ATTACHMENT

PhD Reports

Academic Year 2023/24

ASTROPHYSICS AND COSMOLOGY
Report for the 2023-2024 Academic Year

SUMMARY

Hereafter we present the annual report of the Astrophysics and Cosmology group and PhD program for the 2023-2024 academic year. Regarding teaching, the Teaching Board, as a whole and with the active collaboration of student and postdoctoral staff representatives, has made minor adjustments to the curriculum following feedback from students (Section 1). The group admitted a total of six people to the PhD program in 2024, as in the previous year, of which four received school funding, one received funding from the European Social Fund, and one received the National Doctorate in Space Science and Technology (PhD SST) (Section 2). The transitions to the second, third, and fourth years of the program did not reveal any critical issues (Section 3). The Ph.D. theses defended in the academic year under review were 6, as in the previous year, all approved, of which 4 *cum laude* (one less than last year, Section 4). The post-Doctoral research staff, currently composed of 8 people (3 more than last year) on institute funds and projects, which include a fixed-term researcher supported by PNRR funds, is described in Section 5. Active national and international projects and funding are reported in Section 6. In the project and research areas described in Section 7, the actions undertaken to implement the corrective measures suggested in the report of previous years are highlighted, which specifically were (i) the low participation in filling out the questionnaire, (ii) the strengthening of the training offered in the *background courses,* and (iii) the improvement of the course logistics.

In the context of the School, the APC group supports *the Institute for Fundamental Physics of the Universe* (IFPU) in its governing bodies and in the implementation of scientific programs, and acts in didactic, scientific, and managerial synergy with the Ph.D. in *Astroparticle* and *Theory & Science of Data.* Activities related to group seminars, *Journal Clubs*, invitations for collaborations, conference organization, and collaborative work in general, have increased compared to previous years due to the start-up of international observational projects in which the group holds leadership roles.

The group's strategies for the coming years, in line with previous ones, include capitalizing on the role of individuals working on large international observational projects, transferring the knowledge acquired to adjacent groups within the School, promoting inter-area initiatives by opening the new research lines mentioned above, and developing corresponding proposals for future research lines in relation to ongoing observational efforts.

1. TEACHING

Starting in the 2023-2024 academic year, improvements to the curriculum have been implemented in constant communication and coordination with student and postdoctoral staff representatives. Student staff satisfaction with the improvements is assessed, as is the case every year, through communication and coordination with student and postdoctoral staff representatives, and through a questionnaire for first-year students of every single course, discussed at the Faculty Meeting in June. Positive impacts have been observed from the new *background courses* in *Scientific Computing* and the two new courses in Observational Astrophysics and Gravitational Lensing, offset by the consolidation of courses offered by external and retired faculty. Regarding the responses to the questionnaire, reminders for completion have been sent to student

and postdoctoral staff representatives. Logistically, courses will always be held in room 135, in constant coordination and synchronization with the courses held jointly with the PhD in Astroparticles, and, when necessary and possible, with the aid of online platforms such as Zoom. Furthermore, the importance of updating teaching materials in the form of notes, memos, or presentations has been emphasized to the teaching staff. As in the current academic year, any changes will be reviewed and discussed collectively by the Faculty Board in the Spring and the Faculty Board in June 2025, using the same methodologies.

2. ADMISSION TO THE PH.D.

During 2024, the following students were admitted to the Ph.D. in Astrophysics & Cosmology (gender and nationality in brackets): Karnchana Aroonrueang (India), Elisabeth Keppler (Italy), Margherita Imbriani (Italy), Aliza Mustafa (Iran, as part of the National PhD in Space Science and Technology), Athul Soman (India), Enrico Veraldi (Italy). The table below shows the number of applications received for the session reserved for non-European candidates (*EXTRA-EU)* , for those open to candidates from all over the world (*World)* on school funds (this year including those from the PNRR and not the PhD SST scholarship for the Academic Year in question and the previous one) in the first (I) and second (II) sessions. The numbers in brackets indicate the scholarships available and remaining in each session and the total number assigned. Finally, the last column shows the percentage of foreigners compared to the total applications, and in brackets the percentage of foreigners compared to the total number of candidates admitted to the Ph.D. The data shows the history up to the admission session for the AY 2023/2024.

- Spring Session: 51 applications, of which 9 were Italian, 3 from other EU countries, and 39 from non-EU countries.
- Autumn Session: 164 applications, of which 44 were Italian, 5 from other EU countries, and 115 from non-EU countries.

The gender balance in applications, as in selections, remains stable at 50%, in line with previous years' sessions.

3. YEAR TRANSITIONS

In the 2023-2024 academic year, the Teaching Board discussed and approved the following academic transitions (dates in brackets).

- **I -> II year:** Giovanni Antinozzi, Roberto Caiozzo, Margherita De Toma, Sijil Jose, Mayurakshi Mukherjee have successfully obtained the credits necessary to advance to the II year and defined their thesis project.
- **II -> III year: Carlos Alfonso Alvarez** (May 23, 2024), Francesco Benetti (May 13, 2024), Emma Dreas (May 22, 2024), Claudio Ranucci (May 9, 2024), Martina Torsello (May 20, 2024), held a seminar reporting on the progress of their thesis work. The seminar was followed by a discussion with the faculty, during which no critical issues were identified in the conduct of the research or its presentation.
- **III -> IV year:** Meriem Behiri (May 21, 2024), Minahil Adil Butt (May 21, 2024), Francesco Gabrielli (May 14, 2024), Cecilia Sgalletta (May 20, 2024), Kendall Shephard (June 5, 2024) held a seminar reporting on the progress of their thesis work. The seminar was followed by a discussion among the teaching staff, during which no critical issues with the completion of the doctoral program or thesis writing were identified.

4. PH.D. THESIS DEFENSES

During the academic year in question, the following doctoral theses were successfully defended (application, date, title, supervisors, outcome).

- Francesco Addari, October 18, 2024, thesis entitled "The Initial-Final Mass Relation of White Dwarfs: Insights from PARSEC and COLIBRI TP-AGB models", under the supervision of Prof. Alessandro Bressan, Paola Marigo (Uni-PD), Guglielmo Costa (Université de Lyon , France), approved *cum laude*.
- Massimiliano Parente, October 18, 2024, thesis entitled "Dust in hydrodynamic and semi- analytic galaxy evolution simulations", under the supervision of Prof. Andrea Lapi, Gian Luigi Granato (INAF-TS), Cinthia Ragone-Figueroa (Institute of Theoretical and Experimental Astronomy, Cordoba, Argentina), approved *cum laude.*
- Maria Vittoria Zanchettin, November 22, 2024, thesis entitled "AGN feedback in local galaxies: a multiband galaxies: multiband and multiscale perspective", under the supervision of Prof. Andrea Lapi, Fabrizio Fiore, Chiara Feruglio (INAF-TS), Marcella Massardi (INAF-BO), approved *cum laude.*
- Jian Yao, December 2 , 2024, thesis titled "Foreground Modeling in the Context of Cosmic Microwave Background", under the supervision of Prof. Nicoletta Krachmalnicoff , Carlo Baccigalupi, approved.
- Yacer Boumechta, December 20, 2024, thesis from Tyrol "Modified Gravity in Clusters of Galaxies", under the supervision of Dr. Sandeep Haridasu , by Professors Andrea Lapi and Carlo Baccigalupi, approved.
- Cristiano Ugolini, December 20, 2024, thesis entitled "Massive Black Holes from Single and Binary Stars", under the supervision of Prof. Mario Spera, Alessandro Bressan, approved *cum laude.*

5. POST-DOCTORAL RESEARCH STAFF

In the reporting year, the group employed the following postdoctoral researchers, supported by both institutional and external funding. Thanks to these funded projects, there has been a significant increase in postdoctoral staff compared to previous years.

1. Lumen Boco, on institute funds until October 2024,
2. Alessandro Carones, research fellow on European funds associated with the SPACE RAdioForegroundsPLus project and on funds from the Italian Space Agency for the LiteBIRD project, until August 2026,
3. Ugo Nicolò di Carlo, post-doctoral researcher on PNRR funds Calculation until October 2026,
4. Gayathri Gururajan, post-doctoral research fellow on institutional funds and shared with IFPU,
5. Sandeep Haridasu, post-doctoral research fellow, on funds from the Italian Space Agency relating to the Euclid satellite project of the *European Space Agency* until June 2025,
6. Zhiqiu Huang, research fellow on PRIN 2022 funds for which Prof. Celotti is responsible until June 2026, Marcos Muniz Cueli , on institute funds in sharing and supporting IFPU research lines until October 2025,
7. Samuele Silveravalle , post-doctoral research fellow, on PRIN 2022 funds until June 2026,
8. Tommaso Ronconi, post-doctoral research fellow, on PNRR funds Calculation until March 2025,
9. Leo Vacher, post-doctoral research fellow, on European funds associated with the SPACE RadioForegroundsPlus project and on funds from the Italian Space Agency for the LiteBIRD Project until January 2026.

Considering this increase, which affects all the group's research lines with at least one post-doctoral researcher, the strategic value of post-doctoral research staff is confirmed in supporting the school's research lines and their interface with external resource-providing projects, and in the doctoral path of student staff, with effective co-supervision roles.

6. PROJECT SUPPORT

The group has availed itself of the following international and national funding channels. The identifying acronyms, the lender, the *Principal Investigator* (PI) responsible for the resources, the approximate total funding and the funding for the institute (including staff and travel support), and the period of operation are listed.

International projects

1. EU-H2020-ITN Bid4BESt, Prof. Andrea Lapi, approximately 3.5 M€ in total, 300 K€ for SISSA staff and travel, 2020-2024,
2. EU-H2020-RISE CMB- Inflate, Prof. Carlo Baccigalupi), approximately 3 M€ in total, 200 K€ for extended visit periods of SISSA staff in US and Japanese centres, 2022-2026,
3. EU-HORIZON-CL4-2023-SPACE-01, GA 101135036, approximately 200 K€ in total, for SISSA staff and travel in the framework of the CMB-Stage IV, LitBIRD, Simons Observatory projects.

National projects

4. ASI- Euclid, Prof. Carlo Baccigalupi, 1 post-Doctoral research position for 2 years, travel, 2021-2024,
5. ASI- LiteBIRD, Dr. Nicoletta Krachmalnicoff, 2 post-doctoral research positions for 2 years, travel, 2019-2024,
6. National HPC Center on PNRR funds - Spoke 3 Astrophysics and Cosmos Observations, Prof. Andrea Lapi, 1 post-Doctoral research position for 2 years, travel, scientific computing, 2023-2025,
7. Space Partnership on PNRR funds, Space- It -Up Project, Prof. Carlo Baccigalupi, 1 Fixed-Term Researcher position 2025 - 2027 and Scholarships for the National Doctorate in Space Science and Technology,
8. National Institute for Nuclear Physics (INFN), InDark Initiative, Prof. Carlo Baccigalupi, operating with annual renewal, travel support,
9. LiteBIRD Initiative, Dr. Nicoletta Krachmalnicoff, operating with annual renewal, travel support,
10. INFN, QGSKY Initiative, Prof. Paolo Salucci, operating with annual renewal, travel support,
11. Teongrav Initiative, Prof. Mario Spera, travel support,
12. PRIN MUR 2022, *Charting Unexplored Avenues in Dark Matter,* Prof. Andrea Lapi, 1 postdoctoral research position for 2 years, 2023-2025
13. PRIN MUR 2022, Prof. Paolo Salucci, 1 post-Doctoral research position 2025-2027,
14. PRIN MUR 2022, Prof. Annalisa Celotti, 1 post-Doctoral research position for 2 years, travel, 2024-2026,
15. MUR - Joint School Program, *Data Science Methods for Multimessenger Astrophysics and Multisurvey Cosmology,* Prof. Andrea Lapi, Prof. Carlo Baccigalupi, Prof. Mario Spera, publications and travels, 2022-2025,
16. INAF Large Grant, " MeerKAT and LOFAR Team Up: A Unique Radio Window on Galaxy/AGN co-Evolution" , Prof., Andrea Lapi, publications and travel

17. INAF Mini Grant, *SHORES: Serendipitous H-ATLAS fields Observations of Radio Extragalactic Sources,* Prof. Andrea Lapi, Dr. Francesca Perrotta, Dr. Marcella Massardi, publications and travels

7. LINES OF RESEARCH

The group's research strategy is stable. The fundamental unit of APC research activities at SISSA is represented by thematic groups, often closely interconnected, coordinated by one or more professors. PIs, one or more representatives of the postdoctoral research staff, and several student staff units, often distributed across multiple years of the PhD program. This work unit is effectively characterized in the context of modern research in Astrophysics and Cosmology, both on theoretical and phenomenological topics, and in the interface with the large observational missions of which the APC group is part, and which increasingly requires the analysis of large amounts of data. In this Section, we report the characterizing activities of the Academic Year in question, followed by a brief description of the active research lines. The interface with ongoing international projects has stimulated the proposal and consolidation of three new research lines consolidated in the two previous academic years: *Analysis of Astrophysical & Cosmological Datasets (PI* Prof. Nicoletta Krachmalnicoff, newly appointed Associate Professor in the group), Astro-Chemistry & Astrobiology (PI Dr. Francesca Perrotta), *Gravitational Waves* (Professor Mario Spera, Associate Professor at APC since the 2022-2023 academic year). The lines of research are strongly connected, particularly in the doctoral thesis proposal, with ongoing observation projects and new ones that have begun or for which preparatory work is underway. This connection is achieved through research staff taking on senior roles within the projects themselves, which serve as a catalyst for the growth and international visibility of student staff, and subsequent access to postdoctoral positions. Following the order of mention of the new lines of research, we highlight the data collection at the Simons Observatory, and the preparatory work for the LiteBIRD satellite and the CMB-Stage IV observatory network of the next decade. Still in the electromagnetic field, radio, optical and infrared observations are proposed and analyzed, such as the Euclid satellites and the James Webb Space Telescope (JWST) in combination with ground-based observatories such as the Atacama Large Millimeter Array (ALMA), in particular in preparation for the project Squared Kilometer Array (SKA). Regarding gravitational signals, two projects are fully operational at the Institute, concerning data analysis underway for the Laser Interferometer. Gravitational Observatory in combination with the LIGO-VIRGO-KAGRA system and the preparatory work for the Einstein Telescope (ET) and the Laser Interferometer Space Antenna (LISA).

The group has regular meetings, ranging from educational activities such as *Journal Clubs,* organized entirely by student staff, APC seminars, held weekly with international and national guests, and IFPU colloquia, held monthly at the Via Beirut headquarters on general topics and of interest and collaboration for the institutes that support the center. Initiatives that follow extended scientific visits are noteworthy, such as those of Prof. Alessandro Bressan, visiting the Chinese Academy of Science in the summer and early fall of 2024, and Prof. Baccigalupi, visiting the Main Astronomical Kyiv Observatory in October 2023 and July 2024, following the international conference Cosmology 2023, organized by Professor Paolo Salucci. These initiatives are now maturing into collaborative agreements for the school.

The group's strategies for the coming years include the following main points.

- Capitalizing on the role of the personalities working in large international observational projects, particularly in relation to optical, infrared, millimetric and sub-millimetric observations, and their correlation.

- *Astro Particle, Data Science & Theoretical* group *Particle Physics*, using IFPU facilities for communication and interaction between institute and international groups.
- The promotion of inter-area initiatives through the opening of new lines of research, with particular attention to the life sciences, cognitive sciences, biological sciences, and complex systems.
- The corresponding elaboration of proposals for future research lines in relation to the ongoing observational efforts.
- Consolidating financial support for the group by preparing proposals for national, international, and local funding, capitalizing on existing funding.

Finally, below, we report the APC research lines active in the Academic Year in question.

