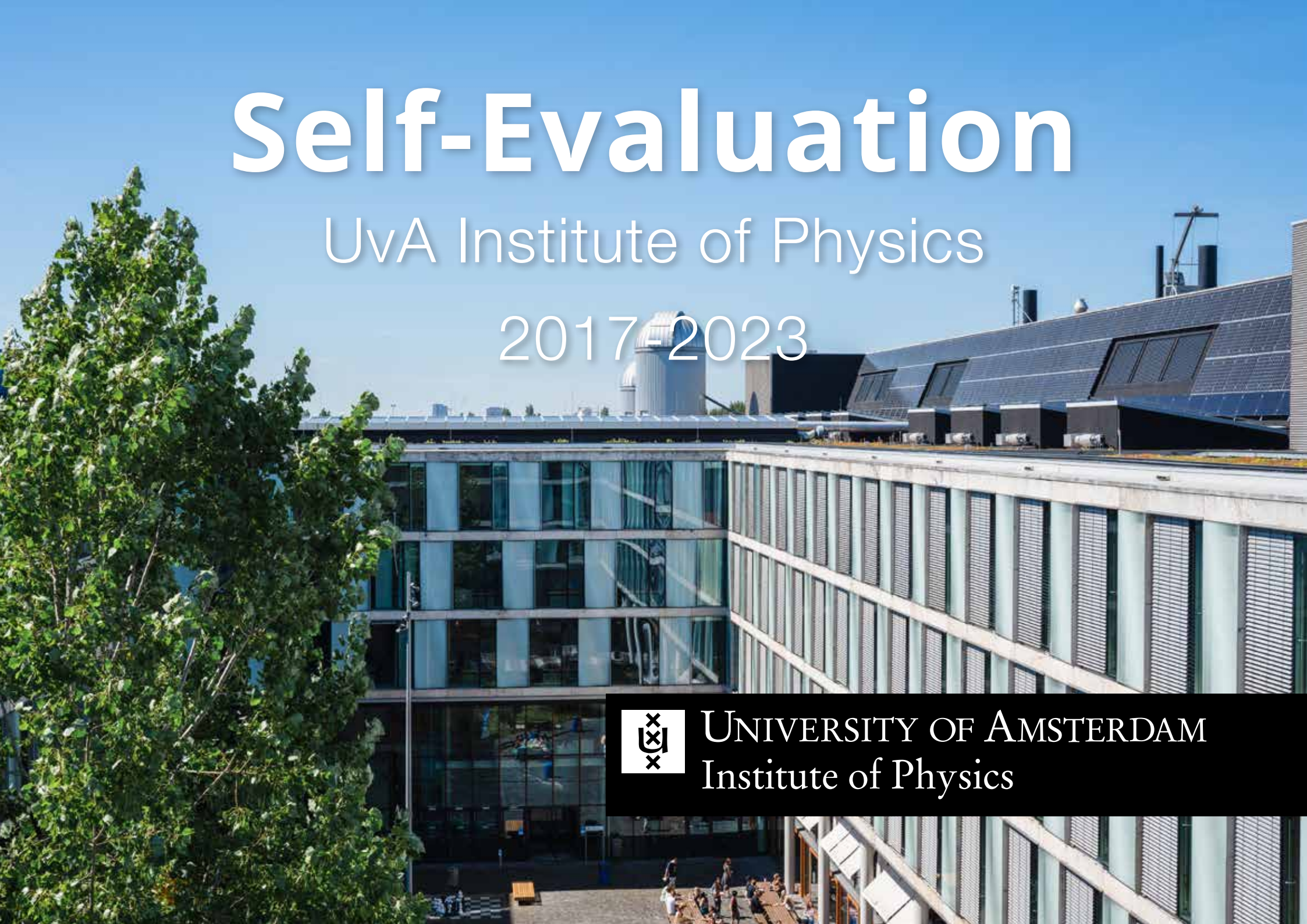
Self-Evaluation

UvA Institute of Physics

2017-2023



University of Amsterdam
Institute of Physics

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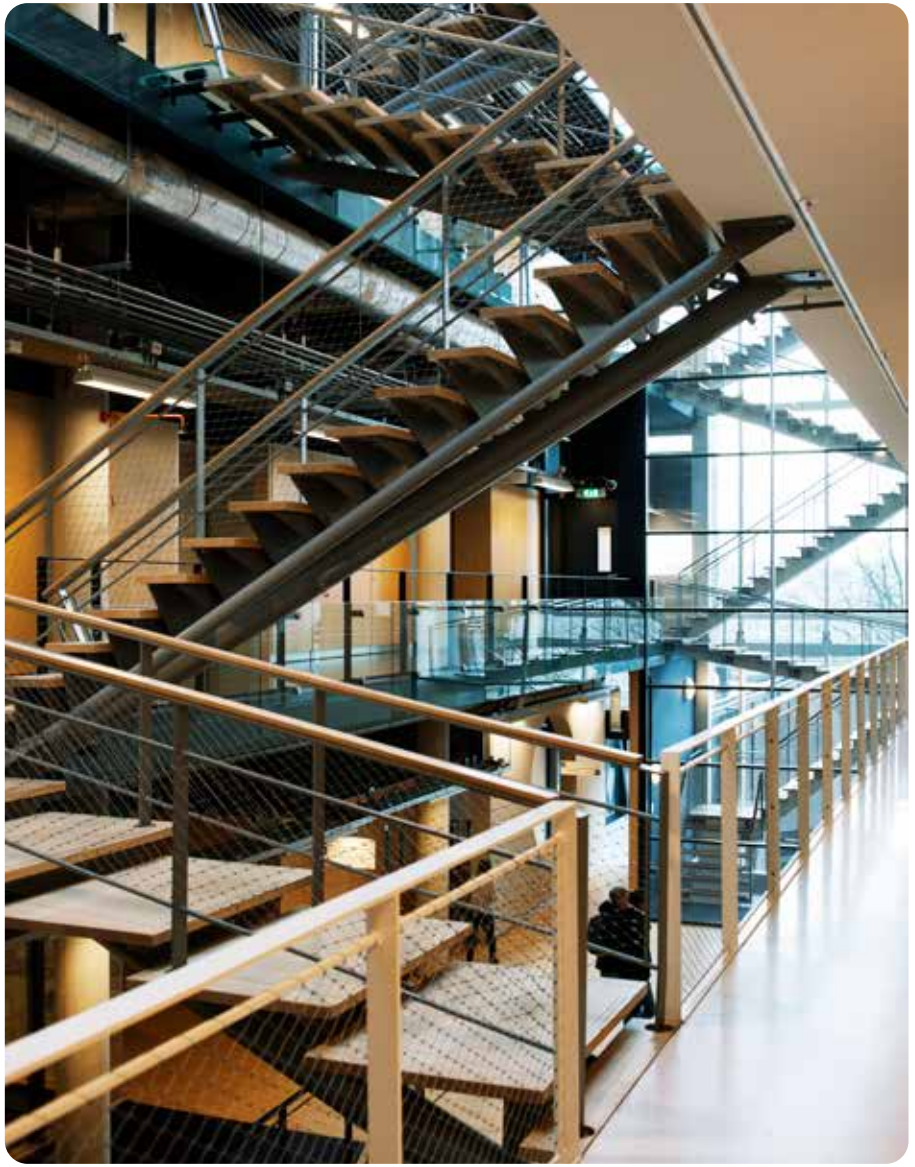

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1. Introduction

1.1. Preamble

This document presents the self-evaluation of the Institute of Physics (IoP) at the University of Amsterdam (UvA). It includes a reflection on our strategy and accomplishments over the seven-year evaluation period 2017 – 2023. The research evaluation is organized under the auspices of the board of the UvA. The procedures for this evaluation are in accordance with the Strategy Evaluation Protocol (SEP) 2021-2027.

After the introductory chapter, and a chapter on the institute as a whole, we laid out the document following IoP's three research divisions, carefully chosen based on their coherence in research topics, requirements on infrastructure, location and international scope.

Throughout, numerous references to quantitative and/or tabulated supporting information are made, which are contained in the appendices.

We very much look forward to discussing our past and present accomplishments and future strategy with the evaluation committee during their visit in March 2024.

On behalf of the entire staff of the IoP and its directorate,

Eric Laenen, Director
Joost van Mameren, Institute Manager

1.2. National context

Below we provide a brief overview of some of the most important national developments during the evaluation period that are relevant to IoP.

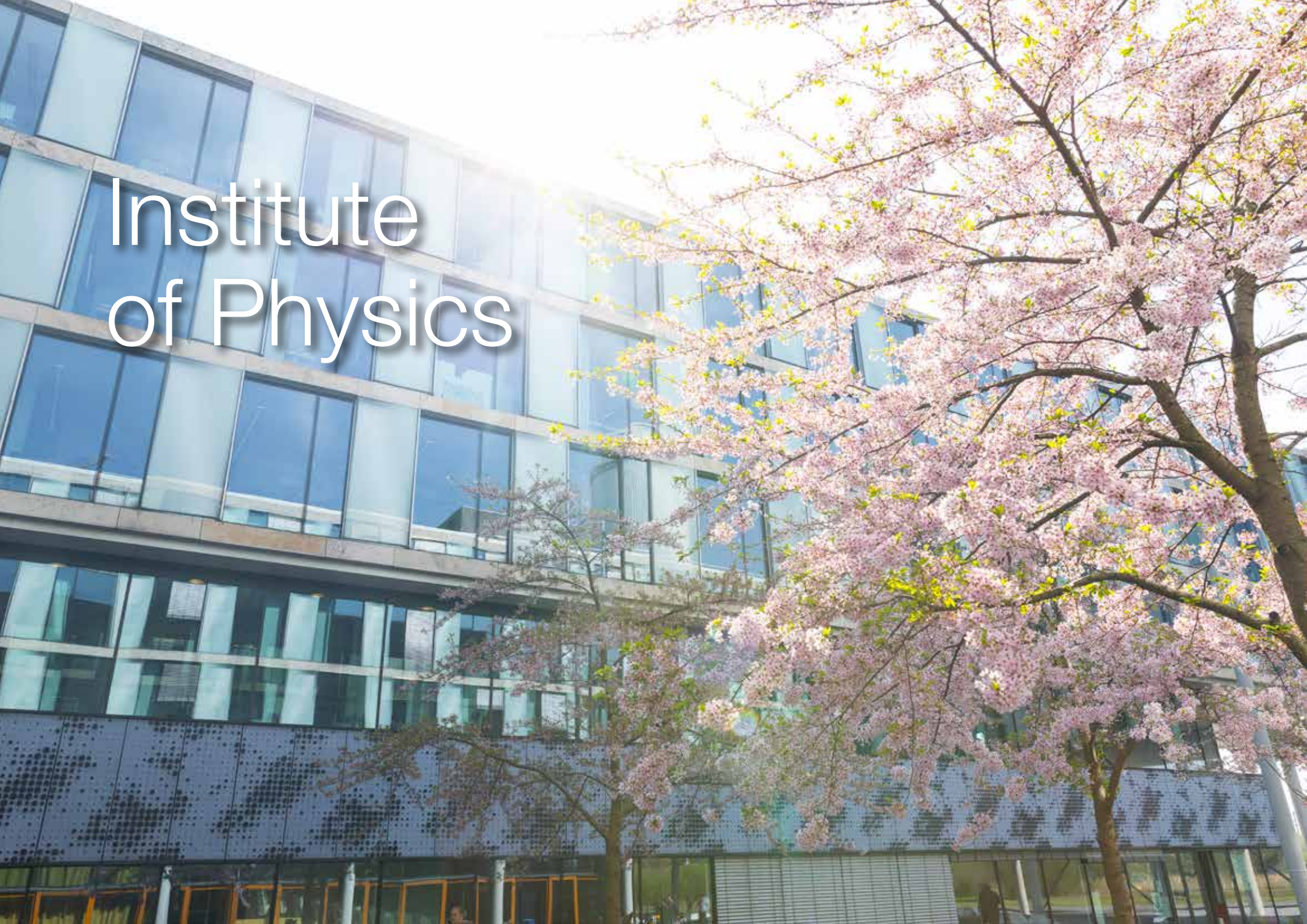
1.2.1. Additional government investments

Besides the historically most common type of research funding, administered by the Dutch Research Council (NWO), the Dutch government has provided additional funding through the following new channels.

