnica Funds

Between December 2023 - November 2024, the part of the reserva tecnica funds related to "Custos de Infraestrutura Direta do Projeto" was used for the following purposes:

a) Design, fabrications and mailings of posters to international institutions for announcements of School/Workshops activities: R$ 46.578,20
b) Advertisement of postdoc positions in international magazines: R$ 3.187,03
c) Advertisement of activities using online mailing system (mailjet): R$ 2.633,22
d) Use of Zoom platform for all ICTP-SAIFR online activities: R$ 9.248,82
e) Purchase of two Notebooks Vostro-3520 Dell to support the activities of ICTP-SAIFR: R$ 10.307,21
f) Purchase of a pointer model Logitech 910-005216 to support the activities of ICTP-SAIFR: R$ 486,00
g) Purchase of two microphones, models BLX24BR/PG58 M15 SISTEMA MIC. S/FIO and BLX14BR/CVL M15 SISTEMA MIC. S/FIO, for Room-2 on the third floor to improve the recording activities: R$ 7.880,00
h) Purchase of Banner for dissemination of activities: R$ 890,00
i) Purchase of two camera batteries and video equipment for interviews with visiting researchers: R$ 4.742,42
j) Purchase of badges and bags for participants at events: R$ 11.250,00
k) Purchase of office supplies for participants at events including paper, pens, envelopes, etc.: R$ 4.661,29
l) Refund of Connor Behan's plane and train tickets to give a 90-minute invited talk on May 20 in Paris at the Pascal Institute workshop on "Speakable and Unspeakable in Quantum Gravity" with the title "Less supersymmetric holography: from gauge-theories to F-theory", and to participate in the Strings 2024 Conference at CERN Switzerland (June 3-7): R$ 7.357,58

And the part of the reserva técnica funds related to "Benefícios Complementares" was used for the following purposes:

a) Airfare for ICTP-SAIFR director Nathan Berkovits to Los Angeles to participate as invited speaker in the program "What is String Theory" at KITP Santa Barbara during the week of January 8-12, 2024 where he presented a 90 minute blackboard seminar on January 11 with the title "On the equivalence of the pure spinor and RNS formalisms". The webpage with link to the video of the talk is https://online.kitp.ucsb.edu/online/strings24/: R$ 10.751,81
b) Airfare for ICTP-SAIFR director Nathan Berkovits to Washington DC to participate as invited speaker at the American Physical Society 2024 Annual Leadership Meeting from January 23-26, 2024 where he gave a 15 minute presentation on ICTP-SAIFR activities on January 24. A webpage with description and photo of the meeting is https://www.primapagina.sif.it/article/1818/chronicle-of-the-aps-annual-leadership-meeting: R$ 11.581,96

c) Airfare for ICTP-SAIFR director Nathan Berkovits to Trieste as invited participant at the 60th Anniversary Symposium of ICTP on November 15, 2024. In addition to meeting with ICTP director and ICTP-SAIFR steering committee president Atish Dabholkar, he participated in the signing ceremony of a new agreement between ICTP and CNPq which will help to finance visitors to ICTP-SAIFR. The webpage for this meeting which also links the ICTP-SAIFR anniversary symposium on February 18-20 is https://www.ictp.it/home/ictps-60th-anniversary: R$ 5.071,87

d) Airfare for ICTP-SAIFR director Nathan Berkovits to Brasilia on July 16 to meet the science minister Luciana Santos and participate in the signing ceremony of the new collaboration agreement between ICTP-Trieste and Brazil's Ministry of Science, Technology and Innovation (MCTI): R$ 3.608,98

e) Inscription of the ICTP-SAIFR vice-director Rogério Rosenfeld at the XV Latin American Symposium on High Energy Physics (November 4 - 8): R$ 1.063,74

f) Perdiem for ICTP-SAIFR vice-director Rogério Rosenfeld to Cinvestav (Mexico) to present a talk with the title "Dark Energy Survey: the end game" at the XV Latin American Symposium on High Energy Physics (November 4 - 8): R$ 7.943,63

g) Airfare, perdiem and inscription taxes for Roberto André Kraenkel to Toledo (Spain) to present an invited talk with the title "Lesson Learned from Epidemic Modeling for COVID-19 with Real-World Data." at the 13th European Conference on Mathematical and Theoretical Biology (July 22 - 26): R$ 19.935,35

h) Perdiem for Roberto André Kraenkel to participate as invited speaker at the STIC AmSud Workshop on Methods of Biological Control of Insect Vectors and Insect Pests in Villa Clythia at Frejus, France (November 18 - 22): R$ 15.748,82

Articles in Refereed Scientific Journals

[1] Nathan Berkovits and Rodrigo S. Pitombo, "4d chern-simons and the pure spinor ads 5× s 5 superstring," *Physical Review D*, vol. 109, no. 10, p. 106015, 2024. doi:10.1103/PhysRevD.109.106015.

[2] C. Behan and Rodrigo S. Pitombo, "Mellin amplitudes for ads3× s3," *Journal of High Energy Physics*, vol. 2024, no. 11, pp. 1–50, 2024. doi:10.1007/JHEP11(2024)059.

[3] V. Bernardes and U. Portugal, "A two parameter family of lightcone-like hyperbolic string vertices," *JHEP*, vol. 07, p. 205, 2024. doi:10.1007/JHEP07(2024)205.

[4] V. Bernardes, Andrei Mikhailov, E. Viana, *et al.*, "Transformations of currents in sigma-models with target space supersymmetry," *SIGMA. Symmetry, Integrability and Geometry: Methods and Applications*, vol. 20, p. 031, 2024. doi:10.3842/SIGMA.2024.031.

[5] C. collaboration *et al.*, "Extracting the speed of sound in quark–gluon plasma with ultra-relativistic lead–lead collisions at the lhc," *Reports on Progress in Physics*, vol. 87, no. 7, p. 077801, 2024. doi:10.1088/1361-6633/ad4b9b.

[6] C. collaboration *et al.*, "Performance of the cms electromagnetic calorimeter in pp collisions at $\sqrt{s} = 13$ TeV," *Journal of Instrumentation*, vol. 19, no. 9, p. P09004, 2024. doi:10.1088/1748-0221/19/09/P09004.

[7] C. collaboration *et al.*, "Test of lepton flavor universality in $\mathrm{B}^{\pm} \to \mathrm{K}^{\pm}\mu^{+}\mu^{-}$ and $\mathrm{B}^{\pm} \to \mathrm{K}^{\pm}e^{+}e^{-}$ decays in proton-proton collisions at $\sqrt{s} = 13$ TeV," *Reports on Progress in Physics*, vol. 87, no. 7, 2024. doi:10.1088/1361-6633/ad4e65.

[8] A. Tumasyan *et al.*, "Measurements of azimuthal anisotropy of nonprompt D0 mesons in PbPb collisions at sNN=5.02TeV," *Phys. Lett. B*, vol. 850, p. 138389, 2024. doi:10.1016/j.physletb.2023.138389.

[9] A. Hayrapetyan *et al.*, "Search for dark matter particles in $W^{+}W^{-}$ events with transverse momentum imbalance in proton-proton collisions at $\sqrt{s} = 13$ TeV," *JHEP*, vol. 03, p. 134, 2024. doi:10.1007/JHEP03(2024)134.

[10] A. Hayrapetyan *et al.*, "Observation of Enhanced Long-Range Elliptic Anisotropies Inside High-Multiplicity Jets in pp Collisions at s=13 TeV," *Phys. Rev. Lett.*, vol. 133, no. 14, p. 142301, 2024.

