ATTACHMENT

PhD Reports

Academic Year 2024/25

ASTROPHYSICS AND COSMOLOGY
Report AA 2024/2025

SUMMARY

We present the annual report of the Astrophysics and Cosmology group and PhD program, relating to the 2024-2025 academic year, summarized below. Regarding teaching, the Teaching Board, as a whole and in particular with the active collaboration of student and post-doctoral staff representatives, has made adjustments to the educational offer following the suggestions emerging from the students (Section 1). The group admitted a total of 5 people to the PhD program in 2024, as in the previous year, of which 4 were funded by the school, 1 as part of the National Doctorate in Space Sciences and Technologies (PhD SST), supported by the National Space- It -Up Project (Section 2). The progressions to the second, third, and fourth years of the program did not reveal any critical issues (Section 3). Five PhD thesis were defended in the academic year under review, all approved cum laude (Section 4). Section 5 outlines the actions taken to implement the corrective measure suggested in the previous year's report, which specifically consisted of encouraging the Teaching Board (CdD) to pay attention to the supervision of thesis, including by organizing meetings with students to discuss the results of the questionnaire and the options for theses selection. The post-doctoral research staff, consisting of numerous individuals this academic year, including a Type A Fixed-Term Researcher supported by project funds, is described in Section 6. Active national and international projects and funding are listed in Section 7. The project and research areas, described in Section 8, describe the consolidation of existing research lines and the lines of reasoning for possible future appointments to be conducted in synergy with the school's structures engaged in research in related areas of interest. Finally, in Section 9, we describe the lines of reasoning that APC intends to discuss with the school's research groups that concern areas of investigation contiguous to APC in relation to the consolidation of ongoing lines of research, and possible future directions.

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 works in educational, scientific, and managerial synergy with the Ph.D. programs in Astroparticle and Gravitation (APG) and Data Science (DS). Activities related to group seminars, journal clubs, invitations for collaborations, conference organization, and collaborative work in general are in line with trends in previous years due to the implementation 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 the individuals working on large international observational projects, transferring the knowledge acquired to adjacent groups within the School, promoting inter-area initiatives by opening new lines of research as indicated by the International Science Advisory Committee, and developing corresponding proposals for future lines of research in relation to ongoing observational efforts.

In Figures 1 and 2 we report and comment on the composition of the APC group and the gender balance in the academic year in question.

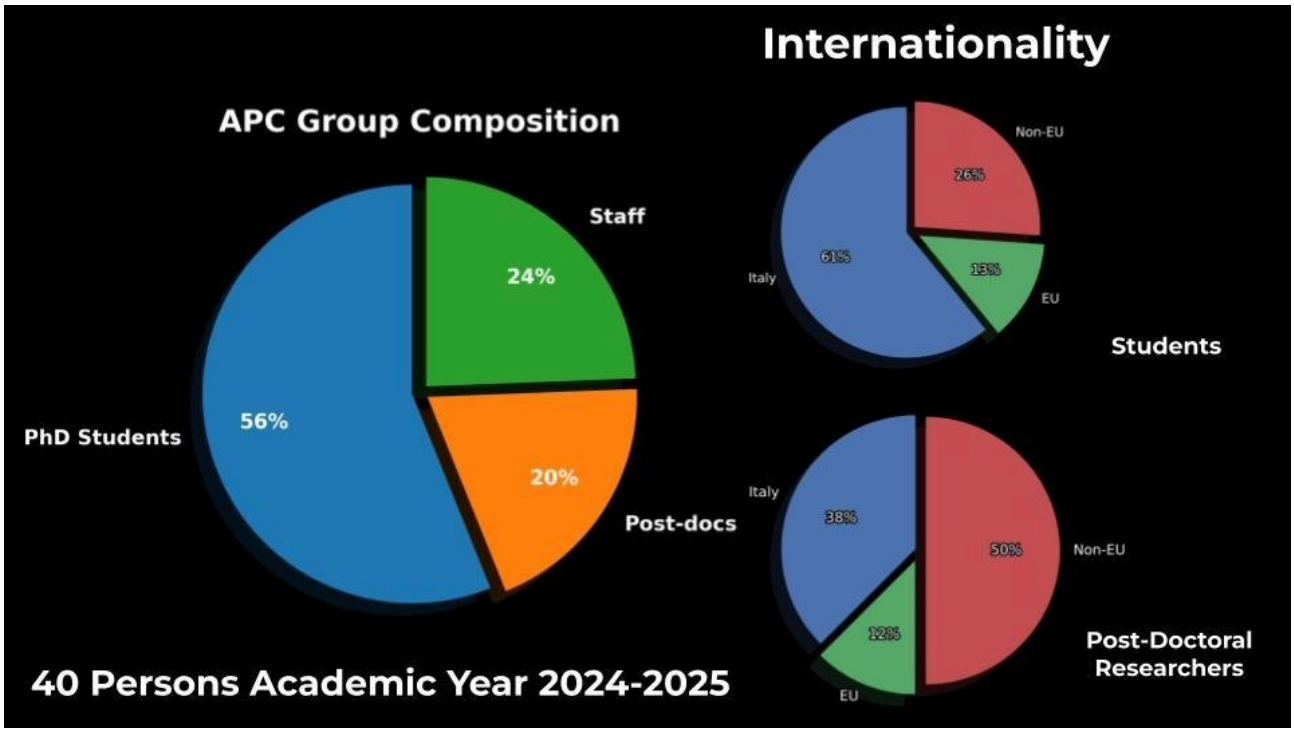

Figure 1. Composition of the APC group and level of internationalization for the 2024–2025 academic year (40 people). The left panel shows the distribution of staff among student staff, postdoctoral researchers, and permanent staff. The right panels highlight the group's high degree of internationalization, particularly among student staff and postdoctoral researchers, with a significant presence of members from non-EU countries. This composition reflects APC's international appeal and its integration into European and global research and training networks.

1. EDUCATIONAL OFFER

In the new academic year, improvements to the curriculum have been undertaken in constant communication and coordination with student and postdoctoral staff representatives. The procedure for assessing student staff satisfaction with the improvements is carried out, as it is every year, through consultation and coordination with student and postdoctoral representatives, and by collecting (anonymous) feedback from first-year student staff, which is discussed at the June Faculty Meeting. The positive impact of the new background courses in Scientific Computing and the two new courses in Observational Astrophysics and Gravitational Lensing has been confirmed, offset by the consolidation of the courses offered by external and retired faculty. Regarding the feedback received from student staff, the modular connection of courses through the 3 Terms , i.e., their programmatic connection and contiguity, has been encouraged. These improvements have been implemented and are effective in the current curriculum, both through the modularization of courses and through the renewal and synchronization of their Syllabi. Logistically, courses are always 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 teaching staff has been reminded of the importance of updating teaching materials in the form of notes, memos, or presentations. As in the current academic year, any changes will be reviewed and discussed collegially within the CdD, particularly next spring, and specifically in the CdD in June 2026, using the same methodologies.

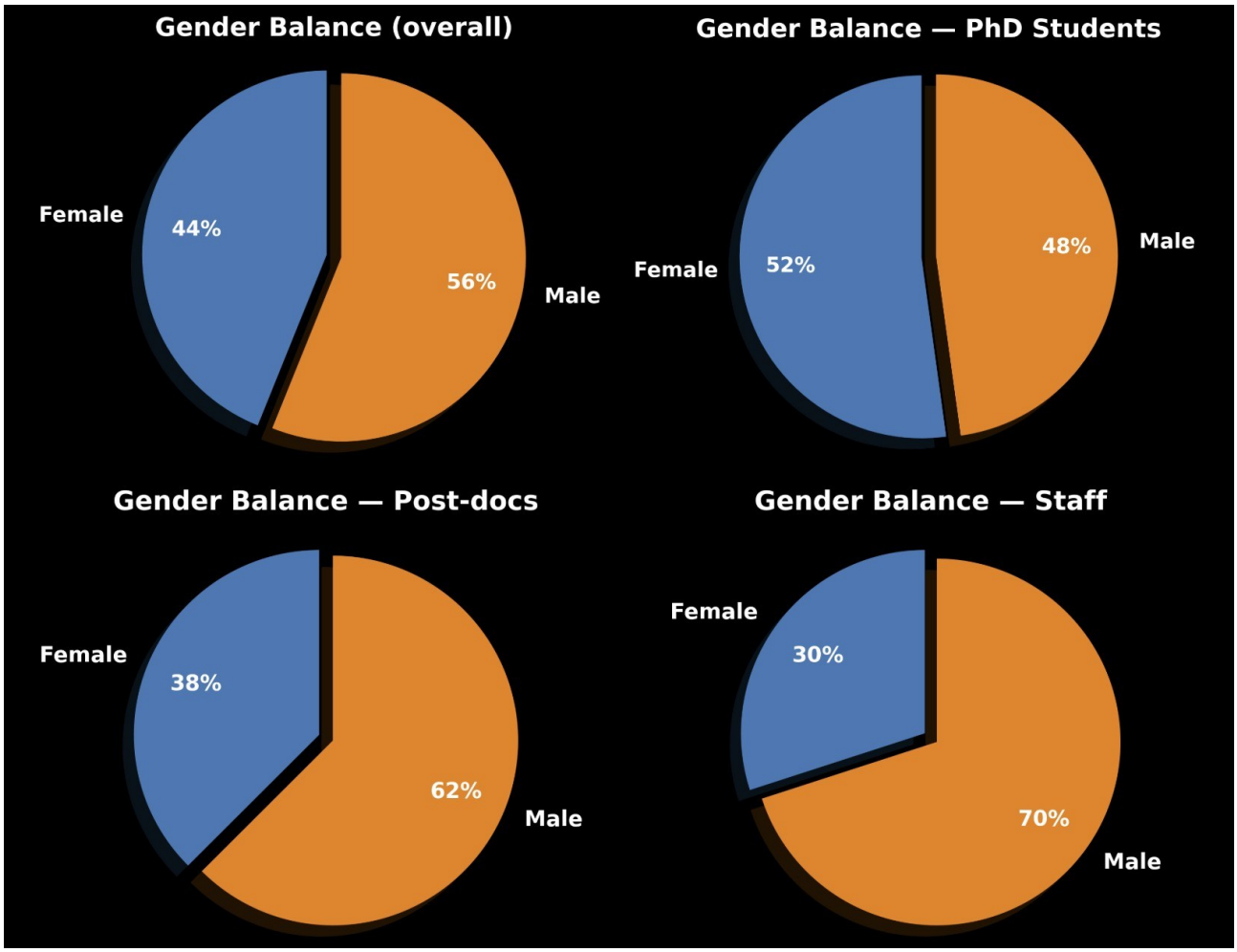

Figure 2. Gender distribution in the APC group, overall and broken down by level (student, postdoctoral research, and permanent staff). The composition shows a good, though not entirely satisfactory, gender balance at the doctoral level, a slight skew among postdoctoral research staff, and a male predominance among permanent staff. It is, however, important to note that, in recent years, female permanent staff have promoted and structured two new strategic research lines for the group (Analysis of Astrophysical and Cosmological Datasets and AstroChemistry), while male permanent staff have contributed to the launch and consolidation of the Gravitational Waves line, highlighting how the group's scientific renewal stems from a varied and complementary contribution from its various members.

2. ADMISSION TO THE PH.D.

In 2025, the following students were admitted to the Ph.D. in Astrophysics & Cosmology (gender and nationality in parentheses): Marta Corioni (Italy), Irene Iorio (Italy), John Houghteling (United States of America), Davide Luchina (Italy), Olga Pietrosanti (Italy). Below, we report the number of applications received from Italian candidates, those from non- Italian but European candidates, and those from non-European candidates, in the spring session only, as the selections resulted in the assignment of all positions, making the fall session unnecessary.

- Spring Session: 147 applications, of which 30.6% were Italian, 4.1% from other EU countries including Switzerland and the United Kingdom, 65.3% from non-EU countries, mostly in Asia and in two cases from the United States of America.

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

3. YEAR PROGRESSIONS

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

- **I -> II year** : Karnchana Aroonrueang , Margherita Imbriani, Elisabeth Keppler, Athul Soman, and Enrico Veraldi successfully earned the credits required to advance to the second year and finalized their thesis projects. 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.
- **II -> III year** : Giovanni Antinozzi (20 May 2025), Roberto Caiozzo (23 May 2025), Margherita De Toma (12 June 2025), Mayurakshi Mukerjee (23 May 2025), Martina Torsello (17 June 2025), Sijil Jose (17 June 2025). The seminar was followed by a discussion by the teaching staff in which no critical issues regarding the completion of the PhD course and the writing of the thesis 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).

- Meriem Behiri, September 29, 2025, thesis titled " Charting the SHORES of the Radio Sky
- Investigating extragalactic source populations ", under the supervision of Prof. Andrea Lapi, Dr. Marcella Massardi (INAF/IRA), Prof. Margherita Talia (UniBO), approved cum laude.
- Minahil Adil Butt, September 29, 2025, thesis titled "Modified Gravity in Galaxy Clusters", under the supervision of Dr. Sandeep Haridasu , Prof. Andrea Lapi, Prof. Carlo Baccigalupi, approved cum laude.
- Francesco Gabrielli, September 19, 2025, thesis entitled "Cosmic transients as probes of stellar and galaxy evolution", under the supervision of Prof. Andrea Lapi, Prof. Mario Spera, Dr. Lumen Boco (University of Heidelberg, Germany), approved cum laude.
- Cecilia Sgalletta, September 19, 2025, thesis entitled "Binary neutron stars and binary black holes: from the Milky Way to the high redshift Universe", under the supervision of Prof. Mario Spera, Prof. Andrea Lapi, Prof. Michela Mapelli (University of Heidelberg), approved cum laude.
- Kendall Shepherd, September 29, 2025, thesis entitled "Winds of Change: The Decisive Role of Mass Loss in the Evolution of Very Massive Stars", under the supervision of Prof. Alessandro Bressan, Dr. Guglielmo Costa (University of Padua, approved cum laude.

5. CORRECTIVE ACTIONS FOLLOWING THE PREVIOUS CPAD REPORT

The questionnaire responses show that the corrective measures introduced by the CdD to improve course organization and logistics were perceived as effective. However, some critical issues remain in the supervision and support phase of thesis selection: approximately 25% of students believe the supervisor's time is insufficient, and nearly 50% would like more regular and structured feedback. Furthermore, two students stated that they were unable to freely choose their thesis, highlighting the need for closer monitoring of the decision-making process and clearer communication about research opportunities and available training programs. The following five key actions are outlined.

Response and corrective measures

1. Clarification on the thesis selection and prevention restrictions for the current year

Regarding the two cases where thesis choices were perceived as restricted, the most likely explanation is that the students are members of the national PhD program, where project constraints may exist (e.g., activities related to space missions as part of the Space- It -Up project funded by the Italian Space Agency and the Ministry of University and Research). In any case, the Board of Directors will promptly verify this information and, for the current academic year, monitor the process: in the current academic year, only one

student is affiliated with the national PhD program, making verification and management even more traceable.