- *Sector Plans*: targeted investments for groups of scientific disciplines to strengthen research and education and to stimulate self-organization and clearer distribution of tasks and research priorities; most funding is for new positions plus start-up packages. Investments are temporary but shall become permanent after a positive evaluation after 6 years. See also section 2.9.1.
- *Starter and incentive grants ('Starters- en stimuleringsbeurzen')*: extra funding provided to universities to provide grants of the order of 300k€ to starting faculty and more senior faculty. his has led to complicated internal university discussions. Impact on IoP funding has so far been quite modest: the additional funding has been added to the budget for IoP's annual internal funding rounds (see section 2.9.2).
- National Growth Fund (NGF): a multi-billion annual investment in large consortia with an emphasis on innovation and economic growth. IoP benefited in particular from the Quantum Delta NL consortium which received 615M€ in the first NGF round in 2022.
  Two other granted NGF consortia relevant for IoP are the Einstein Telescope (for which a reservation of 870 M€ is made for the under the condition that it will be (partially) built in the Netherlands) and the SolarNL consortium.

1.2.2. Other developments

- *Geopolitical tension and knowledge safety*: Increasing geopolitical tensions, the invasion of Ukraine by Russia, and increased focus on industrial sovereignty have resulted in a termination of institutional ties with Russia (affecting IoP in particular via CERN), and a closer scrutiny of international PhD students, postdocs and faculty for possible security risks. Security risks are analyzed based on specialization, country/university of origin, and a national information point is available to provide additional background checks. This has resulted in a decrease of international researchers from high-risk countries and has e.g. led some universities to no longer host Chinese Scholarship Students. IoP follows the policies and escalation mechanisms of the Faculty of Science.
- *Economic situation*: Steeply rising inflation and energy costs have led to substantially higher salaries in collective labor agreements. This has led to large financial pressures all across academia, with most departments facing tough financial decisions. Thanks to a healthy financial starting situation, the current projection is that IoP will not face any immediate financial problems.
- *Political situation*: Recent election results have shifted parliament in a direction that seems less inclined to supporting fundamental research and long-term R&D policies. The increasing negative sentiment towards immigrants has led to a deterioration of the special tax regime for international knowledge workers. Impact on IoP has not (yet) been substantial but this may change once a new government coalition has been formed.
- *Recognition and Rewards*: Starting with the San Francisco Declaration on Research Assessment (DORA), a broad movement has emerged that aims for a more comprehensive view on academic excellence than what was traditionally captured by itemized CVs. This has culminated in a new view on university careers and in the replacement of itemized CVs by narrative or evidence-based CVs in most grant applications. IoP already initiated discussions on the subject well before they emerged at the university level and as a result the changes in IoP have been rather gradual. It is too early to see what implications evidence-based CVs have on funding applications.
- *Collaboration with (fossil) fuel industry*: According to activists and various university communities and groups of students, universities should cut all ties with fossil fuel industry. According to these groups, fossil fuel industries have policies that are not in line with climate agreements, in particular the Paris agreement. Representatives from the fossil fuel industry deny this, and other university communities are of the opinion that the energy transition cannot succeed without the active participation of the fossil fuel industry – anticipating collaborations on renewable and green energy to lead to benefits for society. This discussion has led to a substantial polarization in academia, and many universities have implemented policies to deal with this. UvA has implemented a policy where collaboration is not allowed unless a few strict conditions are met. These policies, and the turbulent discussions that preceded them, have had an adverse impact on some IoP researchers and their existing industrial networks.

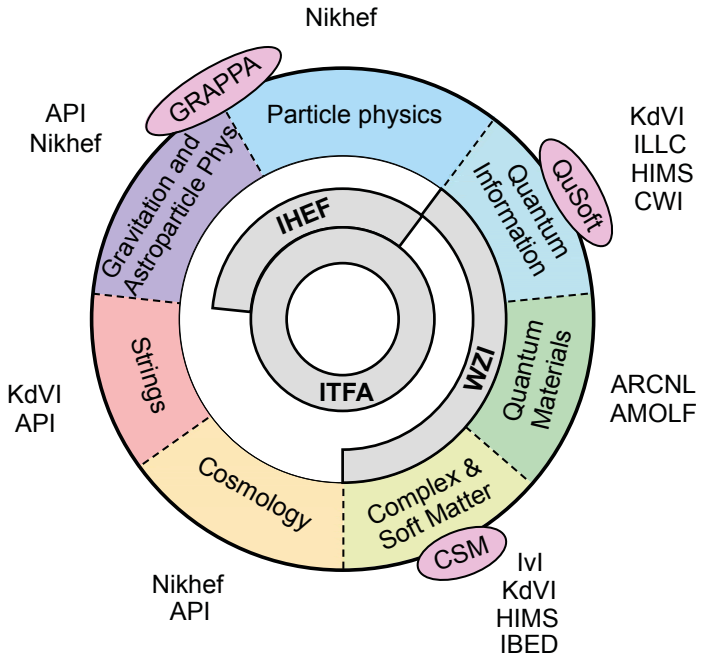

Institute
of Physics

2. Institute of Physics

2.1. Scope and research divisions

The Institute of Physics (IoP) is one of eight institutes in the Faculty of Science of the University of Amsterdam (UvA). Here, about 250 colleagues carry out research in three divisions, each of roughly equal size in terms of (permanent) scientific staff:

- The **Van der Waals-Zeeman Institute (WZI)** performs research in the areas of Quantum Materials / Hard Condensed Matter, Soft Matter, and Quantum Gases & Quantum Information. It also has strong research links with the Advanced Research Center for Nanolithography (ARCNL), in which IoP is one of the constituent partners;
- The **Institute for Theoretical Physics (ITFA)** performs research in the (partly overlapping) themes Computational Soft Matter, Quantum Condensed Matter, String Theory, Theoretical Particle Physics, Astroparticle Physics, Cosmology, Mathematical Physics, and History and Philosophy of Physics;
- The **Institute for High Energy Physics (IHEF)** focuses on both theoretical and experimental particle and astroparticle physics, including by participating in the international collaborations ATLAS (at LHC/CERN), KM3NeT, XENON and Virgo. As part of the Nikhef collaboration, in which several other Dutch universities participate as well, the research program of IHEF is coordinated within Nikhef. Nikhef has its own SEP evaluation cycle, thereby addressing the research programs to which IHEF staff contribute.



Several staff at IoP have shared appointments, either between two IoP divisions (IHEF+ITFA) or between an IoP division and another research institute within the Faculty of Science, notably the Anton Pannekoek Institute for Astronomy (API), the Informatics Institute (IvI) or the Korteweg-de Vries Institute for Mathematics (KdVI).

IoP is embedded in a lively academic ecosystem, with many collaboration partners across its wide range of research topics located in the direct vicinity, as depicted in the schematic on this page. These partners include the seven other research institutes of the Faculty of Science, ranging from the life sciences to the mathematics and astronomy institutes. Similarly, IoP maintains active collaborations with all on-campus NWO institutes (Nikhef, ARCNL, AMOLF, CWI) and with various physics groups at the Vrije Universiteit (VU), just as with

interdisciplinary consortia such as the center for quantum software QuSoft (with ITFA and WZI) and the Dutch Institute for Emergent Phenomena (DIEP; with virtually all IoP groups).

2.2. Mission and strategy

IoP's mission is to carry out excellent research across a broad range of fields in both experimental and theoretical physics, spanning from fundamental to more applied; to provide inspiring education within the physics and adjacent curricula; and to transfer our knowledge and enthusiasm to society, both by collaborating with industrial partners and by boosting interest in physics in general.

The objectives of the IoP include:

- achieving **scientific excellence** and a clear academic signature for the divisions WZI, ITFA and IHEF in their respective fields of expertise;
- fostering a **stimulating, diverse and inclusive work environment** for everyone working at IoP;
- exploiting the potential for **collaboration** within the IoP, with adjacent disciplines at the Faculty of Science, at other UvA faculties, and with organizations based at the Science Park Amsterdam;
- bundling forces so that **leading and coordinating** roles can be taken in national and international research alliances and networks (research schools, research programs with NWO and in the EU, etc.);
- stimulating **knowledge utilization / valorization**, such as through public-private partnerships and spin-offs;
- achieving a level of performance in **education and outreach** that goes beyond the standard for an academic research institution.

2.3. Governance and organization

The IoP is led by a **directorate / management team** consisting of the IoP director, the heads of the three divisions, and the institute manager. This directorate currently consists of:

- Eric Laenen, Director IoP (since May 2022);
- Daniel Bonn, Head WZI (Director until May 2017);
- Jan de Boer, Head ITFA;
- Paul de Jong, Head IHEF (Director from the period May 2017 – May 2022);
- Joost van Mameren, Institute Manager.

The IoP directorate operates in a mostly informal and collegial manner, in which much of the divisions' strategic and operational matters are effectively delegated to the division heads. Likewise, each division has a tradition of informal, shared management, such as via regular staff lunches where matters concerning research and teaching are discussed on an informal basis.

The IoP **support office** provides administrative and secretarial support for matters related to HR, ICT, outreach and PR, finance, event organization, website, etc. Specialized services are offered by faculty-level teams for project administration, finance and control, HR and legal advice, communications and outreach. Over the past years, several support staff have been hired within IoP to specifically support the (broader) QuSoft community.

IoP has a few in-house **technical support** staff embedded within WZI; in principle one per research cluster. In addition, the Faculty of Science comprises a Technology Center (TC) providing mechanical and electronic workshop services to all experimental research institutes of the faculty. IoP alone (through its WZI division) takes up well over 50% of the capacity of the TC, indicating the

important role of such services in an experimental physics context. Technical support for IHEF staff is arranged through the Nikhef technology departments.

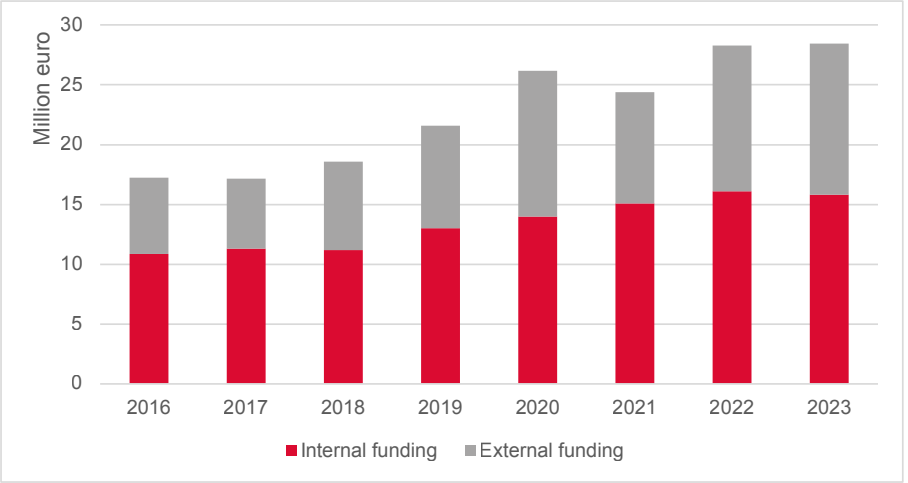
2.4. Funding and budget allocation

UvA uses a full-cost accounting system, in which all costs of the university's supporting infrastructure (housing, financial, personnel, IT services, library, etc.) are attributed to the institute. The institute is compensated for the associated higher internal costs through the university's and faculty's internal budget allocation. This direct (internal) funding budget allocated to IoP is characterized by the following components:

1. A mostly fixed amount of base funding, including capacity budgets for specific infrastructure such as lab space, workshop access, etc;
2. A parametrized component that is primarily determined by performance indicators such as the numbers of PhD degrees and undergraduate diplomas conferred, and the annual turnover of externally funded projects;
3. Fixed (often temporary) budgets earmarked for specific strategic goals, such as investments in research priority areas.