[11] A. Tumasyan *et al.*, "K^{0}_{S} and $\Lambda(\overline{\Lambda})$ two-particle femtoscopic correlations in PbPb collisions at $\sqrt{s_{NN}} = 5.02$ TeV," *Phys. Lett. B*, vol. 857, p. 138936, 2024. doi:10.1016/j.physletb.2024.138936.

[12] A. Hayrapetyan *et al.*, "Search for long-lived heavy neutral leptons decaying in the CMS muon detectors in proton-proton collisions at s=13 TeV," *Phys. Rev. D*, vol. 110, p. 012004, 2024. doi:10.1103/PhysRevD.110.012004.

[13] A. Hayrapetyan *et al.*, "Search for pair production of scalar and vector leptoquarks decaying to muons and bottom quarks in proton-proton collisions at s=13 TeV," *Phys. Rev. D*, vol. 109, no. 11, p. 112003, 2024. doi:10.1103/PhysRevD.109.112003.

[14] A. Hayrapetyan *et al.*, "Constraints on anomalous Higgs boson couplings from its production and decay using the WW channel in proton–proton collisions at $\sqrt{s} = 13$ TeV," *Eur. Phys. J. C*, vol. 84, no. 8, p. 779, 2024.

[15] A. Hayrapetyan *et al.*, "Search for long-lived particles decaying in the CMS muon detectors in proton-proton collisions at s=13 TeV," *Phys. Rev. D*, vol. 110, no. 3, p. 032007, 2024. doi:10.1103/PhysRevD.110.032007.

[16] A. Hayrapetyan *et al.*, "Combined search for electroweak production of winos, binos, higgsinos, and sleptons in proton-proton collisions at s=13 TeV," *Phys. Rev. D*, vol. 109, no. 11, p. 112001, 2024. doi:10.1103/PhysRevD.109.112001.

[17] A. Hayrapetyan *et al.*, "Searches for Pair-Produced Multijet Resonances Using Data Scouting in Proton-Proton Collisions at s=13 TeV," *Phys. Rev. Lett.*, vol. 133, no. 20, p. 201803, 2024.

[18] A. Hayrapetyan *et al.*, "Measurement of Energy Correlators inside Jets and Determination of the Strong Coupling αS(mZ)," *Phys. Rev. Lett.*, vol. 133, no. 7, p. 071903, 2024.

[19] A. Hayrapetyan *et al.*, "Search for Soft Unclustered Energy Patterns in Proton-Proton Collisions at 13 TeV," *Phys. Rev. Lett.*, vol. 133, no. 19, p. 191902, 2024.

[20] A. Hayrapetyan *et al.*, "Search for production of a single vectorlike quark decaying to tH or tZ in the all-hadronic final state in pp collisions at s=13 TeV," *Phys. Rev. D*, vol. 110, no. 7, p. 072012, 2024. doi:10.1103/PhysRevD.110.072012.

[21] A. Hayrapetyan *et al.*, "Observation of the Ξb-$\to\psi$(2S)Ξ- decay and studies of the Ξb(5945)0 baryon in proton-proton collisions at s=13 TeV," *Phys. Rev. D*, vol. 110, no. 1, p. 012002, 2024. doi:10.1103/PhysRevD.110.012002.

[22] A. Hayrapetyan *et al.*, "Search for ZZ and ZH production in the $\mathrm{b\bar{b}b\bar{b}}$ final state using proton-proton collisions at $\sqrt{s} = 13$ TeV," *Eur. Phys. J. C*, vol. 84, no. 7, p. 712, 2024.

[23] A. Tumasyan *et al.*, "Search for a scalar or pseudoscalar dilepton resonance produced in association with a massive vector boson or top quark-antiquark pair in multilepton events at s=13 TeV," *Phys. Rev. D*, vol. 110, no. 1, p. 012013, 2024. doi:10.1103/PhysRevD.110.012013.

[24] A. Hayrapetyan *et al.*, "Search for the Z Boson Decay to $\tau\tau\mu\mu$ in Proton-Proton Collisions at s=13 TeV," *Phys. Rev. Lett.*, vol. 133, no. 16, p. 161805, 2024.

[25] A. Hayrapetyan *et al.*, "Search for exotic decays of the Higgs boson to a pair of pseudoscalars in the $\mu\mu$bb and $\tau\tau$bb final states," *Eur. Phys. J. C*, vol. 84, no. 5, p. 493, 2024.

[26] A. Hayrapetyan *et al.*, "Observation of the $\Lambda_b^0 \to \mathrm{J}/\psi$ decay," *Eur. Phys. J. C*, vol. 84, no. 10, p. 1062, 2024.

[27] A. Hayrapetyan *et al.*, "Observation of double J/ψ meson production in pPb collisions at sNN=8.16 TeV," *Phys. Rev. D*, vol. 110, no. 9, p. 092002, 2024. doi:10.1103/PhysRevD.110.092002.

[28] A. Hayrapetyan *et al.*, "Search for bottom-type vectorlike quark pair production in dileptonic and fully hadronic final states in proton-proton collisions at s=13 TeV," *Phys. Rev. D*, vol. 110, no. 5, p. 052004, 2024. doi:10.1103/PhysRevD.110.052004.

[29] A. Hayrapetyan, Sergio F. Novaes, *et al.*, "Search for light long-lived particles decaying to displaced jets in proton-proton collisions at $\sqrt{s}$ = 13.6 TeV," *Journal of High Energy Physics*, 9 2024. doi:10.1007/JHEP08(2024)215.

[30] T. C. Collaboration, "Observation of quantum entanglement in top quark pair production in proton–proton collisions at $\sqrt{s} = 13$ TeV," *Reports on Progress in Physics*, vol. 87, p. 117801, oct 2024. doi:10.1088/1361-6633/ad7e4d.

[31] C. Collaboration, "The cms statistical analysis and combination tool: Combine," 2024. doi:10.1007/s41781-024-00121-4.

[32] T. C. Collaboration, "Observation of $\gamma\gamma \to \tau\tau$ in proton–proton collisions and limits on the anomalous electromagnetic moments of the τ lepton," *Reports on Progress in Physics*, vol. 87, p. 107801, sep 2024. doi:10.1088/1361-6633/ad6fcb.

[33] T. C. collaboration *et al.*, "Performance of the cms electromagnetic calorimeter in pp collisions at $\sqrt{s} = 13$ TeV," *Journal of Instrumentation*, vol. 19, p. P09004, sep 2024. doi:10.1088/1748-0221/19/09/P09004.

[34] A. Hayrapetyan *et al.*, "Search for heavy neutral leptons in final states with electrons, muons, and hadronically decaying tau leptons in proton-proton collisions at $\sqrt{s}$ = 13 TeV," *JHEP*, vol. 06, p. 123, 2024. doi:10.1007/JHEP06(2024)123.

[35] A. Hayrapetyan *et al.*, "Search for long-lived heavy neutrinos in the decays of B mesons produced in proton-proton collisions at $\sqrt{s} = 13$ TeV," *JHEP*, vol. 06, p. 183, 2024. doi:10.1007/JHEP06(2024)183.

[36] A. Hayrapetyan *et al.*, "Search for dark QCD with emerging jets in proton-proton collisions at $\sqrt{s}$ = 13 TeV," *JHEP*, vol. 07, p. 142, 2024. doi:10.1007/JHEP07(2024)142.