2. Structured monitoring of the thesis selection process in the current academic year

To strengthen supervision, clarity, and freedom of choice, a monitoring process is established with the PhD Coordinator and the students.

a. Meeting 1 in January (preliminary, informal): Review of the status of discussions between students and staff; orientation on areas and opportunities; encouragement of contact with APC groups.
b. Meeting 2 in early spring: progress review; expected objective: finalization of the thesis; planning of any remaining steps.
c. Meeting 3, if necessary before the summer: Closing the decision-making cycle, with targeted support for cases not yet resolved.
d. Review meeting at the end of the academic year: to verify the effective start of research activity, consistency between the final thesis and the ongoing project, and any corrective actions.

3. Strengthening communication on projects and training courses

In response to the demand for greater clarity (projects, trajectories, opportunities), the Degree Programme is strengthening communication with students through opportunities for discussion and greater visibility of available research lines, including the possibilities for integration between groups and topics.

4. Strengthening brainstorming and optimizing teaching offerings

In addition to the traditional meeting in June, an additional meeting will be held in early 2026 to: (i) optimize the course offerings, (ii) provide a very brief presentation of research lines by the PIs and collaborators, and (iii) clarify prerequisites and possible “elective” courses in subsequent years.

5. More regular and traceable feedback

To address the need for greater feedback, it is recommended that each supervision include a minimum frequency of discussions and a clear channel for reporting any critical issues early (even confidentially to the Coordinator), so that intervention can be made before the problem becomes established.

6. 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. Alessandro Carones, Post-Doctoral researcher on European funds associated with the SPACE RAdioForegroundsPLus project and on funds from the Italian Space Agency for the LiteBIRD Project, of which Prof. Baccigalupi is responsible, until August 2026,
2. Ugo Nicolò di Carlo, Post-Doctoral researcher of type A on PNRR Calcolo funds, for which Prof. Spera is responsible, until October 2025,
3. Elham M. Goliaei , Post-Doctoral Researcher funded by institutes associated with the Bridge project, for which Dr. Perrotta and Prof. De Gironcoli of Condensed Matter are responsible, until March 2027,
4. Gayathri Gururajan, Postdoctoral Researcher on Institute Funding and shared with IFPU, until October 2026,
5. Sandeep Haridasu , postdoctoral researcher, funded by the Italian Space Agency for the Euclid satellite project of the European Space Agency until June 2025, after which he will be a fixed-term researcher of type A, with partial coverage by the Space- It -Up project of the Italian Space Agency

and the Ministry of University and Research, for which Prof. Baccigalupi is responsible, until June 2028.

6. Zhiqiu Huang, Post-Doctoral Researcher on PRIN 2022 funds, headed by Prof. Celotti until June 2026,
7. Marcos Muniz Cueli, Post-Doctoral Researcher on institute funds in sharing and support of IFPU research lines until October 2025,
8. Tiziano Schiavone, Post-Doctoral Researcher on PRIN 2022 funds for which Prof. Salucci is responsible, until October 2027,
9. Samuele Silveravalle, post-doctoral researcher on PRIN 2022 funds, for which Prof. Liberati is responsible, until June 2026 ,
10. Tommaso Ronconi, post-doctoral researcher on PNRR Calcolo funds, for which Prof. Spera is responsible, until March 2025,
11. Kendall Shepherd, Postdoctoral Researcher on Institutional Funding until March 2026,
12. Leo Vacher, post-doctoral researcher with European funds associated with the SPACE RadioForegroundsPlus project and with funds from the Italian Space Agency for the LiteBIRD Project, for which Prof. Baccigalupi is responsible, until November 2025.

In light of this increase, which affects all of 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.

7. PROJECT SUPPORT

The group 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-RISE CMB- Inflate, Prof. Baccigalupi, approximately 3 M€ in total, 200 K€ for extended periods of visits of SISSA staff to centers in the United States and Japan, for research in Cosmology, for a period from 2022 to 2026,
2. EU-HORIZON-CL4-2023-SPACE-01, GA 101135036, Prof. Baccigalupi, approximately €200,000 in total, for 2 Postdoctoral research positions and travel, for research in Cosmology.

National projects

1. ASI-Euclid, Prof. Baccigalupi, for 1 post-Doctoral research position for 2 years, travel, for research in Cosmology, for a period ranging from 2021 to 2026,
2. ASI- LiteBIRD , Prof. Baccigalupi, 2 post-Doctoral research positions for 2 years, travel, for a period from 2019 to 2026,
3. National HPC Center on PNRR funds - Spoke 3 Astrophysics and Cosmos Observations, Prof. Andrea
4. Lapi, 1 post-doctoral research position for 2 years, travel, scientific computing, for a period ranging from 2023 to 2025,
5. Space Partnership on PNRR funds, Space- It -Up Project, Prof. Carlo Baccigalupi, 1st position
6. Fixed-Term Researcher and scholarships for the National Doctorate in Space Science and Technology, for a period from 2025 to 2028,
7. National Institute for Nuclear Physics (INFN), InDark Initiative , Prof. Carlo Baccigalupi, operating with annual renewal, travel support,
8. LiteBIRD Initiative , Dr. Nicoletta Krachmalnicoff, operating with annual renewal, travel support,

9. INFN, QGSKY Initiative, Prof. Paolo Salucci, operating with annual renewal, travel support,
10. INFN, Teongrav Initiative, Prof. Mario Spera, operating with annual renewal, travel support,
11. PRIN MUR 2022, Prof. Andrea Lapi, 1 post-Doctoral research position for 2 years, for the period from 2024 to 2025,
12. PRIN MUR 2022, Prof. Paolo Salucci, 1 post-Doctoral research position, for the period from 2025 to 2027,
13. PRIN MUR 2022, Prof. Annalisa Celotti, 1 post-doctoral research position for 2 years, travel, for the period from 2025 to 2027,
14. MUR - Joint School Program, Prof. Andrea Lapi, Prof. Carlo Baccigalupi, Prof. Mario Spera, publications and trips, for the period from 2022 to 2025,
15. INAF Large Grant, Prof., Andrea Lapi, publications and travels, for the period from 2023 to 2025,
16. INAF Mini Grant, SHORES: Serendipitous H-ATLAS fields Observations of Radio Extragalactic Sources, Prof. Andrea Lapi, Dr. Francesca Perrotta, Dr. Marcella Massardi, publications and travel, for the period 2023 to 2025.

8. LINES OF RESEARCH

The group's research strategy is stable. The fundamental unity of APC research activities at SISSA consists of thematic groups, often closely interconnected, coordinated by one or more PIs, one or more postdoctoral research staff, and several student staff units, often distributed across multiple years of the doctoral program. This work unit is effectively characterized by modern research in Astrophysics and Cosmology, both on theoretical and phenomenological topics and in its interface with the large observational missions of which the APC group is a part, which increasingly require the analysis of large amounts of data. This section outlines the characterizing activities of the current academic year, 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 established in the previous two 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), and Gravitational Waves (PI Prof. Mario Spera, Associate Professor in APC since the 2022-2023 academic year). These lines are strongly connected, particularly in the doctoral thesis proposal, with projects that are progressing with observations and with new ones that have begun or for which preparatory work is underway. This connection is achieved through the acquisition of positions of responsibility within the projects by research staff, which serve as a catalyst for the growth and international visibility of student staff, and subsequent access to post-doctoral positions. Consequently, in at least half of the project realities highlighted, the APC group holds roles of responsibility in data analysis and in deriving the consequences on the theories that these efforts concern, and in the remaining ones, the APC group implements stable access to public data and its use in publications.

Following the order of mention of the new lines of research, we point out the data collection of the Simons Observatory , and preparatory work for the satellite LiteBIRD . Still in the electromagnetic field, radio, optical and infrared observations are proposed and analyzed, such as the Euclid satellites , the James Webb Space Telescope (JWST), the Global satellite Astrometric Interferometer for Astrophysics (GAIA), the next Roman satellite Telescope , in combination with ground-based observatories such as Atacama Large Millimeter Array (ALMA), Rubin Observatory , particularly in preparation for the Squared project 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 Einstein Telescope (ET)e for 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 building, 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 second half of 2025, and Prof. Baccigalupi, visiting the Main Astonomical Kyiv Observatory (MAO) in August and October 2025, to maintain scientific collaboration in areas affected by military aggression from third countries. In this regard, we note the school's co-organization of the Summer School in Astrophysics and Cosmology at the MAO, and the international Cosmology conference 2025 , organized by the initiative of Professor Paolo Salucci. These initiatives translate into collaboration agreements that the school stipulates with the interested centers, where the existence of these agreements enhances collaboration with the relevant institutions, such as in China and Ukraine.

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.
- The transfer of knowledge acquired in adjacent groups in the School, in particular to the AstroParticle & Gravitation , 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.

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

1. ***Analysis of Astrophysical and Cosmological Datasets*** **(PI Prof. Nicoletta Krachmalnicoff)** . The group focuses on data analysis, simulations, and theoretical interpretation of data for current and future cosmic microwave background observation systems, and the search for primordial gravitational waves and the effects of dark energy and dark matter. The group plays leading roles in key global collaborations, including the Simons Observatory , and preparatory work for the satellite LiteBIRD .

2. ***Astrochemistry*** **(PI Dr. Francesca Perrotta).** The group focuses its investigations on the identification of complex organic molecules in Galactic and extra-Galactic contexts using ALMA archival observations and JWST observations , with particular attention to spectroscopic research and the cosmological evolution of these systems.
3. ***Stellar Structure and Evolution*** **(PI Prof. Alessandro Bressan)** . The group focuses on the study and simulation of the formation and dynamical evolution of compact stellar remnant binary systems , and of their possible emission of gravitational waves, with particular attention to the study of data from GAIA in relation to the populations of stars in our Galaxy.
4. ***Gravitational Waves*** **(PI Prof. Mario Spera)** . The group is focused on the study, simulation, and interpretation of gravitational wave signals detected by the LIGO-Virgo-KAGRA collaboration , and on preparatory work for future ET and LISA , with particular attention to the astrophysical populations of progenitors of the relevant emissions and their dynamical and evolutionary properties in relation to the galactic environment.
5. ***High Energy Astrophysics*** **(PI Prof. Annalisa Celotti).** The group focuses its investigations on data analysis and theoretical predictions regarding the properties of supermassive black holes in relation to the characteristics and evolution of the host system, combining numerical analysis and physical interpretation.

6. ***Dark matter*** **(PI Prof. Paolo Salucci).** The group focuses its investigations on the detailed analysis of Galactic-scale observations, both locally and for high- *redshift objects* , studying the physical properties of dark matter halos around different galaxy populations, and looking in particular for signatures of interactions between dark matter particles and those of the Standard Model.
7. ***Galaxy Formation and Evolution*** **(PI Prof. Andrea Lapi)** . The research group is engaged in the study of 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 multimessenger emissions (e.g., broad-spectrum electromagnetic radiation, 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, particularly the nature of dark matter, dark energy, and gravity.
8. ***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 Primordial 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 the observation of the distribution of galaxies (Euclid), the cosmic electromagnetic backgrounds (Simons Observatory , LiteBIRD) and gravitational. This complex combination, treated with appropriate analysis and cross-correlation methodologies of independent data sets taking into account instrumental complexities, is interfaced with theoretical predictions relating to the main objectives.

In Figure 3 we report and comment on the impact on the scientific literature of the group's research lines, with respect to the works that include permanent staff, post-doctoral students, and students, summed for all research lines.

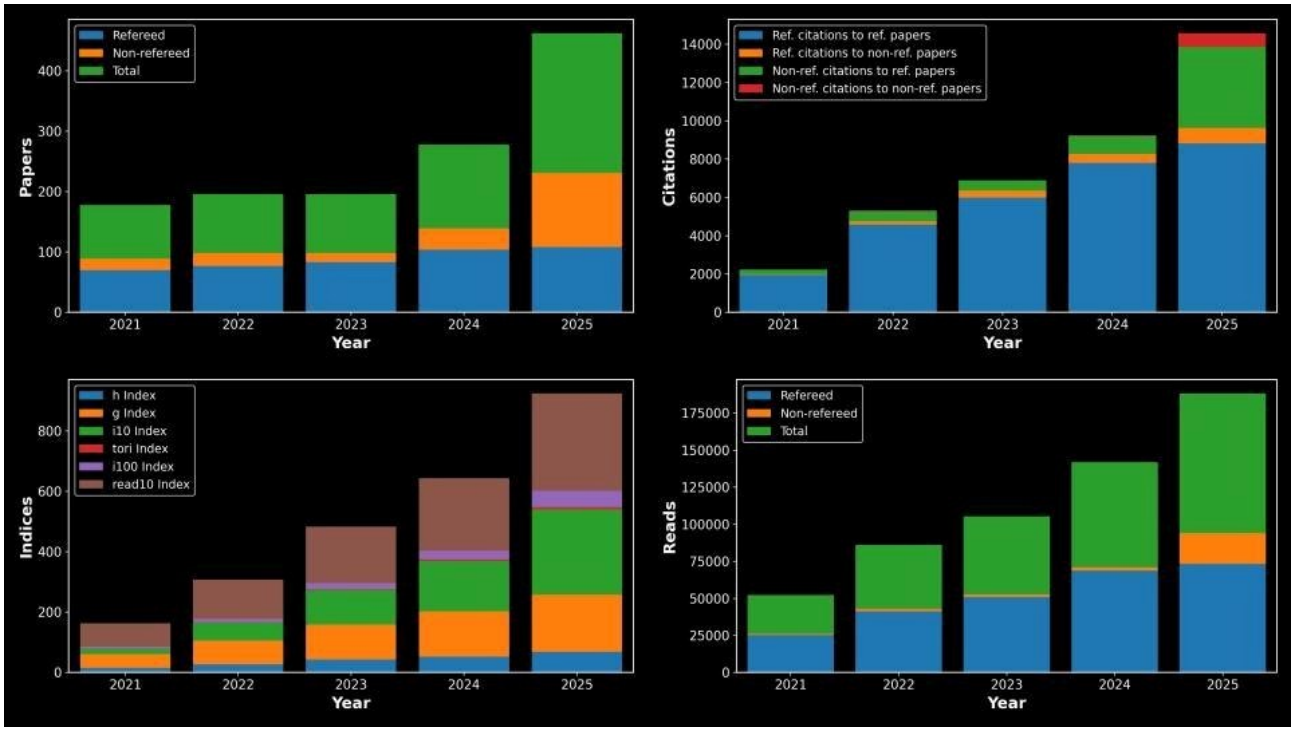

Figure 3. Trends in scientific production and overall bibliometric impact in collaborative work by APC student, postdoctoral, and permanent staff in the period 2021–2025, reconstructed using the NASA ADS database. The panels show, respectively, the number of articles (refereed and non-refereed), the number of citations, the aggregated bibliometric indices (h-index, g-index, i10, i100, tori, read10), and the number of readings (“ reads ”). The values provide an integrated measure of the group's overall scientific productivity and visibility. The trend highlights significant and continuous growth in both quantity and

impact, consistent with the group's increased scientific activity, participation in large international collaborations, and leadership in competitive projects.