- ***Analysis of Astrophysical and Cosmological Datasets*** **(PI Prof. Nicoletta Krachmalnicoff).** The group is engaged in the development of data analysis and simulation techniques for the next generation of experiments for observing the cosmic microwave background and measuring the signature of primordial gravitational waves and the lensing effect originating from cosmic structures, with related impact on our knowledge of dark energy and dark matter. The group plays leading roles in key global collaborations, including the data collection of the Simons Observatory and the preparatory work for the LiteBIRD satellite and the CMB-Stage IV observatory network of the next decade. Activities focus primarily on map analysis, modeling and removal of diffuse Galactic contaminants from measurements, the separation of contributions due to primordial gravitational waves from those due to gravitational lensing, the propagation of instrumental effects, and the study of innovative analysis techniques based on *machine learning.*
- **Astrochemistry and Astrobiology (PI Dr. Francesca Perrotta).** The group focuses on the identification of complex organic molecules in Galactic and extragalactic contexts using ALMA archival observations and JWST observations. In particular, the group studies the conditions for the identification of chiral molecules, investigating polarization-based methods to characterize enantiomeric imbalances in local molecular clouds, and developing stacking codes to statistically identify the spectral signatures of compounds and insert them as indicators of density and/or temperature in the evolutionary context of high- *redshift galaxies.*
- **Stellar Structure and Evolution (PI Prof. Alessandro Bressan).** The group has introduced an advanced treatment of rotation into its stellar evolution code, analyzing its effects on the evolutionary tracks and isochrones of star clusters. It is also active in the study of the formation and dynamical evolution of compact stellar remnant binary systems, and their possible emission of gravitational waves. The dependence of galactic chemical evolution on the chemical *yields produced by* pairs is currently being investigated. Supernovae Instability. He is completing his analysis of the dependence of nebular and X-ray emissions in actively star-forming galaxies on the introduction of stellar binarity effects.
- **Gravitational Waves (PI Prof. Mario Spera).** The group is focused on providing an astrophysical interpretation of the recent gravitational wave signals detected by the LIGO-Virgo-KAGRA collaboration, and on preparatory work for future ET detectors and LISA. Development and interoperability of codes for physical processes and statistical predictions (SEVN, ISTEDDAS, and TSUNAMI) represent strategic lines of investigation. These include prediction of the binding energy of stellar envelopes (SEVN), new parallel algorithms (accelerated by GPUs) in ISTEDDAS, and new spin-orbit evolution methods in TSUNAMI.

- **High Energy Astrophysics (PI Prof. Annalisa Celotti).** The group focuses its investigations on data analysis and theoretical predictions regarding the masses and spins of supermassive black holes from both quasar systems and the prototype source of megamasers. Furthermore, they continue studies on the process of magnetic reconnection, combining numerical analysis and physical interpretation regarding the energy efficiency of reconnection due to the acceleration of ultrarelativistic particles in a magnetized relativistic fluid.
- **Dark Matter (PI Prof. Paolo Salucci).** The group focuses its investigations on the detailed analysis of observations on the galactic scale, both locally and for high- *redshift objects,* looking for signatures of interactions between dark matter particles and those of the standard model. Furthermore, the team is focused on detecting indirect signals from annihilations of dark matter particles from nearby galaxies, to obtain upper limits on their cross sections.
- **Galaxy Formation and Evolution (PI Prof. Andrea Lapi).** The research group is engaged in studying the complex processes that lead to the formation and evolution of galaxies, galactic systems, and black holes in a cosmological context, using combinations of data from ALMA JWST, and the preparatory work for ET and SKA. To this end, the team develops physical models to interpret and understand the astrophysics of galaxies and black holes throughout cosmic history, exploiting their multi-messenger emission (e.g., broad-spectrum electromagnetic, neutrinos, gravitational waves). The team is also heavily involved in the analysis of cosmological data and large-scale structure as tools for understanding fundamental physics, and particularly the nature of dark matter, dark energy, and gravity. The team has recently developed a cosmological model without dark energy in which the acceleration of the Universe is induced by a noise effect related to the formation of large-scale structures.
- **Physical Cosmology (PI Prof. Carlo Baccigalupi).** The group's main objectives are open problems in Cosmology and Fundamental Physics, represented by the Physics of the Early Universe, the nature and properties of Energy and Dark Matter. The investigation methodology is strongly focused on the combination of information from observatories relating to the large-scale structure of the Universe through observations of the distribution of galaxies (Euclid), the cosmic electromagnetic backgrounds (Polar Bear /Simons Array, Simons Observatory, LiteBIRD , CMB-Stage IV) and gravitational fields. This complex combination, treated with appropriate methodologies for the analysis and cross-correlation of independent data sets while considering instrumental complexities, is interfaced with theoretical predictions relating to the main objectives.

ASTROPARTICLE PHYSICS
Report AA 2023/2024

SUMMARY

Below is a summary of useful information for quality assurance for the PhD in Astroparticle Physics for the 2023/2024 academic year. For the current academic year, the total number of scholarships is five. Over the past year, the percentage of foreign applicants out of the total applications for admission has increased to 70%, and out of the total number of those admitted to the oralexam, it was approximately 30%. 157 applications were received, a significant increase of approximately 50% compared to the previous year. These numbers are considered extremely positive for an academic environment with a strong international connotation such as SISSA. The summary of the academic year transitions (see section 3) does not highlight any critical issues. The PhD theses defended in the academic year in question (see section 4) have all been approved, one of which has been postponed to the beginning of 2025. Finally, some issues that emerged from the discussions between the members of the Ph.D. Council and the students were addressed with specific actions (see section 5.), which we can *ex-post* consider successful.

The group started a call of interest for a new hiring in the academic year 2022/23, jointly with the Astrophysics and Cosmology group, which unfortunately remains unfinalized in 2024. The number of postdoc fellows has risen from 12 to 17 thanks to numerous external projects (PRIN, ERC etc.).

Collaborative activities with the IFPU (Institute of Fundamental Physics of the Universe) have been regularly scheduled, with seminars, workshops, and focus weeks on topics of great interest to the Astroparticle research group. In the 24/2023academic year, 26 focus weeks and team meetings were held on various topics in dark matter, cosmic rays, gravity, cosmology, and neutrinos, as well as 11 colloquia. Various research activities are also ongoing with international collaborators and with research institutions in the area, particularly ICTP, INAF, and INFN.

Activities related to group seminars and invitations for collaborations are carried out continuously throughout the academicyear. Approximately 22 group seminars were held on the topics of gravity and astroparticle physics.

CHANGES/IMPROVEMENTS IN TEACHING

The curriculum for the 2023/24 academic year remains very similar to that of th previous academic year. A modest revision of the course schedule was necessary in the second and third terms for organizational reasons. Entrance exams were held in March using a new format that included assessment of qualifications, followed by an oral exam via Zoom for those admitted.

Astroparticle Physics Ph.D. Council, given the intrinsically interdisciplinary nature of the research topics, also decides to constantly monitor the educational offerings of the Ph.D. programs in Astrophysics and Cosmology, Elementary Particle Theory, and Data Science in order to offer students the opportunity to take courses in other educational curricula as well.

1. *SUMMARY OF PH.D. ADMISSION DATA*

A total of 157 applications were received for admission to the doctoral program (67% more than the previous academic year). Approximately 70% of these were from international students (approximately 80% extra EU). Five new students were admitted.

2. *YEAR TRANSITIONS*

In the academic year 2023/2024, the Astroparticle Physics Ph.D. Council thoroughly discussed and approved the following year transitions:

I →II year: AUTIERI, NESHAT, OLIVERI, MC BLAIN, and TORTORA successfully completed their first-year exams, earning enough credits to qualify for the second year. TORTORA has chosen to continue his studies in the PhD program in Theoretical Particle Physics (TPP). TPP student Walter ARATA chooses to continue his studies in the PhD program in Astroparticle physics.

II →III year: PAVICEVIC, KHANSARI, COPPARONI, VERDIANI, LOPEZ held seminars on research topics (4-5 June 2024). No critical issues were identified.

III →IV year: NASO, NERI, CAPUANO, SMARRA, LONGO held seminars on research topics (4-5 June 2024). No critical issues were identified.

3. *PH.D. THESIS DISCUSSION*

During the academic year 2023/2024the following Ph.D. theses were discussed:

- 23 September, Vania Vellucci, “Probing the Regularization of Spacetime Singularities” (supervisor Liberati), honors
- 23 September, Daniele Perri, “Magnetic Monopoles in Cosmic Magnetic Fields: Acceleration and Constraints” (supervisor Kobayashi), honors
- 24 September, Valentina Danieli “Quantum Effects in Cosmology -Unveiling the Quantum Nature of the Primordial Fluctuations” (supervisors Viel, Matarrese, Kobayashi)
- September 24, Francesco Del Porro, “Beyond Lorentz invariance: a journey from Analogue to Hořava Gravity” (supervisor Liberati), honors

BUCCIO's defense will take place in January 2024

4. *PROBLEMS AND ACTIONS*

Astroparticle Physics Ph.D. Council engaged in an extensive discussion of the curriculum, based primarily on the results of a questionnaire on teaching circulated to first-year students and informal discussions with student representative Oliveri. The division into three terms, with specific courses in the third term and core courses in the first two terms , remains a positive consideration.

The course on computational methods, taught for the first time in monographic lectures and exercises by Dr. Musco in the 2023/24 academic year, continues to be monitored. Following student feedback, the content of the monographic lectures will be partially modified in the 2024/25 academic year.

The teaching questionnaire distributed to first-year students did not reveal any significant issues with the courses. However, the low number of responses received regarding teaching remains a critical issue. A discussion with the student representative is underway to encourage participation in the questionnaire.

Regarding the results of the Evaluation Unit and the annual report of the joint commission, the issues highlighted are discussed among Teaching Staff and student representatives, both formally and informally, outlining a systematic path to address them.

The establishment (in the 2022/23 academic year at the students' suggestion) of a student-run Journal Club is welcomed , as it can serve as an additional opportunity for scholarly discussion. Furthermore, following the request of first-year students, an informal presentation of the research topics of the group's PIs is being established, to be held in May each year (and held for the first time in May 2024, with good student response).

Concerning Postdoctoral placement, students are encouraged to undertake research periods abroad and the contribution to student missions is increased to 40% of the group's ordinary fund budget (excluding missions on PRO3 funds or external projects).

It also appears important to involve students even more in the group's various scientific collaborations and in the associated activities (seminars, collaborative meetings, workshops).

For any issues relating to the research conducted, the interaction between student and supervisor, or the exams taken (for first-year students), please note that students are available to discuss and meet with the tutor (assigned to each student) to address them in a shared path with the PhD supervisor.

SEMINAR LIST

IFPU colloquia 2023/2024

- Lam Hui (Columbia University)
  Symmetries in large scale structure, dark matter and black holes
- Slavic Mukhanov (LMU, Munich)
  Resolving Singularities in General Relativity
- Jia Liu (IPMU, Tokyo)
  Cosmology with massive neutrinos
- Pasquale Panuzzo (Paris Observatory)
  Gaia BH3: a 33 solar mass dormant BH discovered in Gaia preliminary data
- Eric Linder (Lawrence Berkeley National Laboratory)
  Who's Afraid of Dark Energy?
- Pasquale Blasi (Gran Sasso Science Institute)
  On a self-regulated escape of cosmic rays from sources
- Tirthankar Choudhury (NCRA, Pune)
  Cosmic Neutral Hydrogen: A Probe of the First Stars in our Universe

- José Manuel Carmona (University of Zaragoza)
  QGMM network: theoretical and experimental challenges and opportunities for research in quantum gravity phenomenology
- Avery Meiksin (University of Edinburgh)
  Revealing the Dark Ages in 21-cm radiation
- Anna Bonaldi (Manchester University)
  The Square Kilometer Array Observatory: current status and science preparatory activities
- Francesca Matteucci (University of Trieste)
  Galactic archaeology: a natural history of the Milky Way

IFPU SPECIAL PROGRAMS 2023/2024

- Raniere de Menezes (University of Turin)
  How the dynamical properties of globular clusters impact their gamma-ray and X-ray emissions
- Ignacio Araya (Universidad Arturo Prat, Chile)
  Dark matter from primordial black holes would hold charge
- Aseem Paranjape (IUCAA, Pune)
  Model-agnostic cosmological constraints from the baryon acoustic oscillation feature in redshift space
- Leandros Perivolaropoulus (Ioannina University)
  The tensions of LCDM and the gravitational transition approach
- Max Goodness (University of Alabama)
  Soft X-ray emission from warm gas in Illustris -TNG circum –cluster environments
- Geraint Lewis (University of Sydney)
  The Formation History of Andromeda's Halo: Clues from Globular Clusters
- Antonio Montero- Dorta (University Technique Federico Santa Maria, Santiago)
  Assembly bias: when galaxy evolution meets cosmology
- Rogerio Rosenfeld (Instituto de Physics Theory (São Paulo)
  Some generalizations of the Early Dark Energy paradigm
- Keita Fukushima (Osaka University)
  Star Formation and Chemical Enrichment in Protoclusters with Cosmological Hydrodynamic Zoom-in Simulations
- Jishnu Sai Puthiyedath (Indian Institute of Science)
  Inflationary cross-correlations of non-minimal spectators and their soft limits
- Yin-Zhe Ma (University of KwaZulu-Natal)
  The “Missing baryons” in the cosmic web—what is it? Where is it? How much?
- Pierre Burger (AIfA , Bonn)
  KiDS-1000 cosmology: Combined second- and third-order shear statistics
- Yousry Elkhashab (University of Padua)
  Relativistic redshift space distortions in the observed galaxy power spectrum.
- Ehsan Hebrew (ICTP)
  Dynamical Tidal Locking Theory: A New Source of the Spin of Dark Matter Halos

- Yongming Liang (University of Tokyo)
  Connection between Galaxies/Quasars and Large-scale Intergalactic Medium at Cosmic Noon
- Emre Bahar (MPE, Garching)
  The SRG/ eROSITA All-Sky Survey: Constraints on AGN Feedback in Galaxy Groups
- Ang Liu (MPE, Garching)
  The eROSITA All-Sky Survey: eRASS1 catalogs of galaxy clusters and superclusters
- Xiaoyuan Zhang (MPE, Garching)
  eROSITA view of the X-ray emission from the cosmic filaments: WHIM, CGM, and AGN
- Siweiì Zou (Tsinghua University)
  Constraining the Role of Stellar Feedback in the Baryonic Cycle from z = 2-6.5
- Emmanuel Artis (always MPE)
  New constraints on f(R) gravity and structure growth with the eRASS1 cluster sample
- Julius Fabbian (Cardiff University)
  Cosmology from CMB and Large-scale Structures with New and Old Probes
- Federico Montano (University of Turin)
  Detecting Relativistic Doppler in Galaxy Clustering via Multi-tracing at Single Galaxy Population
- Jiakang Han (University of Turin)
  Forecasts on cross correlation between CIB and other large scale structure tracers
- I would go Gruzinov (NYU)
  The origin of cosmic magnetic fields.
- Lam Hui (Columbia University)
  Symmetries in large scale structure, dark matter and black holes
- I would go Gruzinov (New York University)
  Ultra-high-energy cosmic rays

SISSA SEMINARS

- Kaloian Lozanov
  Inflation, solitons and induced gravitational waves
- Piero Rettegno
  Binary black hole scattering: numerical simulations and analytical methods
- Valeriya Korol (Max Planck Institute for Astrophysics)
  Galactic Palaeontology: Multi-messenger explorations of the Milky Way through stellar remain binaries
- Adrien Kuntz
  Nonlinear Quasi-Normal Modes: Uniform Approximation
- Scott Melville
  Scattering in de Sitter
- Sagarika Tripathy (Indian Institute of Technology Madras) ONLINE
  Departures from slow roll inflation: Navigating the implications for magnetogenesis
- Patrick Stengel
  Using machine learning to search for scalar lepton partners at the LHC

- Paul Meda
  Trace anomaly and evaporation of dynamical black holes
- Marc Schneider
  Probing the Big Bang with Quantum Fields
- Teppei Minoda
  Constraining the primordial magnetic fields with the 21-cm global signal
- Ivica Smolic
  Taming of singularities by nonlinear electromagnetic fields
- Ramiro Cayuso
  Black hole dynamics in Effective Field Theory extensions to General Relativity
- Julio Arrechea
  The vacuum strikes back: Black stars
- Jieshuang Wang
  Multi-messenger astrophysics: neutron star mergers and active galactic nucleus jet
- Ramit Dey (online)
  Advancing Stochastic Gravitational Wave Background Detection with Spectrogram Correlated Stacking (Specs)
- Tim Linden (Stockholm University) (online)
  Dark Matter Searches with Cosmic-Ray Antinuclear
- Daniel Oriti
  Hydrodynamics on superspace: an effective quantum gravity framework for cosmology
- Richard Buscicchio (Milan Bicocca)
  Statistical challenges in GW inference: an application of field theory to direct population reconstruction in LISA
- Roberto Casadio
  Quantum rotating black holes
- Deepen Garg
  Scalar perturbations from inflationary magnetogenesis
- Luca Theodori
  Degenerates in time delay cosmography for the strong lensing measurement of H0
- Shahin Sheikh-Jabbari
  Covariant Phase Space Formalism with Fluctuating Boundaries

PHYSICS AND CHEMISTRY OF BIOLOGICAL SYSTEMS
Report AA 2023/2024

INTRODUCTION

This report is presented for quality assurance purposes for the Ph.D. in Physics and Chemistry of Biological Systems for the 2023/2024 academic year. The data is organized according to the format already used in previous reports: statistical data on admission to the doctorate (section 1), year transitions (section 2), final doctoral exams (section 3), extracurricular activities (section 4), and actions undertaken to improve quality (section 5). Among the new features, section 4 of this report is now accompanied by specific data on the assignments carried out by students and the seminars organized for their benefit.