Besides this direct university funding, external funding is obtained from the national research funding organization NWO, from international sources (mostly EU/ERC), or from private partners such as companies or foundations.

The graph below shows the budget development of both the direct (internal) and external budgets over the past years. Note that the full-cost accounting system leads to acquired project grants not fully covering the overhead costs of a project. The remainder is covered by direct funding as a matching contribution.



The graph shows that both the direct funding through the largely parametrized allocation model and the external funding have increased significantly over the evaluation period, contrary to national trends in the type of (mostly curiosity-driven) research taking place at IoP. Many of the external grants are personal grants (ERC grants, NWO Vidi/Vici grants) from early to mid-career staff members, although an increasing fraction consists of program/consortium grants. Within the Faculty of Science, IoP is one of the few institutes that consistently generate a positive annual financial balance. For more details, see table A2.1.

2.5. Human Resources policies

2.5.1. Academic Culture

IoP strives for an open atmosphere in which researchers, support staff and students can work safely and be part of an inclusive research community.

All members of IoP are committed to the Netherlands Code for Conduct and Research Integrity as established by the Dutch government. Training and awareness courses on ethics and research integrity are a mandatory part of the training program of PhD students. The university and faculty are committed to a safe and positive environment for students and employees, putting in place procedures to deal with concerns and complaints. Within IoP we promote social safety as a condition for an open and encouraging working climate, for which we provide and actively promote various channels to seek support, including via supervisors, institute management, and confidential advisors (both informal within IoP and formally organized within UvA). All staff members and many PhD students and postdocs of IoP have participated in a recent series of bystander awareness workshops.

2.5.2. Talent management

Career principle

For well over a decade, UvA's Faculty of Science and in particular IoP has explicitly and wholeheartedly embraced the 'career principle' as the leading human resource principle for scientific staff. The career principle is characterized by the fact that staff members can be promoted through the ranks of assistant and associate professor to the highest academic rank of full professor, based solely on their performance. It should thus be seen as a replacement of the 'formation principle' that historically played a dominant role in the Dutch academic system, in which there is a clear hierarchy with a central position for a professorial chair, and associate and assistant professors working on the same theme in a relatively dependent manner and with no clear career perspectives for promotion.

Appointment and promotion criteria

Following a call for more transparent policies on the topic of the career principle among IoP staff, IoP has in the past years laid the groundwork for a major revision of the appointment and promotion criteria for academic staff at the Faculty of Science, which was finalized in 2020. The result was a new set of criteria based on what we expect from a staff member in the fields of teaching, research and organization at the various academic levels. Allowing for discipline-specific characteristics, these criteria play a key role when assessing whether a staff member is eligible for appointment or promotion (while not being used for a box-ticking exercise).

In line with the national and international discussions about Recognition and Rewards in academia (see e.g. the position paper by the Dutch public knowledge institutions and funders of research), the UvA and the Faculty of Science increasingly embrace diversification of career paths, allowing differences in the balance between research, education, organization and valorization efforts, as well as between individual and team achievements. Although this new development is still work in progress, we have several successful examples already among our staff

In most cases, the starting point for an assessment for promotion is the relatively informal discussion with the candidate's supervisor in an annual appraisal interview. Increasingly, a career plan is drafted in the spirit of a tenure track agreement that lays down the assessment criteria and timing of one or two promotion steps over a timescale of 2-5 years. For promotions to full professorship, such career plans have become the default pathway.

IoP has adopted the policy to have each promotion assessed by a committee with a few fixed members, augmented by rotating experts (including from outside the institute and UvA). The candidate is expected to prepare a vision statement in which past and present performance is connected to their personal ambitions and plans for the future, in teaching, research, organization and

valorization/outreach. For all major promotions (assistant -> associate -> full professor), external expert reference letters are requested.

Tenure track policy

The tenure track system is a clear example of the implementation of the career principle. It offers promising academic talents a clear career prospect, helping them to fully develop their potential.

The introduction of the tenure track system had the following objectives:

- recruiting and retaining young, promising academics;
- attracting a larger number of female academic staff and promoting their advancement;
- providing employees with more clarity regarding the performance-related career perspectives offered.

Like all staff members, tenure trackers have an annual appraisal interview with their supervisors. The tenure track includes up to three formal evaluations, carried out by a committee consisting of the IoP directorate augmented by specialist members, as well as one or two non-IoP staff members. In the evaluations, the fulfilment of the criteria laid down for that evaluation in the tenure track agreement upfront is assessed, and the candidate is promoted if on track.

The tenure track system was implemented at the Faculty of Science in 2011 and since then, most new appointments at IoP have been made on the basis of a tenure track agreement. The system has undergone a major evaluation in the Faculty of Science in 2021, after which the Faculty board decided to amend its policy, shifting the tenure decision to a much earlier date, while maintaining the steep career progression. The main driver for this revision was the reported high work pressure that seemed connected with the extended period of job insecurity in a five-year tenure track. Note that within the Faculty of Science, only in a single case (not at IoP) tenure was not given based on lack of performance, out of a pool of 150+ staff hired on a tenure track. Since the revision, several new hires have been appointed without a tenure track agreement, but immediately on a permanent position, with (the prospect of) a tailor-made career plan.

Postdoctoral researchers

A similar revision of appointment and promotion criteria as described above has been carried out by the Faculty of Science for researchers/postdocs. With their typically 2-3 year temporary contracts and their strong focus on obtaining results for their next career step, postdocs are typically a bit harder to 'cater for' than PhD candidates and staff in terms of training. Several (soft skills) training courses offered at the faculty level are open to postdocs too, as is the career service that helps to prepare for next career steps (in particular to sectors outside academia). It has been notoriously difficult to find postdocs willing to engage in institute-level committees such as the PhD/postdoc and the Diversity and Inclusion councils (described below). However, many postdocs play important roles in organizing group-level activities, such as journal clubs or seminar series.

2.5.3. Equity, diversity and inclusion

Staff diversity

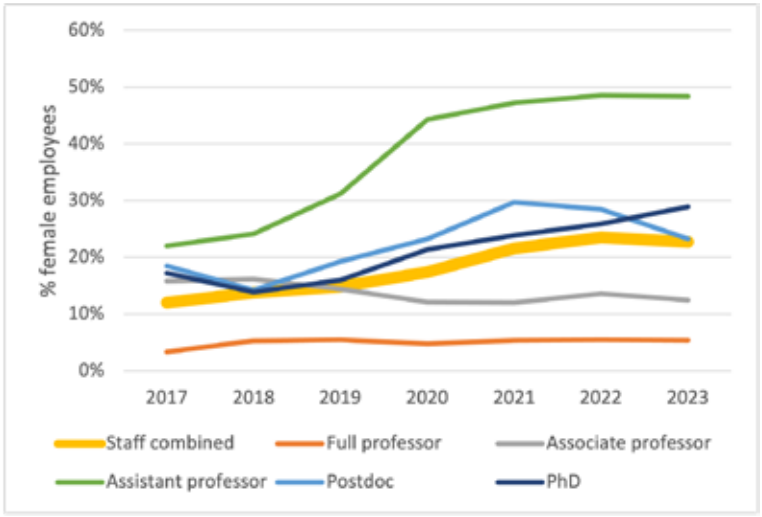
The IoP is proud to host a community of physicists from many different countries. Both the fraction of non-Dutch employees over the years and the number of nationalities represented among our employees have risen over the past years (see table A1.5), including among the permanent staff. Since many years, IoP offers in-house Dutch language classes for all non-Dutch employees, to facilitate a proper landing in Dutch society as well as forging connections within the institute.

When it comes to diversity in Dutch academia, a lot of emphasis has been given to gender diversity. Women in the Netherlands are notoriously underrepresented at all levels of the sciences, and the IoP is no exception. This lack of diversity in the sciences is a complicated issue, the causes of which are complex and spread across many parts of society. It is already manifest in high schools and arguably shaped at a very young age. Although role models can make a difference, the UvA (like many other universities) is hesitant towards a strict top-down hiring approach, e.g. enforcing percentages. IoP's main policy is to promote awareness of diversity and diversity-bias, and to create a safe, supportive, and inclusive work environment. Some concrete measures in this respect include:

- We include at least one female member in hiring and promotion committees;
- We typically have a separate discussion of female/minority applicants for job openings, and similarly for seminar speakers and e.g. participants for workshops/conferences that we organize;
- We are committed to shortlisting at least one but often multiple female candidates for staff positions;
- IoP staff members can flexibly organize their work to find a balance in combining work and family (e.g. leave, part-time work, working from home), in particular in the post-corona era where hybrid working is broadly embraced;
- IoP staff members can submit special funding requests, e.g., for travelling to a conference with their families or a babysitter;
- We offer occasional career support for partners of new hires (although we feel there is certainly room for a more structured approach at the faculty and/or university level).

Both at a national level and at the UvA, various programs have been developed to reduce the gender imbalance, such as the MacGillavry Fellowship program of the Faculty of Science. IoP has in recent years made an effort to catch up in this area, keenly making use of these programs. IoP has also strategically used the positions created through the Sector Plan Bèta-Techniek, where two thirds of the 7.5 fte in new positions were filled with female candidates.

In particular, among new hires at the junior staff level (assistant professor), the fraction of women has therefore steeply increased to around 50% (see table A1.3 and graph below). Since most of these new staff members have been appointed on a tenure track and thus with a clear and fast career perspective, the future staff composition is expected to become more balanced, also in the higher academic ranks. Notably, the overall fraction of female permanent staff (tenure trackers included) has more than doubled over the evaluation period, and is now roughly in line with the fraction of female postdocs and PhD students.



Diversity & Inclusion Council

In 2020, the IoP installed a Diversity & Inclusion Council. This council aims to advise the IoP leadership independently and proactively about efforts to enhance diversity and inclusion at the institute. Their activities include:

- Organizing a paid annual summer research internship for BSc and MSc students from underrepresented groups who are studying at the UvA since the summer of 2021;
- Organizing outreach activities;
- Organizing IoP colloquia on diversity and inclusion;
- Holding a series of events called "Behind the CV", where faculty members and students share with junior researchers some of the struggles that they experienced during their journey to a career in science;
- Organizing a panel of PhD students on the topic "What I wish I had known about doing a PhD!" for MSc students considering to pursue a PhD degree;
- Organizing the "Researcher in the Classroom" project to reach out to high school pupils, including those from underrepresented demographics;
- Taking part in diversity initiatives at the level of the Faculty of Science, such as the "Faces of Science Park" event and connecting to the faculty diversity officer;
- Advocating for parents working in the faculty: improving lactation facilities, increasing the accessibility of information for soon-to-be parents, and advocating for daycare solutions.