9. CONSOLIDATION AND FUTURE RESEARCH AND PROJECT DIRECTIONS

We report the lines of reasoning that we intend to discuss with the school's research groups that concern areas of investigation adjacent to APC in relation to the consolidation of the current APC research lines, and possible future directions.

Figure 4. Staff evolution and roadmap of APC research lines (2022–2028): balance between scientific investments and expected retirements, highlighting consolidated and newly established lines and priority areas proposed for future recruitment (Dark Matter, Multi-Messenger Astrophysics, Stellar Astrophysics, Astrobiology/Exoplanets), in line with the main ongoing and future international projects.

Over the past three years, APC has combined the consolidation of its historical strengths with targeted investments that have already yielded significant results in terms of both personnel and research lines. Among the key developments are career advancements and the formalization of new thematic directions: Mario Spera's promotion (from Type B Researcher to Associate Professor) has strengthened the group's capabilities and visibility in the field of Gravitational Waves; Nicoletta Krachmalnicoff's promotion (from Type A Researcher, then Type B Researcher, to Associate Professor) has anchored a line dedicated to the analysis of astrophysical and cosmological data; Francesca Perrotta has consolidated the transition from primarily cosmological activities to a structured line of astrochemistry; finally, Andrea Lapi's promotion to Full Professor has strengthened the group's leadership in the field of Galaxy Formation and Evolution.

APC is therefore preparing to face a significant wave of retirements (Bressan, Lanza, and Valdarnini so far, Salucci in 2028), which requires forward-looking recruitment planning, consistent with the large observational infrastructures and major ongoing and future international projects. The short- and medium-term roadmap is based on strengthening existing investments (systematic data exploitation, theoretical results, student visibility, structured participation in competitive calls) and on the coordinated discussion of new research lines and replacements through shared actions among the groups and broad expressions of interest. Priority proposals include strengthening and renewing expertise in

- Dark Matter (weak Lensing and Large-Scale Structure in the Era of New Observations, Simulations, Machine Learning Methods, and Cross-Correlations
- the establishment of a structured line in Multi-Messenger Astrophysics (gravitational waves, electromagnetic waves, neutrinos, and other particles, methods of study, analysis and interpretation),
- a reinterpretation of Stellar Astrophysics in synergy with gravitational waves and galactic evolution,
- the expansion of Exoplanets and Astrobiology as an autonomous line, built on expertise in astrochemistry and exploiting the opportunities offered by missions such as PLATO , ARIEL And Roman , with strong interdisciplinary connections, including a possible synergy with Neuroscience).

In Figure 4 we report and comment on the graphics associated with these considerations.

ASTROPARTICLE PHYSICS
Report AA 2024/2025

SUMMARY

We provide below an overview of the information useful for quality assurance for the Ph.D. in Astroparticle Physics for the academic year 2024/2025. For the current academic year, the total number of scholarships was six (one of which was externally funded). In the last year, the percentage of foreigners out of the total applications (142) was approximately 70%, and out of the total number of those admitted to the oral exam, it was approximately 33%. These data are in line with previous years and confirm the international nature of the PhD. The brief summary of the 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. Finally, some issues that emerged from the discussion between the members of the Ph.D. Council and the students have been addressed with specific actions (see section 5.), which we can ex-post consider successful.

The number of postdocs is 17 (the same as the previous year) thanks to numerous external projects (PRIN, ERC etc.).

Activities in synergy with the IFPU institute (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 group . In the 2024/25 academic year, 27 focus weeks and team meetings were held on various topics in dark matter , cosmic rays, gravity, cosmology, and neutrinos, as well as 13 colloquia. Various research activities are also ongoing with international collaborators and with research institutions in the area, particularly ICTP, INAF, and INFN.

seminars and calls for collaborations are ongoing throughout the academic year. Specifically, approximately 17 group seminars have been held on the topics of gravity and astroparticle physics .

CHANGES/IMPROVEMENTS TO THE TRAINING OFFER

The curriculum for the 2024/25 academic year remains very similar to that of the previous academic year. Entrance exams were held in March , with an assessment of qualifications, followed by an oral exam via Zoom for those admitted, as in the previous academic year.

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 DATA FOR ADMISSION TO THE PH.D.*

A total of 142 applications were received for admission to the doctoral program (approximately the same number as the previous academic program). Approximately 70% of these applications were from international students. Six new students were admitted, one of whom received external funding.

2. YEAR PROGRESSIONS

In the academic year 2024/2025 the Astroparticle Physics Ph.D. Council has thoroughly discussed and approved the following year progressions:

1st year : POMAKOV, LOVO, SPADAFORA, D'AMBROSIO successfully completed their 1st year exams, accumulating a sufficient number of credits for admission to the second year.

II III year : AUTIERI, NESHAT, OLIVERI, MC BLAIN, TORTORA held seminars on research topics (4-5 June 2025). No critical issues were identified.

III IV year : PAVICEVIC, KHANSARI, COPPARONI, VERDIANI, LOPEZ held seminars on research topics (4-5 June 2025). No critical issues were identified.

3. PH.D. THESIS DISCUSSION

Ph.D. theses were discussed :

- LODOVICO CAPUANO, “The chime of cosmic bells: nonlinear effects and new physics in the black hole ringdown ”, 09/18/25
- CLEMENTE SMARRA, “Pulsar Timing Array Science and Axion Phenomenology”, 09/18/25
- ALESSANDRO LONGO, "Spontaneously Broken Symmetries: Positivity Bounds beyond Lorentz Invariance and Cosmological solutions of dRGT Massive Gravity", 09/16/25 *cum laude* .
- GIULIO NERI, “Symmetries, charges and thermodynamics at the corners of spacetime”, 09/15/25, *cum laude.*
- VINCENZO NASO, “Two etudes´ in Gravity for particle physicists ”, 09/15/25.

4. PROBLEMS AND ACTIONS

Regarding the results of the Evaluation Committee and the annual report of the Joint Committee, the issues highlighted are discussed within the Teaching Staff and with the student representative, both formally and informally, outlining a systematic path to address them.

Astroparticle Physics Ph.D. Council conducted an extensive discussion on 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 , continues to be positively evaluated . In July 2025, it was also decided to rename the PhD program, which will become the "PhD in Astroparticle and Gravitational Physics" for the 2025/26 academic year. This is to emphasize synergy with other related groups within SISSA and to encourage students to undertake multidisciplinary training paths.

The course on computational methods, taught for the first time in monographic lectures and exercises by Dr. Musco in the 2023/24 academic year, did not receive positive reviews in the 2024/25 academic year and will be replaced in the 2025/26 academic year with a course taught by Professors Viel and Barausse.

The teaching questionnaire distributed to first-year students did not reveal any other significant course issues. However, the low number of responses received regarding teaching remains a critical issue, as was the case in the 2023/34 academic year.

As in the 2023/24 academic year, an informal presentation of the research topics of the group's PIs was held in May 2025 to encourage an informed choice of the PhD thesis in the context of the PIs' research topics.

On the subject of networking and postdoctoral placements, which is of particular interest, 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).

Greater student involvement in the group's various scientific collaborations and related activities (seminars, collaborative meetings, workshops) also appears important. In particular, the faculty has explored with the students the possibility of reorganizing a journal club, which was discontinued last year at the students' request.

For any issues related to the research conducted, the interaction between student and supervisor, or exams taken (for first-year students), students are encouraged to discuss and meet with the tutor (assigned to each student) to address them in a shared process with their PhD supervisor.

SEMINAR LIST

IFPU interviews 2024/2025

1. “Ultra-cold atoms as quantum simulators for relativistic phenomena”.
2. “A CLEVeR view on “halo baryonification ”: from galaxy groups to massive clusters”.
3. “Spontaneously broken spacetime symmetries and a quantum bound on transparency”.

4. “Seeking the New World of Spin Zero – Fundamental mysteries of nature and cosmic microwave background (CMB) polarization.”
5. “Gravitational wave probes of dark matter”
6. “The Dark Sector and the Large Scale Structure of the Universe”
7. “Can Inflation actually Inflate ?”
8. “New clues on the origin of cosmic magnetism from large-scale structures: a smoking gun from primordial magnetic fields?”
9. “Probing Quantum Gravity at all Scales”
10. “Gravitational waves from early universe phase transitions”
11. “The Primordial Black Holes Variations”
12. “Observational probes of dark energy and modified gravity models”
13. “Cosmology in the era of Cosmic Microwave Background Polarization”

IFPU SPECIAL PROGRAMS 2024/2025

1. Ultralight Dark Matter and observable phenomena
2. Dynamical Instabilities in Quantum Field Theory in Curved Spacetime: lessons drawn from Analogue Gravity
3. The astrophysics of the large-scale structures in the era of eROSITA , Euclid, SPT-3G: the emergence of the cosmic web
4. Enabling DR1 Euclid Clusters Cosmology
5. Constraining EFTs without Lorentz
6. Mining the Rainbow: Cosmology in Multicolor via Line Intensity Mapping Surveys
7. The Cosmic Web from Galaxies to Cosmology
8. Luminous quasars as laboratories for the formation and evolution of SMBH/galaxy systems
9. Gravitational Wave Probes of Black Hole Environments
10. The galaxy-IGM interplay in the first billion years of the Universe
11. Mesoscopic Quantum Gravity
12. Exploring Bubble Tails with Gravitational Waves
13. Reconstruction strikes back: Unveiling the dynamics of the universe in next-generation spectroscopic surveys
14. Numerical Relativity and Fundamental Fields
15. Galaxies and ICM across the protocluster to cluster transition – ALMA and VLT/MUSE observations of very massive clusters at z~1.5
16. The environment of Quasars at the Cosmic Dawn
17. Intergalactic Magnetic field: a new probe of the Early Universe
18. Substructures in multi-scale Host Haloes: from Galaxies to Clusters
19. The quest for dual and binary SMBH in multimessenger era
20. Euclid voids for galaxy evolution
21. Exploring the Gamma-ray emission from Galaxy Clusters
22. Towards a Non-singular Paradigm of Black Hole Physics
23. Fun with the phases of the universe
24. Holography at all distances
25. The scenario of interacting dark matter and the structural and cosmological properties of galaxies

26. Testing Gravity with the Large-Scale Structure of the Universe
27. Dark Compact Objects and the Quantum Vacuum

SISSA seminars 2024/2025

1.Dynamics of dRGT ghost-free massive gravity in spherical symmetry
2. Nonlinear dynamics of compact object mergers beyond General Relativity
3. Simulating scalarized black hole binaries in spectra
4. Black holes with scalar hair: from no-hair theorems to non-linear dynamics
5. 'LISA and the No-Hair Theorem: Efforts Towards Precision Tests'
6. A fairy -tail story
7. The Galactic Center as a Gravitational Laboratory
8. Constraining dark-sector effects using gravitational waves from compact binary inspirals
9. The dawn of low frequency GW astronomy
10. Black Hole Spectroscopy Tools for Waveform Modeling
11. Fast detection and reconstruction of merging Massive Black Hole Binary signals
12. High precision black hole scattering: a review of recent results
13. Black Hole Spectroscopy in a Superfluid Laboratory
14. Finding the ringdown of rotating black holes in higher-derivative gravity
15. Classical time evolution in the presence of ghosts: From scalar models to black-hole binaries
16. Geometric k-essence from nonmetricity and late-time cosmology
17. Advanced numerical algorithms for a new era of gravitational wave astronomy – Insights from EMRI modeling in the time-domain

PHYSICS AND CHEMISTRY OF BIOLOGICAL SYSTEMS
Report AA 2024/2025

INTRODUCTION

This report is presented for quality assurance purposes for the Ph.D. in Physics and Chemistry of Biological Systems for the Academic Year 2024/2025. The data are organized according to the scheme already followed in previous reports: statistical data on admission to the doctorate (section 1), progression to the next year (section 2), final doctoral examinations (section 3), extracurricular educational activities (section 4), and actions undertaken for quality improvement (section 5).

1. SUMMARY DATA FOR ADMISSION TO THE PH.D.

During the 2024-2025 academic year, two entrance exam sessions were held for the PhD 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 include additional entrance exam sessions reserved for non-EU citizens, held in years prior to the pandemic and no longer offered, as the online procedure was adopted for all applicants.

AA	No. of admission applications	of which submitted by foreigners	% foreigners
2024-2025	219	208	95
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

The number of applications received in the 2024-2025 academic year is significantly higher than the average for the previous five years (44 ± 8), the vast majority of which were submitted by foreign candidates. When evaluating qualifications, it was found that a significant portion of the applications were submitted by candidates with a background in experimental chemistry and biochemistry, which did not align with the theoretical and computational nature of the PhD program and the research topics described in the call for applications. Also because of this, a total of five applicants were deemed eligible in the two entrance examination sessions, a similar number to that of previous years.

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 academic year 2024-2025

was 4, including two students of non-EU nationality.

2. YEAR PROGRESSIONS

During the 2024-2025 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 progressions for the students:

II -> III year: BEDOYA, FAKHER EDDINE, GILIOLI, PIRAS achieved 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.

II -> III year: DASGUPTA, FORNASA, MOSCHIN, OMER, RAY, SLAVOV held a seminar reporting on the progress of their thesis work, which was adequate and satisfactory except in one case, in which the teaching staff, verifying limited progress compared to the previous year, decided to admit them with reservations, pending a supplementary progress report to be held in January 2026.

III--> IV year : BANERJEE, BUPU, DI MARCO, SACCO, TAJANA, VAN DER HOEK held a seminar reporting on the progress of their thesis work, which was adequate and satisfactory except in one case, in which the teaching staff, verifying limited progress compared to the previous year, decided to admit them with reservations, pending a supplementary progress report to be held in January 2026.

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 a judging committee composed of international experts:

DEL TATTO, GILARDONI, MARCATO, POSANI, SLONGO, SARMIENTO

GILARDONI. Thesis title: "Development and application of methods to integrate molecular simulations with experimental measurements" Supervisor: Giovanni Bussi. Final exam approved on 26/09/2025.

POSANI. Thesis title: "Ensemble Refinement of Cryo-Electron Microscopy Derived RNA Structures using Molecular Dynamics Simulations." Supervisors : Giovanni Bussi, Alessandra Magistrato. Final exam approved

on 26/09/2025.

MARCATO. Thesis title: "Lattice field theories for polymer systems." Supervisor: Angelo Rosa. Final exam approved on 29/09/2025.

SLONGO. Thesis title: "QUBO-Based Sampling of Lattice Polymers on Classical and Quantum Computers." Supervisor: Cristian Micheletti. Final exam approved on 29/09/2025.

SARMIENTO. Thesis title: "First-Exit Statistics in Biased , Active, and Cognitive Systems." Supervisors : Domenica Bueti, Edgar Roldan. Final exam approved on 29/09/2025.

DEL TATTO. Thesis title: "A distance-based framework for causal discovery from high-dimensional time series." Supervisor: Alessandro Laio. Final exam approved on 02/10/2025.