1. SUMMARY OF PH.D. ADMISSION DATA

During the 2023-2024 academic year, two entrance exam sessions were held for the PhD program in Physics and Chemistry of Biological Systems. These sessions included an assessment of qualifications, a written exam, and an online oral exam. For comparison with previous years, the table shows the total number of candidates in the two exam sessions, as well as the number and proportion of foreign applicants. The table does not consider additional entrance exam sessions reserved for non-EU foreigners held in years prior to the pandemic, which were no longer offered since the online procedure was adopted for all applicants.

AA	No. of admission applications	of which submitted by foreigners	% foreigners
2023-2024	43	34	80
2022-2023	67	51	76
2021-2022	53	31	58
2020-2021	38	22	58
2019-2020	19	8	42
2018-2019	44	30	68

The number of applications received is in line with the average figures for the previous 5 years (44 ± 8); the proportion of applications submitted by foreigners was significant, equal to 80%. The number of applications appears congruent with the number of scholarships available from School and PNRR funds (4 in total for the academic year under review) and from external funding from faculty members (1 scholarship from ERC funds from Prof. A. Hassanali). A total of 5 people were admitted in the two entrance exam sessions.

In addition to the scholarships already mentioned, the PhD in FCSB was awarded a doctoral scholarship funded by ICTP in the context of the Joint ICTP-SISSA Phd Program.
In total, the number of new students admitted to the PhD program at FCSB for the 2023-2024 academic year was 6, including four students of non-EU nationality.

2. YEAR TRANSITIONS

During the 2023-2024 academic year, the teaching staff of the Ph.D. in Physics and Chemistry of Biological Systems approved, after extensive and in-depth collegial discussion, the following year transitions for the

students:

I -> II year: DASGUPTA, FORNASA, MOSCHIN, OMER, RAY, and SLAVOV earned the required number of credits through courses and exams and held a seminar reporting the initial results of their thesis work. No critical issues were identified. For student SLAVOV, the evaluation of his progress to the next year has been postponed to January 2025 as he benefited from a three-month suspension of his doctoral scholarship.

II--> III year: BANERJEE, BUPU, DI MARCO, SACCO, TAJANA, TAMAGNONE, VAN DER HOEK held a seminar reporting on the progress of their thesis work, which was adequate and satisfactory in each case. No critical issues were identified.

III--> IV year: DEL TATTO, GILARDONI, MARCATO, POSANI, SLONGO, SARMIENTO held a seminar reporting on the progress of their thesis work, which was adequate and satisfactory in each case. No critical issues were identified.

All students received an individual summary report regarding the overall evaluation of their doctoral work as well as the clarity and effectiveness of the way it was presented.

3. PH.D. THESIS DISCUSSION

Ph.D. theses were successfully defended in the presence of an adjudication committee composed of international experts:

MUZZEDDU. Thesis title: “Stochastic dynamics in soft matter: non- uniform activity and fluctuating fields”; Advisors: A. Gambassi and E. Roldan, Final exam approved on 16/09/2024.

ZHANG. Thesis title: “Spatial organization of DNA across scales: a Bayesian inference and information-theoretic approach”; Advisors: A. Rosa and G. Sanguinetti. Final exam approved on October 23, 2024.

DONKOR. Thesis title: “Structural Characterization of Water in Different Thermodynamic Conditions Through Unsupervised Learning". Advisor: A. Hassanali. Final exam approved on 03/12/2024

WILD. Thesis title: “Feature Selection by Information Imbalance Optimization: Clinics, Molecular Modeling, and Ecology”; Advisor: A. Laio. Final exam approved on 03/12/2024.

Students ZHANG, DONKOR, and WILD took their doctoral exams after requesting, and obtaining, an extension of their doctoral scholarship and a postponement of the submission and defense of their thesis for a period ranging from one month (ZHANG) to three months (DONKOR, WILD).

4. EXTRACURRICULAR EDUCATIONAL ACTIVITIES

In line with previous years and following the guidance of the Advisory Committee (ISAC) and the Evaluation Committee, the PhD faculty promoted extracurricular activities for students and encouraged both undergraduates and postdocs to participate in inter-group and inter-Area scientific initiatives. To this end, PhD students were encouraged to subscribe to the mailing lists for seminars held by related groups, both within and outside the Physics Area, as was done for previous cohorts.

In addition, the faculty members regularly forwarded to the group mailing list notices of seminars on PhD-related topics offered by other SISSA groups, as well as those available online or at other local institutions (e.g., ICTP and the Italian Society of Statistical Physics).
FCSB students continued to organize a series of internal seminars in which they could present their research projects to their peers. This activity was suggested to facilitate internal networking and was held in the spring. The seminars were also deemed useful for helping first-year students navigate the thesis topics offered.

Seminars organized by the PhD FCSB

During the 2023-2024 academic year, the seminar initiative continued, both in person and online, with speakers proposed by both faculty and students. The seminars were mostly presented by students and were spread throughout the academic year, except for the November - March period, which was already covered by lectures.
The total number of seminars held was 21, as detailed below:

Date	**Speaker**
26/10/23	Christos Likos
26/10/23	Peter Virnau
26/10/23	Heikki Haario
26/10/23	Manlio De Domenico
26/10/23	Helmut Schiessel
26/10/23	Modesto Orozco
26/10/23	Martin Zacharias
11/15/23	Francesco Ricci
08/04/24	Guido Tiana
12/04/24	Peter Faccioli
16/04/24	Sarah Woodson
19/04/24	Enzo Orlandini
24/04/24	Yinglong Miao
08/05/24	Nadine Schwierz
15/05/24	Amos Maritan
22/05/24	James Sethna
05/06/24	Stefano Vanni
26/06/24	Lorenzo Casalino
03/07/24	Elisa Frezza
12/07/24	Sebastian Springer
17/09/24	Marco Baiesi

The Coordinator and the Vice-coordinator have reported to the FCSB student representatives that, even in response to requests sent via the mailing list, there was limited participation in the seminars and, above all, in the general colloquia organized by the School, asking for suggestions for increasing participation.

To supplement the report on extracurricular activities, the following summary data for student missions is

presented for the first time. Due to the recent change in the management application used by the School for missions, the aggregate data is reconstructed from the expenses recorded in the group budget for the 2024 calendar year. The data should therefore be considered as approximate, as it does not include missions at no cost to SISSA or paid for with specific project funds.
The number of onerous missions carried out was 27. The missions involved 16 PhD students, therefore a congruent number considering the students from the second to the fourth year of the PhD, the most active regarding the missions, also in relation to networking.

5. ACTIONS FOR IMPROVEMENT

During the 2023-2024 academic year, actions to improve the quality of the PhD program at FCSB focused on three areas: (i) improving the content of the teaching program; (ii) continued efforts to communicate the collection of preferences for thesis topic selection; (iii) participation in seminars and colloquia; and (iv) involvement in collegial initiatives.
Regarding the first point, the coordinator continued the practice, previously established, thanks to feedback from the Evaluation Committee, collecting anonymous questionnaires on individual courses immediately after the course and before the final exams. As previously noted, this approach mirrors that already adopted by universities for the evaluation of degree courses and has the advantage of providing more timely feedback, not influenced by exam results. The survey for the current academic year yielded a favorable evaluation of the courses and of the teaching load, which was distributed more evenly throughout the November - April period, precisely based on the responses to the questionnaires from the previous academic year. Based on the same questionnaires, the content of two of the mandatory courses was also refined, focusing it on topics of greatest interest to students.
Regarding the second point, the coordinator continued to raise awareness among first-year students regarding the opportunity and necessity of making a well-informed choice of thesis topic, thoroughly considering the entire spectrum of research topics listed in the call for applications. As in the previous two years, the coordinator asked each student to provide two topics of interest for their thesis, without any hierarchical order, and to provide a rationale for this selection. The coordinator then collected these motivated preferences in individual meetings with the students, which he shared and discussed with the thesis supervisors to formulate final supervisory proposals for the students. Once again, this year, the process was conducted without any issues. Regarding the interpretation of the responses to the annual questionnaires regarding freedom in choosing a thesis topic, it should be noted that some students are recipients of ad hoc scholarships and are therefore bound by a priori commitment to the topic and supervisor. This data will be separable from other data in the future thanks to the new annual questionnaire developed by the Joint Committee, Evaluation Committee, and Quality Assurance Unit. This will allow for a more precise assessment of satisfaction with the choice of research topic among those included in the call for proposals.
Regarding the third point, the coordinator held several meetings with student representatives, often with the participation of the Deputy Coordinator and other members of the faculty, to gather suggestions for improving participation in seminars and extracurricular activities, including those organized by the School and other groups/PhD programs. A related point of concern is that in this academic year, unlike the previous two, students did not organize private meetings with seminar speakers. Such meetings had been systematically organized by previous cohorts of students, as they considered them very useful for networking purposes. The coordinator raised awareness of this issue among some of the students involved in organizing the seminars. As mitigating measures on the faculty side, supervisors were invited and personally contacted their students to raise awareness of the importance of maintaining a broad range of scientific interests,

especially when considering the choice of a postdoc.

Regarding future actions, we intend to hold a meeting during the 2024-2025 academic year with all supervisors of FCSB students, including internal and external researchers at SISSA who are not members of the Faculty Board. The need, already highlighted in the previous report, arises from the recognition that the traditional moments for such extended meetings (final year exams and doctoral discussions) are poorly suited to serving as informational meetings, discussions, and the exchange of best practices. Further actions will be undertaken based on ideas that emerged from the recent meeting of the coordinator and student representatives (14/01/2025), in which the CPAD report on the annual questionnaire for the 2022-2023 academic year was examined in detail. Specifically, it was agreed to organize moments of sharing and socializing after the in-person seminars to improve well-being at work, engagement, and personal contribution to the various PhD activities, including students who are not based at SISSA. Furthermore, the Coordinator will discuss the salient aspects of the individual course assessments with student representatives. This action will address the perceived limited usefulness of some courses for research purposes, which emerged from some of the responses to the last annual questionnaire. Based on the information gathered, improvement actions will be aimed at enhancing the quality and content of the courses, or at better communicating the importance for students of building the broadest and most solid scientific background possible in order to conduct cutting-edge research independently and competently.
In the end the website will be completely revamped, an action leading into this direction is already underway.

This report has been circulated among the members of the Teaching Board and the Student Representatives of the FCSB course.

STATISTICAL PHYSICS
Report AA 2023/2024

SUMMARY

Below is a summary of the information useful for quality assurance for the PhD in Statistical Physics for the academic year 2023/2024.

The table containing summary data on applications for admission to the Ph.D. program in the academicyear under review and in the 11 previous years, reported in section 2, highlights a significant increase in the number of applications compared to the previous academic year (with the same number of positions offered); the increase is mainly due to applications from foreign students, a positive fact for an international environment such as SISSA. The brief summary of the year changes, presented in section 3, does not highlight any critical issues. The Ph.D. theses defended in the academic year under review have been approved, as reported in section 4. Section 5 provides a series of updated elements regarding the Ph.D. in Statistical Physics, including the actions taken with reference to the issues highlighted in the CPAD report relating to the previous academic year. Finally, section 6 contains a list of the seminars organized by the Ph.D. in Statistical Physics during the academic year 2023-2024.

1. CHANGES/IMPROVEMENTS IN TEACHING

The teaching has not undergone any changes compared to the previous academic year.

2. SUMMARY OF PH.D. ADMISSION DATA

The table below shows the number of applications received for the single admissions session held in the 2024/2023academic year and, in a separate column, the number of international students. The last column shows the percentage of foreign applicants compared to the total. For comparison, the table also shows data relating to the entrance exams of the previous eleven academic years. The number of applications is significantly higher than last year, with the same number of positions offered (five). The increase is essentially due to the greater number of applications from international students, which rises to 66% of the total.

AA (where the entrance exam was held)	Number of admission applications	Number of applications from foreign candidates	% of applicants applying foreigners
2023/2024	71	47	**66%**
2022/2023	54	27	**50%**
2021/2022	54	27	**50%**
2020/2021	53	25	**47%**
2019/2020	65	28	**43%**
2018/2019	57	22	**39%**
2017/2018	62	21	**34%**

2016/2017	54	24	**44%**
2015/2016	42	13	**31%**
2014/2015	42	12	**27%**
2013/2014	31	24	**77%**
2012/2013	31	24	**77%**

3. YEAR TRANSITIONS

In the academic year 2023/2024, the Teaching Council of the Ph.D. in Statistical Physics thoroughly discussed and approved the year transitions ofthe following students:

From I to II year: Students CORAGGIO, DAVILA CUBA, GALANIS, RUSSOTTO, TRAVAGLINO, and ZAMBOTTI earned the required number of credits through courses and exams. No critical issues were identified.

From II to III year: Students BANDINI, BRACCI TESTASECCA, CHALAS, PRUSZCZYK, and STAMPIGGI held a seminar reporting the preliminary results of their thesis work. No critical issues were identified.

From III to IV year: Students FOSSATI, GENTILE, and MUZZI held a seminar reporting on the results obtained so far as part of their thesis work. No critical issues were identified.

Students BRTAN and CODAGNONE have decided to interrupt their doctoral studies to accept job offers that are particularly interesting to them; the former has already obtained the title of Magister philosophiae.

4. Ph.D. THESIS DISCUSSION.

During the ,academic year 2023/2024the Ph.D. theses of the following students were successfully discussed:

- ROTTOLI, “Entanglement in many body systems”, supervisor: Pasquale Calabrese.
- SAADAT, “Long-Range Interactions and Cooperative Effects in Biological Systems”, supervisor: Stefano Ruffo.
- SOLFANELLI, “Harnessing long-range couplings for quantum technologies”, supervisor: Stefano Ruffo.
- SORBA, "Low-energy methods in Statistical Field Theory. From interfaces to quantum quenches", supervisor: Gesualdo Delfino.
- TARABUNGA, “Synthetic quantum matter - from quantum simulation to quantum information”, supervisor: Marcello Dalmonte.
- VANONI, “Non- equilibrium dynamics and localization in statistical quantum systems”, supervisors: Andrea Gambassi and Antonello Scardicchio .

5. PROBLEMS AND ACTIONS

Below is a series of updated elements regarding the Ph.D. in Statistical Physics, which include the actions taken to address the issues highlighted for this Ph.D. in the CPAD report for the academic year2022/2023.

Teaching: The main finding that emerged from the CPAD report for the 2022/2023 academic year regarding the Ph.D. in Statistical Physics concerns the percentage of students reporting low well-being, a percentage significantly higher than the School average. Among the data surveyed by CPAD, the "well-being" data is by its nature the most difficult to interpret, and in this case, interpretation is further complicated by the lack of real critical issues regarding the specific aspects explored in the report. To clarify the situation as much as possible, the coordinator undertook two distinct actions. First, he collected student reports anonymously through their representative. Subsequently, he organized a meeting with all students for a detailed discussion on the various aspects of the Ph.D. 's functioning. These investigations did not reveal any specific critical issues that could be attributed to the well-being data revealed in the 2022/2023 report, a point the students agreed upon during the discussion. However, a general finding emerged: they consider the doctoral program in Statistical Physics "demanding." Despite this, however, students do not request a reduction in the program's burden, believing the energy they put in is a sound investment in their future.

Internationalization of incoming students: The ability to attract high-quality foreign candidates was confirmed by the fact that 5 out of 17 foreigners were admitted, a percentage stable compared to the previous year. Of the 5 admitted students, 3 are international.

Gender balance: 11 female candidates out of 71 candidates passed the entrance exam, 2 of them were classified as suitable, none were admitted.

Networking: As in all previous academic years, with a few exceptions due to personal choices, the students who defended their doctoral theses (see section 4) were awarded postdoctoral fellowships (effective within a few weeks of their doctoral defense) at qualified research institutions: four abroad (Germany, Switzerland, USA) and one in Italy; one foreign student developed an interest in the Master's program in Data Management, to which she was admitted. As indicated in previous reports, the doctoral committee believes that these data should be considered objective indicators of the success of the doctoral program's networking, preferably to more elusive qualitative considerations that may have emerged from the questionnaires. As previously observed and consistent with the doctoral program, the students were included in their supervisors' scientific collaborations, both in national and international networks, where possible.

Internationalization: Research stays abroad for students were encouraged, mainly in France , Switzerland the.United Kingdom and the USA

PhD scholarship extensions due to COVID: Due to the slowdown in thesis work caused by the limitations imposed by the COVIDemergency, SAADAT and SORBA students have benefited from the planned 3- month extension of their PhD scholarships.