The council was strongly involved in an extensive survey of the entire IoP community to determine to what extent our institute offers an inclusive environment (together with the institute manager and members of the PhD council). This survey, which was triggered by the #MeToo and Black Lives Matter movements, was prepared internally but evaluated and analyzed by ECHO, a Dutch expertise center for diversity policy. The survey report (available online as supporting document) has led to a two-day think tank program of IoP members guided by ECHO who have made recommendations for concrete policy changes and grass-roots ideas to make these topics easier to discuss and address in the daily life within the institute. The survey has served as inspiration for several other research institutes within the Faculty of Science, and via ECHO's network also in other national organizations.

2.6. PhD policy and training

2.6.1. Context, supervision and quality assurance

The duration of PhD programs in the sciences in the Netherlands is 4 years. During that period, PhD students are in most cases appointed as regular employees with a competitive salary. When a PhD student is funded from international (EU) sources where only 3 years of funding are provided, an additional fourth year is made available by the institute. Besides a vast majority fully funded PhD positions, some PhD students bring their own scholarship. Such bursary students are treated equally as much as possible.

As primary supervisors, PhD students all have two to four staff members who are ultimately responsible for the quality of the promotion and who do the actual supervision. Historically, only full professors in the Netherlands could confer PhD degrees (in a role denoted in Dutch as "promotor"). The UvA doctorate regulations have abandoned these strict rules, and now all associate professors can obtain the right to confer the degree (*ius promovendi*), which is broadly embraced within IoP. Assistant professors can under some conditions and on a case-by-case basis also obtain this right.

Besides the formal supervisors (either two promotors or a promotor and a

co-promotor), IoP policy prescribes that a PhD mentor (formally indicated as independent supervisor) from a different research group is assigned to each PhD student at the start of the PhD project. This mentor is a contact person for both the PhD student and the main supervisor(s), should a problem arise between the two. Involving a mentor is meant to prevent stagnation of the project, which can help avoid delays. The mentor was introduced in 2013 and is generally perceived by PhD students as well as staff as a valuable means of both quality assurance and improving the well-being of PhD students. UvA also has several confidentiality advisors who can be consulted in case of problems.

For each PhD candidate, a Training and Supervision plan is drafted early in the PhD trajectory, describing the overall aims of the research project, the schools and courses to be attended, and various aspects of the supervision such as type of supervision and frequency of meetings between PhD student and supervisor(s).

During the annual assessment and progress meeting, several important aspects are discussed: general progress of the PhD project, mutual expectations, level of scientific independence, possible schools and conferences to attend, possible courses to follow, things that can be done to support the post-PhD career, etc. Besides formal annual assessment and progress meetings, the format of the day-to-day supervision is mostly left to the supervisor(s) and the PhD student.

2.6.2. Education and training

Skills training

The Faculty of Science offers extensive (soft) skills training, with the program *Mastering your PhD* as the main compulsory training component, and various presentation/writing/didactical skills trainings as optional elements. In addition, a dedicated career coach for PhD candidates is available both for group and individual counseling sessions.

In some cases, PhD students are offered the possibility to independently identify relevant course modules on an *ad hoc* basis, such as presentation or academic writing courses. The institute or department typically provides a financial contribution in case the research group is lacking funds.

Some of the courses offered to PhD students are aimed at helping PhD candidates think about their future well before the end of their contract. The Faculty of Science has a career service desk aimed specifically at PhD students and postdocs (in particular those considering a career outside of academia). Its service entails both group training events and 1-on-1 consultation. Besides this, the annual Amsterdam Physics and Astronomy Career Day (APAC Day) is organized for all MSc and PhD students as well as postdocs in Physics and Astronomy. Next to talks by alumni who left academia, the program includes feedback sessions on CV composition, as well as advice about grant writing.

Topical training

For topical training, the IoP participates in three national research schools:

- Dutch Research School for Theoretical Physics (DRSTP) – for all PhD students working under supervision of ITFA researchers;
- Research School Subatomic Physics (OSAF) – for all PhD students working under supervision of IHEF researchers, and who are hence embedded at Nikhef;
- National research school for fluid mechanics J.M. Burgerscentrum (JMBC joined since 2022) – for all PhD students in experimental and theoretical/ computational soft matter.

These research schools provide a substantive scientific (and sometimes soft skills) educational program coordinated by an education committee in which the UvA is represented at all times.

Note that not all PhD students of IoP fall under these research schools. In particular, some PhD students in WZI currently have no research school for their scientific training.

Educational tasks

Every PhD student is expected to contribute up to 10% of their time to education (roughly equivalent to at most 24 ECTS of teaching assistantship). The preferences of the PhD student and supervisor are taken into account as much as possible in the distribution of educational efforts over the PhD contract duration. In practice an effort is made to exempt the final year from educational tasks.

2.6.3. PhD duration and success rates

We have made a concerted effort over the evaluation period to make sure that every PhD student finishes in time as much as possible. Obviously, the corona pandemic has led to delays in many PhD trajectories, which in the last years is starting to show up in the average duration to completion and in the number of contract extensions provided. Tables A3.1 and A3.2 present the collective statistics of our PhD program during the evaluation period. Table A3.1 differentiates for three types of PhD candidates: 1) PhD candidates who are employed by UvA; 2) scholarship PhD candidates who join IoP with their own scholarship funding; and 3) external PhD candidates, who graduate at UvA but mostly do their research in other institutions, such as AMOLF, with their supervisor affiliated as professor at IoP.

Over the evaluation period, 72% of our PhD candidates graduated within five years after enrolment (22% within four years; 25% for employed-only). As shown in table A3.2, the average duration of all completed PhD trajectories has been 55.7 months. This is a bit over half a year longer than the nominal length of the contract, which has our attention. Typically, 3-4 months are needed for formalities between the completion of the thesis and the actual defense, during which the candidates are not expected to work on their dissertation, and in practice often move on to new employment. The scheduling pressure on and the summer closure of the two locations within UvA for PhD defenses tends to increase this waiting period, despite the fact that more slots were added to the calendar.

Causes of delay or (rare) dropout vary: there are cases where there are insufficient results for a PhD thesis, sometimes the writing of the thesis itself takes longer than anticipated, sometimes experimental setbacks or personal circumstances of the PhD candidate give rise to delays. In the past years, the corona pandemic has obviously contributed significantly to this, both in terms of (mental) health impact and inadequate access to (lab) facilities, supervision, etc. during lockdown periods. As described in section 2.6.1, we have introduced several mechanisms whereby we try to identify potential delays as early as possible and try to prevent or minimize them. We expect that after the impact of corona has faded out, a further decrease in the average duration for the upcoming years will be realized.

2.6.4. PhD & Postdoc council

IoP has a PhD & postdoc council as an informal but important representational body within the institute. This council has two main objectives: to provide advice about PhD and postdoc policies in regular meetings with the institute management, and to organize events where PhD candidates from different groups can get to know each other. The council is the driving force behind the many social and/or academic events, such as (1) an annual IoP-funded PhD/postdoc symposium by and for PhD students and postdocs (paused during the pandemic but successfully revived in 2023); (2) a monthly pizza seminar in which

three researchers of IoP (PhD/postdoc or staff) share their latest results with the broad IoP community; (3) the annual institute barbecue at the end of the academic year; and (4) an informal monthly gathering for PhD candidates and postdocs in a bar on campus.

The IoP management regularly discusses key topics with the council, such as scientific integrity policy, the quality of supervision and measures for improvement, and connected to that the general well-being of PhD students and postdocs. Together with IoP management, the council has over the past years held several surveys about the well-being of PhD students and postdocs (in particular in corona times), as well as organized sessions led by a professional trainer on mental health problems such as severe imposter syndrome. They were also strongly involved in setting up the survey on equity and inclusion matters described in the above.

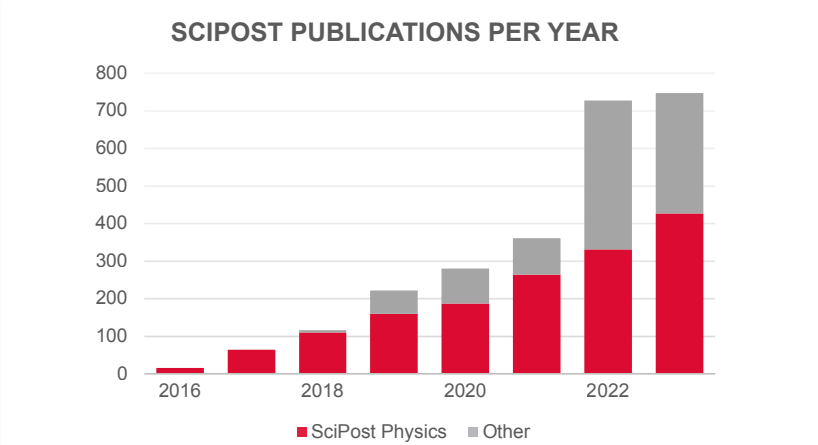
2.7. Open science

IoP supports the NWO guidelines for open science and has introduced a set of procedures for data management and storage as an integral part of the research process. IoP also promotes publishing papers as open access. In the reporting period, an average of 95% of our articles were published as open access, with an upward trend. Open access publishing is clearly encouraged and broadly embraced.

IoP aims at an open science environment that is efficient and in line with requirements of the university, research funders and scientific publishers. Our research yields a wide variety of (meta)data, ranging from lab journals to large data sets from theoretical calculations or data from experiments and analyses. IoP is developing a research data management (RDM) plan in alignment with

Highlight

SciPost



Number of publications in SciPost journals per year, 2016-2023

SciPost: the home of genuine open publishing Open access publishing is becoming more and more important in today's scientific climate. Since 2016, IoP has hosted SciPost, a full scientific publication portal, sponsored by more than 100 institutions worldwide, that offers freely, openly, globally and perpetually accessible science. SciPost is an initiative of IoP physicist Jean-Sébastien Caux, the current chair of the non-profit SciPost Foundation.

Today, SciPost consists of 14 different journals on physics, astronomy, chemistry and political science. The number of publications, as shown in the figure, has grown steadily over the years. In June 2023, SciPost celebrated its 2000th publication and it has since then passed the 2500 mark.

faculty and university policies that have been formulated in the past years. As part of the faculty plan, data stewards have been appointed to assist the research institutes in implementing RDM. The policy requires that prior to starting a new project, researchers prepare a data management plan (DMP) describing where and how the data will be long-time stored, and whether and how the results will be made available for use by third parties. In practice, DMPs are mostly prepared for externally funded projects, for which the funding agency requires a DMP prior to the start of the project.

IoP invested in a dedicated 250 TB data server that is internally available for storing, accessing and archiving (meta)data. IoP researchers increasingly publish their data associated with scientific publications in replication packages through online services such as *Figshare* or *Zenodo*. The IoP data steward is working on a protocol to harmonize these practices, in line with the Faculty's RDM plan.

An initiative worth mentioning here is SciPost, a complete platinum-level open access scientific publication portal that was initiated by IoP's Jean-Sébastien Caux, which has grown substantially to a thriving publication outlet for scientific research. SciPost is highlighted on the previous page.

2.8. Education and outreach

Within the Faculty of Science, research and teaching are organized in separate management lines. As all educational programs are evaluated separately, the ones in which IoP staff teach are not discussed in detail in the present research evaluation. To provide some context, the most relevant aspects regarding teaching are described below.