4. EXTRACURRICULAR EDUCATIONAL ACTIVITIES

As in previous years, the PhD faculty promoted extracurricular educational activities for students and postdocs. To this end, faculty members regularly circulated notices of seminars and intergroup and interarea scientific initiatives on the Statistical and Molecular Biophysics group mailing list . First-year students were encouraged to subscribe to the seminar mailing lists of related groups, both within and outside the Physics Area, as was done for previous cohorts.

Furthermore, the faculty members have routinely forwarded to the group mailing list notices of seminars on topics related to the PhD, offered by other SISSA groups and also available online or at other local institutions (e.g., ICTP and the Italian Society of Statistical Physics).

Seminars organized by the PhD FCSB

During the 2024-2025 academic year, the seminar initiative continued, both in person and online, with speakers proposed by both faculty and students. Compared to previous years, there was less interest among students in presenting the speakers. The seminars were concentrated during the period with the least teaching load, from February to September.

The total number of seminars held was 11, as detailed below:

Date	**Speaker**
17/11/24	Marco Baiesi
04/02/25	Gareth Tribello

27/02/25	Matthew Boccalini
14/05/25	Roberto Cerbino
28/05/25	Felix Ritort
11/06/25	Luca Giorgetti
17/09/25	Sergei Nechaev
26/09/25	Jürgen Köfinger
26/09/25	Yulia Zavadlav
26/09/25	Janusz Bujnicki
26/09/25	Giulia Palermo

To supplement the report on extracurricular activities, some summary data on student missions is provided. The aggregate data is reconstructed from the expenses recorded in the group budget for the calendar year 2025 and should therefore be considered as an approximate estimate, 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 36. The missions involved 20 PhD students, therefore a congruent number compared to the second to fourth year PhD students, the most active in the missions, also in relation to networking.

5. ACTIONS FOR IMPROVEMENT

During the 2024-2025 academic year, actions to improve the quality of the PhD program at FCSB focused on three areas: (i) improving the content of the program; (ii) improving the group and doctoral program web pages; (iii) continued efforts to communicate the collection of preferences for thesis topic selection; and (iv) improving communication between faculty, students, and postdocs; (v) changing the name of the PhD program.

Regarding the first point, it should be noted that, in the academic year 2024-2025, Dr. Christoph Zechner took up office as RTDB. Dr. Zechner, who belongs to the Statistical and Molecular Biophysics group, was therefore co-opted into the teaching staff of the PhD in Physics and Chemistry of Biological Systems and contributed to expanding the teaching offering through the course " Stochastic Processes in Biophysics ", included among the compulsory courses. (ii) Dr. Zechner also oversaw a radical update of the group and doctoral web pages, planned among the improvement objectives indicated in the previous report. The contents of the new web pages were discussed and chosen by the faculty in order to facilitate the retrieval of various information, from those of practical use for students and postdocs, to those aimed at giving visibility to the scientific production of the entire group. The contents available on the new web pages include: (a) publications, with evidence of those involving students; (b) announcements for doctoral and postdoc positions; (c) educational offer; (d) texts of past written exams for admission to the doctorate; (d) doctoral regulations. For point (iii), the Coordinator continued the practice, already defined previously also thanks to the feedback of the Evaluation Committee, of collecting anonymous questionnaires relating to the

individual teaching courses immediately at the end of the course and before the exams. The survey for the academic year in question provided a favorable evaluation of the courses, including the even distribution of the teaching load between November and April , the appropriateness of the topics covered, and the difficulty level of the lessons. Positive feedback indicates the appropriateness of the adjustments to the schedule and course content made in previous years based on the questionnaires collected.

Regarding point (iii), the Coordinator continued to raise awareness among first-year students whose scholarships are not already tied to externally funded topics of the opportunity and necessity of making a well-informed choice of thesis topic, thoroughly considering the full spectrum of research topics listed in the call for applications. To this end, in addition to the information provided to students in the introductory meeting (October 1, 2024), the Coordinator held a dedicated meeting on February 28, 2025. As in the previous three years, the Coordinator therefore asked each student to explore the available research topics and to provide two topics of interest for their thesis, without hierarchical order between them, and to provide a reason for this selection. The Coordinator then collected these justified preferences in individual meetings with the students, which he shared and discussed with the subject area supervisors to formulate final supervision proposals for the students. This year too, the procedure went smoothly.

Regarding point (iv), the Coordinator and the Vice-Coordinator held several meetings with student representatives, sometimes extended to include the postdoc representatives and other members of the faculty. As in previous years, the goal was to gather suggestions for improving seminar participation and improving overall communication between faculty, students, and postdocs. Among the more structured meetings were : (a) the one on December 10, 2024, dedicated to providing feedback to students and postdocs on the content they had chosen to represent the group's research activities at the " Physics Day" meeting in December 2024; the one on January 14, 2025 , to begin gathering suggestions for speakers for seminars; (c) the meeting on July 4, 2025, aimed at discussing the draft annual report of the Joint Committee and also formulating concrete proposals for improving communication between the faculty and students/postdocs. On this occasion, the suggestion emerged to organize two regular meetings per year between faculty and student and postdoc representatives, to discuss topics and improvements proposed by students and postdocs. The proposal was accepted by the faculty and will be included among the objectives for subsequent years. Another initiative undertaken independently by the faculty, starting in spring 2025, was to organize a social gathering after the group seminars (both in person and online).

Finally, regarding point (v), the teaching staff proposed, accepted by the various bodies of the School, to change the name of the doctorate to " Molecular and Statistical Biophysics ", deeming it more suitable for reaching the audience of potential doctoral students with the appropriate scientific background . This name will be effective starting in the 2025-2026 academic year.

As future actions for the 2025-2026 academic year, we therefore propose holding regular meetings between

the faculty and student and postdoc representatives, followed by a meeting with all doctoral students' supervisors, including internal and external researchers at SISSA who are not members of the Faculty Board. This meeting is aimed at effectively mapping any critical issues or identifying improvements that can be addressed through collective action.

Finally, at the express request of the students and members of the faculty, this report would like to recall that the 2024-2025 academic year was marked by the passing of Samuel Tamagnone, a third-year FCSB doctoral student, following an accident during a field trip. Samuel was a highly active member of SISSA and a FCSB student representative. For this reason, but above all for his level-headedness and open, positive attitude toward others, he was a role model for many students and his peers. His sudden passing, which reverberated throughout the School, left a void and a sense of disorientation as profound as his extensive network of personal and significant contacts.

This report was circulated among the members of the Teaching Staff and the Representatives of the Postdocs and Students of the FCSB course and of the Statistical and Molecular Biophysics group.

STATISTICAL PHYSICS
Report AA 2024/2025

SUMMARY

Below is a summary of the information useful forquality assurance for the Ph.D. in Statistical Physics for the academic year 2024/2025.

The table containing summary data on applications for admission to the Ph.D. program in the academic year under review and in the previous 10 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 percentage of applications from foreign students remains high, equal to two-thirds of the total, a positive figure for an international environment such as SISSA. The brief summary of the transitions from year to year, 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. program 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. program in Statistical Physics during the academic year 2024-2025.

1. CHANGES/IMPROVEMENTS TO THE TRAINING OFFER

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

2. SUMMARY DATA FOR ADMISSION TO THE PH.D.

The table below shows the number of applications received for the single admissions session held in the 2024/2025 academic 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 ten academic years. The number of applications is significantly higher than last year, given the same number of positions offered (five). The percentage of applications from international students is, as in the previous year, equal to two-thirds of the total.

AA (where the admission exam was held)	Number of admission applications	Number of applications from foreign candidates	% of foreign applicants
2024/2025	86	58	**67%**
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%**

3. YEAR PROGRESSIONS

In the academic year 2024/2025, the Teaching Council of the Ph.D. in Statistical Physics thoroughly discussed and approved the year progressions of the following students:

From the first to the second year: Students BETTARINI, KAMPANIS, JENA, MAKOUDI, and PANDURANGHAN earned the required number of credits through courses and exams. No critical issues were identified.

From the second to the third year: Students CORAGGIO, DAVILA CUBA, RUSSOTTO, TRAVAGLINO, and ZAMBOTTI held a seminar reporting the preliminary results of their thesis work. No critical issues were identified.

From the third to the fourth year: Students BANDINI, BRACCI TESTASECCA, CHALAS, PRUSZCZYK, and STAMPIGGI held a seminar reporting on the results obtained so far as part of their thesis work. No critical issues were identified.

The student GALANIS decided to interrupt his doctorate in his second year for personal reasons.

4. Ph.D. THESIS DISCUSSION .

During the academic year 2024/2025 the Ph.D. theses of the following students were successfully discussed:

- MUZZI, “Probing Complexity, Universality and Dimensional Reduction in Nonequilibrium Statistical Physics”, supervisors: Andrea Gambassi and Marcello Dalmonte.
- FOSSATI, “Entanglement and Asymmetry in Quantum Field Theory,” supervisor: Pasquale Calabrese.

- GENTILE, “Aspects of entanglement in holography, harmonic lances and non- relaAvisAc quantum field theory”, supervisor: Erik Tonni.

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 year 2023/2024.

Teaching: The CPAD report for the 2023/2024 academic year regarding the Ph.D. in Statistical Physics found that the percentage of students reporting a low level of well-being is higher than the School average. Among the data surveyed by CPAD, the "well-being" data is by its nature the most general and difficult to interpret, and in this case, interpretation is further complicated by the lack of substantial critical issues regarding the "concrete" aspects explored by the questionnaire. In drafting its report, CPAD therefore relied not only on discussions with the student representative but also on the free comments contained in the questionnaire. These comments, however, reflect the opinions of individual students and risk being statistically insignificant. To clarify the situation, the coordinator organized a meeting with the students to which he also invited Professor Giovanni Bussi, outgoing CPAD coordinator; Professor Bussi graciously accepted the invitation. The detailed discussion with the students revealed no unclear points or open questions, a finding consistent with the coordinator's constant availability to provide any useful clarification. The coordinator therefore reiterates that the "well-being" data is not necessarily indicative of critical issues that need to be resolved. This finding can be explained by the fact that some students consider the course of study "demanding." However, they do not request a reduction in the burden, believing the energy they put in is a sound investment in their future.

Internationalization of incoming students: Of the 15 students eligible for admission, three are international, a percentage lower than the previous year. Of the five admitted students, one is international.

Gender balance: 15 out of 86 candidates passed the entrance exam, two of whom were considered suitable and one was admitted.

Networking: With a few exceptions due to personal choices, PhD students in Statistical Physics typically continue their research through postdoctoral fellowships abroad. Two of the three PhD students who graduated in the 2024/2025 academic year will undertake postdoctoral fellowships abroad (Belgium, Denmark). A third postponed their thesis defense by three months to make up for a three-month gap in their fellowship for health reasons and will evaluate future options. As indicated in previous reports, the PhD Committee believes that these data should be considered objective indicators of the success of networking related to the PhD program, preferable to more elusive qualitative considerations that may emerge from the questionnaires. As has been done in the past and consistent with the PhD program, students have been included in their supervisors' scientific collaborations, both nationally and internationally, where possible.

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

6. SEMINARS ORGANIZED BY THE PH.D. IN STATISTICAL PHYSICS IN THE 2024/2025 Academic Year

1. September 10, 2024
   Alioscia Hamma (University of Naples Federico II)
   Compleity , entanglement and stabilizer entropy

2. September 17, 2024
   Benjamin Beri (University of Cambridge)
   Dynamical magic transitions in monitored Clifford+T circuits

3. September 24, 2024
   Enrique Rico (Institute for Quantum Information Processing, Germany)
   Constructing the spin-1 Haldane phase on a qudit quantum processor

4. October 8, 2024
   Chiara Paletta (University of Ljubljana)
   Integrability of open quantum circuits

5. November 12, 2024
   Rodrigo Pereira (International Institute of Physics-UFRN, Natal)
   Nonlinear Effects on Charge Fractionalization in Critical Chains

6. November 19, 2024
   Cristoph Minz (SISSA)
   On the mass dependence of modular operators over double cone regions in QFT

7. November 26, 2024
   Romain Daviet (University of Cologne)
   Universal non-equilibrium behaviors of limit-cycle phases

8. December 3, 2024
   Antonello Scardicchio (ICTP)
   Recent progress on renormalisation group analysis of Anderson and MBL models

9. December 10, 2024
   Jacopo Romano (SISSA)
   Interface dynamics in driven and active binary mixtures

10. December 17, 2024
    Pierpaolo Fontana (Universitat Autonoma de Barcelona and ICFO)
    An efficient finite-resource formulation of non-Abelian lattice gauge theories beyond one dimension

11. January 14, 2025
    Gennaro Tucci (Max Planck Institute for Dynamics and Self-Organization)
    Collective dynamics of a mixture of phoretic Janus colloids

12. January 21, 2025
    Filippo Colomo (University of Florence)
    Tracy-Widom distribution in the six-vertex model

13. January 28, 2025
    Aljaz Godec (Max Planck Institute, Gottingen)
    Thermal relaxation asymmetry: from single molecules to hydrodynamic fluctuations

14. February 11, 2025
    Matteo Marinelli (University of Trieste)
    Novel Platforms for Quantum Information Processing with Rydberg Atom Arrays

15. February 25, 2025
    Giuliano Chiriaco (University of Catania)
    Exploiting memory effects and dissipative dynamics in quantum systems

16. March 4, 2025
    Viktor Eisler (TU Graz)
    Hamiltonian entanglement for inhomogeneous free-fermion systems

17. March 11, 2025
    Guido Giachetti (ENS, Paris)
    Monitored Mean-Field Systems: Replication Approach and Beyond

18. March 18, 2025
    Manoj K. Joshi (Institut fur Quantenoptik und Quanteninformation , Austria)
    Hamiltonian learning and verification of quantum simulators

19. March 25, 2025
    Marcello Dalmonte (ICTP)
    Quantum simulating lattice gauge theories: 'particle physics' with Rydberg atom ar -rays

20. April 1, 2025
    Saverio Pascazio (University of Bari)
    Super- and subradiance in cold atomic clouds: cooperative decay modes and random states

21. April 16, 2025
    Rupak Majumder (Tata Institute of Fundamental Research, Mumbai)
    Finite-size effects in Kuramoto type systems from Large Deviation perspective

22. May 6, 2025
    Yasir Iqbal (Indian Institute of Technology Madras)
    Evidence for a Z2 Dirac spin liquid in the generalized Shastry-Sutherland model

23. May 13, 2025
    Olalla Castro- Alvaredo (City, University of London)
    Irrelevant Perturbations in Integrable Quantum Field Theory: Completing the Boot-strap Program

24. May 19, 2025
    Federico Balducci (Max Planck Institute for the Physics of Complex Systems, Dresden)
    Symmetry re-breaking and effective theory of quantum coarsening

25. May, 20, 2025
    Esko Keski- Vakkuri (University of Helsinki)
    Magic from the Vacuum?

26. May 27, 2025
    Duncan Haldane (Princeton University)
    Geometry and fluid dynamics of the quantum Hall effect

27. May 27, 2025
    Arnab Kundu (Saha Institute of Nuclear Physics, Kolkata)
    Driven CFTs, Dynamical Phase Transitions & Geometric Duals

28. June 17, 2025
    Giacomo Gradenigo (Gran Sasso Science Institute)
    Localization transition and ensemble inequivalence in two paradigmatic cases: the Discrete Non-Linear Schroedinger Equation and Bose-Einstein condensation

29. July 1, 2025
    Ginestra Bianconi (Queen Mary University of London)
    Gravity from entropy

30. July 29, 2025
    Mohammad Ali Rajabpour (Universidade Federal Fluminense, Brazil)
    The Pfaffian Playbook: A Unified Toolkit for Gaussian Fermions in Any Basis

THEORETICAL PARTICLE PHYSICS
Report AA 2024/2025

SUMMARY

Below is an overview of information useful for quality assurance for the Ph.D. in Theoretical Particle Physics for the 2024/25 academic year.