6. SEMINARS ORGANIZED BY THE PH.D. IN STATISTICAL PHYSICS IN THE 2023/2024 Academic Year

1. September 12, 2023
   Velimir Ilic (Mathematical Institute, Serbian Academy of Sciences and Arts) Super-additivity, generalized concavity and quasi-homogeneity in non-additive systems

2. November 7, 2023
   Mark Arildsen (SISSA)
   Beyond Li-Haldane Counting: A Close Look at Chiral Topological Order in the Entanglement Spectra of (2+1)-Dimensional Spin Liquid Ground States, with a Focus on PEPS

3. November 14, 2023
   Artur Hutsalyuk (SISSA)
   Spin chains with "medium-range " interactions and cellular automata

4. November 21, 2023
   Shachar Fraenkel (Tel-Aviv University)
   Extensive long-range entanglement in a nonequilibrium steady state

5. November 28, 2023
   Lata Kh. Joshi (SISSA)
   Measurements of many-body quantum chaos

6. December 5, 2023
   Hubert Saleur (IPhT Saclay)
   Non-invertible symmetries in loop soups and applications

7. December 12, 2023
   Lorenzo Piroli (University of Bologna)
   Many-body entanglement from polynomially -many measurements

8. December 19, 2023
   Sara Murciano (Caltech)
   Quantum criticality under imperfect teleportation

9. January 16, 2024
   Alessandro Foligno (University of Nottingham) Quantum information spreading in generalized dual-unitary circuits

10. January 23, 2024
    Alvise Bastianello (Technical University of Munich) Thermodynamics and transport in classical integrative spin chains

11. January 30, 2024
    Giuseppe Policastro (ENS, Paris)
    Binding Complexity and the Cost of Entanglement

12. March 5, 2024
    Manoj K Joshi (Institute for Quantum Optics and Quantum Information, Innsbruck) Many-body physics with trapped ions

13. March 12, 2024
    Mario Collura (SISSA) Unveiling Quantum Matrix Product States: Novel Approaches to Non-Stabilizer Assessment and Stabilizer Group Learning

14. March 15, 2024
    Suchita Agrawal (Max Planck Institute of Quantum Optics)
    Quantum Gas Microscopy of Programmable Lattices and Extended Hubbard Model

15. March 19, 2024
    Vasco Cavina (Scuola Normale Superiore, Pisa)
    Thermodynamics in non- equilibrium quantum systems: A Keldysh approach

16. March 26, 2024
    Misaki Ozawa (University Grenoble Alpes)
    Multiscale Data-Driven Energy Estimation and Generation

17. April 4, 2024
    Eli Barkai (Bar Ilan University)
    Quantum dynamics pierced by measurements: the first hitting time problem

18. April 9, 2024
    Tommaso Rizzo (La Sapienza, Rome)
    Beyond the Bethe lattice solution of Anderson localization

19. May 7, 2024
    Mate Lencses (Wigner Research Center for Physics, Budapest) Non-unitary multicriticality and PT symmetry breaking

20. May 23, 2024
    Luca Tagliacozzo (Instituto de F isica Fundamental, Madrid) Temporal entropies and conformal field theories

21. May 28, 2024
    Federico Corberi (University of Salerno)
    Phase-ordering kinetics in ferromagnetic systems with long-range interactions

22. June 4, 2024
    Sergej Moroz (Karlstad University)

In pursuit of deconfined quantum criticality in Ising gauge theory entangled with single-component fermions

23. June 11, 2024
Dganit Meidan (Ben Gurion University)
Dynamics of non-interacting fermions subjected to generalized measurement schemes

24. June 18, 2024
Sarah Loos (University of Cambridge)
About fluctuating many-body systems with nonreciprocal interactions

25. June 20, 2024
Jitendra Kethepalli (International Center for Theoretical Sciences, Bangalore) Equilibrium properties of confined Riesz gas

26. July 2, 2024
M. Ali Rajabpour (Univerdade Federal Fluminense)
Minors or: how I learned to stop worrying and love the exponential

THEORETICAL PARTICLE PHYSICS
Report AA 2023/2024

SUMMARY

Below is a summary of useful information for quality assurance for the Ph.D. in Theoretical Particle Physics for the 2023/24 academic year.

The table containing summary data on applications for admission to the Ph.D. program in the current academic year and in the previous five-year period (see section 2) shows a high level of internationality among the participants. This year, a constant level of internationalization among the selected candidates has been maintained. However, the number of selected female candidates remains low (none in the current year), requiring corrective measures to be implemented in future years.

The brief summary of year transitions (see section 3.) does not highlight any critical issues.

Ph.D. theses were defended in the academic year under review (see section 4), all approved *cum laude,* and the Visiting Students program continued (see section 5).

1. *CHANGES/IMPROVEMENTS TO THE TEACHING OFFER, DISTANCE LEARNING MODE*

The departure of Professor Cecotti required the assignment of an external position for the string theory course for the 2023/24 academic year, as had occurred in the previous academic year. For the 2023/24 academic year, the position was assigned to Professor Alberto Lerda. The retirement of Professor Percacci, who held the QFT II course, required further reorganization of the courses. The QFT II course was entrusted to Professor Serone, while Professor Bonelli was entrusted with the new QFT III course.

2. *SUMMARY OF PH.D. ADMISSION DATA (REMOTE SELECTION)*

The table below shows the number of applications received, separated by non-EU and EU (including Italy) candidates, and the total number of applications received. We also include the number of foreign applicants (and their percentage), as well as data relating to the joint SISSA-ICTP scholarship. The data refers to the 2023/24 academic year in question and the five previous academic years.

	Non-EU	EU	TOTAL	FOREIGNERS	% FOREIGNERS	ICTP	ICTP Admitted
2018/19	45	64	109	78	72	14	1
2019/20	17	115	132	69	52	8	1
2020/21	44	71	115	63	55	8	1
2021/22	67	64	131	78	60	18	0
2022/23	55	58	113	62	55	7	1
2023/24	88	72	160	98	61	20	0

Despite the absence of social restrictions due to the pandemic, it was decided to maintain the remote selection exam for the 2023/24 academic year. As in the previous year, students who were positively evaluated based on their qualifications took a written exam with open-ended or multiple-choice questions, under video proctoring via Zoom. The School's Secretariat made the exam anonymous to the examining committee. Students who passed the written exam subsequently took an oral exam via video link. For the following year, the Teaching Committee decided to maintain the remote exam, but to base it solely on the

evaluation of qualifications and an oral exam via video link, with the aim of further increasing internationalization and increasing the number of selected female candidates.

3. YEAR TRANSITIONS AND CRITICAL ISSUES

Starting in the 2022/23 academic year, the Teaching Staff has decided that students must submit a list of scientific activities they have attended (seminars, journal clubs, colloquia, etc.) for their final exams. This list contributes to the approval of the year transition. This practice has continued in the academic year under review. In the 2023/24 academic year, the Ph.D. Council of Theoretical Particle Physics thoroughly discussed and approved the following year transitions:

I –> II year: Fabrizio Aramini, Walter Arata, Stefano Lanza, Pietro Moroni and Johann Sebastian Quenta Raygada have achieved the required number of credits through courses and exams. Walter Arata requested and was granted a transfer to the Ph.D. in Astroparticle Physics, due to a greater affinity with his scientific interests. On the other hand, student Michele Tortora (coming from the Ph.D. in Astroparticle Physics) requested and was granted a transfer to the Ph.D. in Theoretical Particle Physics, due to a greater affinity with his scientific interests. All students were paired with a thesis advisor with whom they began their research.

II –> III year: Quoc -Trung Ho, Muhammad Sohaib Khalid, Alessandro Piazza, Anant Shri , Amartya Harsh Singh, Gabriel Pedde Ungureanu and Marco Venuti They held a seminar reporting the initial results of their thesis work. No critical issues were identified.

III –> IV year: Shreyansh Agrawal , Ideal Majtara , Marina Moleti , Alfredo Stanzione and Beniamino Valsesia They held a seminar reporting the initial results of their thesis work. No critical issues were identified.

Ph.D. scholarship .

4. PH.D. THESIS DISCUSSION

During the 2023/24 academic year, the following Ph.D. theses were successfully discussed:

1) Flavio Riccardi, supervisor P. Putrov and A. Urbano, " dS QNMs and PBHs beyond the Gaussian limit," cum laude – 23/10/2023.
2) Mehmet Asim Gumus, rel. A. Azatov and E. Mirò , "Mapping out EFTs with analytic S-matrix", cum laude – 06/12/2023.
3) Eyoab Dejene Bahiru, rel. K. Papadodimas and F. Benini, "Holography, localization of information, and subregions", cum laude – 15/12/2023.
4) Stephane A. Bajeot, rel. S. Benvenuti, "Aspects of supersymmetry: duality, enhancement, and (super)-power of deconfinement", cum laude – 12/01/2024.
5) Riccardo Ciccole, rel. M. Serone and L. Di Pietro, "Symmetries, anomalies, and phases of the chiral Gross-Neveu model", cum laude – 12/01/2024.
6) Niloofar Vardian , rel. K. Papadodimas and M. Bertolini, "Quantum error correction and holography, Krylov complexity, and continuous tensor networks, cum laude – 05/07/2024.
7) Francesco Garosi, rel. D. Marzocca, "Present and future tools for testing the Standard Model and beyond", cum laude – 09/16/2024.

8) Andrea Antinucci, rel. F. Benini, “Topological Aspects of Quantum Field Theory”, cum laude – 09/27/2024.
9) Giulio Barni, rel. A. Azatov, “ Ultrarelativistic phase transition in the early universe: The faster the better”, cum laude – 09/27/2024.
10) Fabiana De Cesare, rel. M. Serone and L. Di Pietro, “Exploring phases of non-Abelian gauge theories with perturbation theory”, cum laude – 09/27/2024.
11) Giovanni Rizi , rel. F. Benini, “Symmetries and their holographic aspects in quantum field theory”, cum laude – 09/27/2024.

5. VISITING STUDENTS

The Visiting Student Training Program saw the following students in the 2023/24 academic year:

1) Ouneis Gluton – 9/1-15/2 and 22/4-26/6 2024 (Institut de Mathématiques de Bourgogne, France)
2) Maël Jacques Jean-Claude Chantreau – 4/3-28/6 2024 (ENS de Lyon, France)
3) Lucas Agustin Acito – 22/4-26/6 2024 (National University of La Plata, Argentina)

6. SEMINARS ORGANIZED IN THE PH.D.

During the academic year 2023/24, the following seminars were organized within the Ph.D .:

1. Michele Galli (Humboldt U., Berlin), “Constistent truncations and KK spectra via exceptional field theory”, 11/10/2023
2. Vineeth Krishna Talasila (TIFR, Mumbai), “Supersymmetric grey galaxies and revolving black holes”, 20/10/2023
3. Arsenii Titov (University of Pisa), “Modular invariance and the strong CP problem”, 25/10/2023
4. Beatrix Mühlmann (McGill U.), “The Virasoro Minimal String”, 15/11/2023
5. Álvaro Pastor Gutiérrez (Heidelberg, Max Planck), “Unveiling hidden phases and charting strong sectors”, 22/11/2023
6. Ahmed Almheiri (NYU Abu Dhabi), “Holography on the quantum disk”, 29/11/2023
7. Micha Berkooz (Weizmann I., Rehovot), “Double scaled SYK: from chord diagrams to the dual bulk”, 29/11/2023
8. Guido Martinelli (U. La Sapienza, Roma), “Flavor physics, the unitarity fit, anomalies, and all that”, 30/11/2023
9. Denis Karateev (University of Geneva), “Trace anomalies and the dilation-graviton amplitude”, 07/12/2023
10. Ville Vaskonen (Padua U. and NICPB, Tallinn), “Slow and supercooled cosmological phase transitions”, 13/12/2023
11. Trilateral phenomenology meeting (Trieste-Ljubljana-Nova Gorica), 15/12/2023
12. Tin Sulejmanpasic (Durham University), “The phases of theories with the ZN 1-form symmetry”, 10/01/2024
13. Gabriele di Ubaldo (IPhT, Paris), “AdS3/RMT2 duality”, 24/01/2024
14. Giorgos Eleftheriou (King's College London), “The giant graviton expansion in the bulk”, 31/01/2024
15. Matthew Schwartz (Harvard U.), “Landau, Cutkosky, and Pham: Geometry and analyticity of scattering amplitudes”, 07/02/2024
16. Alexander Zhiboedov (CERN), “High-energy gravitational scattering and energy correlators”, 07/02/2024

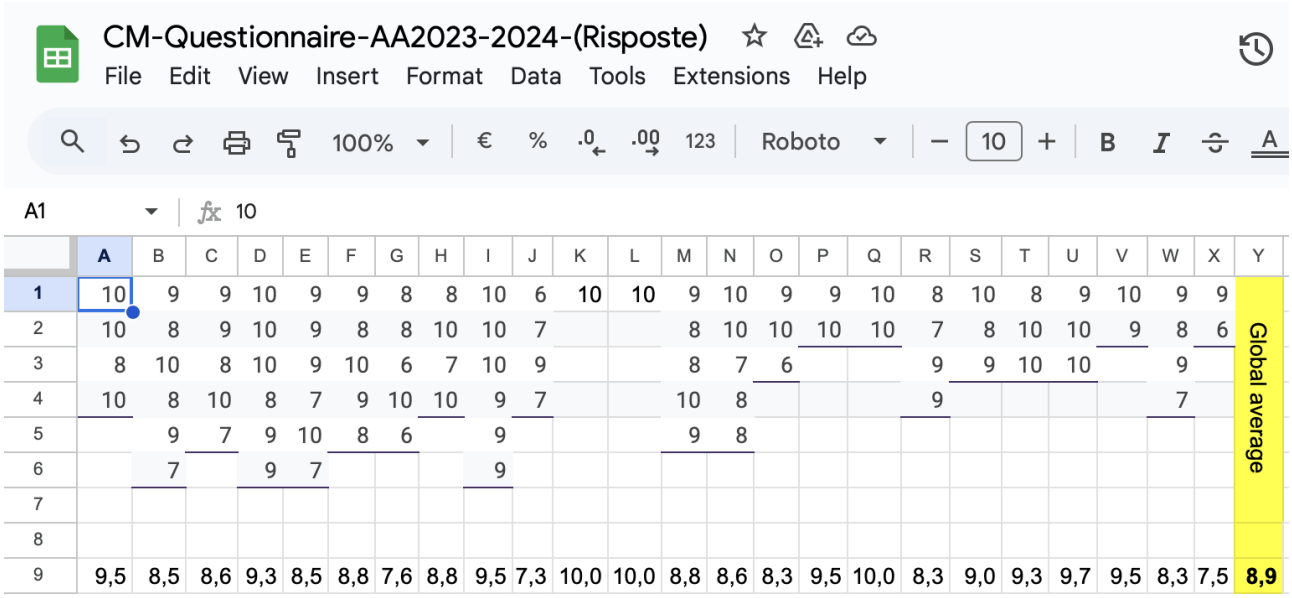
17. Balt van Rees (Ecole Polytechnique), “QFT in AdS instead of LSZ”, 28/02/2024
18. Slava Rychkov (IHES), “O(N) x O(2) model from 3D to 4D - the tale of disappearing fixed points”, 28/02/2024
19. Paolo Gregori (IPhT - CEA Paris-Saclay), “Non-perturbative topological recursion in Jackiw-Teitelboim gravity”, 06/03/2024
20. Tatsuhiro Misumi (Kindai University), “More on resurgence in quantum theory”, 13/03/2024
21. Sean Colin-Ellerin (UC Berkeley), “Graviton entanglement”, 19/03/2024
22. Simone Blasi (DESY), “The role of impurities in cosmological phase transitions”, 27/03/2024
23. Masha Baryakhtar (U. of Washington), 03/04/2024
24. Neal Weiner (New York University), 03/04/2024
25. Jan Boruch (Warsaw University), 17/04/2024
26. Clara Murgui (IFAE, Barcelona), “Quantum sensors as particle detectors”, 24/04/2024
27. Sunjin Choi (KIAS, Seoul), “Black hole states at finite N”, 02/05/2024
28. Marcos Mariño (University of Geneva), “Trans-series from condensates”, 06/05/2024
29. Jan de Boer (U. of Amsterdam), “The statistical interpretation of semi-classical gravity”, 08/05/2024
30. Rob Myers (Perimeter Institute), “Holographic scattering and non-minimal RT surfaces”, 08/05/2024
31. Ethan Torres (CERN), “Giving a KO to 8D gauge anomalies”, 15/05/2024
32. Diego Redigolo (INFN Florence), “Is dark matter electroweak?”, 22/05/2024
33. Felix Haehl (University of Southampton), “Euclidean wormholes from arithmetic and quantum chaos”, 29/05/2024
34. Javi Serra (Madrid, IFT), “Light scalars beyond the SM at finite density”, 05/06/2024
35. Beatrix Muehlmann (McGill University), “Remarks on 2d quantum cosmology”, 26/06/2024
36. Jacopo Papalini (University of Gent), “Gravity hologram of double-scaled SYK”, 03/07/2024
37. Yasaman Farzan, “Jovian Signal at BOREXINO”, 22/07/2024
38. Gaston Giribet (New York University), 18/09/2024

CONDENSED MATTER PHYSICS

Report AA 2023/2024

Below is an overview of useful information for quality assurance for the PhD in Theory *and Numerical Simulation of Condensed States* for the 2023/2024 academic year.