2.8.1. BSc Natuur- en Sterrenkunde (Physics and Astronomy)

The bachelor program Physics and Astronomy is a joint degree program mostly taught by teachers from IoP, the Anton Pannekoek Institute for Astronomy, and the Department Physics and Astronomy of the Vrije Universiteit Amsterdam (VU). Since several years, the program attracts a stable and increasing influx of well over 100 first-year students. Including students in the double Physics/Mathematics BSc program and 'Bèta-gamma' students with a physics major (see below), this adds up to a total of roughly 180 students taking part in our first-year courses. The first and second year of the program are taught mostly in Dutch, the third in English.

2.8.2. MSc Physics and Astronomy

UvA and VU join forces in the master's program Physics and Astronomy, taught entirely in English. The program has been attracting well over 100 first-year students for years, many of whom transfer from our own BSc program. Over the past few years, the number of new students has steeply risen to over 150. The program has several MSc tracks which are loosely linked to the participating research divisions / departments. The tracks most relevant to IoP are Theoretical Physics (over 60 first-year students in the past years), GRAPPA (combined experiment/theory; 30-40 new students per year) and Advanced Matter and Energy Physics (AMEP) (mostly experimentally oriented; about 20 new students per year – much less than desired considering the number of research groups offering thesis projects).

Recently, a taskforce started to investigate the possibility of restructuring of the MSc program more along thematic lines (e.g., quantum technologies, soft matter) rather than along experimental/theoretical physics lines – i.e. more in the spirit of the GRAPPA track, in order to better cater to student needs and – ideally – arrive at a more balanced influx into the various tracks.

2.8.3. Other educational programs

- The UvA's Institute for Interdisciplinary Studies offers a broad and interdisciplinary BSc program called '*Beta-Gamma*' (Natural and Social Sciences). Second-year students who choose to major in physics within this program essentially follow large parts of the BSc program Physics and Astronomy.
- The Faculty of Science is currently making preparations for a new interdisciplinary BSc program named *Science, Technology & Innovation* (website in Dutch), focusing on four themes: 1) high-tech designer materials, 2) renewable energy and resources, 3) engineering life and health, and 4) information science, modelling and simulation. Several IoP staff members are involved in the conception of this program, which is planned to start in the academic year 2024/2025.
- The Faculty of Science is also preparing for a new MSc program named *Quantum Computer Science*, building on the research strengths encompassed by QuSoft. While mainly coordinated by UvA's Graduate School for Informatics, IoP staff members are involved in the preparations and as teachers in the curriculum, which is also planned to start in the academic year 2024/2025.
- Several teachers from IoP are involved in the *Liberal Arts and Sciences* program of the Amsterdam University College, which is taught entirely in English.
- Ambitious students have the possibility to do a *double Mathematics / Physics BSc program* (3 years, 216 ECTS credits) and a *double Mathematics / Theoretical Physics MSc program* (3years, 180 ECTC credits).

2.8.4. Outreach

IoP is active in outreach towards the general public, and towards high school teachers and pupils in particular. Since 2016, outreach activities have been coordinated by Marcel Vonk (spending 0.5 fte on this task next to his 0.5 fte for research and teaching) and supported by the Communications department of the Faculty of Science as well as the IoP secretariat. Recently, Vonk has initiated an Outreach Team with representatives from each division that together with several students will allow for an even broader and well-organized portfolio of outreach activities.

Some examples of successful outreach activities that took place in the evaluation period:

- Many *lab tours* in the WZI and IHEF labs, usually several per month. Visitors range from high school pupils to the Dutch King and French president Macron;
- The *Natk4All program*, a nation-wide course with 20-30 participants annually, organized and taught over the years by IoP staff and PhD's. The course teaches basic quantum physics to high school teachers who are in the process of obtaining their first-degree teaching license;
- The *Quantum Master Classes* for high school students, organized by Waalewijn, Groenland and Vonk, reach 20-30 of the best pupils from local high schools annually. Some pupils who participated in previous years have gone on to study physics in Amsterdam and are now PhD students at ITFA and KdVI;
- The recent *Researcher in the Classroom* project by De Vries and Sonneveld, promises to be successful in reaching out to high school pupils, including those from underrepresented demographics;
- The *lectures at Comenius College* by Van der Schaar and Schoutens;
- The *Quantum Universe website* (of which Vonk is editor-in-chief), reaching and educating many pupils and teachers, with each article being read ~200-300 times;
- The symposium *Viva Fysica* for high school physics teachers and their most

interested pupils, attracting around 200 visitors annually;

- *Science & Cocktails* events, organized through DIEP, a series of public lectures intertwined with music/art performances (see also the highlight on page 42).
- An *Open Day* during the national Science Week (~2000 visitors annually at the Faculty of Science), with demonstrations, lab tours, talks, workshops, etc. Aimed at the general public, with a particular focus on primary and high school students.
- The successful quantum innovation hub *Quantum.Amsterdam*, which IoP helped conceive and maintain through the strong involvement in QuSoft, brings quantum closer to society through a wide variety of activities.
- Several IoP staff members have engaged in writing mostly *popular science books* for a larger audience – see the cover gallery below for an impression.

2.9. Accomplishments during the evaluation period

Most of the IoP accomplishments are described in Chapters 3-5 about the individual divisions. A few institute-level developments are described below.

2.9.1. Sector Plan 'Bèta-Techniek'

A major funding development during the evaluation period with large positive impact on IoP has been the launch of the Sector Plan 'Bèta-Techniek' in 2018. This initiative was aimed at strengthening Physics, Chemistry, Mathematics and Computer Science departments (at general universities) as well as Applied Sciences departments (at universities of technology) in view of increasing student numbers. All universities were invited to submit plans for creating new staff positions relevant to their unique research profile. IoP was deeply involved in the plans from UvA's Faculty of Science, called 'Connecting Science'. For IoP, this plan led to the creation of 7.5 fte new staff positions, several of which shared with other disciplines to foster collaborations (leading to a total of 9 new positions). Since this plan was approved in the fall of 2019, IoP has successfully filled all positions, two thirds of which with female talents. IoP chose to focus on hiring junior faculty in view of the current demographic build-up of the institute (see figure A1.4 in the appendix) and previous success in attracting top young talent in this manner. The profiles of several of the new positions were deliberately chosen in response to external expert advice, including those of the previous SEP assessment committee and IoP's Scientific Advisory Panel (SAP).

The following positions were created:

- Within the research priority area Gravitation & AstroParticle Physics Amsterdam (GRAPPA): one theorist in (astro)particle physics and gravity (Jordy de Vries); one experimentalist in detector development and

collider physics, with close connections to industry, medical applications and universities of applied sciences (Jory Sonneveld); one experimental astroparticle physicist in neutrino physics and searches for dark matter and axions (Tina Pollmann);
- Within the research priority area Quantum Matter & Quantum Information (QM&QI): one experimentalist (Anna Isaeva) and one theorist (Irene Aguilera) in materials physics; a joint theory position in mathematical quantum physics together with KdVI (Mikhail Isachenkov);
- Within the research priority area Soft Matter: an experimentalist in fluid/solid mechanics (Mazi Jalaal); one theorist jointly with the Informatics Institute, with significant synergy with UvA's Institute for Advanced Study (Clélia de Mulatier); one theorist in Computational Soft Matter (Sara Jabbari-Farouji).

2.9.2. IoP-internal project funding

As described in section 2.4, funding for the institute (both direct/internal and external) has been steadily growing over the years. As a result, IoP has consistently produced a modest to sizeable annual budget surplus for almost a decade. In view of the substantial growth in terms of permanent staff (in an increasingly crowded Faculty building), IoP decided not to (exclusively) spend this surplus on new staff positions, but rather on internally funded PhD and postdoc positions. Whereas such positions were ubiquitous in Dutch academia a few decades ago, national budget cuts to university budgets have gradually removed such temporary positions from university departments, increasing the pressure on scientific staff to acquire external funding.

Staff can apply for this funding. This internal funding scheme is quite unique, both within the UvA and nationally. Projects are expected to fulfil one or more of the following criteria:

1. The project aims to build or strengthen **collaboration** within the institute, bringing together principal investigators in different research groups and/or divisions;
2. The project comprises (part of) a peer-reviewed project proposal submitted for external funding but **rejected** with demonstrably positive referee and jury assessments;
3. The project aims at safeguarding scientific **continuity** in a group faced with a substantial grant running out;
4. The project positively contributes to the **diversity** of IoP's scientific staff.

Most funded project applications invoke the collaboration criterium, sparking a lot of new research collaborations, mostly within IoP and to some extent with external partners.

The table below shows the number of granted projects over the past years, as well as the increasing turnover in terms of the associated project costs. Now that the first projects have come to an end, the annual turnover has started to stabilize to a sustainable level of 2 M€.

Year	# New projects	Annual turnover in IoP projects
2016	6	-
2017	6	k€ 22
2018	7	k€ 410
2019	8	k€ 1.230
2020	12	k€ 1.418
2021	6	k€ 1.885
2022	6	k€ 2.149
2023	9	k€ 2.180

The program is generally perceived as a great success, and its relative uniqueness in the Dutch academic landscape has aided in attracting new staff. Most of the collaborative projects sparked novel connections within IoP and with partner institutes that would not have come to fruition without this seed funding, leading

to joint publications and even successful applications for follow-up external funding. IoP is therefore committed to maintaining the program as long as financially sustainable. We currently have no reason to expect a discontinuation in the foreseeable future. For the coming years, we expect that approximately 5-8 new projects can be sustainably funded each year.

2.9.3. Embedding in the Amsterdam context

During the evaluation period, IoP has made a concerted effort to strengthen the collaboration with its immediate academic neighbors, both with the other disciplines within the Faculty of Science and with the NWO institutes on campus. In the aftermath of the regrettable downscaling of the ambitions for joining forces with the Vrije Universiteit (VU, see next section), many new fruitful collaborations have been initiated and/or reinforced:

- Several of the Sector Plan positions were strategically designed to be **shared positions with other institutes** in the Faculty of Science, intensifying the collaborations with in particular IvI, KdVI, API, and HIMS (see section 2.9.1);
- The opportunities created by new **interdisciplinary initiatives** such as DIEP and AI4SMM have been actively and successfully embraced by IoP staff, leading to multiple exciting new project collaborations;
- IoP has expanded its footprint in the **Nikhef collaboration** through multiple new staff appointments. Similarly, new staff appointments at the public-private partnership institute **ARCNL** (co-founded by ASML) have been realized, making ARCNL an increasingly important partner;
- The significant buzz around the quantum theme (a.o. the conception and growth of the center for quantum software QuSoft, the funding impetus by the Quantum Delta NL (QDNL, National Growth Fund award) has helped to create a unique **quantum hub** in Amsterdam, as part of the national quantum ecosystem. IoP is well embedded in this hub. Local partners include Faculty of Science institutes (IvI, KdVI, ILLC, HIMS), CWI, the Vrije Universiteit (VU) and the Amsterdam University of Applied Sciences (HvA). The QDNL grant also provides substantial co-funding for campus development, which at Amsterdam Science Park will be employed for the creation of a new building next to the Science Faculty building with working title LabQ. The development of LabQ is in full swing and the building is expected to be opened in 2027. It will be home to most key partners in the local quantum ecosystem, including QuSoft and some of the lab facilities developed in the context of the QDNL program;
- The Faculty of Science has decided to boost and leverage its **technology profile** (both towards for academic/societal collaboration partners and for future students), including through a dedicated funding program. Although still in the making, the chosen focus on *Molecular and Material Design* (MMD) places IoP in a good starting position for this development. Related to this, IoP staff are actively involved in the development of the new BSc program, 'Science, Technology, and Innovation' (ST&I, see section 2.8.3). We are also expanding the technological aspects of our master's education with a particular focus on the physics of materials.