The table containing summary data on applications for admission to the Ph.D. program in the current academic year and the previous five-year period (see section 2) shows a very high number of applications received, along with a high level of internationality among participants, which has increased in the current academic year. The current year has seen a constant level of internationalization among the initially selected candidates, standing at 33%. The number of initially selected female candidates is also very high, at 33%, the result of corrective measures compared to previous years regarding the admission exam format. Unfortunately, both figures were subsequently revised downward (both to 17%) due to the withdrawal of one initially selected foreign candidate and the scrolling of the ranking.

The brief summary of the academic year (see section 3) does not highlight any particular critical issues. Four Ph.D. thesis were defended during the academic year in question (see section 4), all approved *cum laude*, and the Visiting Students program continued successfully (see section 5).

The number of seminars organized within the Ph.D. remains high (see section 6.).

6. CHANGES / IMPROVEMENTS TO THE TEACHING OFFER

Professor Cecotti's retirement required the assignment of an external position for the "String Theory" course for the 2024/25 academic year, as had occurred in the two previous academic years . For the 2024/25 academic year, the position was also assigned to Professor Alberto Lerda (U. del Piemonte Orientale). During the year, the hiring process for Dr. Gabriel Cuomo (starting in November 2025) as a Tenure-Track Researcher was completed.

For the academic year in question, the coordination of lesson timetables with the Astroparticle and Gravitational Physics sector has been intensified, a sector with which we have been holding joint courses for some years now.

7. SUMMARY DATA FOR ADMISSION TO THE PH.D., DISTANCE SELECTION

The table below shows the number of applications received, separated by non-EU and EU (including Italy) candidates, and the relative total, along with the number of foreign applicants (and their percentage), as well as data relating to the joint SISSA-ICTP scholarship. The data refer to the five academic years prior to the academic year in question.

	Non-EU	EU	TOTAL	FOREIGNERS	% FOREIGNERS	ICTP	ICTP Admitted
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

For the 2024/25 academic year in question, the table below shows the number of applications received, broken down by Italian, EU, and non-EU applicants, as well as the total number of applications received. We also report the percentage of foreign applicants and the percentage of female applicants. The joint SISSA-ICTP scholarship was not funded.

	ITALY	EU	NON-EU	TOTAL	% FOREIGNERS	% FEMALE
2024/25	91	51	151	293	69%	14%

Despite the absence of social restrictions due to the pandemic, it was decided to maintain the remote selection exam for the 2024/25 academic year. Unlike previous years, the entrance exam did not include a written test. Instead, the approximately thirty students who were positively evaluated based on their qualifications and reference letters took an oral exam via remote video connection on the Zoom platform. This change to the entrance exam format was implemented with the aim of further increasing internationalization and increasing the number of selected female candidates. Given the very positive results, the Teaching Board has decided to maintain this format for the following academic year as well .

8. YEAR PROGRESSIONS AND CRITICAL ISSUES

Starting in the 2022/23 academic year, the Teaching Committee 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 2024/25 academic year, the Ph.D. Council of Theoretical Particle Physics thoroughly discussed and approved the following year transitions:

I –> II year: Vittorio Cagioni, Marco Caramanti, Massimo Cipressi, Bruno Missoni, and Gorka Prieto Varela have achieved the required number of credits through courses and exams. Simone Corbo (coming from the Ph.D. in Astroparticle and Gravitational Physics) requested and obtained from the Teaching Committee a

transfer to the Ph.D. in Theoretical Particle Physics, due to a greater affinity with his scientific interests. All students proceeded to a combination with two thesis supervisors with whom they began their research activity.

II –> III year: Fabrizio Aramini, Walter Arata, Stefano Lanza, Pietro Moroni and Johann Sebastian Quenta Raygada They held a seminar reporting the initial results of their thesis work. No critical issues were identified.

III – IV year: Quoc-Trung Ho, Muhammad Sohaib Khalid, Alessandro Piazza, Anant Shri, Amartya Harsh Singh, Gabriel Pedde Ungureanu, and Marco Venuti held a seminar reporting on the results obtained so far in their thesis work. No critical issues were identified.

Marina Moleti requested and obtained a 3-month extension of her Ph.D. scholarship to make up for 3 months of leave previously granted for health reasons, as well as a further 1-month extension without scholarship to complete her thesis work, taking advantage of a foreign scholarship she had won.

9. PH.D. THESIS DISCUSSION

During the 2024/25 academic year, the following Ph.D. thesis were successfully discussed:

1) Ideal Majtara, rel. G. Bonelli and A. Tanzini, “BPS blow-up surface defects and Hurwitz chiral ring expansions”, cum laude – 19/09/2025.
2) Agrawal Shreyansh, rel. L. Donnay and M. Bertolini, “Echoes of infrared universality: Soft theorems and asymptotic symmetries beyond the leading order”, cum laude – 19/09/2025.
3) Alfredo Stanzione, supervisor A. Azatov and D. Marzocca (INFN), “Tracing New Physics Across Scales: From Collider Signatures to Cosmological Probes,” cum laude – 19/09/2025.
4) Beniamino Valsesia, supervisor L. Donnay and A. Bissi (ICTP), “Bottom-up and top-down aspects of celestial CFT,” cum laude – 19/09/2025.

10. VISITING STUDENTS

The Visiting Student Training Program saw the following students in the 2024/25 academic year :

1) Max Uetrecht – 9/2-6/4 2025 (TU Dortmund University)
2) Georg Stettinger – 16/3-29/3 2025 (Czech Academy of Science)
3) Aleena D/o Zulfiqar Ali – 13/5-12/6 2025 (Lums University, Lahore)
4) Maciej Kierkla – 9/6-9/9 2025 (University of Warsaw)
5) Hachimou China Adamou – 15/9-12/12 2025 (Radioisotope Institute of Abdou Moumouni University in

Niamey, Niger)

11. SEMINARS ORGANIZED IN THE PH.D.

During the academic year 2024/25, the following seminars were organized within the Ph.D .:

1. René Meyer (University of Wurzburg), “Symmetry-Resolved Entanglement in AdS & BCFT”, 09/10/2024
2. Shani Meynet (Uppsala University), “Emergent Non-Invertible Symmetries — The Adjoint QCD Example”, 10/23/2024
3. Gabriele Rigo (Saclay IPhT), “A Multiverse Outside of the Swampland”, 10/30/2024
4. Josef Seitz (Weizmann Institute), “Twisted times, the Schwarzian and its deformations in DSSYK”, 06/11/2024
5. Stathis Vitouladitis (Universite Libre de Bruxelles), “ Generalized symmetries and state-operator correspondence for nonlocal operators”, 20/11/2024
6. Zhenghao Zhong (Oxford University), “A Radioactive Higgs Mechanism”, 11/27/2024
7. Nicolas Cresto (Perimeter Institute), “Asymptotic Higher-Spin Symmetries in Gravity”, 11/29/2024
8. Markus Dierigl (CERN), “The Axion is Going Dark”, 11/12/2024
9. Cihan Pazarbasi (Okinawa Institute of Science and Technology), “Exact WKB in all sectors”, 12/12/2024
10. Sebastian Ellis (Geneva University), “Classical (and quantum) heuristics for gravitational wave detection”, 12/18/2024
11. Alexandre Belin (University of Milan-Bicocca), “3D gravity and a measure on the space of 2D CFTs,” 22/01/2025
12. Salvo Mancani (University of Padua), “ Exploring Duality Symmetries at c=2”, 05/02/2025
13. Chiara Toldo (University of Milan), “The spectrum of near-BPS Kerr-Newman black holes and the ABJM mass gap,” 26/02/2025
14. Edward Hardy (Oxford University), “Gravitational waves and axion stars from strings”, 03/26/2025
15. Yasuyuki Hatsuda (Rikkyo University), “Deformed Schur indices and Macdonald polynomials”, 03/28/2025
16. David Marsh (Stockholm University), “ Dilaton phase transitions and axion relic pockets”, 04/09/2025
17. Gabriele Ferretti (Chalmers University), “Four-dimensional gauge theories for composite Higgs models”, 04/16/2025
18. Diego Rodriguez Gomez (Oviedo University), “Non-BPS branes as holographic symmetry operators”, 04/23/2025
19. Malte Buschmann (U. of Amsterdam, GRAPPA), “The QCD axion mass”, 04/30/2025
20. Shai Chester (Imperial College London), “Monopoles, duality, and QED3”, 14/05/2025
21. Itay Bloch (UC Berkeley), “Quantum Magnetometry in Search of Dark Matter”, 05/21/2025
22. Kamran Vaziri (U. of Amsterdam), “A non-perturbative construction of the de Sitter late-time boundary”, 05/28/2025
23. Hongliang Jiang (Imperial College London), “TQFTs from SCFTs: Symmetry, Duality, and Anomaly”, 04/06/2025
24. Daniele Dorigoni (Durham U.), “Modular Features of Superstring Scattering Amplitudes: Generalized Eisenstein Series and Theta Lifts”, 11/06/2025
25. Morimitsu Tanimoto (Niigata Unviersity), “CP violations and strong CP problem in texture zeros approach”, 07/07/2025
26. Francesco Mignosa (Oviedo U.), “R-symmetry operators from non-BPS branes”, 09/07/2025
27. Andreas Blommaert (IAS Princeton), “SYK from complex Liouville”, 03/09/2025

28. Andreas Crivellin (PSI Villigen), “Indications for New Higgs Bosons at the Electroweak Scale”, 09/24/2025

12. PROBLEMS AND ACTIONS

The CPAD 2025 report highlighted a specific critical issue: an imbalance in gender representation. As described in the summary and in section 2, starting from the academic year under review, the Teaching Committee changed the entrance exam format, which had a decidedly positive impact (33% of female candidates were initially selected). For this reason, the Teaching Committee decided to maintain this new format for the following year as well.

CPAD also suggested promoting intra-student activities, such as a junior seminar organized and led by students, to foster interaction and exchange. It should be noted, however, that the group already organizes a weekly journal club on high-energy physics topics open to the entire scientific community, sometimes hosted by students. Furthermore, students already organize their own journal club (or junior seminar) for students. Therefore, this critical issue does not appear to exist.

THEORY AND NUMERICAL SIMULATIONS OF CONDENSED MATTER
Report AA 2024/2025

Below is an overview of useful information for quality assurance for the PhD in *Theory and Numerical Simulations of Condensed Matter* for the 2024/2025 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 teachers are now ready to hold their courses both online and in hybrid mode, although students are strongly advised to attend classes in person unless there are serious reasons. The internal questionnaires administered to students provided positive responses with an average of 7.9 which, although lower than last year (it was 8.9), remain around the average of previous years (three years ago the average was 7.7, two years ago 8.2).

8	10			5	6	6	5	7	7	8	7	7	8	3	8			8	8	9	9	8	8	8	9	8	7
7	8	6	6	6	9	8		9	8	10	8	10	7	9	8		8	8	9	9	4	10		10	9	10	10
8	8	6	4	9	9	7		10	10		7	5	10	3	6		7	7	8	10	8	6		9	8	10	
10	9	6	8	10	10	10		10	7		10		6	7	10		10	10	10	10	10			8	8	6	
10	10	8	9	7	9	5		10	7									8			7				10		
5	8	3	6	6	10	8		9																	8		
8		6	7	8	8																				7		
		8			8																						
8,0	8,8	6,1	6,7	7,3	8,6	7,3	5,0	9,2	7,8	9,0	8,0	7,3	7,8	5,5	8,0		8,3	8,2	8,8	9,5	7,6	8,0	8,0	8,8	8,4	8,5	8,5

Caption: Each column corresponds to a course and lists all the scores earned by that course. At the bottom, in the yellow row, are the average grades for each course. The average of the averages is 7.9.

The number of students has remained stable at 38, increasing over the last four years due to recruitment using industrial grants linked to projects or the PNRR. The percentage of international students is increasing compared to previous years (34%). The table containing summary data on applications for admission to the Ph.D. in the academic year under review and in previous years (see section 2) shows an increase in the number of applications compared to last year. The applications proved to be of very good quality (24 eligible candidates compared to 18 the previous year). All grants were awarded in the spring

session, making the second session unnecessary. Please note that in the previous session, 6 grants were awarded through the ordinary call and 6 through industrial and PNRR calls. This year, 7 grants were awarded through ordinary funds. As in previous years, the percentage of applications from non-Italian candidates stands at around 80%. This year, the percentage of non-EU candidates admitted through the ordinary selection process is 50%. In total, we have 2 out of 7 foreign students in the first year (28%). The brief summary of the year transitions see section 3) does not reveal any problems. This year, eight doctoral theses were defended.

CHANGES/IMPROVEMENTS TO THE TRAINING OFFER

The structure of the training offer introduced in previous academic years has been improved in the 2020/2021 academic year. The training path has since then been 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 and specialized courses, 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). Last year, two curricula were also presented to students, intended as a thematic organization of the courses ("Quantum Science and Technologies" and "High performance modeling of materials") for students with specific interests in these two potentially interdisciplinary fields.

SUMMARY DATA FOR ADMISSION TO THE PH.D.

The table below shows the number of applications received in the 2024/2025 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 PNRR program, and the Joint SISSA/ICTP curriculum.

Starting from the academic year 2015/2016, all available scholarships were assigned in the spring session, and therefore the second session was not held. The number of applications received in the first session (76) is increasing compared to previous academic years**.** 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 (24 in total). The rate of internationality of the

applications is very high (80%), as is the value recorded this year for the internationality of the admitted students (2 students out of 7 admitted). Unfortunately , in the year in question other recruitment channels (ICTP, Industrial Scholarships) were not active but it is expected that at least three additional scholarships from other programmes will be activated in the coming year.

	I SESSION	II SESSION% NON ITA	Industrial PhD, TII-QRC, PNRR , ICTP
2024/2025.	76 (7).	80%	
2023/2024.	70 (6)	80 % (33 %)	6 students of which 3 NON-EU
2022/2023	24 (6 →5 for one waiver)	54% (50% →40%)	1 EU (waived) 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 PROGRESSIONS*

In the academic year 2024/2025 the Doctoral College approved the following year progressions:

I--> II year : Africani, D'Auria, Dal Molin, Kaushik, Lamma, Llemit , Manna, Paradiso, Pham, Pineda Jimenez, Servi, Villani, 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 : Ahmed , Arezzo, Ccuiro 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.