The course structure continues according to the scheme initiated in the 2020/2021 academic year and includes, between a first trimester (October-December) of basic courses common to all students and a third cycle of advanced courses (March-May), an intermediate cycle (during the period January-February) called “hands on": essentially, a series of advanced problems, proposed by each of the PIs, and offered to the students, who select some, tackle them and solve them, guided in this by the PI/tutor who proposed the problem. All instructors are now ready to hold their courses both online and in hybrid mode. The internal questionnaires administered to students provided positive responses, confirming a growing trend that has been going on for three academic years now (two years ago the average was 7.7, last year 8.2).



CM-Questionnaire-AA2023-2024-(Risposte)

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1	10	9	9	10	9	9	8	8	10	6	10	10	9	10	9	9	10	8	10	8	9	10	9	9	
2	10	8	9	10	9	8	8	10	10	7			8	10	10	10	10	7	8	10	10	9	8	6	
3	8	10	8	10	9	10	6	7	10	9			8	7	6			9	9	10	10		9		
4	10	8	10	8	7	9	10	10	9	7			10	8				9					7		
5		9	7	9	10	8	6		9				9	8											
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9	9,5	8,5	8,6	9,3	8,5	8,8	7,6	8,8	9,5	7,3	10,0	10,0	8,8	8,6	8,3	9,5	10,0	8,3	9,0	9,3	9,7	9,5	8,3	7,5	**8,9**

Global average

Legend: Each column, from A to X, corresponds to a course and lists all the scores earned by that course. At the bottom, in row 9, are the average grades for each course. Cell Y9 lists the average of the averages, which is 8.9, up from 8.2 last academic year.

The number of students remains stable at 38, a slight increase compared to last year, thanks to recruitment using industrial grants linked to projects or the PNRR. The percentage of international students stands at around 40% of the total. The table containing summarized data on applications for admission to the Ph.D. in the academic year under review and in previous years (see section 2) shows a significant increase in the number of applications compared to last year, confirming that last year's decline was due to the hacker attack on the CM website last year. The applications proved to be of good quality (18 eligible: all grants were awarded in the spring session, making the second session unnecessary). The percentage of applications from non-Italian candidates is high, around 80%. This year, the percentage of non-EU candidates admitted to the ordinary selection process is 33%. Three of the six students who were offered a grant through other ongoing programs (PNRR PhDs, industrial PhDs, Joint PhD with ICTP) are international. In total, we therefore have 5

foreign students out of 12 in the first year (41%). The brief summary of the year transition) see section 3) does not highlight any problems. This year, many doctoral theses (18) were discussed also due to the extensions of scholarships caused by the health emergency.

CHANGES/IMPROVEMENTS TO THE TEACHING OFFER

The structure of the teaching offer introduced in previous academic years has been improved in the 2021/2020 academic year. The teaching program is now divided into a first trimester, which hosts " *general courses, with the aim of providing a common background to all* "Ph.D. students , an intermediate cycle of " *training through problem solving* ", with the aim of providing students with better tools for tackling complex Condensed Matter problems, and a third cycle in which more specific advanced courses are offered, both in-depth studies of the basic courses and those with a specialized profile, from which students can choose for their study plan. Attendance is mandatory for the four courses in the first trimester (Electronic structure, Many -Body Theory and Strongly Correlated Electrons, Numerical methods for condensed matter systems, Statistical Mechanics).

SUMMARY OF PH.D. ADMISSION DATA

The table below shows the number of applications received during the 2022/2023 academic year and, for comparison, in previous academic years (the data refers to the academic year in which the exam session was held). For each session, the number of scholarships offered is shown in brackets. The last column shows the percentage of applications from non-Italian candidates, and the percentage of non-Italian students admitted at the end of the selection process is shown in brackets. A new column shows the number of non-Italian students admitted through the Industrial Doctorate selection process, the National Research Council (NRRP), and the Joint SISSA/ICTP curriculum.

Starting from the 2015/2016 academic year, all available scholarships were awarded in the spring session, and therefore the second session was not held. The number of applications received in the first session (70) has significantly increased compared to previous academic years, in particular the previous one in which the CM website was the target of a hacker attack. The quality of the applications is high and has led – as already mentioned – to assigning all scholarships at the end of the first session and to the selection of a suitable number of suitable candidates (18 in total). The internationality rate of the applications is very high (80%), as is the value recorded this year for the internationality of the admitted students (2 out of 6 students admitted). The internationality rate in the other ongoing programs is excellent (PNRR doctorates, Joint PhD industrial doctorates with ICTP), where 3 out of 6 admitted students are NON-EU foreigners. The Ph.D. teaching staff carefully monitors this internationality parameter, while maintaining the centrality of the quality and objectivity of the selection process.

A.A.	I SESSION II SESSION	% NON ITA	Industrial PhD, TII-QRC, PNRR, ICTP
2023/2024	70 (6)	80 % (33 %)	6 students of which 3 NON-EU
2022/2023	24 (6 to 5 for a waiver)	54% (50% to 40%)	1 EU (has opted out) and 3 NON-EU
2021/2022	41 (6)	56% (17%)	4 students, of which 3 NON-EU
2020/2021	46 (7)	43% (0%)	2 NON-EU students
2019/2020	59 (7)	51% (12.5%)	
2018/2019	50 (7)	65 % (40%)	
2017/2018	59 (8)	44% (25%)	
2016/2017	67 (8)	67% (22%)	
2015/2016	51 (7)	52% (22%)	

1. YEAR TRANSITIONS

In the academic year 2023/2024 the Doctoral College approved the following year transitions:

I--> II year: Ahmed, Arezzo, Cuiro Montalvo, Cortes Santamaria, Euste, Mello, Timsina, Zavatti, have achieved the required number of credits through courses and exams and the initial results of their research activity have been deemed satisfactory. No problems have been identified.

II--> III year: Alessandroni, Andreoni, Florez, Frau, Hirkani, Pasqua, Staffieri, Tagliente, Tan, Torchia, and Wang have achieved the required number of credits through courses and exams, and the initial results of their research have been deemed satisfactory. No problems have been identified.

III--> IV year: Bacciconi, Caldara, Dalmonte, Lumia, Giuli, Hsouna , Paviglianiti, and Piccioni held a seminar reporting the results of their research. No problems were identified.

2. PH.D. THESIS DISCUSSION

During the 2024/2023academic year, 18 PhD theses were defended. Among these, the students M. Badin, G. Bellomia, M. Ferraretto, N. Golenic , A. Khosravi, G. Lami, N. Ranabhat , P. Torta, F. Paoletti, and A. Blason, already mentioned as about to defend their theses in 2024 in the previous report, successfully defended their theses. They are joined by the students PC Cruz, M. Ferraretto, M. Tsisishvili , G. H. Spasov, A. Santini, X. Gong, E. Drigo, A. Fiorentino, C. Malosso , D. Nello, who defended their theses by 2024 (last defense on December 18, 2024). All students entitled to an extension of their scholarship due to the health emergency defended their theses with this last group. Honors were awarded in 15 out of 18 cases.

The 18 theses discussed this year are

1) N. Golenic , supervisors S. de Gironcoli and, title: "*Nanophotonics of Thin-film Materials: a Many-body Approach '',* approved *cum laude.*
2) A. Khosravi, supervisor GE Santoro and E. Tosatti, title: "*Friction, tribology and rheology at the atomic scale: from metal nanocontacts to 2D materials and graphene*", approved *cum laude.*

3) G. Lami, supervisor M. Collura, title: "*Pushing the boundaries of Matrix Product States in quantum many-body physics and computing"*, approved *cum laude*.

4) A. Blason , supervisor M. Fabrizio, title: "*Electronic correlations in topology materials* ", approved *cum laude*.

5) PC Cruz, supervisor A. Silva, title: "Quantum Fisher information in non-interacting systems after a sudden quench".

6) Ferraretto M., supervisor M. Capone, title: "Novel quantum states in multicomponent fermionic systems".

7) N. Ranabhat , supervisor M. Collura, title: "Dynamics of full counting statistics, thermalization, and deconfinement transition in long range Ising model"

8) F. Paoletti, supervisor A. Amaricci , M. Capone, title: "Static and Dynamical Correlations in Topological Transitions"

9) P. Torta, supervisor G. Santoro, title: "Quantum Approximate Optimization Algorithm and Variational Quantum Computing: from binary neural networks to ground state preparation"

10) G. Bellomia , supervisor A. Amaricci , M. Capone, title: "Quantum information insights into strongly related electrons"

11) M. Tsitsishvili, supervisor M. Fabrizio, M. Dalmonte, title: " Many body systems in and out of equilibrium "

12) GH Spasov, supervisor Vanossi, Rossi, G. Santoro, Benassi, title: "CFD-DEM Simulation of the Deposition of Pharmaceutical Aerosols in Human Airways"

13) A. Santini, supervisor G. Santoro, M. Collura, title: "Advanced Perspectives in Non-Equilibrium Quantum Dynamics"

14) X. Gong, supervisor A. Dal Corso, title: "Ab initio thermoelasticity of crystals at extremes"

15) E. Drigo, supervisor S. Baroni, title: "Thermoelectric effects in polar liquids and ionic conductors"

16) A. Fiorentino, supervisor S. Baroni, title: "Advances in lattice thermal transport in crystals and glasses"

17) C. Malosso , supervisor A. Hassanali, S. Baroni, title: "Dielectric and dynamical properties of supercooled water "

18) D. Nello, supervisor A. Silva, title: "On Thermodynamics of Driven Quantum Systems: Novel Results and Perspectives"

4. <u>PROBLEMS AND ACTIONS</u>

The Faculty is monitoring the effectiveness and acceptance of the changes made to the curriculum during the 2020/2021 academic year. All data collected so far suggests the effectiveness of the changes. In

the future, the aim is to further improve the curriculum by offering two first-year exam curricula, one on Quantum Technologies and one on High-performance Modeling of Materials, which will be piloted in 2024.

THEORETICAL AND SCIENTIFIC DATA SCIENCE
Report AA 2023/2024

SUMMARY

The PhD program in Data Science and Theory continues to grow, and in 2023-24 it reached a steady state in terms of the number of PhD student cohorts, having recruited its fourth wave.

The teaching offer for the 2023-24 academic year remained similar to that of the previous year, while the format of the Journal Clubs was changed to allow for better inclusion of students, who actively participated as speakers.

The gender balance of students admitted for the 2023-24 academic year is improving, with two female students admitted out of a total of nine. The Teaching Staff reiterates its commitment and focusses on continuing to improve on this point.

1. CHANGES TO THE COURSE OFFER

For the 2023-24 academic year, following discussions with student representatives and the launch of the joint program with Human Technopole (two students were admitted out of three available scholarships), a careful review of the content and training commitment of some modules was conducted, as well as a benchmarking of the offerings compared to those of other PhD programs in the Physics Area. The benchmarking showed that the TSDS curriculum is approximately the median in terms of number of courses and teaching hours compared to other PhD programs in physics, and therefore it was decided not to significantly change the training load, following the guidelines already established for the 2022-23 academic year.

In order to consolidate and deepen the collaboration with the Human Technopole (HT), which has funded 2 PhD scholarships for this academic year, we have introduced two mini-modules delivered by HT teachers in the course "Applications of Data Science to the Natural Sciences": the first, "Data Modelling for Cancer Genomic Data", by Dr. Sottoriva , and the second "Systems Biology of Bacterial Growth : Nutrient and Antibiotic Perturbations " by Dr. Pinheiro.

2. SUMMARY OF PH.D. ADMISSION DATA (admitted to the 2023-24 academic year)

For the 2023-24 academic year, two admissions sessions were held, one in March 2023 and a second in June 2023. All sessions were held entirely on the Zoom platform.

The number of applications submitted in the March 2023 session was 49, of which 30 (69%) were international, and 11 (22%) were female, for 8 doctoral scholarships (2 from School funds; up to 3 funded by Human Technopole under the aegis of the joint program; 2 from the PNRR, one of which co-funded by Additati Consulting, and 1 from the PNRR FAIR-Future of AI Research program). Of the 6 scholarships subsequently accepted, 33% were female students.

In June 2023, a second session was held for two PNRR/FAIR doctoral scholarships not awarded in the first round. Thirty-seven applications were received, 10 of whom (27%) were female. Of the seven candidates admitted to the oral exam, two (29%) were female. However, the two selected students are both male.

In total, 9 students were admitted, including an additional scholarship obtained through the joint SISSA/ICTP program, of which 2 were female (22%) and 2 were international (22%).

Although the teaching staff is not yet satisfied with the gender balance, at least a substantial maintenance of the percentage of females has been observed throughout the selection process (28% of applications, 22% of selections).

The number of international applications received remains high.

3. YEAR TRANSITIONS

I -> II year:
In October 2024, the transition exams for all students were held. After careful consideration and in-depth discussions, the outcome was as follows:
Students RUDY SKERK, CLARA CANAVESE, ADALBERTO VALSECCHI, NANDO TEZOH, FABIOLA RICCI, ALI HUSSAINI, MATTEO SANTORO, and ALESSIO GIORLANDINO earned the required number of credits at the end of their first year and took the final exam in the form of a presentation with Q&A on the research topic they investigated over the summer. No critical issues were identified.
Already during the summer of 2024, the students CLARA CANAVESE and ADALBERTO VALSECCHI, part of the joint program with HT, started their research work on site at
the Human Technopole in Milan.

II -> III year:
Students CARETTI, RIGO, MISHRA, and NEWMADJI presented their ongoing research in a final exam. No critical issues were identified.

III -> IV year:
Students RENDE and KOUADRI presented their ongoing research work in a final exam. No critical issues were identified.

4. PHD THESIS DISCUSSION

students KARCHEV, FOLCHINI, and EL-KAZWINI received a three- month extension of their studies due to COVID. Their theses were defended on December 16, 2024, and will be the subject of the next annual report.

The GENG student (who, having begun his studies in January 2022 on a PNRR/Green scholarship, is following a study plan compressed into just 3 years and out of phase with the rest of the cohort) has obtained a 2-month extension of his thesis (compared to the scheduled deadline of 31/12/2024) and will defend it in February 2025.

5. *PROBLEMS AND ACTIONS*

We are pleased to note the increased participation in the questionnaire by our students, who have been sensitized to the importance of providing their opinions. We have taken on board the Committee's recommendation regarding the opportunity to discuss the results of the questionnaire with the student representative. This will take place at one of the upcoming Faculty Meetings, where the student representative is regularly invited to participate for matters not falling within the exclusive purview of the faculty.

The results considering the question on wellbeing are noteworthy (which are within the SISSA average for TSDS), and efforts will be renewed to continue creating social and group opportunities. The " pastoral tutor" system introduced two years ago seems to be working well in identifying potential issues as soon as they arise. Each student's academic and personal situation is systematically discussed at every Faculty meeting, in order to jointly assess any emerging critical issues.

The issue of gender balance and internationalization is constantly monitored by the Teaching Staff, and the TSDS group already tracks these variables throughout the selection process, as highlighted above and recommended at School level by the Commission.

On the issue of networking, we reiterate our recommendation (already expressed last year) that the Committee support a change in SISSA rules to allow financial support for students attending dinners with guests and seminarians visiting Trieste—an important networking opportunity at a very low cost. The same applies to reimbursement from group funds for a limited number (one or two) of social dinners per year: undoubtedly an important way to "build a team" and foster a sense of belonging among students, as well as to facilitate relationships between students, researchers, and PIs.

No particular critical issues were identified regarding the perception of the quality of the training offered or of supervision.

On the question " Where you free to choose your supervisor?", the high percentage of negative responses can be explained by the fact that 5 out of 9 grants were project-based, therefore with a predefined topic and supervisor. The usefulness of this question in situations of this kind is unclear - in fact, a negative response cannot be taken as an indication of a critical issue.