[37] A. Hayrapetyan *et al.*, "Search for Higgs boson pair production in the $b\bar{b}W^+W^-$ decay mode in proton-proton collisions at $\sqrt{s}$ = 13 TeV," *JHEP*, vol. 07, p. 293, 2024. doi:10.1007/JHEP07(2024)293.

[38] Enrico Bertuzzo, C. Grojean, and G. M. Salla, "Alps, the on-shell way," *Journal of High Energy Physics*, vol. 2024, no. 5, pp. 1–43, 2024. doi:10.1007/JHEP05(2024)175.

[39] P. Rogozenski, E. Krause, and V. Miranda, "Modeling neutrino-induced scale-dependent galaxy clustering for photometric galaxy surveys," *Journal of Cosmology and Astroparticle Physics*, vol. 2024, no. 04, p. 076, 2024. doi:10.1088/1475-7516/2024/04/076.

[40] J. Xu, T. Eifler, V. Miranda, X. Fang, E. Saraivanov, E. Krause, H.-J. Huang, K. Benabed, and K. Zhong, "Constraining baryonic physics with des y1 and planck data: Combining galaxy clustering, weak lensing, and cmb lensing," *Physical Review D*, vol. 110, no. 6, p. 063532, 2024. doi:10.1103/PhysRevD.110.063532.

[41] X. Fang, E. Krause, T. Eifler, S. Ferraro, K. Benabed, R. Pranjal, E. Ayçoberry, Y. Dubois, and V. Miranda, "Cosmology from weak lensing, galaxy clustering, cmb lensing, and tsz–i. 10× 2pt modelling methodology," *Monthly Notices of the Royal Astronomical Society*, vol. 527, no. 4, pp. 9581–9593, 2024. doi:10.1093/mnras/stad3808.

[42] K. V. Berghaus, J. A. Kable, and V. Miranda, "Quantifying scalar field dynamics with DESI 2024 Y1 BAO measurements," *Phys. Rev. D*, vol. 110, no. 10, p. 103524, 2024.

[43] J. Gordon, B. F. de Aguiar, J. a. Rebouças, G. Brando, F. Falciano, V. Miranda, K. Koyama, and H. A. Winther, "Modeling nonlinear scales with the comoving Lagrangian acceleration method: Preparing for LSST Y1," *Phys. Rev. D*, vol. 110, no. 8, p. 083529, 2024.

[44] J. Gordon, B. F. de Aguiar, J. Rebouças, G. Brando, F. Falciano, V. Miranda, K. Koyama, and H. A. Winther, "Modeling nonlinear scales with the comoving lagrangian acceleration method: Preparing for lsst y1," *Physical Review D*, vol. 110, no. 8, p. 083529, 2024. doi:10.1103/PhysRevD.110.083529.

[45] A. G. Abac, R. Abbott, Riccardo Sturani, *et al.*, "Ultralight vector dark matter search using data from the kagra o3gk run," *Phys. Rev. D*, vol. 110, p. 042001, Aug 2024. doi:10.1088/1475-7516/2024/08/007.

[46] L. S. Collaboration, V. Collaboration, K. Collaboration, *et al.*, "Observation of gravitational waves from the coalescence of a 2.5–4.5 me compact object and a neutron star," *Astrophysical Journal Letters*, vol. 970, no. 2, p. L34, 2024. doi:10.3847/2041-8213/ad5beb.

[47] A. G. Abac, R. Abbott, H. Abe, Riccardo Sturani, *et al.*, "Search for eccentric black hole coalescences during the third observing run of ligo and virgo," *The Astrophysical Journal*, vol. 973, p. 132, sep 2024. doi:10.3847/1538-4357/ad65ce.

[48] C. Fletcher, J. Wood, R. Hamburg, P. Veres, C. Hui, E. Bissaldi, M. Briggs, E. Burns, W. Cleveland, M. Giles, Riccardo Sturani, *et al.*, "A joint fermi-gbm and swift-bat analysis of gravitational-wave candidates from the third gravitational-wave observing run," *The astrophysical journal.-Chicago, Ill., 1895, currens*, vol. 964, no. 2, pp. 1–35, 2024. doi:10.3847/1538-4357/ad1eed.

[49] A. G. Abac *et al.*, "Observation of Gravitational Waves from the Coalescence of a 2.5–4.5 M $_\odot$ Compact Object and a Neutron Star," *Astrophys. J. Lett.*, vol. 970, no. 2, p. L34, 2024. doi:10.3847/2041-8213/ad5beb.

[50] S. Hussain, E. De Gouveia Dal Pino de Gouveia, and G. Pagliaroli, "Neutrinos and gamma rays from galaxy clusters constrained by the upper limits of icecube," *The Astrophysical Journal*, vol. 960, no. 2, p. 124, 2024. doi:10.3847/1538-4357/ad10a6.

[51] K. Abe, S. Abe, F. Acero, A. Acharyya, R. Adam, A. Aguasca-Cabot, I. Agudo, A. Aguirre-Santaella, J. Alfaro, R. Alfaro, E. De Gouveia Dal Pino, Fabio Iocco, Farinaldo S. Queiroz, Rodrigo Nemmen, *et al.*, "Prospects for γ-ray observations of the perseus galaxy cluster with the cherenkov telescope array," *Journal of cosmology and astroparticle physics*, vol. 2024, no. 10, p. 004, 2024. doi:10.1088/1475-7516/2024/10/004.

[52] S. Abe, J. Abhir, A. Abhishek, F. Acero, E. De Gouveia Dal Pino, Fabio Iocco, *et al.*, "Dark matter line searches with the cherenkov telescope array," *Journal of Cosmology and Astroparticle Physics*, vol. 2024, p. 047, jul 2024. doi:10.1088/1475-7516/2024/07/047.

[53] F. Cangemi *et al.*, "Probe AGNs variability with the Cerenkov Telescope Array," *PoS*, vol. Gamma2022, p. 093, 2024.

[54] A. Trois, J. Douneaux, S. Scuderi, R. White, G. Tagliaferri, L. Proserpio, G. Tosti, P. Bruno, J. Cailleux, V. Conforti, E. De Gouveia Dal Pino, *et al.*, "Status of the small-sized telescopes programme for the cherenkov telescope array observatory," in *Ground-based and Airborne Telescopes X*, vol. 13094, pp. 1540–1556, SPIE, 2024. doi:10.1117/12.3019790.

[55] S. Abe, J. Abhir, A. Abhishek, F. Acero, A. Acharyya, R. Adam, A. Aguasca-Cabot, I. Agudo, A. Aguirre-Santaella, J. Alfaro, E. De Gouveia Dal Pino, Fabio Iocco, Rodrigo Nemmen, *et al.*, "Prospects for a survey of the galactic plane with the cherenkov telescope array," *Journal of cosmology and astroparticle physics*, vol. 2024, no. 10, p. 081, 2024. doi:10.1088/1475-7516/2024/10/081.

[56] E. H. Colombo, Ricardo Martinez-Garcia, J. M. Calabrese, C. López, and E. Hernández-García, "Pulsed interactions unify reaction–diffusion and spatial nonlocal models for biological pattern formation," *Journal of Statistical Mechanics: Theory and Experiment*, vol. 2024, no. 3, p. 034001, 2024. doi:10.1088/1742-5468/ad2b57.