Year I --> IV : Alessandroni, Andreoni, Florez, Frau, Hirkani, Pasqua, Staffieri, Tagliente, Tan, Torchia, and Wang have earned 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.

2. PH.D. THESIS DISCUSSION

During the 2023/2024 academic year , eight PhD theses were defended, as the extensions due to the health emergency in previous years were exhausted. Honors have been awarded to seven of them so far.

The 8 theses discussed this year are

1)- Caldara, Matteo, “Emergent phenomena in quantum mixtures: from ultra-cold gases to light-matter systems”, supervised by M. Capone and M. Richaud, approved cum laude.

2)- Giuli Samuele, “Efficient and effective quantum embedding methods for strongly correlated materials and models”, supervised by M. Capone, approved cum laude.

3)- Delmonte Anna, “Dissipative and Measurement-Induced Phases in Many-Body Quantum Systems”, supervised by R. Fazio and G. Santoro, approved cum laude.

4)- Paviglianiti Alessio, “Entanglement and Quantum Complexity in Monitored Quantum Many-Body Systems”, supervised by A. Silva, approved cum laude.

5)- Lumia Luca, “Quantum and classical aspects of complexity in open many-body dynamics”, supervised by M. Collura and R. Fazio, approved cum laude.

6)- Piccioni Davide, “Electron-phonon coupling in strongly correlated systems: a Variational Monte Carlo study of the Su-Schrieffer-Heeger Hubbard model”, supervised by M. Fabrizio and F. Becca, approved cum laude.

7)- Bacciconi Zeno, “Many-body physics of cavity embedded quantum matter”, supervised by M. Dalmonte and M. Capone, approved cum laude.

8)- Tsouna Maha, thesis to be discussed on 17/12/2025

PROBLEMS AND ACTIONS

No specific issues have been identified. In the 2024-2025 academic year, an effort was made to establish a regular seminar series to enrich the curriculum by exposing students to cutting-edge research. In future years, there are plans to further expand these activities, including establishing a Journal Club.

DATA THEORY AND SCIENCE
Report AA 2024/2025

SUMMARY

The PhD program in Data Science and Theory, formally accredited in 2021, reached an important milestone with the successful defense of its first students' theses in 2025. Recruitment of new PhD students has remained stable and the number of applications received has been robust.

The course programme for the 2024-25 academic year has remained substantially unchanged from the previous year, as has the format of the Journal Clubs.

The gender balance of students admitted for the 2024-25 academic year has declined slightly, with only one female student in seven admitted (compared to 2/9 in the 2023-24 academic year). The Teaching Staff reiterates its commitment and focus on continuing to improve on this point.

1. *CHANGES TO THE COURSE PROGRAMME*

The course programme for the 2024-25 academic year remained substantially unchanged compared to the previous year, as no critical issues were encountered in this regard.

In January 2025, a 14-hour module on the topic of 'Models of temporal dynamics', delivered by Dr Francesca Mastrogiuseppe, was added to the curriculum; this module had previously been missing from the course offering.

2. *SUMMARY DATA FOR ADMISSION TO THE PHD (admitted to the 2024-25 academic year)*

For the 2024-25 academic year, a single application session was held in March 2024, which was conducted entirely on the Zoom platform. Five scholarships were awarded through School Funds, one through Area Science Park funds, and two through Human Technopole funds—a collaboration now in its second year.

The number of applications submitted in the March 2024 session was 81 (essentially equal to the total number registered in the two sessions of the 2023-24 academic year, i.e. 86), of which 58 (72%) were international, and 17 (21%) were female, for 8 doctoral scholarships. Among those admitted to the written exam, 53% were international students and 26% were female. Among those admitted to the oral exam, 47% were international students and 24% were female, demonstrating that the examination procedures do not present issues of gender-based selection.

In total, 7 students were admitted (one HT scholarship was not awarded), of which one was female (14%) and one international (14%).

While the Faculty remains unsatisfied with the gender balance, the percentage of women has at least remained substantially stable throughout the selection process. It is also noteworthy that the final list of admitted students was determined by moving down the ranking list following the withdrawals of candidates who, had they accepted, would have improved gender and international diversity.

The number of international applications received remains high.

3. *YEAR PROGRESSIONS*

I -> II year:
In September 2025, the progression exams for all students were held. After careful consideration and in-depth discussions, the outcome was as follows:

the students LUCA FRATTEGIANI, MATTEO ALLIONE, MARCO GIUNTA, CHRISTOPHER ERAZO, ALESSANDRO SERRA and GIANMARCO PULEO have
achieved the required number of credits at the end of their first year and took the final exam, which consisted of a presentation with Q&A on the research topic they had investigated over the summer. No critical issues were identified.

Student ELEONORA BERGAMIN successfully took her progression exam on November 5, 2025, after a postponement (granted by the Faculty Board) due to health reasons.

Among these, during the summer of 2025, the student LUCA FRATTEGIANI, part of the joint program with HT, began research work on-site at the Human Technopole in Milan.

II -> III year:
Students RUDY SKERK, CLARA CANAVESE, NANDO TEZOH, FABIOLA RICCI, ALI HUSSAINI, MATTEO SANTORO, and ALESSIO GIORLANDINO presented their ongoing research in a final exam. No critical issues were identified.

In September, ADALBERTO VALSECCHI requested a three-month suspension from his doctoral program for health reasons, which was granted by the Faculty Board. For this reason, he did not take the final year exam. He is expected to resume his doctoral studies in January 2026.

III -> IV year:
Students FEDERICO CARETTI, MAURO RIGO, SATVIK MISHRA, and GIBBS
NEWMADJI presented their ongoing research work in a final year exam. No critical issues were identified.

4. *PHD THESIS DISCUSSION*

Students KONSTANTIN KARCHEV, SARA FOLCHINI and NOUR EL-KAZWINI have
They defended their thesis on December 16, 2024 (after a three-month extension due to Covid), and were all awarded the degree of Doctor of Data Science. They were the first three doctoral students to complete their studies in the Data Science and Theory group.

The student MINGMENG GENG (who began his studies in January 2022 on a PNRR/Green scholarship, and followed a study plan compressed into just 3 years) successfully defended his thesis on 3/2/2025.

Student RICCARDO RENDE defended his thesis on 11/09/2025.

Student IDRIS KOUADRI defended his thesis on 25/09/2025.

Among the students who successfully defended their theses, KARCHEV, RENDE and EL-KAZWINI were awarded the doctoral degree *cum laude* .

5. *PROBLEMS AND ACTIONS*

It is pleasing to note that almost all students reported having had freedom of choice in their doctoral research topic, a clear increase compared to the previous year, likely as a result of clearer formulation of the application.

Please note that some students feel the feedback they receive from their supervisor is insufficient, and the Teaching Staff is committed to improving this aspect.

The seminar list features a wide range of presentations spanning various disciplines in machine learning, statistics, computational physics, and data science. The meetings include theoretical and applied contributions: from Gaussian Processes and diffusion, from the creativity of neural networks to Bayesian methods , to more specialized topics such as wavelets , spatial omics, efficient deep learning, and hierarchical models. There are also multidisciplinary workshops and talks dedicated to the intersection of AI and natural sciences, cosmology, bioinformatics, and biomedical research. Overall, the program offers a rich and varied overview of the current challenges and opportunities in data-driven scientific research. With a total of 32 seminars (compared to 18 the previous year), the program has significantly expanded both in variety and in the networking opportunities offered by internationally renowned speakers.

2024

October 15, 2024 – *Claudia Merger* : **Simple models for complex data: what Gaussian Processes can and cannot teach us about Diffusion**

October 18, 2024 – *Elisa Gremmo* : **The Creativity of Artificial Neural Networks: A Philosophical Perspective**

October 22, 2024 – *Bruce Bassett* : **Open questions in Bayesian Inference from SKA to Conscious AI**

October 22, 2024 – *Serena Bradde* : **Why Avoid Question Marks in Research Article Titles?**

October 25, 2024 – *Bruce Bassett* : **Hands on session with the latest AI tools**

October 29, 2024 – *Misaki Ozawa* : **Multiscale Data-Driven Energy Estimation and Generation**

29 October 2024 – *Bruce Bassett* : **Building a Successful Career in Industry**

30 October 2024 – *Misaki Ozawa* : **An introduction to wavelets**

31 October 2024 – *Misaki Ozawa* : **An introduction to wavelets**

November 12, 2024 – *David Prelogović* : **Simulation-based inference and optimal compression of the cosmic 21-cm signal**

November 19, 2024 – *Francesco Iorio* : **CRISPR-based second-generation of genetic vulnerability - maps in cancer cells**

November 26, 2024 – *Francesco Cagnetta* : **Probing Hierarchical Data Structures with Diffusion Models**

December 17, 2024 – *ML & Science Workshop* Speakers &

titles:

- *Christoph Weniger* : **Simulation-Based Inference in cosmology**
- *Jason McEwen* : **Scientific machine learning in cosmology**
- *Daniela Huppenkothen* : **Hacking the Universe: Leveraging Data Science in HighEnergy Astrophysics and Beyond**
- *Francesco Denti* : **Of mice and music: finite-infinite shared atoms nested priors for the segmentation of large-scale grouped data**
- *Fabio Anselmi* : **Inverse Design of a Quantum System to Control Target Properties Using Automatic Differentiation**
- *Alessio Ansuini* : **An Empirical Journey Through Neural Representations: From ConvNets to Large Language Models**

2025

January 21, 2025 – *Marco Stefanelli* : **A neural network observation operator for weather radar data assimilation**

January 28, 2025 – *Martin De Los Rios* : **Equivariant CNNs for model-agnostic reconstruction of galaxy Dark Matter profiles**

February 11, 2025 – *Rebekka Burkholz* : **Efficient Deep Learning – What Do We Need to Succeed?**

February 25, 2025 – *Antonio Sclocchi* : **Probing Hierarchical Data Structures with Diffusion**

March 18, 2025 – *Junsong Cang* : **The EDGES measurement disfavors an excess radio background**

April 1, 2025 – *Davide Risso* : **Scalable and interpretable analysis of single-cell and spatial omics**

April 10, 2025 – *Gastone Castellani* : **Neural Ordinary Differential Equations and Data Integration in BioMedical Research**

April 28, 2025 – *Martin Uhrin* : **Equivariant Neural Networks: A General Framework for Learning in Physical Systems**

May 6, 2025 – *TSDS Neurips Blitz Talks 003* : **(multiple speakers)**

May 27, 2025 – *Catalina Vallejos* :
Using routine healthcare data to predict future health: two cautionary tales May 28, 2025 –

David Hogg : **Is machine learning good or bad for science?**

September 9, 2025 – *Daniele Bigoni* : **Challenges and opportunities in data assimilation**

September 11, 2025 – *Richard Zecchina:* **Dynamical deep learning (without gradient computations)**

September 16, 2025 – *Yoonsoo Nam* : **Solve Layerwise Linear Models First to Understand Neural Dynamical Phenomena**

MATHEMATICAL ANALYSIS, MODELLING AND APPLICATIONS
Report AA 2024/2025

SUMMARY

Below is a summary of information useful for quality assurance for the Ph.D. in Mathematical Analysis, Modelling, and Applications for the 2024/2025 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 (162), a number of scholarships assigned of around 12, a percentage of foreigners on the total number of applications of around 72% and a percentage of those admitted of 29%. Overall, we consider these indicators to be significant in light of the selection carried out with very selective exams (written and oral, but also qualifications). In the academic year in question, all the ministerial scholarships (8) were assigned during the spring session of the entrance exams (ALL-COUNTRY I). It should be noted that, in light of these assignments, 7 students were actually admitted to the doctoral course following the late communication of the renunciation of the scholarship by one of the selected candidates, a circumstance which made the activation of the autumn session of the entrance exams impracticable (ALL-COUNTRY II). The average indicators reported (averages over 6 academic years, see section 2) highlight the impact of the implementation of the National Recovery and Resilience Plan on the number of scholarships awarded and applications received annually. The summary data reported in section 2 also take into account scholarships awarded through specific international calls for applications for the ICTP/SISSA joint doctoral program. Overall, the preparation and scientific quality of the candidates were highly appreciated by the committees. It should be noted that many Italian AMMA doctoral students have had experience abroad as part of their master's degree.

The brief summary of the transition exams (see section 3) does not reveal any critical issues. 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, the *cum laude mention* among the excellent theses was awarded to those that significantly exceeded expectations based on a comparison that often took into account the supervisors' history over several years.

Students of the doctoral program in Mathematical Analysis, Modelling, and Applications receive important awards and recognitions every year at conferences in which they participate with posters and oral contributions (participation fellowships , travel grants , paper prizes , etc.) and 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 Dr. Paolo Ventura, who was awarded, together with his doctoral thesis supervisors, Profs. Massimiliano Berti and Alberto Maspero, the “2025 Frontiers of Science Award in Mathematics ” (awarded at the International Congress on Basic Sciences (ICBS), held in Beijing in July 2025), the fourth edition of the “Barcelona Dynamical Systems Prize,” awarded in 2024, and the Iapichino Prize of the Accademia Nazionale dei Lincei. Dr. Paolo Ventura had already won the prize for the best doctoral thesis in mathematics in the academic year 2023/2024, a prize awarded to alumnus Dr. Daniele Tiberio for the best doctoral thesis in mathematics in the academic year 2024/2025. We also remember alumna Dr. Maria Strazzullo, who won the ECCOMAS 2024 Young Researchers Committee scholarship with the project: “CRAFT – Control and reduction of regularizations in applications for turbulent flows.” finally the alumnus Dr. Ariel Surya Boiardi and the student Roberto Marchello, who were the winners of the prize for the best poster presented at the international workshop “New horizons In structural mechanics , elasticity and homogenization ” , held in Lucca on 28-31 July 2025.

Please note that in the reference period Academic Year 2024/2025 the program of visits by international doctoral students to SISSA (ViS – Visiting Student program) continued, as did the program for pre-doc scholarships , for which a specific commission was established. Furthermore, doctoral thesis continue in collaboration with SISSA's key companies (Danieli Automation SpA, Fincantieri SpA, EPS Italia Srl, Danieli Automation SpA, Siemens AG, SMACT Competence Center ScpA , Engys Ltd, FAST Computing Srl), both through the application of the PNRR (DM 630 and DM 352) 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), also continue . 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* .

13. CHANGES/IMPROVEMENTS TO THE TRAINING OFFER AND SUPPORT ACTIVITIES

The curriculum of the Mathematical Analysis, Modelling, 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, including new additions (Ilya Chevyrev, Davide Riccobelli, and Antonio Colanera), several invited courses (Marco Mazzucchelli, Marco Pozzetta, Massimiliano Morini, Don Zagier, Mario Sigalotti, Chongchun Zeng, Kohei Suzuki), and the *mathLab* research group with its curriculum in numerical analysis and theoretical and computational mechanics. Most 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 drawn 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, including internationally, the Faculty 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 supervisor 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.