The range of seminars and journal clubs offered remains varied and high caliber, with many invited speakers offering students the opportunity to interact with visitors and thus foster positive networking. Student participation in these activities is high (estimated between 80 and 90%). During the period covered by this report, 18 seminars were held, in line with the previous year's offerings. The complete list of seminars is as follows:

1) Stefano Anselmi 26/09/23 Can we use Baryon Acoustic Oscillations distances, Paris Observatory
2) Raul Jimenez 02/10/23 CINNs: solving general inverse problems with reinforced learning, University of Barcelona
3) Elisabetta Tola 5/12/23 Wetlands: Fighting the Ecological Crisis, ?

4) Florian Jug 01/09/24 From Content-Aware Denoising to Semantic Unmixing of Microscopy Data, Human Technopole
5) Amin Alibakhshi 23/01/24 High Accuracy Evaluation of Interactions Between Atoms and Molecules: the Interplay Between Theoretical Methods and Machine Learning, Christian-Albrechts -University
6) Alessandro Sanzeni 30/01/24 Probing the operating principles of cortical circuits with theory and optogenetics, Bocconi
7) Danijel Skočaj 06/02/24 Deep learning – key enabling technology for solving data-based problems, University of Ljubljana
8) Diego Doimo 27/02/24 Understanding Transformers with Geometric and Mechanistic Interpretability, Area Science Park
9) Marco Baroni 12/03/24 Unraveling Unnatural Language Models: First Insights into Large Language Models' Puzzling Out-of-Distribution Behavior , Pompeu Fabra University
10) Erika Coppola 26/03/24 Advancements in Machine Learning Techniques for High resolution Climate Emulator: Why, How and Where we stand, ICTP
11) Filippo Vicentini 09/04/24 Quantum simulation with Neural Quantum States, Ecole polytechnique
12) Fernanda Pinheiro 16/04/24 From systems biology to evolutionary predictions, Human Technopole
13) Andrea Sottoriva 07/05/24 Data Modeling for Cancer Evolution, Human Technopole
14) Kirsten Fischer 17/05/24 Optimal signal propagation in ResNets through residual scaling, Juelich Research Center
15) Claudio Zeni 06/06/24 Accelerating materials design with AI emulators and generators, Microsoft Research
16) Eliel Camargo-Molina 17/06/24 Teaching Transformers to Master Particle Physics Equations, Uppsala University
17) Marco Stefanelli 18/06/24 A neural-network methodology to define a 3DVar non-linear observation operator for complex observation systems University of Ljubljana
18) Eleonora Presani , 04/07/24, What does AI Safety look like and how can we find consensus, META

MATHEMATICAL ANALYSIS, MODELLING AND APPLICATIONS

Report AA 2023/2024

SUMMARY

Below is a summary of useful information for quality assurance for the Ph.D. in Mathematical Analysis, Models, and Applications for the 2023/2024 academic year. As is usual practice, the Ph.D. Council has made several changes and improvements to the curriculum to accommodate new arrivals, new needs, and developments described in section 1. This includes the partial renewal of existing courses and the launch of new ones. These courses continue to be highly appreciated by students in terms of attendance and content, both externally and online.

From the table containing the summary data of the applications for admission to the Ph.D. in the academic year under examination and in the previous five-year period (see section 2) we can see an average number of applications exceeding one hundred (160), a number of scholarships awarded of around 12, a percentage of foreigners on the total number of applications of around 74% and a percentage of those admitted of 26%. Overall, we consider these indicators to be significant considering the selection carried out with very selective exams (written and oral, but also qualifications). It should be noted that in the academic year in question, all the ministerial scholarships (8) were awarded during the spring session (ALL-COUNTRY I). The additional ministerial scholarships (5) awarded in the autumn session (ALL-COUNTRY II) derive from the actions made possible by the application of the National Recovery and Resilience Plan (PNRR DM 629 and DM 630). It is noted that the implementation of this plan has led to an increase in applications compared to the previous academic year (from 144 to 266 with 83% participation from abroad). It should be noted that the summary data reported in section 2 also considers the scholarships (1) awarded through specific international calls reserved for the ICTP/SISSA joint doctoral program. In general, the preparation and scientific quality of the candidates were highly appreciated by the commissions. It should be noted that many Italian AMMA doctoral students have had experiences abroad regarding to their master's degree.

The brief summary of the transition exams (see section 3) does not reveal any critical issues, except the failure of student Evangelos Nastas to advance to the second year, as required by the AMMA doctoral program regulations. The Ph.D. theses defended during the academic year under review (see section 4) were all approved with considerable appreciation by the examining committees. Specifically, *cum laude* mention was awarded among the excellent theses to those that significantly exceeded expectations based on a comparison that often considers the history of several years of proposing supervisors.

Students of the doctoral program in Mathematical Analysis, Models, and Applications win every year important prizes and awards at conferences in which they participate with posters and oral contributions (participation fellowships , travel grants , paper prizes , etc.) and are awarded by national organizations (such as INdAM , SIMAI, UMI, AIMETA) or international organizations (such as SIAM, ICIAM, ECCOMAS, IACM, IMU). In particular, we remember alumnus Paolo Ventura, who won the 2024 Pitagora Prize, established by the Department of Mathematics and Computer Science of the University of Calabria with the patronage and supervision of the Italian Mathematical Union. Dr. Paolo Ventura also won the prize for the best doctoral thesis in mathematics in the 2023/2024 academic year and, recently, the fourth edition of the prestigious Barcelona Dynamical Systems Prize, with the doctoral thesis supervisors (Prof. Massimiliano Berti and Alberto Maspero). We also remember second-year student Dario Coscia, who won the first edition of the Artificial Intelligence Prize, awarded by the University of Trieste to students in the master's degree program in Data Science and Scientific Computing.

Please note that in the reference period Academic Year 2023/2024 the program of visits by other students to SISSA (Study in SISSA fellowships) continued, as did the program for pre-doc scholarships, for which a specific commission was established. Furthermore, doctoral theses are continuing in collaboration with SISSA's key companies (AB Electrolux, Danieli SpA, Fincantieri SpA, EPS Italia Srl, Danieli Automation SpA, Siemens AG, SMACT Competence Center ScpA , Danieli SpA, Engys Ltd, FAST Computing Srl), both through the application of the PNRR (DM 630) and the PON (National Operational Programme) and through industrial grants. Joint thesis activities with TU/Eindhoven, the University of Amsterdam, and Sorbonne Université in Paris, funded through the PNRR program (DM 351 and DM 118), are also continuing. The topics of this joint thesis concern the *digital transition*, the *environmental transition,* and *cultural heritage*, also through the development of advanced methods for numerical simulation with *Machine Learning.*

1. *CHANGES/IMPROVEMENTS TO THE TEACHING OFFER AND SUPPORT ACTIVITIES*

The curriculum of the Mathematical Analysis, Models, and Applications program follows the structure established in the 2013/2014 academic year and is continually enriched and updated thanks to a significant turnover of faculty, with new additions (Ricardo Grande Izquierdo, Beatrice Langella, and Federico Pichi as RtdA), various invited courses (Wilhelm Schlag , Giovanni Bellettini , Massimiliano Morini, Elia Bruè, Emanuel Carneiro, Daniele Semola, Mario Sigalotti), and the *mathLab* research group offering courses in numerical analysis and theoretical and computational mechanics. Most of the courses focus on advanced functional analysis, including topics closely related to the faculty's research interests, such as control, bifurcations in nonlinear systems, shape optimization, harmonic analysis, functional analysis, numerical analysis, mechanics, etc. Students engaged in applied research can also take advantage of the experimental scientific equipment available at the SAMBA and BioMat laboratories in the Mathematics Area. The PhD program website and its course offerings are regularly updated. Specifically, the course offerings for the current term are available on the Courses website and include a list of courses borrowed from the data science program.

The admission exam for the program includes an assessment of candidates' qualifications, a written test with exercises to be selected from three sections (mathematical analysis, numerical analysis, and continuum mechanics), and an oral exam. Exams are normally held in person. However, in order to attract talented young people at an international level, the Teaching Board has established procedures for participating in the admission exams remotely.

Incoming students typically meet with the coordinator and vice-coordinator of the doctoral program and receive information regarding the program and the requirements for advancing to the second year. Students admitted to the first year are assigned a tutor while they await the selection of their supervisors and thesis topic. They also receive a self-assessment questionnaire, which is discussed with the supervisors and analyzed by the Faculty Board before approving individual student study plans.

2. *SUMMARY OF PH.D. ADMISSION DATA*

The table below shows the number of applications received for the session reserved for NON-EU candidates, for those open to ALL-COUNTRY candidates in spring (I) and autumn (II), and the related total. The numbers in brackets refer to the available/remaining scholarships in each session and to the total number of scholarships actually awarded. Finally, the last column reports the percentage of foreigners in relation to total applications and in brackets the percentage of foreigners in relation to the total number of candidates admitted to the Ph.D. The data refers to the academic year in question and the five previous academic years. Please note that the spring session was established starting from the 2016/2017 academic

year. The PhD program took on its current structure and name starting from the 2013/2014 academic year, also including topics in numerical analysis and theoretical and computational mechanics.

	NON-EU	ALL-COUNTRY I	ALL-COUNTRY II	TOTAL	% FOREIGNERS
2023/2024	- (-)	108 (8)	158 (5)	**317 (14)**	**85% (14%)**
2022/2023	- (-)	34 (8)	152 (11)	**222 (19)**	**79% (42%)**
2021/2022	- (-)	48 (8)	86 (7)	**134 (15)**	**65% (36%)**
2020/2021	- (-)	48 (8)	- (-)	**48 (10)**	**67% (29%)**
2019/2020	58 (8)	38 (8)	43 (7)	**139 (8)**	**67% (25%)**
2018/2019	53 (8)	27 (8)	24 (4)	**104 (8)**	**79% (13%)**

The statistics (last two columns) include international candidates awarded scholarships for the PhD in Mathematical Analysis, Models, and Applications through the joint ICTP/SISSA program and selected through specific international calls for applications. The statistics also include candidates selected for scholarships made available through PNRR actions (Ministerial Decrees 629 and 630), external funding from European and/or industrial projects, and the MSCA doctoral network.

3. YEAR TRANSITIONS

In the academic year 2023/2024, the Teaching Board of the PhD course in Mathematical Analysis, Models and Applications thoroughly discussed and approved the following year transitions:

I --> II year: Tommaso Barbieri, Nicola Clinco, Dario Coscia, Isabella Carla Gonnella, Guglielmo Padula, Antonio Milosh Radakovic, Sergio Scalabrino, Dario Sterzi, Rubio Gunawan The, Chiara Trifone, Alessandro Vici, Edoardo Voglino, Matteo Zanardini. Please note that students Rashid Ashraf, Qusain Haider, Hammad Khaliq, and Mustafa Ramadan, having started their doctoral studies several months late, took the transition exam on December 19, 2024. No critical issues have been identified, except for the failure of student Evangelos Nastas to progress to the second year, as required by the AMMA doctoral program regulations.

II --> III year: Thomas Beretti, Giuseppe Cosma Brusca, Anouar Dahdah, Davide Donati, Lorenzo Fabris, Tolibjon Ismoilov , Anna Ivagnes, Roberto Marchello, Michele Motta, Anantha Krishnan Orunnukaran Mani, Pranjivan Mehta Pavan, Elisa Savio, Armin Sheidani , Maria Teresa Rotolo. No critical issues were identified.

III --> IV year: Irene Anello, Lorenzo Bardone, Ariel Surya Boiardi, Fabrizio Caragiulo, Antonio Pedro De Azevedo Bezerra Vitor Ramos, Moaad Khamlich , Pierfrancesco Siena, Simone Vincini. No critical issues were identified.

4. PH.D. THESIS DISCUSSION

During the academic year 2023/2024, the following doctoral theses in Mathematical Analysis, Models and Applications were successfully discussed (**student**, supervisor(s), " *thesis title")*:

- **Luca Gennaioli**, prof. Nicola Gigli: "*Geometric analysis and measure theory in general ambient spaces"*;

- **Giacomo Maria Leccese,** prof. Stefano Bianchini: "Dissipative *solutions to Hamiltonian system, and one conjecture for non-autonomous viscous conservation laws and one in measure theory"*;

- **Valentin Nkana Ngan**, prof. Gianluigi Rozza, prof. Giovanni Stabile, Dr. Andrea Mola: *"Hybrid reduced-order methods for segregated fluid-structure interaction solvers in an ALE approach using the Finite Volume Method";*

- **Marco Feder,** prof. Luca Heltai , prof. Andrea Cangiani: "Non-*matching and polytopic finite element techniques with applications to multilevel methods"*;

- **Daniele Tiberio,** prof. Antonio Lerario, prof. Luca Rizzi: "Sard *properties for polynomial maps in infinite dimensions and applications to sub-Riemannian geometry"*.

Fourth-year students **Giulio Ortali** (co- supervised student with TU/Eindhoven) and **Sajad Salavatidezfouli** (PON PhD) will defend their doctoral theses on January 29, 2025. In addition, fourth-year students **Diego Silimbani** and **Harshith Gowrachari** (PON PhD) will discuss their doctoral theses in February and June 2025 respectively. See the Past PhD Theses webpage , dedicated to theses discussed as part of the doctorate and which lists the publications of AMMA alumni .

5. *MISCELLANEOUS*

To enhance the promotion of the doctoral program and student interaction, this year too, the AMMA doctoral program actively supported the JMD – Junior Math Days (https://indico.sissa.it/event/148/) initiatives for the presentation of SISSA's mathematics doctorates and to attract young talent, presenting the courses and research activities of the various groups. These activities are organized by SISSA mathematics students and supported by their faculty. This initiative has become international and is no longer limited to students from Italian universities.

Another initiative that continues to be supported by the AMMA PhD is the SISSA SIAM Student group Chapter of the Society for Industrial and Applied Mathematics which organizes on-site dissemination activities, colloquia, seminars, and supports various types of events (summer schools, joint events with other SIAM students) chapters around the world, etc.). These initiatives are quite successful and also involve a doctorate in Mathematical Physics and Geometry, a master's degree in HPC, and a bachelor's degrees in mathematics and DSSC with other universities. SIAM activities allow for a better international positioning of students, and many of them have found postdoctoral positions through this network of collaborations (Vienna, Berlin, Eindhoven, Lausanne, Cambridge, Austin). During the reference period, the SISSA SIAM Student group Chapter organized the SISSA Women in Mathematics 2024 event, which saw the participation of Prof. Valentina Beorchia (UniTS), Prof. Valeria Chiadò Piat (PoliTO) and alumna Dr. Maria Strazzullo (PoliTO).

Furthermore, for ten years, doctoral students have organized weekly AJS (Analysis Junior Seminars) seminar series to foster student interaction and communication within the Doctoral School regarding various research topics. These informal and inclusive seminars, open to non-experts as well, foster the exchange of ideas and the development of basic scientific communication skills. Attendance is excellent. This year's

seminars were held in a hybrid format. The presentations are recorded and made available on a dedicated YouTube channel .

During the reporting period, research and teaching activities were carried out primarily in person, while maintaining a hybrid format when necessary. Furthermore, various funding schemes (such as PRO3 and Erasmus+) supported student mobility, including abroad, to foster cultural and scientific exchange within the scope of related research activities.

Finally, we would like to highlight the meetings held by Dr. Francesca Romana Vender in April 2024, entitled "Symphony of the Mind: Integrating Psyche, Body, and Mind. Personal Motivation as a Fundamental Tool in the Professional Development of the Researcher," as part of the activities for Ph.D. students and aimed at developing transversal skills.

MATHEMATICAL PHYSICS AND GEOMETRY
Report AA 2023/2024

SUMMARY

Here you will find some useful information for quality assurance for the Ph.D. in Mathematical Physics and Geometry for the 2023/2024 academic year. With the aim of providing a diversified educational offering in terms of both level of content and topics, courses taught by faculty members are complemented by courses taught by external faculty and postdocs from the Mathematics Area. See section 1.

The table containing the summary data of the applications for admission to the Ph.D. program in the academic year shows a notable increase in the total number of applications (140) and a stable, but high, percentage of foreigners (69% compared to 68% last year), numbers that we consider very positive for an international environment such as SISSA. The brief summary of the changes in the academic year (see section 3) does not highlight any critical issues. All the Ph.D. theses defended in the academic year under examination (see section 4) except one were approved *cum laude.*

1. CHANGES/IMPROVEMENTS TO THE TEACHING OFFER

Upon recommendation of the Teaching Board of the Ph.D. in Mathematical Physics and Geometry, and also following requests from students, in addition to the institutional courses taught by SISSA faculty (full list available here: https://www.math.sissa.it/education/1/courses/all?page=1), the following new courses have been activated during the 2023/2024 academic year, taught by external faculty or by SISSA postdocs/RTDAs. One cycle corresponds to 20 hours of lessons.