2.9.4. Reflection on recommendations of previous evaluation

Most recommendations from the previous SEP evaluation concerned IoP's three research divisions and will thus be addressed in the next chapters. The most important institute-level recommendation concerned the **collaboration with the Vrije Universiteit (VU)**, which at the time of the SEP site visit had just seen a major setback.

Over the period 2012-2017, as a result of many years of intensifying collaboration in education, IoP, the Department of Physics and Astronomy at

the Vrije Universiteit (VU) and UvA's Anton Pannekoek Institute for Astronomy had been making preparations to form a joint *Department of Physics and Astronomy* (DPA). The aim was to form a world-leading research entity, exploiting the research complementarity and potential synergies of the three partner institutes. In the years leading up to the previous SEP site visit, the plans for a major relocation were being prepared, in which also other science disciplines would be redistributed over the two campuses of UvA and VU. For Physics and Astronomy, the clear focal point would be at Amsterdam Science Park, creating a concentrated hub of activity by the intended relocation of most of the VU Physics department. However, to the dismay of the physics and astronomy community of UvA and VU (staff and students), the plans for the creation of DPA on Amsterdam Science Park were eventually voted down in the spring of 2017 by the participating bodies at the university level. The concerns raised by the central student and works council were in fact unrelated to the plans for our domain, but instead focused on the relocation plans for the joint Informatics institutes and in particular their teaching programs. Since the relocation of the VU Physics was coupled to the relocation of the UvA informatics to the VU campus, the planned move became impossible.

Despite the SEP recommendations and the efforts by the departments involved, eventually no (partial) relocations could be realized between the campuses, and most of the originally identified research synergies did not materialize. Since then, VU Physics, IoP and API have developed largely independently but successfully, with the collaboration (besides through Nikhef and ARCNL) presently focusing mostly on the joint degree education programs at BSc and MSc levels. Fortunately, in the years following the dramatic decision to abandon the relocation, IoP has been able to shake off most of the disappointment and seize many new opportunities, such as through the Sector Plan mentioned before.

2.10. SWOT analysis

Strengths

- The IoP groups and divisions perform excellent, state-of-the-art research, and are widely recognized for this excellence.
- The addition of the new groups enabled by the Sector Plan 'Bèta-Techniek' have strengthened IoP's profile, in particular towards more application-oriented research directions.
- The policy of creating joint appointments (either between two IoP divisions (IHEF+ITFA) or jointly at one of IoP's divisions and another research institute within the Faculty of Science) has helped to foster new interdisciplinary collaborations.
- The quite unique internal project funding scheme has further helped to initiate and foster innovative collaborative projects that would have been unlikely to start otherwise.
- IoP's embedding in the growing Amsterdam Science Park campus, with several important strategic partner institutes both within UvA's Faculty of Science and among the on-campus NWO institutes (Nikhef, ARCNL, AMOLF, CWI), provides ample possibilities for scientific collaborations.
- The educational programs that IoP staff cater to have a strong reputation and attract many good students, with an overall only moderate teaching workload for staff.
- IoP is proud of its general culture of solidarity and egalitarianism, with minimal hierarchy. Through e.g. the internal IoP funding rounds, care is taken to provide opportunities to all staff in the institute, with little to no incentives to compartmentalize budgets or interests.
- The importance of equity, diversity and inclusion as core part of the institute's culture has been broadly embraced over the past years. While many points of improvement can still be identified, we feel we are on the

right track, also thanks to our committed D&I council.
- The quality and readiness to help of the support staff within IoP and the Faculty of Science is perceived as high.

Weaknesses

- With a historic emphasis on IoP's three divisions, there is as yet no strong branding strategy at IoP level.
- Although the overall influx of MSc students in the Physics and Astronomy program is healthy, their distribution over the various tracks and thereby research groups is inhomogeneous, leading to arguably too many students in Theoretical Physics, and certainly too few in (table-top) experimental physics (AMEP).
- The participation levels in the monthly colloquium are low, possibly indicative of underdeveloped interest beyond one's own field of research and/or lagging cohesion and exchange at the division/institute level, partly caused by the large number of other competing more specialized scientific activities happening at and around the institute.
- The work pressure is perceived as high, in particular among young staff members (in spite of the moderate teaching loads and the changes in tenure track policies).
- The onboarding procedures for new staff are perceived as insufficient, in particular when it comes to learning the ropes of the educational organization. The mentoring scheme for tenure trackers in its current setup needs to be strengthened.

Opportunities

- The increasing attention to furthering the technology profile at the level of the university and the Faculty of Science, with an associated investment program, creates opportunities for many IoP groups to collaborate.
- The various new research consortia and institutes launched under IoP leadership roles (Dutch Institute for Emergent Phenomena, QuSoft, ARCNL) as well as the possibilities enabled by artificial intelligence methodologies for physics can be further and more broadly exploited.
- The pending renovation of the main Faculty of Science building will include a major revision of the office concepts (with input from our staff) and can be exploited to create a better workplace experience, with state-of-the-art facilities for hybrid working, well-equipped meeting rooms, etc. In addition, the preparations for a new building geared towards the quantum community (including QuSoft; opening expected in 2027) creates opportunities for enhanced collaboration.
- With SciPost as a successful launchpad, IoP is ready to take a leadership role in open science initiatives, by supporting the expansion of SciPost's activities into other branches of science.

Threats

- The current national political and economic climate seems unfavorable for university research and education. Increasing cost levels and salaries have generally put university funding under pressure. The national atmosphere around internationalization is under pressure, with the reduction of the long-standing tax-benefit policy for international 'knowledge workers' (the 30% rule) negatively affecting our international competitiveness.
- The international competition for in particular female talent poses a threat for IoP's retention power for female staff as they progress through the academic ranks.
- Despite substantial budget increases at NWO, the success rates for funding applications for curiosity-driven science remain low. New funding instruments with more emphasis on societal challenges and public-private

collaborations have become available, but not all IoP groups are equally well positioned to be successful in such funding calls.
- The high pressure on the housing market in the Amsterdam region and the associated decreasing affordability of living in or close to Amsterdam negatively affects IoP's competitiveness in attracting both talent on the international job market, and visitors and conferences to Amsterdam.
- Lack of a culture of private donations and independent funding foundations limits opportunities compared to several neighboring countries.
- The quality of high-school education in the Netherlands is decreasing according to international review studies (PISA), which will eventually affect our student population in a negative manner.

2.11. Strategy for the next six years

We lay out our strategy for the coming years in the paragraphs below. The strategy for research is for a large part defined and pursued on the level of IoP's divisions, and thus described in the relevant sections of the next chapters. Below, we describe strategic aspects that impact IoP as a whole.

2.11.1. Strategy within the institute

For the next evaluation period, IoP aims to **consolidate the strong points** of the institute, which include the strong reputation of groups and divisions, stability in funding levels, healthy staff size, well-trained PhD graduates, etc. We will continue our successful practice of IoP-internal funding rounds to stimulate collaborations and new initiatives. The present age distribution among our staff (see figure A1.4) indicates that a small fraction of our staff will retire in the coming years. To the extent that this is not yet in progress, we will use this to strategically define which of our groups best benefit from strengthening.

At the same time, we aim to enhance **cohesion** within the institute. After multiple division-level staff retreats, IoP held a first well-received two-day staff retreat for all IoP staff, focused on this and other strategic topics (see pictures below). We concluded there that it is worthwhile to invest in a more visible **institute identity**, without compromising the strengths of individual groups/ divisions. The mostly social events organized by our PhD/postdoc council already ensure that the younger generation increasingly have a sense of belonging on the institute level; the continued joint projects enabled by the IoP funding rounds will keep strengthening this among the permanent staff as well.

The people of IoP are our main asset, from bachelor's students to staff. In order to support them, we will continue to enhance **equity, diversity and inclusion** within the institute. We aim to diversify also in other dimensions than gender, and to further improve the social safety and sense of belonging. For this, the

results of the extensive survey carried out in the past years (available online) contain many important leads. Our Diversity & Inclusion council will continue to play an important role in providing valuable advice on policies and strategy.

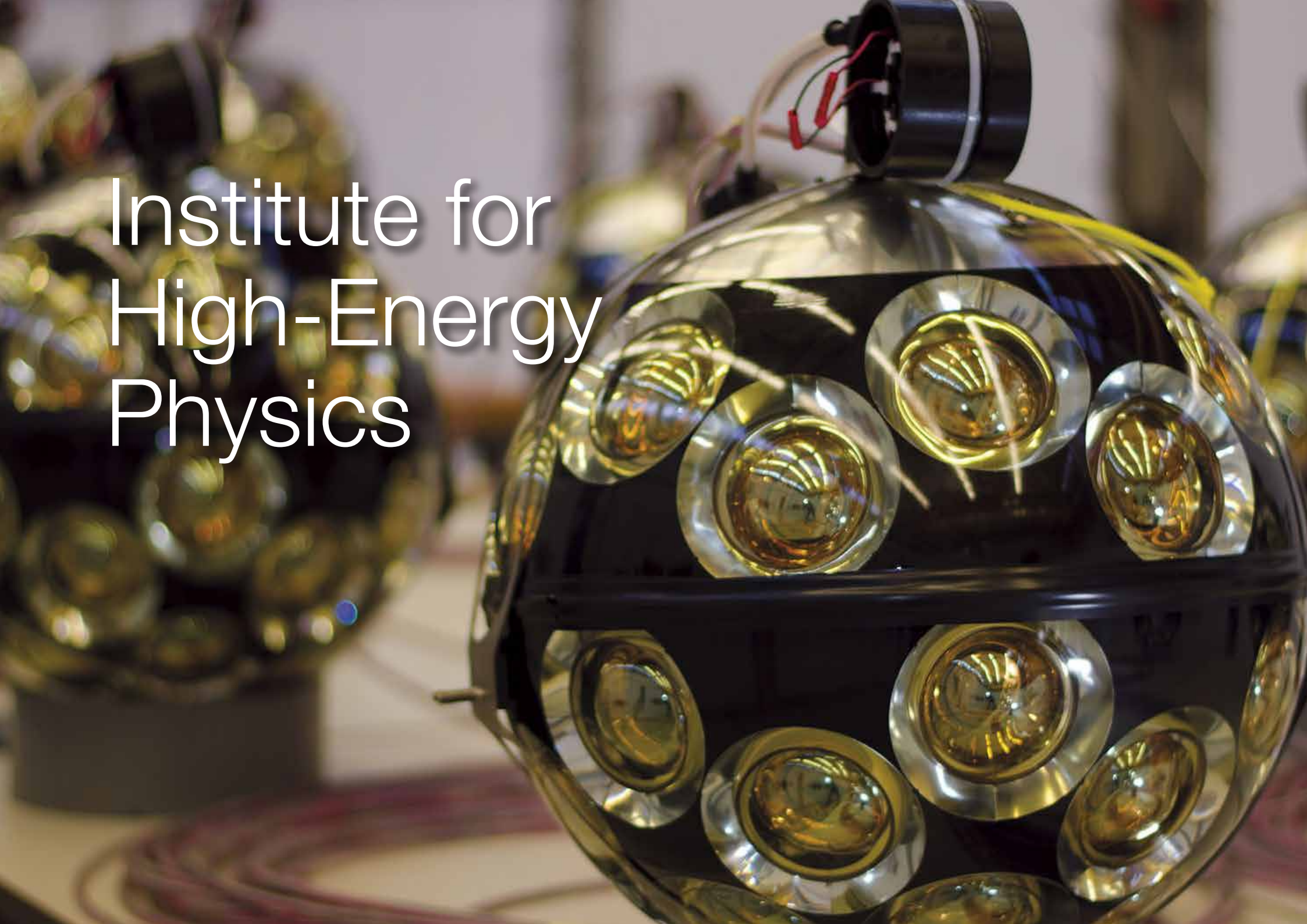
2.11.2. External strategy

Connections to other disciplines and sectors are key to our strategy. We aim to start or strengthen collaborations with research institutes and centers such as DIEP, QuSoft and IvI (specifically in the area of AI) and with industrial and societal partners. In particular, connections with DIEP will continue to be stimulated using DIEP fellowships to attract talented postdoctoral researchers who can make connections between existing research groups. Connections to QuSoft meanwhile build on IoP research groups whose research directly or indirectly impact quantum computation, such as those of Safavi Naini, Gerritsma, Schreck and Schoutens. The realization of the LabQ building will further reinforce the quantum ecosystem at Amsterdam Science Park. Finally, growing connections with IvI will be supported in areas of research where AI plays an increasing role, such as in the analysis of large cosmological (Weniger) or particle collider data sets (Verkerke), as well as in foundational aspects of AI (Cheng).