[57] T. Portella, V. Sudbrack, R. Coutinho, P. Prado, and R. A. Kraenkel, "Bayesian spatio-temporal modeling to assess the effect of land-use changes on the incidence of cutaneous leishmaniasis in the brazilian amazon," *Science of The Total Environment*, vol. 953, p. 176064, 2024. doi:10.1016/j.scitotenv.2024.176064.

[58] C. Cabal, G. A. Maciel, and Ricardo Martinez-Garcia, "Plant antagonistic facilitation across environmental gradients: a soil-resource ecosystem engineering model," *New Phytologist*, vol. 244, no. 2, pp. 670–682, 2024. doi:10.1111/nph.20053.

[59] S. Poloni, R. A. Kraenkel, and R. Mendes Coutinho, "Biological invasions forming intraguild predation communities in homogeneous and heterogeneous landscapes," *Theoretical Ecology*, vol. 18, no. 1, pp. 1–16, 2025.

[60] M. W. Grunst, Z. Qin, E. Dodero-Rojas, S. Ding, J. Prévost, Y. Chen, Y. Hu, M. Pazgier, S. Wu, X. Xie, José N. Onuchic, *et al.*, "Structure and inhibition of SARS-CoV-2 spike refolding in membranes," *Science*, vol. 385, no. 6710, pp. 757–765, 2024. doi:10.1126/science.adn565.

[61] Y. Qiang, Victor L. Quito, T. V. Trevisan, and P. P. Orth, "Probing majorana wave functions in kitaev honeycomb spin liquids with second-order two-dimensional spectroscopy," *Physical Review Letters*, vol. 133, no. 12, p. 126505, 2024. doi:10.1103/PhysRevLett.133.126505.

[62] C. E. Villegas, E. Marinho, P. Venezuela, and Alexander R. Rocha, "Optical spectra and exciton radiative lifetimes in bulk transition metal dichalcogenides," *Physical Chemistry Chemical Physics*, vol. 26, no. 17, pp. 13251–13260, 2024.

[63] C. E. Villegas and Alexander R. Rocha, "Screened hydrogen model of excitons in semiconducting nanoribbons," *Physical Review B*, vol. 109, no. 16, p. 165425, 2024. doi:0.1103/PhysRevB.109.165425.

[64] P. Lyu, F. Matusalem, E. Deniz, Alexander R. Rocha, and M. S. Leite, "In situ solid-state dewetting of ag–au–pd alloy: From macro-to nanoscale," *ACS Applied Materials & Interfaces*, 2024. doi:10.1021/acsami.4c11397.

[65] F. Duarte, F. Matusalem, D. Grasseschi, Alexander R. Rocha, L. Seixas, C. J. de Matos, S. Mukim, and M. Ferreira, "Decoding disorder signatures of aucl3 and vacancies in mos2 films: from synthetic to experimental inversion," *Journal of Physics: Condensed Matter*, vol. 36, no. 49, p. 495901, 2024. doi:10.1088/1361-648X/ad7568.

[66] E. Marinho Jr, C. E. Villegas, P. Venezuela, and Alexander R. Rocha, "Many-body effects on electronic properties and optical response of single-layer penta-nin2 for infrared optoelectronics," *ACS Applied Nano Materials*, vol. 7, no. 17, pp. 20176–20185, 2024. doi:10.1021/acsanm.4c03019.

[67] E. Marinho Jr, C. E. Villegas, P. Venezuela, and Alexander R. Rocha, "Photovoltaic efficiency of transition metal dichalcogenides thin films by Ab initio excited-state methods," *ACS Applied Energy Materials*, vol. 7, no. 3, pp. 1051–1059, 2024. doi:10.1021/acsaem.3c02523.

[68] R. N. Pedrosa, C. E. Villegas, Alexander R. Rocha, R. G. Amorim, and W. L. Scopel, "Optical properties enhancement via wsse/silicene solar cell junctions," *Energy Advances*, vol. 3, no. 4, pp. 821–828, 2024. doi:10.1039/D3YA00529A.

[69] G. F. Alves, Chee Sheng Fong, L. P. Leal, and Renata Z. Funchal, "Limits on wr from meson decays," *Physical Review Letters*, vol. 133, no. 16, p. 161802, 2024. doi:0.1103/PhysRevLett.133.161802.

[70] K. Babu, P. Di Bari, Chee Sheng Fong, and S. Saad, "Leptogenesis in so (10) with minimal yukawa sector," *Journal of High Energy Physics*, vol. 2024, no. 10, pp. 1–37, 2024. doi:10.1007/JHEP10(2024)190.

[71] M. S. Gomes-Filho, P. de Castro, Danilo B. Liarte, and F. A. Oliveira, "Restoring the fluctuation–dissipation theorem in kardar–parisi–zhang universality class through a new emergent fractal dimension," *Entropy*, vol. 26, no. 3, p. 260, 2024. doi:10.3390/e26030260.

[72] T. Čadež, D. K. Nandy, D. Rosa, A. Andreanov, and B. Dietz, "The rosenzweig–porter model revisited for the three wigner–dyson symmetry classes," *New Journal of Physics*, vol. 26, no. 8, p. 083018, 2024. doi:10.1088/1367-2630/ad5d86.

[73] J.-Y. Gyhm, D. Rosa, and D. Šafránek, "Minimal time required to charge a quantum system," *Physical Review A*, vol. 109, no. 2, p. 022607, 2024. doi:10.1103/PhysRevA.109.022607.

[74] L. Castiglioni, S. Penati, M. Tenser, and Diego Trancanelli, "Interpolating bremsstrahlung function in abjm model," *Physical Review D*, vol. 109, no. 12, p. 126010, 2024. doi:10.1103/PhysRevD.109.126010.

[75] R. G. Pozzi and Diego Trancanelli, "Bootstrap of the defect 1/2 bps wilson lines in n= 4 chern-simons-matter theories," *Physical Review D*, vol. 110, no. 6, p. 066006, 2024. doi:10.1103/PhysRevD.110.066006.

[76] J. F. Silva and E. Miranda, "Multi-dirac and weyl physics in heavy-fermion systems," *Physical Review B*, vol. 109, no. 3, p. 035153, 2024. doi:10.1103/PhysRevB.109.035153.

[77] M. F. Cavalcante, M. V. Bonança, E. Miranda, and S. Deffner, "Nanowelding of quantum spin-1 2 chains at minimal dissipation," *Physical Review B*, vol. 110, no. 6, p. 064304, 2024. doi:10.1103/PhysRevB.110.064304.

[78] A. Carvalho, E. De Gouveia Dal Pino, T. Medina-Torrejón, and G. Kowal, "Computing particle feedback in rmhd-pic simulations of relativistic jets," *Boletim da Sociedade Astronômica Brasileira*, vol. 35, no. 1, pp. 18–19, 2024.

[79] S. A. Faria, R. Santos-Lima, and E. De Gouveia Dal Pino, "Amplification of magnetic fields by a turbulent dynamo in the weakly collisional, viscous intra-cluster medium," *Boletim da Sociedade Astronômica Brasileira*, vol. 35, no. 1, pp. 255–257, 2024.

[80] W. E. Clavijo-Bohórquez, E. De Gouveia Dal Pino, and C. Melioli, "Role of agn and star formation feedback in the evolution of galaxy outflows," *Monthly Notices of the Royal Astronomical Society*, p. stae487, 2024. doi:10.1093/mnras/stae487.