14. SUMMARY DATA FOR ADMISSION TO THE PH.D.

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 refer 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
2024/2025	- (-)	114 (8)	- (-)	**114 (7)**	**71% (28%)**
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%)**

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 academic years prior to the one under review, the statistics also include

candidates selected for scholarships made available through PNRR actions and external funding from European and/or industrial projects and the MSCA doctoral network.

15. YEAR PROGRESSIONS

In the academic year 2024/2025, the Faculty Board of the PhD course in Mathematical Analysis, Models and Applications thoroughly discussed and approved the following academic changes:
I --> II year: Riccardo Berforini D'Aquino, Malek Borjini, Giovanni Canali, Gabriele Codega, Gaspare Li Causi, Francesco Magni, Luca Edoardo Mosconi, Gabriele Nani, Roman Oleinik, Filippo Olivo, Marco Picerni, Alessandro Poletto, Nicolò Tedesco and Lorenzo Tomada. Please note that student Malek Borjini took the progression exam on 7 November 2025 , having started her studies in December 2025. No particular critical issues have been identified.

II --> III year: Rashid Ashraf, Tommaso Barbieri, Nicola Clinco, Dario Coscia, Isabella Carla Gonnella, Qusain Haider, Hammad Kahliq, Guglielmo Padula, Antonio Milosh Radakovic, Mustafa Ramadan, Sergio Scalabrino, Dario Sterzi, Rubio Gunawan The, Chiara Trifone, Alessandro Vici, Edoardo Voglino, Matteo Zanardini. No particular critical issues were identified.

III --> IV 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, Maria Teresa Rotolo, Elisa Savio and Armin Sheidani . No critical issues were identified.

16. PH.D. THESIS DISCUSSION

During the academic year 2024/2025, the following doctoral theses in Mathematical Analysis, Modelling and Applications were successfully discussed (**student** , supervisor(s), " *thesis title*"):

- **Irene Anello** , prof. Antonio DeSimone: " *Mathematical modeling of spontaneous oscillations in flagellar and bio-inspired systems"* ;
- **Lorenzo Bardone** , prof. Sebastian Goldt: " *Learning beyond the Gaussian approximation: Algorithmic hardness, neural network dynamics and independent components"* ;
- **Ariel Surya Boiardi** , Prof. Giovanni Noselli: *" Nonreciprocal dynamics in soft active structures . From swimming robots to odd periodic systems ";*
- **Antonio Pedro De Azevedo Bezerra Vitor Ramos** , prof. Emanuel Carneiro: "Fourier optimization, de Branges spaces, and zeros of L-functions";
- **Moaad Khamlich** , prof. Gianluigi Rozza and Dr. Federico Pichi: " *Advanced optimal transport strategies for efficient computation and reduced order modeling in complex systems"* ;

- **Pierfrancesco Siena** , prof. Gianluigi Rozza and prof. Michele Girfoglio: " *Reduced order models in biomedical applications: Integrating data-driven and equation-based approaches* ";

- **Simone Vincini** , Prof. Nicola Gigli and Prof. Stefano Bianchini: " *Variational problems in a nonsmooth geometric setting* ".

Fourth-year student **Fabrizio Caragiulo** (advisor: Prof. Marcello Porta) will discuss their doctoral thesis on 10/12/2025. See the Past PhD Theses webpage , which is dedicated to theses discussed as part of the doctorate and which lists the publications of AMMA alumni .

17. 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) initiatives of the Mathematics Area. These events present SISSA's mathematics doctoral programs and aim 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 the Area's faculty. This initiative has become international in scope and is no longer limited to students from Italian universities.

Another initiative that continues to be supported by the AMMA doctoral program is the SISSA SIAM Student Chapter of the Society for Industrial and Applied Mathematics, which organizes on-site outreach activities, colloquia, and seminars, and supports various types of events (summer schools, joint events with other SIAM Student Chapters around the world, etc.). These successful initiatives also involve the doctoral program in Mathematical Physics and Geometry, the master's program in HPC, and the bachelor's programs in mathematics and DSSC with other universities. SIAM activities enhance the international positioning of students, and many have found postdoctoral positions through this collaborative network (Vienna, Berlin, Eindhoven, Lausanne, Cambridge, Austin). During the reporting period, the SISSA SIAM Student Chapter group organized the SISSA Women in Mathematics 2025 event, which saw the participation of Professor Roberta Ghezzi (University of Rome Tor Vergata), Professor Veronica Felli (University of Milan Bicocca), and alumna Dr. Annamaria Ortu (University of Gothenburg).

Furthermore, for thirteen years, the doctoral students have organized the AJS (Analysis Junior Seminars) seminar series , held weekly, to foster interaction among students and communication within the Doctoral School regarding various research topics. These informal and inclusive seminars, open to even non-experts, foster the exchange of ideas and the development of basic scientific communication skills. Attendance is excellent. The seminars during the reference year were held in a hybrid format. The presentations are recorded and made available on a dedicated YouTube channel . Also noteworthy are the seminar series offered by the research groups affiliated with the doctoral program, particularly Analysis Seminars , Geometric Structures seminars and mathLab Seminars .

During the reporting period, research and teaching activities were primarily conducted in person, while

ensuring 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 mention the initiative “Peer to peer science communication ”, organised by SISSA Medialab Srl and consisting of a series of meetings aimed at doctoral students and young researchers, with lectures and practical sessions to improve the communication skills of the participants.

GEOMETRY AND MATHEMATICAL PHYSICS
Report AA 2024/2025

SUMMARY

Here you will find some useful information for quality assurance for the Ph.D. in Geometry and Mathematical Physics for the 2024/2025 academic year.

With the aim of providing a diversified educational offering, the courses taught by SISSA internal faculty were complemented by some courses taught by external faculty and postdocs from the Mathematics Area. See section 1.

Only one exam session was held in the 2024/2025 academic year, in February 2024. 99 applications were received in this session, compared to the 84 applications received in the corresponding session in the 2023/2024 academic year. Comparing these two exam sessions, there is an increase in applications of approximately 18%. Please note that in the 2023/2024 academic year, the doctoral program was able to benefit from additional ESF and ICTP grants, which were not available in the 2024/2025 academic year.

Of the applications received in the 2024/2025 academic year, 58% came from foreign students, a higher percentage than the percentage corresponding to the previous year's exam session (52%). We consider this result to be very positive for the international environment at SISSA. The brief summary of the year transitions (see Section 3) does not highlight any critical issues. All the Ph.D. theses defended in the academic year under review were approved *cum laude* , except one. The last Ph.D. thesis of the 2024/2025 academic year will be defended on December 19th .

1. CHANGES/IMPROVEMENTS TO THE TRAINING OFFER

In addition to the institutional courses held by SISSA professors (full list available at: https://www.math.sissa.it/education/1/courses/all?page=1), during the academic year 2024/2025 the following new courses have been activated, held by external professors or by SISSA postdocs/RTDAs (1 cycle corresponds to 20 hours of lessons).

Ivan Penkov (Constructor University Bremen)

Representations of classical infinite-dimensional Lie algebras and ind -geometry (1 cycle)

Matteo Gallone (SISSA)

An introduction to long time prethermalization (1 cycle)

Giovanni Russo (SISSA)

Selected topics in Riemann Geometry and Representation Theory (1 cycle)

Gregorio Falqui (University of Milan Bicocca)

Hamiltonian methods for integrable systems (1 cycle)

Emanuele Pavia (SISSA)

Homotopical algebra (with a look toward algebraic geometry) (1 cycle)

Don Zagier (Max Planck Institute, Bonn)

From quadratic forms to modular forms to quantum modular forms (2 cycles)

Michele Graffeo (SISSA)

Complex Algebraic Surfaces (1 cycle)

Lorenzo Baldi (University of Leipzig)

A course on non-negative polynomials (0.5 cycles)

- *SUMMARY DATA FOR ADMISSION TO THE PH.D.*

Attached are the tables relating to the entrance exam for the 2025/2026 academic year . For the February 2024 exam session , 99 applications were received, of which 37 were from non-EU candidates (37%). Among those eligible, there were 11 Italians, 8 EU candidates, and 6 non-EU candidates, for a percentage of foreigners of 56%. The percentage of women out of the total eligible candidates is 12% (3 out of 25).

- *YEAR PROGRESSIONS*

In September 2025, the Faculty Board approved the following year progressions. All progressions occurred without any issues.

Student Žiga Gladek decided to drop out at the end of the first year of his doctoral program. He regularly took the necessary exams to advance to the next yearand prepared a thesis, which allowed him to obtain the degree of Magister Philosophiae .

SURNAME	**NAME**	**PROGRESSION**
Bousclet	Anis	IN THE 2ND YEAR
Cortelli	Lorenzo	IN THE 2ND YEAR
Crimi	Giordano	IN THE 2ND YEAR
Da Ponte	Nicola	IN THE 2ND YEAR

Lorenzi	Lucrezia Beatrice	IN THE 2ND YEAR
Miceli	Marco	IN THE 2ND YEAR
Morstabilini	Luca	IN THE 2ND YEAR
Pietropaoli	Cecilia	IN THE 2ND YEAR
Elimam Abdelrazek	Mahmoud	IN THE 3RD YEAR
Barbato	Lorenzo	IN THE 3RD YEAR
Bignami	Nicolò	IN THE 3RD YEAR
Ciusa	Pietro	IN THE 3RD YEAR
Fabbri	Simone	IN THE 3RD YEAR
Forero Pulido	Christian	IN THE 3RD YEAR
Selvaggi	Ian	IN THE 3RD YEAR
Tripodi	Valerio	IN THE 3RD YEAR
Aliouane	Mohamed	IN THE 4TH YEAR
Bais	Valentina	IN THE 4TH YEAR
Cecchi	Lorenzo	IN THE 4TH YEAR
Chialastri	Adriano	IN THE 4TH YEAR
Ginzburg	Matias	IN THE 4TH YEAR
Goller	Leonardo	IN THE 4TH YEAR
Montagnani	Matteo	IN THE 4TH YEAR
Nicosanti	Thomas	IN THE 4TH YEAR
Pedroni	Tommaso	IN THE 4TH YEAR
Singh	Ayush	IN THE 4TH YEAR

Testa	Matteo	IN THE 4TH YEAR

- *PH.D. THESIS DISCUSSION*

SURNAME	NAME	THESIS TITLE	NATION OF BIRTH	DISTINCTION	External referees	speakers
Abdelraouf	Asem Ismail	On realizations of Hypergeometric Motives	EGYPT	Yes	Voight (Sydney) - Kerr (Washington Un)	Sibilla - Fernando Villegas
Lehmann	Alessandro	The curvature problem and deformations of triangulated categories	ITALY	Yes	Hochloch e Barros (Antwerp) - Kaledin (Steklov)- Keller (Paris Cité)- Van den Bergh (Hasselt)	Lowen (Antwerp) - Sibilla
Fila-Robattino	Filippo	Supergravity and Spinors in the BV-BFV Formalism	ITALY	Yes	Mnev (Un.Notre Dame) - Fiorenza (La Sapienza) - Grassi (Un. Piemonte Orientale)	Tanzini - Cattaneo (UZH)
Benyahia	Younes El Maamoun	Indirect constructions of exotic surfaces in 4-manifolds	ALGERIA	Yes	Miller (Swarthmore College)-Sakalli (Unisouth Florida)	Torres
Malech	Oliviero	Exotic surfaces in 4-manifolds, stabilizations, and framings	ITALY	Yes	Meihan (Ist.Fourier Grenoble)-Casali (UNIMORE)	Torres

Rosana	Andrea	Metric and Probabilistic Aspects of Grassmann and Tensor Geometry	ITALY	Yes	Horobet (Hungarian Univ of Transilvania) - Ke Ye (Chinese Academy of Sciences)	Lerario
Bertellotti	Alessandro	On the Geometry of Ends of Ricci Shrinkers	ITALY	Yes	Mantegazza (Federico II) - Impera (Politecnico Torino)	Buzano (Poli Torino) - Gigli
Singh	Harman Preet	Large-Scale Response Theory for Gapless Lattice Fermi Systems in Low Dimensions	INDIA	Yes	Horia Cornean (Univ. Aalborg, DK) - Alessandro Giuliani (Univ. Roma 3)	Porta
Rachenkov	Dmitrii	The Analogue of the Shapiro-Tater Conjecture for the PainlevéIV Equation	RUSSIA	No	Th.Botner (Un. Bristol) - Masoero (Un.Lisbon)- Roffelsen (Un.Sidney)	Grava - Guzzetti
Vitale	Elisa	Relative Quot schemes over families of smooth and nodal curves	ITALY		Fabio Perroni (UNITS); Martin Ulirsch (Paderborn University)	Fantechi; Lothar Gottsche (ICTP)

5.

Elisa Vitale's final exam will be held on December 19 , 2025.

5. *PROBLEMS AND ACTIONS*

Based on the analysis of the questionnaire administered to students at the school, the PhD program in Geometry and Mathematical Physics reported dissatisfaction with the organization of courses during the 2023/2024 academic year. Consequently, during the 2024/2025 academic year, greater attention was paid to course scheduling, and in particular, efforts were made to avoid overlap between courses on related topics.

To enhance the promotion of the doctoral program and foster student interaction, the PhD program in Geometry and Mathematical Physics actively supported the Junior Math Days (

https://indico.sissa.it/event/173/) during the 2024/2025 academic year. This initiative aims to attract young talent by presenting the courses and research activities of the various groups in the Mathematics Area to final-year master's students. The activity is 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.

The PhD student selection process for the 2025/2026 academic year was conducted online, as in previous years, starting with the 2020/2021 academic year. This process increased the number of international applicants and allowed us to select high-caliber students.

Finally, at the request of the Mathematics students, the *Peer-to-Peer Science Communication* event was organized in June 2025 , in conjunction with the PhD program in Mathematical Analysis, Models, and Applications. This consisted of a series of talks by mathematicians from both inside and outside SISSA, and by SISSA Medialab staff, on the topic of scientific communication in research environments. The course was very successful, with good student participation.

COGNITIVE NEUROSCIENCE
Report A.A. 2024/2025

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 2024/2025 to make the former shine even more, and to address the latter. This document is specifically based on the 2025 yearly report of the Student–Professor Joint Committee (Commissione Paritetica Allievi–Docenti, CPAD).