We will try to capitalize on the fact that we are well positioned to play a central role in the **technology ambitions** of the Faculty of Science (see section 2.9.3), leveraging our own technological strengths as well as our strategic partnerships with the nearby NWO institutes. We are considering reserving part of the IoP-internal project funding to support these initiatives.

We will keep **supporting grant applications** of our staff in terms of early-on pitch sessions, professional text editing, interview preparation including 'grill sessions'. It is generally more difficult for many of our staff to successfully apply for consortium-level and/or more application- and societal/industrial partner-oriented funding calls – often requiring a solid external network as well as options to secure in-kind or in-cash cofinancing. We therefore aim to pay special attention to facilitating and supporting our staff's active engagement in this context. Specifically, we will encourage our senior staff to more proactively include their younger colleagues in such consortia.

Both our full adherence to the principles of open science and our pride for **SciPost** as a brainchild from our own midst motivate us to support this platform both in cash and in kind for the foreseeable future. We aim to help it grow into a major publishing platform across many scientific disciplines.



Institute for High-Energy Physics

3. Institute for High-Energy Physics (IHEF)

The Institute for High-Energy Physics (IHEF) carries out research in particle and astroparticle physics. The goal of the research at IHEF is to unravel outstanding questions about Nature, such as: *What is the origin of mass for elementary particles? What is the equation of state of neutron stars? Are there new symmetries, new physical laws? What explains the patterns we see in the Standard Model of particle physics? What is the neutrino mass hierarchy? Is there CP violation in the lepton sector? What is dark matter?* IHEF is an integral part of Nikhef, the Dutch National Institute for Subatomic Physics.

3.1. Organization

IHEF comprises five research groups: collider physics, neutrino physics, dark matter, gravitational waves, and R&D for future detectors. The Theoretical Particle Physics group does theoretical research related to all these experimental themes and is embedded in Nikhef, IHEF and ITFA; it will be described as part of the ITFA division in Chapter 4.

The experimental research is carried out in international collaborations at particle accelerators such as those at CERN (Geneva), and within the context of astroparticle physics at locations in France and Italy. UvA physicists within IHEF are active in the ATLAS, KM3NeT, DUNE and XENONnT experiments. IHEF members also carry out data analysis at the Virgo (Italy) and LIGO (USA) gravitational wave interferometers. Other members are active in particle physics phenomenology.

The UvA is represented in the Nikhef board, together with five other universities and NWO. Nikhef coordinates the national (astro)particle physics strategy and interacts with international partners such as CERN. Nikhef functions as the home base for IHEF researchers, and UvA (astro)particle physicists have their offices there. IHEF researchers have access to engineers, technicians, and the workshop at Nikhef, as well as to the Nikhef computing infrastructure managed by SURF, including the LHC computing Grid of which Nikhef and SURF support a Tier-1 node.

Research group	**Current staff** (Part-time appointments and professors by special appointment in *italic*; new hires underscored)	**Connects to**
ATLAS	Flavia de Almeida Dias, Paul de Jong, Clara Nellist, Hella Snoek, Marcel Vreeswijk, Ivo van Vulpen, *Wouter Verkerke* (Nikhef)	Nikhef, ITFA, GRAPPA, Radboud U Nijmegen
Neutrino Physics	Ronald Bruijn, Paul de Jong, Patrick Decowski, Tina Pollmann, *Aart Heijboer* (Nikhef)	Nikhef, GRAPPA, U Leiden
Dark Matter	Auke-Pieter Colijn, Patrick Decowski, Tina Pollmann	Nikhef, GRAPPA, RUG
Gravitational Waves	Samaya Nissanke, Philipp Mösta	Nikhef, GRAPPA, VU
Detector R&D	Ronald Bruijn, Auke-Pieter Colijn, Jory Sonneveld, Tina Pollmann, Hella Snoek	Nikhef
Theoretical Particle Physics	Gianfranco Bertone, Eric Laenen, Jordy de Vries, Wouter Waalewijn (all joint with ITFA)	ITFA, GRAPPA, Nikhef Theory Group, U Utrecht
Others	Stan Bentvelsen (Nikhef director since 2014)	

In the period 2017-2023, Paul Kooijman (Neutrino Physics) retired, Frank Linde (Gravitational Waves) transferred to NWO-I/Nikhef, David Berge (0.5 fte ATLAS) left for DESY Zeuthen and the Humboldt University in Berlin, and Els Koffeman (Detector R&D) left the UvA and Nikhef.

3.2. Mission and strategy

IHEF carries out world-leading research in particle and astroparticle physics, and trains physicists from bachelor to postdoctoral level. Our overall mission is to study the interactions and structure of elementary particles and fields and to use them as probes of processes in the Universe.

Over the past evaluation period, IHEF's objectives were:

- To study the mechanism of generation of mass for gauge bosons and elementary fermions;
- To search for new particles or interactions beyond the Standard Model, either directly through the detection of new particles, or indirectly through the measurement of quantum effects due to new particles on precision observables;
- To directly detect gravitational waves from cosmic events involving massive objects and study their sources;
- To detect very-high-energy neutrinos of cosmic origin, identify their sources, and study the properties of neutrinos themselves;
- To directly detect interactions of dark matter particles in highly sensitive low-background experiments and elucidate the nature of dark matter.

3.3. Accomplishments during the evaluation period

3.3.1. People and organization

IHEF has grown during the evaluation period, among others through hires funded (partly) by the Sector Plans, funds to improve the educational program, and the MacGillavry Fellowship program. New hires have been strategically aligned with the Nikhef mission, strengthening particle physics phenomenology (de Vries), detector R&D (Sonneveld), the Dark Matter group (Pollmann) and the ATLAS group (De Almeida Dias, Nellist). After a strategic discussion in GRAPPA and in close collaboration with the astronomical institute, we strengthened gravitational wave theory and interpretation (Nissanke, Mösta) for full exploitation of LIGO-Virgo data, in line with recommendations after the previous evaluation.

IHEF members have taken leading roles in detector design and construction, in coordinating roles in large collaborations, and in data analysis resulting in scientific advancement. Research at IHEF is by its nature collaborative, with research strategies set nationally (i.e., through Nikhef) and internationally (e.g. CERN, ASPERA). IHEF members have played key roles in shaping these strategies. IHEF members have been successful in acquiring funding in consortia (e.g., KM3NeT Roadmap proposal, NWA grant and several NWO-XL grants), as well as individually (e.g., NWO Vidi grants de Vries and De Almeida Dias; NWO Vici grant Heijboer).

Some important funding developments are listed below:

2018: KM3NeT Roadmap proposal granted.
2020: NWO Physics program grant for Dark Matter and Neutrino Groups.
2021: ENW-XL proposal for Higgs physics in ATLAS granted, Dutch Black Hole

consortium and PTOLEMY NWA grant approved.
2022: ENW-XL FASTER program for fast-timing detectors granted.
2023: Einstein Telescope National Growth Fund proposal granted.

Highlight **ATLAS Inner Tracker detector**

Under the leadership of Marcel Vreeswijk, a team of engineers and scientists is building two 'end cap' structures for the future all-silicon ATLAS Inner Tracker detector. One of these end-cap structures will be fully assembled at Nikhef. Each end cap will consist of 6 disk-shaped detection layers, featuring XX m2 of silicon-strip sensors, a two-phase CO2 cooling system and will be read out with the FELIX data acquisition system co-developed at Nikhef. The complete detector element is projected to be transported to CERN and installed in the ATLAS detector in 2027.

3.3.2. Research quality

In ATLAS we realized a rich program of new detailed **Higgs boson studies** using the LHC Run-2 data (Van Vulpen, Snoek, Verkerke). We performed new precision measurements and expanded the types of accessible signatures in Higgs couplings to WW and ZZ, and to a range of fermions: top, bottom and charm quarks, and tau leptons and muons. The Higgs measurement interpretation framework was significantly evolved. Notable combined interpretations published include the Higgs self-coupling interpretation of single and double Higgs production, the new combined interpretations of all Run-2 Higgs data, and their Effective Field Theory (EFT) interpretations.

In the **search for direct Beyond-the-Standard-Model (BSM) physics** signatures (De Jong, De Almeida Dias), new results on searches for supersymmetry in a wide range of signatures were performed, significantly expanding the sensitivity with respect to LHC Run-1 results. Multiple searches for signs of Lepton Flavor Violation were published. These searches were complemented with two broad 'general' searches that look for deviations in a range of final states that is chosen as wide as was practically feasible. Finally, searches for heavy Higgs partners, which occur in several BSM theories, were also published.

The **study of top-quark interactions** (Vreeswijk, Nellist) has focused mostly on the polarized production of single top quarks, enabling the precision study of CP-violating properties of top-quark interactions to which this final state is uniquely sensitive. The latest interpretations of these results are now also available in the Standard Model Effective Field Theory framework. A new research line was added in the measurement of four-top production, an extremely rare process with large sensitivity to BSM physics, resulting in a first observation of this process in 2022.

In detector construction, the assembly of the carbon-fiber frames of both **Inner Tracker strip end-cap structures** of LHC was started in 2020 (Vreeswijk). One end-cap structure has been completed, and the second is under construction, along with the assembly of cooling manifolds. The complete detector assembly is scheduled for completion during long shutdown 3 (LS3), during 2026-2028. We are performing detailed signal response simulations for Low-Gain Avalanche Detector (LGAD) silicon detectors as part of the high-precision timing High Granularity Timing Detector, which will also be installed in LS3. More generally, we aim to advance the time resolution in semiconductor detectors towards picoseconds, studying a variety of new sensor concepts (Snoek, Sonneveld). The challenge is to make them fast and improve the radiation hardness.

IHEF members also took a leading role in the expansion of the **KM3NeT detector** (which looks for atmospheric and cosmic neutrinos), its commissioning and analyses of first data (De Jong, Bruijn, Heijboer). At the time of writing, 18 detector lines have been deployed in KM3NeT/ORCA (near France), and 28 lines have been deployed in KM3NeT/ARCA (Italy). Funding for more than 50% of the detector is available, including an NWO Roadmap for Large-scale Research Infrastructure grant awarded in 2018. Through Nikhef, IHEF contributes to further detector construction, timing and position calibration, reconstruction and simulation software, modernization of the KM3NeT computing model, and data analysis. A **first neutrino oscillation analysis** was performed, confirming the capabilities of the detector to make a first neutrino mass ordering determination in one experiment with more exposure. With the same dataset, **competitive limits on BSM physics** in neutrinos have been set. Furthermore, first searches for neutrino point sources and neutrinos from dark matter annihilation have been performed; for a competitive sensitivity more exposure will be needed. The group has also been involved in following up external gamma-ray burst-, IceCube- and LIGO/VIRGO alerts.