[81] Enrico Bertuzzo, Y. F. Perez-Gonzalez, G. M. Salla, and R. Z. Funchal, "Gravitationally produced dark matter and primordial black holes," *Journal of Cosmology and Astroparticle Physics*, vol. 2024, p. 059, sep 2024. doi:10.1088/1475-7516/2024/09/059.

[82] D. Barducci, Enrico Bertuzzo, M. Taoso, C. Ternes, and C. Toni, "Illuminating the dark: mono-γ signals at NA62," *Journal of High Energy Physics*, vol. 2024, no. 10, pp. 1–20, 2024. doi:10.1007/JHEP10(2024)016.

[83] Enrico Bertuzzo, T. Sassi, and A. Tesi, "Complex dark photon dark matter eft," *Journal of High Energy Physics*, vol. 2024, no. 10, pp. 1–39, 2024. doi:10.1007/JHEP10(2024)109.

[84] Fabio Iocco and L. Visinelli, "Compatibility of jwst results with exotic halos," *Physics of the Dark Universe*, vol. 44, p. 101496, 2024. doi:10.1016/j.dark.2024.101496.

[85] G. Arcadi, G. C. Dorsch, J. P. Neto, Farinaldo S. Queiroz, and Y. Oviedo-Torres, "Probing a dark sector with collider physics, direct detection, and gravitational waves," *Physics Letters B*, vol. 848, p. 138382, 2024. doi:10.1016/j.physletb.2023.138382.

[86] A. de Jesus, S. Kovalenko, T. de Melo, J. Neto, Y. Oviedo-Torres, Farinaldo S. Queiroz, Y. Villamizar, and A. Zerwekh, "On the role of lhc and hl-lhc in constraining flavor changing neutral currents," *Physics Letters B*, vol. 849, p. 138419, 2024. doi:10.1016/j.physletb.2023.138419.

[87] J. Alves, L. Angel, L. Guedes, R. Neves, Farinaldo S. Queiroz, D. da Silva, R. Silva, and Y. Villamizar, "Updated big bang nucleosynthesis bounds on long-lived particles from dark sectors," *Physics Letters B*, vol. 855, p. 138845, 2024. doi:10.1016/j.physletb.2024.138845.

[88] G. Acampora, C. Ahdida, R. Albanese, C. Albrecht, A. Alexandrov, M. Andreini, A. Anokhina, T. Asada, N. Auberson, C. Baldanza, Farinaldo S. Queiroz, *et al.*, "SND@LHC: the scattering and neutrino detector at the LHC," *Journal of Instrumentation*, vol. 19, no. 05, p. P05067, 2024. doi:10.1088/1748-0221/19/05/P05067.

[89] L. Angel, G. Gambini, L. Guedes, Farinaldo S. Queiroz, and V. de Souza, "Constraining gamma-ray lines from dark matter annihilation using fermi-lat and hess data," *Journal of Cosmology and Astroparticle Physics*, vol. 2024, no. 04, p. 028, 2024. doi:10.1088/1475-7516/2024/04/028.

[90] S. S. da Costa, D. R. da Silva, Á. S. de Jesus, N. Pinto-Neto, and Farinaldo S. Queiroz, "The H_0 trouble: confronting non-thermal dark matter and phantom cosmology with the CMB, BAO, and Type ia supernovae data," *Journal of Cosmology and Astroparticle Physics*, vol. 2024, no. 04, p. 035, 2024. doi:10.1088/1475-7516/2024/04/035.

[91] C. Accettura, D. Adams, R. Agarwal, C. Ahdida, C. Aimè, N. Amapane, D. Amorim, P. Andreetto, F. Anulli, R. Appleby, Farinaldo S. Queiroz, *et al.*, "Erratum: Towards a muon collider," *The European Physical Journal C*, vol. 84, no. 1, p. 36, 2024. doi:10.1140/epjc/s10052-023-12257-5.

[92] A. Alves, G. G. da Silveira, V. Gonçalves, Farinaldo S. Queiroz, Y. Oviedo-Torres, and J. Zamora-Saa, "Searching for a leptophilic z^\prime and a 3-3-1 symmetry at clic," *The European Physical Journal C*, vol. 84, no. 2, pp. 1–9, 2024. doi:10.1140/epjc/s10052-024-12515-0.

[93] D. Rosa, R. Francisco, T. Frederico, G. Krein, and M. Yamashita, "Confinement-induced unatomic trimer states," *Physical Review A*, vol. 110, no. 4, p. 042803, 2024. doi:10.1103/PhysRevA.110.042803.

[94] F. X. Azeredo, D. C. Duarte, R. L. Farias, G. Krein, and R. O. Ramos, "Deconfinement and chiral phase transitions in quark matter with chiral imbalance," *Physical Review D*, vol. 110, no. 7, p. 076007, 2024. doi:10.1103/PhysRevD.110.076007.

[95] G. Heymans, N. Svaiter, B. Svaiter, and G. Krein, "Critical casimir effect in a disordered o (2)-symmetric model," *Physical Review E*, vol. 109, no. 5, p. 054108, 2024. doi:10.1103/PhysRevE.109.054108.

[96] T. Frederico, R. Francisco, D. Rosa, G. Krein, and M. Yamashita, "Discrete scaling in non-integer dimensions," *Few-Body Systems*, vol. 65, no. 2, p. 28, 2024. doi:10.1007/s00601-024-01895-4.

[97] D. Rosa, T. Frederico, R. Francisco, G. Krein, and M. Yamashita, "Reliability of the born-oppenheimer approximation in noninteger dimensions," *Few-Body Systems*, vol. 65, no. 3, p. 77, 2024. doi:10.1007/s00601-024-01946-w.

[98] M. Cravo and Horatiu Nastase, "3-point function of currents for holographic cosmology and monopole non-gaussianities," *Journal of High Energy Physics*, vol. 2024, no. 5, pp. 1–50, 2024. doi:10.1007/JHEP05(2024)056.

[99] A. Anabalón, Horatiu Nastase, and M. Oyarzo, "Supersymmetric ads solitons and the interconnection of different vacua of n=4 super yang-mills," *Journal of High Energy Physics*, vol. 2024, no. 5, pp. 1–28, 2024. doi:10.1007/JHEP05(2024)217.

[100] A. Anabalón and Horatiu Nastase, "Universal ir holography, scalar fluctuations, and glueball spectra," *Physical Review D*, vol. 109, no. 6, p. 066011, 2024. doi:10.1103/PhysRevD.109.066011.

[101] Horatiu Nastase and J. Sonnenschein, "Euler fluid in 2+ 1 dimensions as a gauge theory and an action for the euler fluid in any dimension," *Physical Review D*, vol. 109, no. 8, p. 085006, 2024. doi:10.1103/PhysRevD.109.085006.

[102] M. R. Barbosa and Horatiu Nastase, "Penrose limit of t dual of maldacena-nastase solution and dual orbifold field theory," *Physical Review D*, vol. 109, no. 8, p. 086025, 2024. doi:10.1103/PhysRevD.109.086025.

[103] P. Meert and Horatiu Nastase, "Rotational holographic transport from kerr-newman-ads black hole," *Physical Review D*, vol. 110, no. 4, p. 046004, 2024. doi:10.1103/PhysRevD.110.046004.

[104] M. Barbosa, Horatiu Nastase, C. Nunez, and R. Stuardo, "Penrose limits of i-branes, twist-compactified d5-branes, and spin chains," *Physical Review D*, vol. 110, no. 4, p. 046015, 2024. doi:10.1103/PhysRevD.110.046015.