C. Bartocci (Genoa)	Quiver varieties	(1 cycle)
G. Falqui (Milan Bicocca)	Hamiltonian methods	(1 cycle)
M. Gallone (SISSA)	Self- adjoint operators in quantum mechanics	(1 cycle).
M. Gallone (SISSA)	Introduction to non-perturbative methods for fermionic models	(1 cycle)
P. Gavrylenko (SISSA)	2-dimensional conformal field theory	(2 cycles)
P. Hajac (Warsaw)	Introduction to C * algebras	(1 cycle)
D. Lewanski (Trieste)	Enumerative geometry and quasi-modular Forms	(2.5 cycles)
G. Panati (Roma Sapienza)	Mathematical methods for solid state physics	(1 cycle)

2. SUMMARY OF PH.D. ADMISSION DATA

Attached are the tables relating to the entrance exam for the academic year 2024/2025. There has been an increase in the number of applications for admission (140) and in the percentage of non-EU candidates (69%, for a total of 97 applications). Among those eligible, there were 13 Italians, 2 EU and 6 non-EU, with a percentage of foreigners of 38%. The percentage of women out of the total eligible candidates is 29% (6 out of 21).

3. YEAR TRANSITIONS

In September 2024, the Faculty Board approved the following academic transitions. All transitions occurred without any issues.

SURNAME	**NAME**	**RIDE**
ABDELRAZEK	MAHMOUD ABDELRAZEK ELIMAM	IN THE 2ND YEAR
BEARDED	LORENZO	IN THE 2ND YEAR
CHECKLISTS	NICHOLAS	IN THE 2ND YEAR
CIUSA	PETER	IN THE 2ND YEAR
BLACKSMITHS	SIMONE	IN THE 2ND YEAR
CLEAN FORERO	CHRISTIAN DAVID	IN THE 2ND YEAR
WILD	IAN	IN THE 2ND YEAR
TRIPODS	VALERIO	IN THE 2ND YEAR
ALIOUANE	MOHAMED	IN THE 3RD YEAR
BAIS	VALENTINA	IN THE 3RD YEAR
CECCHI	LORENZO	IN THE 3RD YEAR
CHIALASTRI	ADRIAN	IN THE 3RD YEAR
GINZBURG	MATIAS GABRIEL	IN THE 3RD YEAR
GOLLER	LEONARDO	IN THE 3RD YEAR
MONTAGNANI	MATTHEW	IN THE 3RD YEAR
NICOSANTI	THOMAS	IN THE 3RD YEAR
PEDRONI	THOMAS	IN THE 3RD YEAR
SINGH	AYUSH	IN THE 3RD YEAR
HEAD	MATTHEW	IN THE 3RD YEAR
BENYAHIA	YOUNES EL MAAMOUN	IN THE 4TH YEAR
BERTELLOTTI	ALEXANDER	IN THE 4TH YEAR
ROBATTINO ROW	PHILIP	IN THE 4TH YEAR
GAUTAM	AJAY	IN THE 4TH YEAR
GROSSUTTI	ANDREA	IN THE 4TH YEAR
LEHMANN	ALEXANDER	IN THE 4TH YEAR
MALECH	OLIVIERO	IN THE 4TH YEAR
RACHENKOVA	DMITRII	IN THE 4TH YEAR
ROSANA	ANDREA	IN THE 4TH YEAR
SINGH	HARMAN PREET	IN THE 4TH YEAR
TAMAI	ALEXANDER	IN THE 4TH YEAR
VITAL	ELISA	IN THE 4TH YEAR

4. *PH.D. THESIS DISCUSSION*

SURNAME	NAME	THESIS TITLE	DATA DEFENSE	SUPERVISORS	PRAISE
ZANCHETTIN	JACOPO	Algebraic Structures in Noncommutative Geometry: A Study of Hopf Algebras, Hopf-Galois Extensions, and Hopf Algebroids	09/01/24	DABROWSKI, LANDI	Yes
ARNAUDO	PAUL	Black hole perturbations from supersymmetric gauge theory and analytic perturbative methods	20/09/24	BONELLI, TANZINI	Yes
ALDERS	RICHARD	Formulae of Jeffrey-Kirwan type in enumerative geometry	27/09/24	TOW	Yes
ULSNAES	TORSTEIN	Boundary extensions of symmetric spaces in equivariant KK-theory	10/10/24	DOELMAN, DABROWSKI , MESLAND	No
SILLARS	LORENZO	Invariants of almost complex and almost symplectic manifolds	18/10/24	TOMASSINI, STOP	Yes
OUNESLI	HAMZA	Some problems realization in Smooth Ergodic Theory	12/11/24	LUZZATTO	Yes
KUANG	QIANGRU	Applications of Grothendieck - Riemann-Roch theorem for stacks and stringy Chow ring of weighted blow-ups	04/12/24	TALPUS, SIBYL	Yes
KURYLENKO	VADYM	Local Ehrhart Theory and Gale Duality	12/16/24	RODRIGUEZ VILLEGAS	Yes

KHALID	MUHAMMAD SOHAIB	Destabilizing submanifolds for partial differential equations in complex geometry	12/17/24	DYREFELT, STOPPA	Yes

The theses were all approved with honors except one.

5. *PROBLEMS AND ACTIONS*

To enhance the promotion of the doctorate and student interaction, the GMP doctoral program actively supported the JMD Junior Math Days (https://indico.sissa.it/event/85/) this year, presenting SISSA's mathematics doctorates and attracting young talents. These activities are organized by SISSA mathematics students and supported by faculty. This initiative has become international in scope and is no longer limited to students from Italian universities.

Given the success of the selection process adopted the previous year, the PhD student selection process for the 2024/2025 academic year was conducted online. This process also allowed us to select high-caliber international students.

COGNITIVE NEUROSCIENCE
Report A.A. 2023/2024

In what follows, we describe the state of the art in the Cognitive Neuroscience (CNS) PhD at SISSA, highlighting our strengths and weaknesses, and illustrating the actions that we've taken during the Academic Year 2023/2024 to make the former shine even more, and to address the latter. This document is specifically based on the 2024 yearly report of the *Student–Professor Joint Committee* (*Commissione Paritetica Allievi–Docenti*, CPAD).

1. CPAD report: considerations and actions

According to the CPAD report, the CNS PhD compared to previous year has improved on the critical issues of "Networking" (according to a more positive trend of the whole school), and "Quality of the Courses". The issues linked to "Discrimination and Inclusiveness" and in general to wellbeing seem to remain instead, although the small number of responders to the questioners do not allow to draw strong conclusions based on it. The CNS faculty has made and is currently trying to strengthen the positive initiatives taken in the previous year(s) and to implement new ones to improve the student's quality of life.

a. *Networking.* As in the previous year, we are actively fostering the interactions of our students with fellow students, as well as postdocs and PIs, of the various groups within our PhD program, as well as other groups of different areas and PhD programs through the following initiatives.
    i. We maintain a regular within-PhD meeting that has been historically a hallmark of our program: a weekly *journal club*, where every student, on the field of neuroscience, followed by an in-depth discussion of the paper by the whole audience.
    ii. We invite colleagues from different research institutions. Last year we hosted Elisabetta Boaretto,(Weizmann Institute of Science), Peter Stern (Science Magazine, Senior Editor), David Sanders (Purdue University), Serena Bradde (Chief Editor at Phys Rev X Life), Paola Binda (University of Pisa), Marshall Hussain Shuler (Johns Hopkins University, Baltimore) Tadeusz Kononowicz (Univesity Paris-Saclay), Bianca van Kemenade (University of Gießen), Leenoy Meshulam (University of Washington, Seattle) John Widloski (Univ California at Berkeley) Robert Volcic (New York University Abu Dhabi), Elvira de Leonibus (TIGEM, Naples, CNR, Rome), Lisi Beyersmann (Macquarie University, Sydney), Sendy Caffarra (University of Reggio Emilia), Claudio Mulatti (University of Trento), Séverine Casalis (University of Lille), Giorgia Silani (University of Vienna) Claus Lamme (University of Vienna), Corrado Corradi-Dell'Acqua (University of Trento), Roi Cohen Kadosh (Surrey University, UK), Krzysztof Cipora (Loughborough University, UK), Luisa Girelli (Milano Bicocca) .
    iii. Several PIs at CNS maintain active collaborations among them, as well as with colleagues in other areas and PhD programs. Just to name a few: 1) D. Zoccolan is collaborating with the groups of D. Crepaldi and E. Piasini (within CNS), L. Ballerini and G. Legname (within the Neuroscience Area) and A. Laio and S. Goldt (in the Physics Area); 2) PIs Diamond and Bueti are collaborating in two projects, one concerning brain mechanisms of time perception and the second concerning brain algorithms for accumulating noisy evidence to make perceptual decisions. The latter is also in collaboration with Edgar Roldan, ICTP. Both projects are headed by 3 PhD students, two are CNS students, one is a PhD candidate of the course in physics of the biological system co-supervised with Edgar Roldan; 3) The Bueti group has

collaboration with Alessandro Laio's (Biophysics group) concerning the application of a causality algorithm applied to EEG data, with Eugenio Piasini on mathematical quantification of "complexity" and "interestingness" in visual images and their influence on time perception 4) the Diamond group has a collaboration with S. Goldt of the Data Science group of Physics on memory dynamics and learning . 5) a student in Treves' limbo group is collaborating with A. Laio in Stat. Biol. Physics. 6) PIs Diamond and Piasini are collaborating on one project on sequential decision making, involving two PhD students. 7) E. Piasini is collaborating with S. Goldt on the joint supervision of a student, working on a project on learning and noise correlations in recurrent networks, and with K Reinhard in the Neurobiology group on a project of neural coding in the superior colliculus. 8) A student in Crepaldi's lab is also working with Alessandro Treves as part of his PhD.

Together, these partnerships provide important opportunities for close-range, in-person scientific exchanges and interactions to CNS students. For example, it is not uncommon for them to participate in joint lab meetings of two groups or to be invited as guests to lab meetings of other groups. Periodically, Diamond and Bueti's lab have joint lab meetings.

iv. Similarly, all CNS faculties have many active collaborations with colleagues outside SISSA, both in Italy and abroad. Just to name a few: 1) D. Zoccolan is collaborating with the groups of Gabriel Kreiman (Harvard), Vijay Balasubramanian (University of Pennsylvania), Giorgio Vallortigara (CIMEC, Trento) and Judit Gervain (University of Padova) - in addition, D. Zoccolan has recently obtained a SFARI grant to support his participation in an international consortium studying genetic rat models of autism (the consortium nature of this grant is allowing trainees in Zoccolan's lab to interact, both remotely and in person, with their peers in the other labs of the consortium in the USA, Canada and the UK) ; 2) E. Piasini collaborates with Jean Barbier (ICTP), Giuliano Iurilli (Italian Institute of Technology), Manuela Allegra (CNR Padova), , Alex Filipowicz (Toyota Research Institute), Fabio Anselmi (University of Trieste), Clélia de Mulatier (University of Amsterdam), Ingmar de Vries (University of Trento), and several groups at the University of Pennsylvania, including those of Joshua Gold, Vijay Balasubramanian and Marc Fuccillo; 3) M. Diamond is collaborating with Omri Barak (Technion, Haifa) and Nathan Keim (Penn State University) under the auspices of an HFSP project; 4) In Italy, R. Rumiati leads one PRIN with Sara Mondini (Padua University), and Maria Caterina Silveri (Catholic University, Milan) as units, and she is a unit of another PRIN with Fabio Lucidi and Fabio Alivernini (Sapienza, Rome). She is part of the national PNRR project 'AGE-IT' involving several scientists from life and social sciences and she also collaborate with Paolo Manganotti e Maria Assunta Cova (Trieste University), Barbara Tomasino (IRCSS 'Eugenio Medea'), Alessandro Grecucci (Trento University), Sara Mondini (University of Padua) and Alessia Tessari (Bologna University); a project on the effects of COVID on cognition and the brain was funded by the MUR involving several neuroscientists from IUSS, IMT and SSSA. As to the collaboration abroad, Rumiati has being involved in projects with Carol Coricelli (Institut Lyfe, Lyon, France) Gianni De Fraja (Nottingham University, UK), Giorgia Silani (Wien University, Austria) and Yaakov Stern (Columbia University, USA); 5) Treves has been collaborating with Elisa Ciaramelli (Univ Bologna), Elvira De Leonibus (TIGEM Napoli), Remi Monasson (ENS Paris) and Edmund Rolls (Oxford); and recently other collaborations have started with Tor and Hanne Stensola (Univ Agder), Aldo Genovesio (La Sapienza) and Adriano Barra (Univ Salento); 6) Crepaldi collaborates closely with Roberto

Bottini (University of Trento), Daniel Casasanto (Cornell, US), Noam Siegelman (Hebrew University of Jerusalem), Louisa Bogaerts (University of Gent), Felix Schoenbrodt (Munich), and Lisi Beyersmann and Anne Castles (Macquarie University, Australia). 7) Bueti has active collaborations with Wietske Van der Zwaag, Serge Dumoulin and Ben Harvey (Spinoza Centre for Neuroimaging, Amsterdam and Utrecht University), Paola Binda (University of Pisa), Elisa Castaldi (University of Florence), Ulirike Rimmele (University of Geneva), Vincenzo Romei (University of Bologna). 8) Diamond has undertaken two collaborations under the auspices of new PRIN projects: i) with Elisa Ciaramelli of the University of Bologna and ii) with Marco Mainardi and Serena Bovetti of the Universities of Padova and Torino, respectively.

Again, this gives our students the possibility to interact, most often remotely but in some cases through in-person visits, with top scientists in the field of neuroscience.

v. Also this year, we organized a Welcome Day for the new students of our PhD. This event, beside a presentation of all the research groups, labs, and facilities and an overview of the organization of our program, also featured two external speakers: Luca Tarasi (University of Bologna) and Rasmus S Petersen (University of Manchester). Both speakers not only presented their research, but also explained their career paths to CNS students, discussing the challenges of a career in neuroscience.

b. *Technical skills.* Like in the previous year, we have kept the technical/methodological courses, especially on the front of programming, advanced statistical analysis and machine learning (more details are provided below in the teaching section). Notably, for some of these courses we are taking advantage of the expertise of one of our faculty members, E. Piasini. These new courses complement an already existing package of methodological courses, which are instead focusing on the development of hardware and devices (again, see the section below). Finally, our students have been strongly encouraged to also attend the courses of the PhD in Data Science.

2. Teaching and Support to our Students' Research

In the current AY (2023-2024), we have been offering 7 core theoretical courses that were taught by the 7 active faculties of our PhD during the AY: Alessandro Treves, Mathew Diamond, Davide Zoccolan, Eugenio Piasini, Raffaella Rumiati and Domenica Bueti. The first 5 courses were also offered to the students (about 15) of the Master in Physics of Complex Systems (a joint program of Politecnico di Torino, ICTP, SISSA and several French Universities based in Paris), while all courses were also attended by the 4 students of the Master In Neuroscience of the University of Trento that participate to the joint program with SISSA and 3 students of the national PhD in Neuroscience. Multiple Masters thesis students, hosted individually without any institutional convention, also enrich the student body. The participation in our courses of such a mixed audience is a strength of our teaching, since it allows students with very different backgrounds (mainly psychology and physics) to interact, bringing to the discussion of the topics covered during the classes a rich diversity of viewpoints and questions. In addition to these courses, we also implemented several technical courses. Three of them are meant to provide an introduction to understand and design lab equipment: 1) an introduction to electronics (taught by Erik Zorzin, a SISSA technician of the Mechatronics lab); 2) an introduction to Solidworks (taught by Marco Gigante, a SISSA technician of the Mechatronics lab); and 3) and an introduction to Arduino and microcontrollers (taught by Fabrizio Manzino, from SISSA's startup CyNexo).

As in the previous year, we have a shared calendar of all neuroscience courses. This is to avoid as much as

possible the overlap between courses and to give the students the opportunity to know the entire teaching offer, from genomics to neurobio to cognitive neuroscience. We also organize courses that are explicitly direct to the students of the three PhDs. These courses are: “Scientific Dissemination” (taught by Prof. Valentina Parma, Monell Chemical Senses Center), “Scientific Programming” (taught by Dr. Jon Carr, Royal Holloway University of London), and “Introduction to Statistics” (to be taught by Giovanni Zanco, University of Siena).

These three courses are meant to improve the students' soft skills, programming and data analysis skills.

Finally, we are also offering a course on Methodologies such as EEG and TMS (taught by Marco Zanon, CNS technician). We believe that this offer of methodological courses nicely addresses the issue raised by the students about the need to improve their technical skills.