1. CPAD report: considerations and actions

According to the CPAD report, this year the CNS PhD does not exhibit any specific critical issues with respect to the rest of the School. The issues linked to "Discrimination and Inclusiveness" and in general to wellbeing seem to be aligned with the trend of the school 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 rotation throughout the academic year, has to present a recent article in 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 , Claudio Mulatti (University of Trento), Séverine Casalis (University of Lille), Giorgia Silani (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), Zhaoping Li (Max Planck Institute for Biological Cybernetics, Tuebingen), Ines Samengo (Inst. Balseiro, Bariloche), Guy Tabacnik (Univ. Nova Gorizia), Eric De Giuli (Toronto Metr. Univ), Ahmed El-Hady (University of Konstanz), Claus Lamme (University of Vienna), Edmund Rolls (Oxford), Silvia Serino (Milano Bicocca), David Kastner (UCSF), Marino Pagan (University of Edinburgh), Aldo Genovesio (Universita' del Piemonte Orientale), Yonatan Loewenstein (Hebrew University), Alessandro Toso (University Medical Center Hamburg-Eppendorf), Ambra Ferrari (University of Trento CIMeC). Rava Azeredo da Silveira (University of Basel), Philippa A. Johnson (Leiden University), Xiao-Jing Wang (New York University), Michael Sokoletsky (Weizmann Institute of Science), Martin Wiener (George Mason University), Virginie van Wassenhove (Université Paris-Saclay and NeuroSpincenter), Yonatan Loewenstein (The Hebrew University of Jerusalem).
   The CPAD noted a discrepancy between the large number of scientific guest invitations listed in previous CNS reports and again reported here, and the relatively low seminar attendance (<5) reported by 38% of the students. We believe that this discrepancy is only minimally related to the fact that not all guests listed in this section deliver seminars; for example, 70% of guest speakers listed above delivered a seminar during the past academic year. We are more inclined to attribute this discrepancy mainly to students' choices to attend only those seminars aligned with their scientific interests.
   iii. Several PIs at CNS maintain active collaborations amongst themselves, 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 E. Piasini (within CNS), L. Ballerini and G. Legname (within

the Neuroscience Area) and A. Laio, F. Mastrogiuseppe 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, leading to a 2025 publication in Neuron. 5) a student in Treves' limbo group is collaborating with A. Laio in Stat. Biol. Physics and, on a different project, with D. Bueti. 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 closerange, 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 continues his participation in an international consortium supported by a a SFARI grant to study 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), ManuelMolano-Mazon (Universitat Politecnica de Catalunya), 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 PRINPNRR 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. She also collaborates with Paolo Manganotti e Maria Assunta Cova (Trieste University), Barbara Tomasino (IRCSS 'Eugenio Medea'), Alessandro Grecucci (Bari 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) 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). 7) Diamond has undertaken two collaborations under the auspices of PRIN projects, which conclude in 2026: 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: Aldo Genovesio of the Università del Piemonte Orientale and Iacopo Hachen of the Max Planck Institute of Animal Behavior and University of Konstanz. Both speakers not only presented their research, converging on the theme of the complexity inherent in population coding, 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 AY (2024-2025), we hoffered 6 core theoretical courses that were taught by the 6 active faculties of our PhD during the AY: Mathew Diamond, Davide Zoccolan, Eugenio Piasini, Alessandro Treves, Raffaella Rumiati and Domenica Bueti. The first 4 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.
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, through her 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 among 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 >40% of our students are non-Italian 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 counselor and psychological counseling).

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:

	Defense date	External assessors	Supervisor	Current post
Judit Fiedler	03/10/2025	Ahmed El-Hady (Konstanz), Claus Lamm (Viena), Edmund Rolls (Oxford), Silvia Serino (Milano Bicocca)	Alessandro Treves	Mothering in Budapest

Nadia Bersier	25/11/2024	Roberto Baiocco (Università Roma1-Sapienza); Corrado CorradiDell'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 (Loughborou gh University, UK); Luisa Girelli (Milano Bicocca); Laura Zamarian (Medical University Innsbruck	Raffaella Rumiati	Post-doc University of Tuebingen, Germany
Angelina Tadic	30/06/2025	David Kastner (UCSF); Marino Pagan (Univerisity of Edinburgh); Ambra Ferrari (University of Trento); Cinzia Chiandetti (University of Trieste)	Davide Zoccolan	Borsista di ricerca at SISSA
Yukti Chopra	24/06/2025	Yonatan Loewenstein (Hebrew University), Alessandro Toso (University Medical Center Hamburg-Eppendord), Zhaoping Li (Max Planck Institute for Biological Cybernetics Tuebingen), Ambra Ferrari (Univ Trento CIMeC)	Mathew Diamond	Borsista di ricerca at SISSA

NEUROBIOLOGY
Report A.A. 2024/2025

Summary

Below is a table of information useful for quality assurance for the PhD in Neurobiology related to the 2024/2025 academic year. As can be seen, the number of applications oscillates between 28 and 77 candidates for available places (77 in 2024/2025). The average percentage of foreigners in the total number of applications is 57% (87% in 2024/25) and the average percentage of foreigners in the total admissions is 40% (75% in 2024/2025): 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. Due to a change in supervisor and project, the progress report of one student has been postponed to December 2025.

1. Changes to the training on offer

No major structural changes were made to the training courses in 2024-2025. Where possible, courses were held in person. In section 6, we present efforts that were made in response to the questionnaire, to improve the PhD for the 2025-2026 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 2024-2025, 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
2024/2025	4	77	67	87	75
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

3. Progress reports and passage to the next year

In the academic year 2024-2025 the faculty of Ph.D. in Neurobiology thoroughly discussed and approved the progress reports detailed below.

Year I--> II Furkan Cinar Ilhan, Giulia Salzano, Zhiqiang Zhu, Dunja Dugonjic
Year II--> III Po-Yu Liao, Alessandro Massaro, Camilla Perna, Mariia Ermolaeva
Year III--> IV Safaa Mamoun Abdelmageid Ali, Lorenza Tortella

In 2025, Jacopo Giorgi (Year III) shifted from an experimental to a theoretical project, prompting a change in supervision (Prof. Ballerini replaced by Prof. Zoccolan, with Prof. Giugliano as co-supervisor) and the rescheduling of his Neurobiology Progress Report to 18 December 2025. He was therefore admitted to the 4th year with reserve until December 2025.

Camilla Lodetti was on maternity leave from January 2025 until end of November 2025. She hence did not present a progress report in October 2025 and remains a II-year student for the academic year 2025/2026.

4. PhD. Thesis discussion

Surname	Name	Title of Thesis	Date	Supervisors
MOHAMMAD-SHIRAZI	ATIYEH	Immediate changes in CNS networks triggered by a physical trauma to the spinal cord	14/11/24	TACCOLA
FONTANINI	MARIO	Nanoscale single-cell interfaces allow optical activation of single neurons and sensory-motor modulation in organotypic slices	06/12/24	BALLERINI
DIVERSI	FRANCESCO	Papillomavirus as a novel viral vector for ex vivo gene therapy of the skin	09/12/24	HEPPENSTALL
APICELLA	ROSAMARIA	Integrative physiology of the motor output	13/02/25	TACCOLA
MONTRONE	MICHELE	Sensory Neuron Rewiring in Pancreatic Ductal Adenocarcinoma: from Single-Cell RNA Profiling to Extracellular Vesicles-based strategies	01/10/25	HEPPENSTALL, DE CASTRO REIS, GENOVA (Burlo)

5. Seminars

The following seminars were organized by NBIO and the Neuroscience Area as a whole:

Date	Name	Title
20.11.24	Shimpei Ishiyama	Neuroscience of fun
20.11.24	Raunak Basu	Mapping the world around us: Topology-preserved spatial mapping in the Orbitofrontal cortex
20.11.24	Hiroki Asari	What does the eye tell the brain in vivo under different behavioral contexts?
20.11.24	Ambra Ferrari	Multimodality as a design feature of human cognition
21.11.24	Letizia Mariotti	Neuron-astrocyte networks for goal-directed actions and spatial memory
27.11.24	Juan Carlos Boffi	Towards understanding how the brain processes environmental information to tune animal behavior
27.11.24	Damiano Mangoni	From Junk to Jewel: Unveiling the Regulatory Potential of Retrotransposon-Derived RNAs in Brain Development and Functions
27.11.24	Gretel Kamm	The neurobiology of sickness

In addition, NBIO invited the following speakers:

Date	Name	Title
14.10.24	Ronaldo Ichiyama	Neurorehabilitation and Recovery of Function Following Severe Spinal Cord Injury
22.05.25	Uwe Mayer	Different structures, same functions? Bird's visual cortex and their hippocampus

15.09.25	Hugues Abriel	Rare Disease Genetics with Nanopore Sequencing: Research with African Partners

6. Problems and actions

In the previous report, we proposed a set of actions to address the students' dissatisfaction. These have shown a clear impact with the vast majority of students rating their overall experience in Neurobiology as satisfactory and their well-being as high. Below we describe how these actions have successfully improved the quality of the PhD and the additional actions we aim to take in 2025-2026.

Conference participation: Except for one, all Neurobiology students have attended at least one conference in the past year – a number that the students agreed to be reasonable for an experimental PhD program.

Relevance of courses: All students considered the overall course quality of 2023/2024 as good enough. The stronger focus on practical training appears to be welcomed by the students, even if they may not directly use the learned skills in their own project. Although the teaching quality was judged as good, in the latest student questionnaire the majority of 3rd and 4th year students rated the content as 'rather unhelpful' in strengthening their scientific background. We believe that this is partially because these evaluations refer to the courses taught in 2020-2022, which suffered from restrictions due to covid and where recent changes such as more practical training had not been implemented yet. Generally, Neurobiology admits students from a very varied range of backgrounds and who perform vastly different PhD projects. It will hence never be possible to offer courses that are directly applicable for all enrolled students. We believe that one of the main purposes of the PhD courses is to expose the students to new topics and thought processes to strengthen their overall scientific understanding, and to turn them into critical and insightful scientists. We hence do not plan any substantial changes to the teaching program for 2025-2026 but will encourage faculty to highlight how the content of their courses may be applicable to the students beyond the specific topic that is taught. Given these considerations, we also think that this question should be reformulated to ask students about the impact of the courses on their development as a scientist rather than on the direct applicability to their own project.

Journal Club: The quality of journal clubs has slightly improved. Students can now vote for a paper that they would like to be discussed. An informal discussion with the students suggests that they generally deem it an important initiative. In 2025-2026, the journal club will be organised by a student in the course of a 150h job with the hope that this will further increase interest and participation. The attendance by faculty in the past year has been acceptable and will be further encouraged to set an example. In the next academic year, we will also quantify the attendance by students to obtain an objective assessment of the relevance and quality of the journal club.

Technical Support: The improvement of the technical support and collaboration with the technical personnel is an ongoing process across the Neuroscience Area. Some aspects have improved in the past year including consequent training for new equipment and announcement of courses in the shared calendar and via email. The Neurobiology faculty, together with the colleagues in the other neuroscience PhDs and the technicians themselves, is conducting a survey to identify future needs to cover all lab activities and to implement other aspects highlighted in last year's report including a list of available equipment and stronger presence of technicians in the laboratories.

Seminar attendance: A large portion of Neurobiology students attended <5 seminars in the academic year 2023/2024. Three steps will be taken to improve these numbers: (1) Invited speaker seminars will be added more consistently to the shared Neuroscience teaching calendar; (2) whenever possible, seminars will be announced earlier to ensure that attendance is possible despite experimental work that may need longer term planning; (3) faculty members will be asked to encourage their group members to make suggestions for speakers to invite and/or organise the invitation of speakers to also improve their networking exposure. In addition, we repeat our suggestion from last year that colloquia and other seminars should be advertised

more visibly and earlier by the relevant offices.

General issues across the SISSA PhD programs highlighted by this year's questionnaire include (language) discrimination and poor awareness of the available services. To address these, the Neurobiology faculty will be reminded to speak English in all types of meetings and to enforce inclusive language in their groups. This is aided by the fact that Neurobiology has a high percentage of international faculty (3 out of 6 for the year 2025-2026). For the welcome day of the 2025-2026 first year students, a student representative was asked to present the available services at SISSA more extensively which included an informative pamphlet. We expect that this will increase the awareness in the new student cohort.

FUNCTIONAL AND STRUCTURAL GENOMICS
Report AA 2024/2025

SUMMARY

Below is a summary of information useful for quality assurance purposes for the Ph.D. in Functional and Structural Genomics for the 2024/2025 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. Four seminars were organized (section 5), a lower number than the previous year and than expected. This reduction is explained by the fact that, in collaboration with the entire Area, several seminars were organized in November and December 2024. 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) shows a sharp increase in the number of applications and potential interest in the Ph.D. compared to previous years, especially from foreign candidates. The percentage of applications from foreign students for the academic year under review was around 90%. Two of the four available scholarships were awarded to foreign candidates. The brief summary of the transitions from year to year (section 3) reveals no problems. The Ph.D. theses defended in the academic year under review *(* three in total, section 4) were approved with *honors* .

1. CHANGES TO THE COURSE OFFER

The structure of teaching activities has followed that of the previous academic year. The training program continues to include, in addition to teaching provided by 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* in the Genomics program. No critical issues have been identified.

2. SUMMARY DATA FOR ADMISSION TO THE PH.D.

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
24-25	NA	*	*	*	*

3. YEAR PROGRESSIONS

In the 2024/2025 academic year, the Ph.D. Council of Functional and Structural Genomics discussed and approved the following year transitions, with the exception of AYESHA AHSAN and IRAM SHEHZADI, who began late due to visa issues. These two students only presented their research project in a spring session of the 2025/2026 academic year.
I → II year: M. IANNUZZI, L. LIOTTI, V. PANICO, and A. KOBAL held a seminar reporting on the results achieved during the first year and presenting their thesis project. Student A. KOBAL participated in the progress reports this year because she spent the year on maternity leave. No critical issues were identified.
II → III year: I. FERGANI, A. MAZZETTI, G. PISTORIO, C. SGHERZA held a seminar reporting the initial results of their thesis work. No critical issues were identified.
III → IV year: G. DE LEO, ES MAFTEI, M. MINTSEVA held a seminar reporting on the progress of their thesis work. No critical issues were identified.

4. PH.D. THESIS DISCUSSION

Ph.D. theses were successfully discussed :
1. C. FERRACIN, supervisor G. Legname, on December 17 , 2024 with a thesis entitled: " Understanding the role of SERPINA3/SerpinA3n in prion diseases "
2. U. RANGASWAMY, supervisor R. Sanges, on 07 May 2025 with a thesis entitled : " Unraveling Molecular Complexity through single cell approaches: from olfactory bulb architecture to drdsal root ganglia remodeling in pancreatic cancer".
3. L. NIKOLIC, supervisor G. Legname, on May 5 , 2025 with a thesis entitled: "A genome -wide microRNA screen uncovers modifiers of α- synuclein fibril internalization ".

5. SEMINAR LIST
seminars organized:

June 19 , 2025
Silvia Kirsten Nicolis (University of Milano-Bicocca) "Targeting the SOX2-controlled 3D gene regulatory network to provide novel understanding of neurodevelopmental disorders"

October 16, 2025
- Dafne Campigli Di Giammartino (IIT) "Exploring the Role of 3D Chromatin Architecture and Non-Coding Elements in Cancer Stem Cells"
- Alessia Indrieri (Tigem) "MicroRNAs Modulation: a novel frontier in the treatment of mitochondrial-mediated neurodegeneration"
- Manuela Basso (Cibio, University of Trento) "c- Myc Driven Astrogliosis Impairs Neuron-Glia Communication in ALS"

6. *PROBLEMS AND ACTIONS*

The findings of the latest CPAD report and the discussions between the Faculty 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 2024/2025 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.