[105] Horatiu Nastase and C. L. Tiedt, "Holographic transport with topological term and entropy function," *Brazilian Journal of Physics*, vol. 54, no. 4, p. 114, 2024. doi:10.1007/s13538-024-01487-x.

[106] Horatiu Nastase and C. L. Tiedt, "Susceptibilities from holographic transport with topological term," *Brazilian Journal of Physics*, vol. 54, no. 4, p. 106, 2024. doi:10.1007/s13538-024-01488-w.

[107] T.-Y. Kang, F. Bocci, Q. Nie, José N. Onuchic, and A. Levchenko, "Spatial–temporal order–disorder transition in angiogenic notch signaling controls cell fate specification," *Elife*, vol. 12, p. RP89262, 2024. doi:10.7554/eLife.89262.

[108] J. Martin, M. Lequerica Mateos, José N. Onuchic, I. Coluzza, and F. Morcos, "Machine learning in biological physics: From biomolecular prediction to design," *Proceedings of the National Academy of Sciences*, vol. 121, no. 27, p. e2311807121, 2024. doi:10.1073/pnas.2311807121.

[109] V. Kazakov, H. Murali, and P. Vieira, "Huge bps operators and fluid dynamics in $\mathcal{N} = 4$ SYM.," *arXiv preprint arXiv:2406.01798*, 2024.

[110] R. Nechushtai, L. Rowland, O. Karmi, H.-B. Marjault, T. T. Nguyen, S. Mittal, R. S. Ahmed, D. Grant, C. Manrique-Acevedo, F. Morcos, José N. Onuchic, *et al.*, "Cisd3/mint is required for complex i function, mitochondrial integrity, and skeletal muscle maintenance," *Proceedings of the National Academy of Sciences*, vol. 121, no. 22, p. e2405123121, 2024. doi:10.1073/pnas.2405123121.

[111] M. Sandoval-Velasco, O. Dudchenko, J. A. Rodríguez, C. P. Estrada, M. Dehasque, C. Fontsere, S. S. Mak, R. Khan, V. G. Contessoto, A. B. O. Junior, José N. Onuchic, *et al.*, "Three-dimensional genome architecture persists in a 52,000-year-old woolly mammoth skin sample," *Cell*, vol. 187, no. 14, pp. 3541–3562, 2024. doi:10.1016/j.cell.2024.06.002.

[112] S. Brahmachari, T. Markovich, F. C. MacKintosh, and José N. Onuchic, "Temporally correlated active forces drive segregation and enhanced dynamics in chromosome polymers," *PRX Life*, vol. 2, no. 3, p. 033003, 2024. doi:10.1103/PRXLife.2.033003.

[113] E. Ding, S. N. Chaudhury, J. D. Prajapati, José N. Onuchic, and K. Y. Sanbonmatsu, "Magnesium ions mitigate metastable states in the regulatory landscape of mrna elements," *RNA*, vol. 30, no. 8, pp. 992–1010, 2024. doi:10.1261/rna.079767.123.

[114] A. Wang, X. Lin, K. N. Chau, José N. Onuchic, H. Levine, and J. T. George, "Racer-m leverages structural features for sparse t cell specificity prediction," *Science Advances*, vol. 10, no. 20, p. eadl0161, 2024. doi:10.1126/sciadv.adl0161.

[115] M. Lequerica-Mateos, J. Martin, José N. Onuchic, F. Morcos, and I. Coluzza, "Designing proteins: Mimicking natural protein sequence heterogeneity," *The Journal of Chemical Physics*, vol. 161, no. 19, 2024. doi:10.1063/5.0232831.

[116] N. S. de Santi, F. Villaescusa-Navarro, and L. R. Abramo, "Graph neural networks for robust parameter inference in cosmology: the first steps before real data," *Boletim da Sociedade Astronômica Brasileira*, vol. 35, no. 1, pp. 206–210, 2024.

[117] C. Bom, A. Cortesi, U. Ribeiro, L. Dias, K. Kelkar, A. Smith Castelli, L. Santana-Silva, V. Lopes-Silva, T. Gonçalves, L. R. Abramo, *et al.*, "An extended catalogue of galaxy morphology using deep learning in southern photometric local universe survey data release 3," *Monthly Notices of the Royal Astronomical Society*, vol. 528, no. 3, pp. 4188–4208, 2024. doi:10.1093/mnras/stad3956.

[118] A. Abed Abud, B. Abi, R. Acciarri, M. Acero, M. Adames, G. Adamov, M. Adamowski, D. Adams, M. Adinolfi, C. Adriano, Marcelo M. Guzzo, *et al.*, "Supernova pointing capabilities of dune," tech. rep., Los Alamos National Laboratory (LANL), Los Alamos, NM (United States . . . , 2024. https://www.osti.gov/biblio/2406213.

[119] A. Abed Abud, B. Abi, R. Acciarri, M. Acero, M. Adames, G. Adamov, M. Adamowski, D. Adams, M. Adinolfi, C. Adriano, Marcelo M. Guzzo, *et al.*, "The hypothetical track-length fitting algorithm for energy measurement in liquid argon tpcs," tech. rep., Argonne National Laboratory (ANL), Argonne, IL (United States); Brookhaven . . . , 2024. https://www.osti.gov/biblio/2462789.

[120] L. F. P. Salles, Marcus A. M. de Aguiar, and F. M. D. Marquitti, "Evolution of cooperation in a two-species system with a common resource pool," *Journal of theoretical biology*, vol. 577, p. 111670, 2024. doi:10.1016/j.jtbi.2023.111670.

[121] J. U. Lizárraga, F. M. Marquitti, and Marcus A. M. de Aguiar, "Assortativity in sympatric speciation and species classification," *Physica A: Statistical Mechanics and its Applications*, vol. 653, p. 130111, 2024. doi:10.1016/j.physa.2024.130111.

[122] R. Fariello and Marcus A. M. de Aguiar, "Exploring the phase diagrams of multidimensional kuramoto models," *Chaos, Solitons & Fractals*, vol. 179, p. 114431, 2024. doi:10.1016/j.chaos.2023.114431.

[123] M. C. Rossato and Marcus A. M. de Aguiar, "Modelos genotípicos de polimorfismo em lagartos uta stansburiana baseados no jogo pedra-papel-tesoura," *REMAT: Revista Eletrônica da Matemática*, vol. 10, no. especial, pp. e4007–e4007, 2024. doi:10.35819/remat2024v10iespecialid7085.

[124] R. S. Vieira, L. H. Daniel, and Marcus A. M. de Aguiar, "Caos em osciladores forçados sem amortecimento via mapas estroboscópicos," *Revista Brasileira de Ensino de Física*, vol. 46, p. e20240229, 2024. doi:10.1590/1806-9126-RBEF-2024-0229.

[125] K. O'Keeffe, G. K. Sar, M. S. Anwar, J. U. Lizárraga, Marcus A. M. de Aguiar, and D. Ghosh, "A solvable two-dimensional swarmalator model," in *Proceedings A*, vol. 480, p. 20240448, The Royal Society, 2024. doi:10.1098/rspa.2024.0448.

[126] J. U. Lizárraga, K. P. O'Keeffe, and Marcus A. M. de Aguiar, "Order, chaos, and dimensionality transition in a system of swarmalators," *Physical Review E*, vol. 109, no. 4, p. 044209, 2024. doi:10.1103/PhysRevE.109.044209.