Finally, this year too, we scheduled a special session of Progress Report for the students in their final year (to be held at the end of March), which we feel helps our students get better prepared and meet the defense deadline.

3. Discrimination and wellbeing

Concerning this critical point a few considerations are necessary. It is fundamental that the school has indications of the state of the wellbeing of the personnel also through the students’ questionnaire. However, the questionnaire is anonymous and a real understanding of the nature and entity of the problems is only possible by having access to the free comments that are strictly confidential and that the CPAD and the Nucleo di Valutazione cannot share with the single PhD. For this reason, we believe it is important for the future that for what concerns the delicate matter of students' wellbeing there should be prompt and effective communication between CPAD, NdV and CUG. These bodies can all have access to this confidential information and together with the single PhD they can eventually discuss potential actions. In our case it happened that the deputy CNS coordinator (Bueti) is also the chair of the CUG, while Crepaldi was part of the NdV (and an ombudsperson until June 2024); through their perspective, but also thank to a conversation with the student representative of the CNS PhD, we did understand that the major problem was related to linguistic barriers inside and outside the school. A different issue concerns the difficulty of bearing the competition between peers and the discrimination based on educational background. This last issue is a consequence of the very diverse backgrounds (i.e., psychology, biology, physics) of our cohort of students. All these different issues seem particularly relevant with the group of peers. As a NOTE we should point out here that ~37% of our students are foreigners and that these numbers may have influenced the comments on the discrimination. Concerning this last issue, the lack of additional information prevented us from putting in place very targeted actions. More generally we act inside the PhD in the following two ways.

a. Having open conversations with the students about these issues, we tried to promote as much as possible the knowledge of the wellbeing services offered by the CUG (ombudspersons, confidential counsellor and psychological counselling).
b. During the students “welcome day” we made clear that: 1. We are committed to creating an environment in which everyone is entitled to being treated with courtesy and respect, 2. We aim to provide a harassment and bullying-free environment for all, regardless of sex sexual orientation or gender identity, disability, physical appearance, race, nationality, ethnicity and religion. 3 sexual language, sexist, racist, or otherwise exclusionary jokes are not tolerated. 4. Students from Italy are kindly invited to speak mostly in English around the lab, cafeteria, or any

SISSA environment.

4. Successful completion of the PhD and placement

Of our 4th–year students, two have already successfully defended their PhD in 2021 and found a placement for their first postdoc:

	Defence date	External assessors	Supervisor	Current post
Olga Šolaja	22/01/2024	Lisi Beyersmann (Macquarie University, Sydney), Sendy Caffarra (University of Reggio Emilia), Claudio Mulatti (University of Trento), Séverine Casalis (University of Lille)	Davide Crepaldi	Post-doc at SISSA
Valeria Centanino	20/02/2024	Paola Binda, University of Pisa; Marshall Hussain Shuler, Johns Hopkins University, Baltimore, Bianca van Kemenade, University of Gießen Germany, Tadeusz Kononowicz (Univesity Paris-Saclay	Domenica Bueti	Post-doc at SISSA
Elisabetta Pisanu	09/10/2023	Giorgia Silani (Universität Wien); Alessandro Grecucci (Università di Trento); Maria Rosaria Nappa (Università degli Studi di Roma Tor Vergata); Michela Sarlo (Università di Urbino)	Raffaella Rumiati	Post-doc at SISSA
Nadia Bersier	25/11/2024	Roberto Baiocco (Università Roma1-Sapienza); Corrado Corradi-Dell'Acqua (Università di Trento); Claus Lamm (University of Vienna); Sonia Herbette (CHUV, Svizzera)	Raffaella Rumiati	Post-doc SISSA
Maristella Lunardon	03/12/2024	Roi Cohen Kadosh (Surrey University, UK); Krzysztof Cipora (Loughborough University, UK); Luisa Girelli (Milano Bicocca); Laura Zamarian (Medical University Innsbruck	Raffaella Rumiati	Post-doc University of Tuebingen, Germany

NEUROBIOLOGY

Report A.A. 2023/2024

Summary

Below is a table of information useful for quality assurance for the PhD in Neurobiology related to the 2023/2024 academic year. As can be seen, the number of applications oscillates between 5 and 20 candidates for available places (7 in 2023/2024). The average percentage of foreigners in the total number of applications is 52% (66% in 2023/24) and the average percentage of foreigners in the total admissions is 31% (40% in 2023/2024): numbers that we consider representative for an international environment such as SISSA. As indicated in section 3, no critical issues were raised in progress reports and transition to the next year.

1. Changes to the training on offer

No major structural changes were made to the training courses in 2023-2024. Where possible, courses were held in person. In section 5, I present efforts that were made in response to the questionnaire, to improve the PhD for the 2024-2025 academic year.

2. Summary data on admissions to the PhD

The table below indicates the number of positions available, the total number of admission applications received in the various sessions, and the number of applications submitted by foreign candidates. The last two columns report the percentage of foreigners compared to total applications and the percentage of foreigners admitted to the Ph.D. The data refer to the academic year 2023-2024, and to the 5 previous academic years.

Academic Year	Positions Available	Total Number of Applicants	Number of applications from foreigners	Percent of foreign candidates	Percent of foreign candidates admitted
2023/2024	5	35	23	66	40
2022/2023	4 (3 admitted)	46	26	57	33
2021/2022	5	33	9	27	20
2020/2021	5	28	11	39	20
2019/2020	4	35	23	66	50
2018/2019	7	67	36	54	20

3. Progress reports and transitions to the next year

In the academic year 2023-2024 the faculty of Ph.D. in Neurobiology thoroughly discussed and approved the progress reports detailed below. There were no critical issues:
Year I--> II Po-Yu Liao, Camilla Lodetti, Alessandro Massaro, Camilla Perna
Year II--> III Jacopo Giorgi, Safaa Mamoun Abdelmageid Ali, Lorenza Tortella
Year III--> IV year: Montrone Michele, Recupero Luca, Ricci Chiara

4. PhD. Thesis discussion

Surname	Name	Title of Thesis	Date	Supervisors
FERRARINI	DENISE	Engineering toxins as neuropeptides: targeted pain modulation via recombinant adeno-associated virus (rAAV) vectors delivery to nociceptors	15/12/2023	HEPPENSTALL
MANZATI	MATTEO	Spontaneous activity alteration in in vitro models of neuronal pathologies	18/12/2023	GIUGLIANO
HOSSEINI	ALI	Characterizing Synchronous Activity Propagation in Modular Neuronal Networks using Microscale Unidirectional Culture Devices	15/04/2024	GIUGLIANO
SCHIAVO	IRENE	"Sortagged" AAV: a novel chemo-enzymatic approach for site-specific ligand conjugation on AAV vectors	03/06/2024	HEPPENSTALL
SANCHEZ TRIVIÑO	CESAR ADOLFO	Chemosensory Systems: Sympathetic Modulation of Vomeronasal Neurons and Electrophysiological Insights from the Human Olfactory Epithelium	22/07/2024	MENINI - PIFFERI

5. Problems and actions

The questionnaire revealed a level of dissatisfaction amongst the students concerning the issues of wellbeing, quality of the courses, conferences or schools, and seminars attended. This was in contrast with positive indicators for interactions between individual students and their PIs. Having been made aware of this discontent, the PhD coordinator met with all Neurobiology students to discuss the problems and potential actions. I discuss the results of these discussions in more detail below.

Wellbeing

The concerns here were of a personal nature and have now been resolved with the help of the school psychological services.

Quality of the courses.

While the students acknowledged that the courses offered have improved, they still felt that some were too specialized and thus not particularly useful for their training. They would appreciate more practical training with insights into how research is done in different fields. There was also some criticism that that the requested Molecular Biology/Cell culture technical course was offered too late in the year to be of use to most students.

Conferences or schools

Students agreed that being able to attend 1 conference per year as an experimentalist would be appropriate for their research. However, there was little understanding on what is available for students to attend. Supervisors are therefore encouraged to advise students on which conferences may be of interest. Students are also encouraged to suggest conferences and discuss them with their supervisors.

Seminars attended

The low number of seminars attended was discussed and it was agreed that this problem stems from 2 causes. Firstly, several students are reticent to actually attend seminars, citing a lack of time and lack of interest. Secondly, there are not enough seminars organized by faculty. It was agreed that a solution would be to organize seminars by Area rather than PhD, and that a centralized budget should be set aside for this. Students are also encouraged to suggest speakers, especially for SISSA colloquia. Finally, more advertising for upcoming seminars needs to be done, for example posters in the cafeteria and entrance, and 1 or 2 dedicated boards for neuroscience topics placed in visible locations.
Beyond these concerns, several other issues were raised:

Journal Club

Despite being requested by the students, journal club is still poorly attended and appreciated. Students felt that the choice of papers being presented were often too specialized, and that they also lack guidance on how to present and critique papers. It was therefore suggested that the choice of what paper to present could be made collectively, and that faculty should attend journal clubs whenever possible.

Choice of Supervisor

First year students would appreciate more transparency on their choice of supervisor before they commit to a PhD at SISSA. This may be achieved by including information on the procedure for selection of supervisors when informing successful candidates by email, and by encouraging informal lab visits and discussions between candidates and PIs after the entrance exams.

Technical Support

All students reported on a lack of technical support in their experiments. They discussed the difficulties in gaining access to some equipment because of overuse (e.g. confocal microscopes and centrifuges), that many instruments are broken (cryostats, -80 freezers), and that often it is difficult to find staff to report these and other problems. They also bemoaned a lack of teaching of technical skills by staff, and a lack of information on any introductory courses that are run. To remedy these problems, it was suggested that technical staff be more present in the laboratory (students often complain that no one is there), that information on courses etc is advertised on posters around the labs, and that every new person who comes into the lab is reminded that they must do the mandatory tour with the technical staff. Moreover, the neurotech website should be extended with a page that lists all available instruments at SISSA and the list should be printed and put at the entrances of each lab. This would help identifying who to ask about introductions or to report issues to, and it would also counteract the fact that many students are not aware of what equipment we have in the laboratories. In addition, staff are asked to add any courses (also ones organized ad hoc) to the centralized Neuroscience calendar, and students are encouraged to consult it. Finally, because this is an area that is not covered adequately by the questionnaire, it should be implemented better in the future.

FUNCTIONAL AND STRUCTURAL GENOMICS

Report A.A. 2023/2024

SUMMARY

Below is a summary of information useful for quality assurance for the Ph.D. in Functional and Structural Genomics for the 2023/2024 academic year (AY). The structure of teaching activities has remained consistent with the innovations introduced in the previous academic year, also reintroducing the three courses common to the Area taught by external professors. Five seminars were organized (section 5), a lower number than the previous year and lower than expected. This reduction is explained by the fact that, in collaboration with the entire Area, eight seminars were organized in the months of November and December 2024, which will be included in next year's calculation. From the table containing summary data on applications for admission to the Ph.D. in the academic year under review and in the previous five-year period (section 2), it can be seen that the ratio between the number of available scholarships and the number of candidates is 0.02, indicating a high number of applications and potential interest in the Ph.D. A sharp increase compared to previous years, especially among foreign candidates. The percentage of applications from foreign students, in fact, was about 90% for the year under review. Two of the four available scholarships were awarded to foreign candidates. The brief summary of the transitions from year to year (section 3) highlights no problems. The Ph.D. theses defended in the academic year under review (two in total, section 4) were approved with *honors. Two students will defend their theses in 2025. The actions undertaken to* eliminate the critical issues that emerged in the past from discussions between the members of the Ph.D. Council and the students continue a process begun in previous years, although the Ph.D. continues to suffer from abstentionism regarding participation in the annual questionnaire.

1. *CHANGES TO THE COURSE OFFER*

The structure of teaching activities has followed that of the previous academic year. The teaching program continues to include, in addition to teaching provided by the internal members of the Teaching Committee, a series of courses taught by colleagues from other SISSA Areas or other institutions. Additionally, thanks to the collaboration of the technical staff of the Neuroscience Area, students continue to be offered specific technical courses, essential for qualifying them to conduct *wet experimental activities* of the Genomics program. No critical issues have been identified.

2. *SUMMARY OF PH.D. ADMISSION DATA*

The table below shows the number of applications received for the session reserved for NON-EU candidates, for those open to ALL-COUNTRY candidates, and the corresponding TOTAL. The numbers in parentheses indicate the available/remaining scholarships for each session and the total number of scholarships actually awarded. NA indicates unassigned scholarships. The FOREIGNERS column shows the percentage of foreigners out of total applications, and the percentage in parentheses shows the percentage of foreigners out of the total number of candidates admitted to the Ph.D. Column B/C shows the ratio of scholarships to candidates. The data refers to the academic year in question and the previous five years. We introduced a second selection session starting from the 2019/2020 academic year. This is the reason for the double indication in

the ALL-COUNTRY column starting from the 2019/2020 academic year. Since the selections were all conducted remotely or in a hybrid manner, it was not deemed necessary to conduct an exclusive selection for NON-EU candidates starting from the 2020/2021 academic year.

AA	NON-EU	ALL-COUNTRY	TOTAL	FOREIGNERS	B/C
18-19	6 (2)	17 (2)	23 (2)	52% (0%)	0.09
19-20	3 (3)	20 (3) / 6 (1)	29 (3)	55% (67%)	0.10
20-21	NA	29 (3)	29 (3)	58% (33%)	0.10
21-22	NA	62 (4) / 8 (2)	70 (3 + 1NA)	77% (33%)	0.06
22-23	NA	27 (5) / 12 (2)	39 (5)	64% (40%)	0.13
23-24	NA	130 (4) / 50 (2)	180 (4)	90% (50%)	0.02

3. YEAR TRANSITIONS

In the academic year 2023/2024 the Ph.D. Council of Functional and Structural Genomics discussed and approved the following year transitions:
I → II year: I. FERGANI, A. MAZZETTI, G. PISTORIO, C. SGHERZA held a seminar reporting the results produced during the first year and presenting their thesis project.
Student A. Kobal did not participate because she was on maternity leave. No critical issues were identified.
II → III year: G. DE LEO, ES MAFTEI, M. MINTSEVA held a seminar reporting the initial results of their thesis work. No critical issues were identified.
III → IV year: L. GRAZIANI, A. BURATO, M. AYUB held a seminar reporting on the progress of their theses work. No critical issues were identified.

4. PH.D. THESIS DISCUSSION

During the academic year 2023/2024, the following Ph.D. theses were successfully discussed:
1. M. TUCCILLO, supervisor A. Mallamaci , "Addressing limits of *Emx2* therapy of glioblastoma multiforme by transgene isolation and epigenetic pharmacological intervention".
2. S. BOCHICCHIO, supervisor R. Sanges, "Understanding the function of *AHDC1* using *in vitro* models", approved *cum laude*.

Due to the problems and delays caused by the pandemic, the following students will defend their theses by 2025:
1. U. RANGASWAMY, supervisor R. Sanges, meeting scheduled for April 2025.
2. L. NIKOLIC, supervisor G. Legname, meeting scheduled for April 2025.
However, there are no critical issues regarding the completion of the work.

5. SEMINAR LIST

- Prof. E. Fornasiero – 18/01/2024 - Analysis of protein turnover in the brain: lessons from physiology and aging.
- Prof. R. Gibbs – 03/26/2024 – Discovery of human disease genes.
- Prof. A. Poletti – 05/20/2024 – Exploring both established and emerging targets to mitigate the

toxicity associated with misfolded proteins in motor neuron diseases.

- Prof. M. Biagioli – 04/10/2024 – Dancing in circles: neglected RNA molecules in genetic brain disorders.
- Prof. S. Lodato – 04/10/2024 – Spontaneous activity in the developing cerebral cortex in health and disease.

6. *PROBLEMS AND ACTIONS*

The findings of the latest CPAD report and the exchanges between the Teaching Staff and students (via representatives and/or in plenary meetings) indicate that the ongoing processes to reduce the critical issues identified in previous years continue the positive trend observed in recent years. No particular critical issues emerged in the last plenary meeting with students at the beginning of the 2023/2024 academic year. However, the questionnaire shows that the following issues continue to exist, albeit to a lesser extent than in previous years:

- Reduced participation in the questionnaire
- Reduced participation in seminars
- Reduced attendance at conferences

Current practices to reduce the impact of these issues are as follows:

- The coordinator and teachers should continue to raise awareness of the importance of completing the questionnaire. The teaching staff would be supportive if the School decided to make participation mandatory for the next academic year.
- Students are asked to suggest seminar participants who might be of interest, and the faculty is asked to organize seminars more closely related to the students' research projects.
- Raising awareness among the coordinator and teachers regarding the importance of attending conferences and establishing good networking.