[127] M. Novaes and Marcus A. M. de Aguiar, "Kuramoto variables as eigenvalues of unitary matrices," *Physical Review E*, vol. 110, no. 2, p. 024217, 2024. doi:10.1103/PhysRevE.110.024217.

[128] D. Princepe, S. Czarnobai, R. A. Caetano, F. M. Marquitti, Marcus A. M. de Aguiar, and S. B. Araujo, "Intermittent migration can induce pulses of speciation in a two-island system," *Evolution*, vol. 78, no. 4, pp. 758–767, 2024. doi:10.1093/evolut/qpad210.

[129] Marcus A. M. de Aguiar, "On the numerical integration of the multidimensional kuramoto model," *Brazilian Journal of Physics*, vol. 54, no. 4, p. 119, 2024. doi:10.1007/s13538-024-01493-z.

[130] O. J. P. Éboli, M. Gonzalez-Garcia, and M. Martines, "Bounds on quartic gauge couplings in heft from electroweak gauge boson pair production at the lhc," *Physical Review D*, vol. 109, no. 3, p. 033007, 2024. doi:10.1103/PhysRevD.109.033007.

[131] J. Abajian, F. Aprile, R. C. Myers, and Pedro Vieira, "Correlation functions of huge operators in ads3/cft2: domes, doors and book pages," *Journal of High Energy Physics*, vol. 2024, no. 3, pp. 1–42, 2024. doi:10.1007/JHEP03(2024)118.

[132] A. Homrich, D. Simmons-Duffin, and Pedro Vieira, "Light-ray wave functions and integrability," *Journal of High Energy Physics*, vol. 2024, no. 10, pp. 1–48, 2024. doi:10.1007/JHEP10(2024)125.

[133] E. Berthier, H. Yang, M. Guo, Pierre Ronceray, and C. P. Broedersz, "Nonlinear mechanosensation in fiber networks," *Physical Review Research*, vol. 6, no. 1, p. 013327, 2024. doi:10.1103/PhysRevResearch.6.013327.

[134] S. Amiri, Y. Zhang, A. Gerardos, C. Sykes, and Pierre Ronceray, "Inferring geometrical dynamics of cell nucleus translocation," *Physical Review Research*, vol. 6, no. 4, p. 043030, 2024. doi:10.1103/PhysRevResearch.6.043030.

[135] R. Pitombo, M. Vasconcellos, P. Abrantes, R. de Melo e Souza, G. Penello, and C. Farina, "Periodic strings: A mechanical analogy to photonic and phononic crystals," *American Journal of Physics*, vol. 92, no. 2, pp. 108–114, 2024.

[136] L. Amalberti, Z. Yang, and Rafael A. Porto, "Gravitational radiation from inspiralling compact binaries to n 3 lo in the effective field theory approach," *Physical Review D*, vol. 110, no. 4, p. 044046, 2024. doi:10.1103/PhysRevD.110.044046.

[137] C. Dlapa, G. Kälin, Z. Liu, and Rafael A. Porto, "Local in time conservative binary dynamics at fourth post-minkowskian order," *Physical Review Letters*, vol. 132, no. 22, p. 221401, 2024. doi:10.1103/PhysRevLett.132.221401.

[138] M. Bošković, M. Koschnitzke, and Rafael A. Porto, "Signatures of ultralight bosons in the orbital eccentricity of binary black holes," *Physical Review Letters*, vol. 133, no. 12, p. 121401, 2024. doi:10.1103/PhysRevLett.133.121401.

[139] G. F. Alves, Renata Z. Funchal, and P. A. Machado, "Could sbnd-prism probe lepton flavor violation?," *Physical Review D*, vol. 110, no. 3, p. 035031, 2024. doi:10.1103/PhysRevD.110.035031.

[140] V. Dornelas, P. de Castro, J. M. Calabrese, W. F. Fagan, and Ricardo Martinez-Garcia, "Movement bias in asymmetric landscapes and its impact on population distribution and critical habitat size," in *Proceedings A*, vol. 480, p. 20240185, The Royal Society, 2024. doi:10.1098/rspa.2024.0185.

[141] D. C. Jorge and Ricardo Martinez-Garcia, "Demographic effects of aggregation in the presence of a component allee effect," *Journal of the Royal Society Interface*, vol. 21, no. 214, p. 20240042, 2024. doi:10.1098/rsif.2024.0042.

[142] W. F. Fagan, A. Krishnan, Q. Liao, C. H. Fleming, D. Liao, C. Lamb, B. Patterson, T. Wheeldon, Ricardo Martinez-Garcia, J. F. Menezes, *et al.*, "Intraspecific encounters can lead to reduced range overlap," *Movement ecology*, vol. 12, no. 1, p. 58, 2024. doi:10.1186/s40462-024-00501-w.

[143] Isabela Matos, M. Quartin, L. Amendola, M. Kunz, and Riccardo Sturani, "A model-independent tripartite test of cosmic distance relations," *Journal of Cosmology and Astroparticle Physics*, vol. 2024, no. 08, p. 007, 2024. doi:10.1088/1475-7516/2024/08/007.

[144] K.-W. Wong, C. M. Steiner, A. M. Blum, D. Lin, Rodrigo S. Nemmen, J. A. Irwin, and D. R. Wik, "Nustar observation of the tev-detected radio galaxy 3c 264: Core emission and the hot accretion flow contribution," *The Astrophysical Journal*, vol. 974, p. 82, oct 2024. doi:10.3847/1538-4357/ad6a1a.

[145] J. Maithil, M. S. Brotherton, O. Shemmer, B. Luo, P. Du, J.-M. Wang, C. Hu, S. C. Gallagher, Y.-R. Li, and Rodrigo S. Nemmen, "X-ray properties of reverberation-mapped agns with super-eddington accreting massive black holes," *Monthly Notices of the Royal Astronomical Society*, vol. 528, pp. 1542–1554, 01 2024. doi:10.1093/mnras/stae115.

[146] D. Marsango, J. S. Schimoia, S. B. Rembold, T. Storchi-Bergmann, Rodrigo S. Nemmen, G. S. Couto, G. L. Souza-Oliveira, and J. H. Costa-Souza, "Short and long time-scales

variability of the h double-peaked profile of pictor a," *Monthly Notices of the Royal Astronomical Society*, vol. 529, pp. 3089–3101, 03 2024. doi:10.1093/mnras/stae694.

[147] Rodrigo S. Nemmen, A. Vemado, I. Almeida, J. Garcia, and P. N. Motta, "Emergence of hot corona and truncated disc in simulations of accreting stellar mass black holes," *Monthly Notices of the Royal Astronomical Society*, vol. 531, pp. 805–814, 04 2024. doi:10.1093/mnras/stae1133.

[148] J. Hubisz, S. Ironi, G. Perez, and Rogerio Rosenfeld, "A note on the quality of dilatonic ultralight dark matter," *Physics Letters B*, vol. 851, p. 138583, 2024. doi:10.1016/j.physletb.2024.138583.

[149] J. Mena-Fernández, M. Rodríguez-Monroy, S. Avila, A. Porredon, K. Chan, H. Camacho, N. Weaverdyck, I. Sevilla-Noarbe, E. Sanchez, L. Toribio San Cipriano, Rogerio Rosenfeld, *et al.*, "Dark energy survey: Galaxy sample for the baryonic acoustic oscillation measurement from the final dataset," *Physical Review D*, vol. 110, no. 6, p. 063514, 2024. doi:10.1103/PhysRevD.110.063514.

[150] T. Abbott, M. Adamow, M. Aguena, S. Allam, O. Alves, A. Amon, F. Andrade-Oliveira, J. Asorey, S. Avila, D. Bacon, Rogerio Rosenfeld, *et al.*, "Dark energy survey: A 2.1% measurement of the angular baryonic acoustic oscillation scale at redshift z eff= 0.85 from the final dataset," *Physical Review D*, vol. 110, no. 6, p. 063515, 2024. doi:10.1103/PhysRevD.110.063515.

[151] J. Rebouças, J. Gordon, D. H. de Souza, K. Zhong, V. Miranda, Rogerio Rosenfeld, T. Eifler, and E. Krause, "Early dark energy constraints with late-time expansion marginalization," *Journal of Cosmology and Astroparticle Physics*, vol. 2024, no. 02, p. 042, 2024. doi:10.1088/1475-7516/2024/02/042.

[152] A. Hayrapetyan, A. Tumasyan, W. Adam, J. Andrejkovic, T. Bergauer, S. Chatterjee, K. Damanakis, M. Dragicevic, P. Hussain, M. Jeitler, Sergio F. Novaes, *et al.*, "Measurement of the production cross section of a higgs boson with large transverse momentum in its decays to a pair of τ leptons in proton-proton collisions at $\sqrt{s} = 13$ TeV," *Physics Letters B*, vol. 857, p. 138964, 2024. doi:10.1016/j.physletb.2024.138964.

[153] A. Hayrapetyan, A. Tumasyan, W. Adam, J. Andrejkovic, T. Bergauer, S. Chatterjee, K. Damanakis, M. Dragicevic, P. Hussain, M. Jeitler, Sergio F. Novaes, *et al.*, "Searches for violation of lorentz invariance in top quark pair production using dilepton events in 13TeV proton-proton collisions," *Physics Letters B*, vol. 857, p. 138979, 2024. doi:10.1016/j.physletb.2024.138979.

[154] A. Hayrapetyan, A. Tumasyan, W. Adam, J. Andrejkovic, T. Bergauer, S. Chatterjee, K. Damanakis, M. Dragicevic, P. Hussain, M. Jeitler, N. Krammer, A. L.

Sergio F. Novaes, *et al.*, "Measurement of the polarizations of prompt and non-prompt J/ψ and $\psi(2s)$ mesons produced in pp collisions at $\sqrt{s} = 13$ TeV," *Physics Letters B*, vol. 858, p. 139044, 2024. doi:10.1016/j.physletb.2024.139044.

[155] A. Hayrapetyan *et al.*, "Search for new physics in high-mass diphoton events from proton-proton collisions at $\sqrt{s}$ = 13 TeV," *JHEP*, vol. 08, p. 215, 2024. doi:10.1007/JHEP06(2024)123.

[156] A. Hayrapetyan, A. Tumasyan, W. Adam, J. Andrejkovic, T. Bergauer, S. Chatterjee, K. Damanakis, M. Dragicevic, P. Hussain, M. Jeitler, Sergio F. Novaes, *et al.*, "Search for the decay of the higgs boson to a pair of light pseudoscalar bosons in the final state with four bottom quarks in proton-proton collisions at $\sqrt{s} = 13$ TeV," *Journal of High Energy Physics*, vol. 2024, no. 2403.10341, pp. 1–44, 2024. doi:10.1007/JHEP06(2024)097.

[157] A. Hayrapetyan, "Portable acceleration of cms computing workflows with coprocessors as a service," tech. rep., Lawrence Livermore National Laboratory (LLNL), Livermore, CA (United States ..., 2024. doi:10.1007/s41781-024-00124-1.

[158] A. Hayrapetyan *et al.*, "Nonresonant central exclusive production of charged-hadron pairs in proton-proton collisions at s=13 TeV," *Phys. Rev. D*, vol. 109, no. 11, p. 112013, 2024. doi:10.1103/PhysRevD.109.112013.

[159] A. Hayrapetyan *et al.*, "Combination of Measurements of the Top Quark Mass from Data Collected by the ATLAS and CMS Experiments at s=7 and 8 TeV," *Phys. Rev. Lett.*, vol. 132, no. 26, p. 261902, 2024. doi:10.1103/PhysRevLett.132.261902.

[160] M. Smith, Victor L. Quito, A. Burkov, P. Orth, and I. Martin, "Theory for cd 3 as 2 thin films in the presence of magnetic fields," *Physical Review B*, vol. 109, no. 15, p. 155136, 2024. doi:10.1103/PhysRevB.109.155136.

[161] J. A. Kable and V. Miranda, "Sound horizon independent constraints on early dark energy: the role of supernova data," *JCAP*, vol. 10, p. 011, 2024.

[162] William G. C. Oropesa, E. S. Nascimento, and A. P. Vieira, "Mean-field model for a mixture of biaxial nematogens and dipolar nanoparticles," *Physical Review E*, vol. 109, no. 5, p. 054701, 2024. doi:10.1103/PhysRevE.109.054701.

[163] K. V. Berghaus, T. Karwal, V. Miranda, and T. Brinckmann, "Cosmology of dark energy radiation," *Physical Review D*, vol. 110, no. 6, p. 063557, 2024. doi:10.1103/PhysRevD.110.063557.

[164] Rui Aquino, N. O. Silvano, and D. G. Barci, "Laser induced $\mathcal{PT}$-symmetry breaking in the fluctuations of electronic fluids," *Phys. Rev. B*, vol. 110, p. 085147, Aug 2024. doi:10.1103/PhysRevB.110.085147.

Annexed Files

10.1 First Page of Publications

See the three annexed files, "**Papers**_$0i$" with $i = 1, 2, 3$, for publications of professors, direct doctoral students, and postdocs on the ICTP-SAIFR research team.

10.2 Scientific Reports of Postdocs and Direct Doctoral Students

See the three annexed files, "**RepotsDiredDoctoral_01**" and "**RepotsPostDoc**_$0i$" with $i = 1, 2$, for scientific reports of:

- Guilherme Henrique da Silva Costa.
- Rui Aquino dos Santos da Silva.
- Márcio Sampaio Gomes Filho.
- Pablo Souza de Castro Melo.
- Louis Legrand.
- Duive Maria van Egmond.
- Walter Esteban Riquelme Chamblas.
- Cassiano Antonio Daniel.
- Ulisses Marques Portugal.
- João Victor Silva Rebouças.
- Hao-Lan Xu.
- Debarghya Chakraborty.

Note: Hao-Lan Xu and Debarghya Chakraborty have recently joined the ICTP-SAIFR. Instead of their scientific reports, their research summary will be attached.

10.3 Scientific Reports of EP, JC and TT

See the annexed file "**Reports_EP_JC_TT_01**" for reports of:

- Lucas Campos.
- Felipe Ponciano de Novaes.
- Clewton Luís Ferreira da Fonseca.
- Celina Lerner.
- Felipe Gustavo Guimarães Saldanha.
- Alexandre Vinicius Aleixo Lourenco Conceição.
- Cintia Aparecida Cirillo.

- Ana Clara de Paula Moreira.
- Artur Stein.
- Victoria Pimenta Barel.
- Igor Zolnerkevic.
- William Gabriel Carreras Oropesa.
- Haniel Nunes Pereira Pinheiro.

10.4 Slides Presented in Workshops, Conferences and Meetings

See annexed presentations, "**Slides_01**" of ICTP-SAIFR researchers who used Reserva Técnica funds.