Highlight **New Horizons Prize for Nissanke**

Nissanke at the 2020 New Horizons Prize award ceremony. Photo credit: Breakthrough Prize Foundation.

IHEF member Samaya Nissanke received the 2020 New Horizons Prize from the Breakthrough Prize Foundation. This prize recognizes early-career achievements in physics and mathematics. Together with Jo Dunkley (Princeton) and Kendrick Smith (Perimeter), Nissanke received the prize for their development of novel techniques to extract fundamental physics from astronomical data. The laureates were recognized at the eighth annual Breakthrough Prize gala awards ceremony on November 3, 2019 at NASA Ames Research Center in Mountain View, California, and broadcast live on National Geographic.

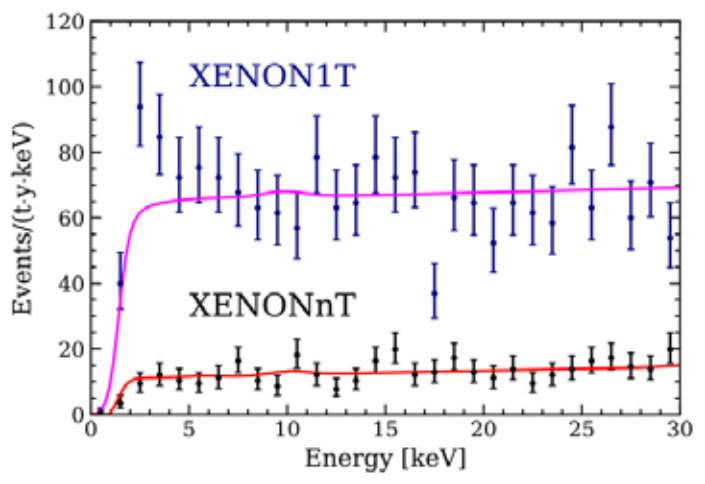
Within DUNE, we have contributed to the design of the data acquisition (DAQ) for **ProtoDUNE-SP**, and to the analysis of its data with emphasis on shower- and neutral pion reconstruction (De Jong). Recently, studies of liquid argon scintillation light detection and measurements of material reflectivity and fluorescence have also been started, with the aim to contribute to the light detection system in the future Near Detector (Decowski, Pollmann). Nikhef also contributes in-kind 10% to the DUNE Grid computing needs.

The XENON1T **dark matter** experiment was upgraded to XENONnT in the past years. XENON1T generated about 25 publications and many thousands of citations, with world-leading results on dark matter and other rare event searches (Decowski, Colijn, Pollmann). We redesigned the DAQ for 'triggerless' operation in XENONnT, upgraded the detector support and levelling system and initiated the development of a new analysis reconstruction framework. We also played key roles in the **analysis of the first low-energy electronic recoil** signal and the **first data for weakly interacting massive particle (WIMP) search from XENONnT**.

The observation of the binary neutron star GW170817 **gravitational wave signal** was a watershed moment in the review period. We played a leading role in the detection and parameter constraint efforts for GW170817 and binary black-hole inspirals and mergers. IHEF members led and contributed to the equation of state analysis for GW170817, helped detect GW190521, participated in the detection and analysis of O3 signals, and predicted detailed kilonova and sGRB signatures from neutron-star merger simulations (Nissanke, Mösta).

IHEF also remains a strong partner in the **Einstein Telescope** (ET) Collaboration, which has been growing organically. The collaboration was formalized in 2022 and successfully secured funding from the National Growth Fund, including 42 M€ for the preparation of a bid to host ET in the Euroregion Meuse-Rhine

Highlight **XENON1T and XENONnT**



The low-energy electronic recoil spectrum in XENON1T (pink line) and XENONnT (red line). XENONnT excluded a reported XENON1T excess in this energy region as being due to new physics.

The XENON collaboration reported an observed excess in XENON1T low-energy electronic recoil data in 2020, see figure. This data was compatible with a trace background of radioactive tritium, but also with beyond-the-Standard-Model signals such as solar axions interacting with the atomic electrons of xenon, generating over 500 citations. During the construction of the superseding XENONnT experiment, special care was taken to minimize tritium contamination. The collaboration prioritized the XENONnT analysis to investigate the low-energy electronic recoil data, reporting no excess with an approximately five times lower background, the lowest ever achieved in a dark matter detector. IHEF researchers were intimately involved in both publications.

(EMR) near Maastricht, with 870 M€ reserved for construction cost in case ET is indeed hosted (in part) in the Netherlands (Bentvelsen, Linde, Nissanke).

There is a fruitful **theory-experiment collaboration** between IHEF and ITFA. Laenen has worked with the ATLAS group on EFT operators for single top quark physics; Waalewijn, also with the ATLAS group, on jet observables and energy correlators; Bertone with the Dark Matter and Gravitational Waves groups on new dark matter signatures; Ando with the KM3NeT group on cosmic neutrino signals, dark matter and multimessenger astronomy, and De Vries with a number of groups on new long-lived particles, CKM anomalies, electric dipole moments, and neutrinoless double beta decay.

3.3.3. Societal relevance

Experimental particle- and astroparticle physics is curiosity-driven science of high societal relevance. The research questions we try to answer relate to the fundamental building blocks of nature in terms of matter and forces, and the origin and evolution of our Universe itself: *what are we made of, and how did we get here?* Such questions appeal to a wide audience of all ages, inspire children to develop their talents for discovery, and are deeply embedded in our cultural DNA.

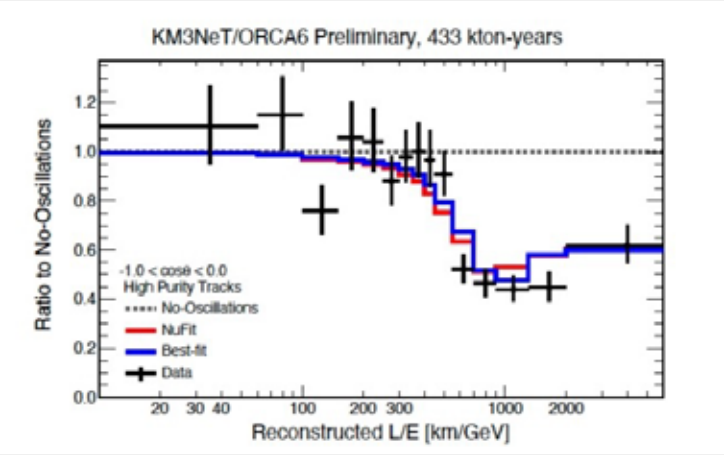
The development of *human capital* is one of the main products of our science program. We train students (bachelor, master, PhD) and early-career scientists in using scientific methods to approach complex problems, to use and develop modern methods, software and technology, and to contribute to advancing the boundaries of scientific knowledge. In experimental (astro)particle physics they typically do so in large international collaborations, where they learn team-science skills and intercultural collaboration and communication. This gives them a unique combination of hard and soft skills, and an international network that lasts a lifetime.

Experimental progress relies on *advances at the frontiers of technology*. Through Nikhef and in close collaboration with industry, IHEF scientists design, prototype and construct new particle detectors for the experiments we carry out. Such detectors typically also have applications outside particle physics, and the knowledge transfer offices of Nikhef and CERN help us to make such connections, to industry but also to other branches of science. Examples include the commercialization of Medipix and Timepix detectors for medical purposes, MEMS-technology developed for gravitational-wave science, the precise White-Rabbit timing system, and the interest of computer vendors to work closely with Nikhef in high-speed internet applications. The preparations for a future Einstein Telescope, possibly in the Euregion Meuse-Rhine, have triggered close cooperations with numerous companies and science institutions in the Netherlands, Belgium and Germany, with a significant role for IHEF/Nikhef.

Experimental (astro)particle physics uses, produces, and advances *modern software and computing*. Particle physics has pioneered analysis of very large data sets and the use of collaborative tools. The Nikhef scientific computing infrastructure is part of the national eScience infrastructure managed by SURF and is open to other sciences than particle physics. IHEF/Nikhef co-developed software, including data analysis and fitting software like RooFit/RooStats, software to model gravitational waves from massive dynamic astronomical sources, particle track reconstruction software, and data acquisition software.

Societal relevance includes bridging the gap between academia and society, in the form of *education and outreach*. IHEF physicists regularly give lectures at schools, e.g. via the *Researcher in the Classroom* initiative. We contribute to the development of educational material for particle physics in high-school curricula. We offer opportunities for participation in short school projects at Nikhef ("profielwerkstukken") as well as Master classes in particle physics as member of the European Particle Physics Outreach Group. University students follow

Highlight **Neutrino oscillations captured by KM3NeT**



Oscillation length divided by neutrino energy spectrum for selected muon neutrino candidates in KM3NeT/ORCA, normalized to the expected distribution without oscillations.

The physics goal of the ORCA building block of KM3NeT is to measure atmospheric neutrino oscillations and determine the neutrino mass ordering. A first analysis of neutrino oscillations was performed with only six detection lines (out of more than 100 planned) and 500 days of lifetime, combining to a detector exposure of 433 kton-years. Oscillations of muon neutrinos were observed and fitted oscillation parameters agree with the world average; precision on the mixing angle theta_23 approaches that of other leading experiments, providing excellent prospects for a first determination of the neutrino mass ordering in one experiment with a larger exposure. This measurement is a prime target for IHEF physicists; the Nikhef team built a major part of the detector, wrote the reconstruction software and co-led the data analysis.

dedicated courses on particle physics, and we also contribute to teaching those outside the UvA, notably at technical universities. We have also established a number of links to Universities of Applied Sciences through student projects at Nikhef. We take part in European training networks like ATTRACT, and we offer opportunities for physics teachers to visit Nikhef and CERN. IHEF physicists have a regular presence in the media (TV, radio, newspapers, magazines) and are active on social media, such as Twitter/X, YouTube and TikTok. The Leiden Wall Formula project, co-initiated by Ivo van Vulpen, was awarded several prizes; Ivo van Vulpen also wrote a popular science book and was appointed professor by special appointment in Science Communication at the Universiteit Leiden.

3.3.4. Reflection on recommendations of previous evaluation

Recommendation 1: *Expand and continue the work on gravitational wave research by reinforcing the theoretical research efforts on this subject.*

The hiring of Samaya Nissanke and Philipp Mösta, both jointly with the Astronomical Institute of the UvA have strengthened the research profile in this direction. Mösta is an expert in numerical modelling of supernovae and compact object mergers, with predictions for gravitational wave and neutrino signatures. Nissanke is an expert on gravitational wave data analysis and interpretation, and multi-wavelength follow-up observations; she also works on preparatory studies for future facilities such as the Einstein Telescope.

Recommendation 2: *Prepare a solid personnel strategy, anticipating upcoming retirements.*

We hired seven new faculty members through the Sector Plans and the MacGillavry Fellowship at IHEF. These searches followed an internal strategic discussion and are also aligned with the Nikhef strategy. This has made the staff composition at present well balanced and future proof. Jordy de Vries is a phenomenologist with wide collaborations with multiple groups, both in theory and experiment. Jory Sonneveld strengthens the detector R&D group, preparing for future experiments and tightening links to technology in education. The previously somewhat small dark matter group was enforced with Tina Pollmann, who also links to DUNE. Flavia de Almeida Dias and Clara Nellist reinforced ATLAS after several other people switched to other experiments or responsibilities.

Recommendation 3: *Try to innovate in outreach activities, making use of the current favorable environment.*

IHEF takes part in new IoP-wide initiatives such as Researcher in the Classroom and Science and Cocktails, and in those of Nikhef such as the “Dimensies” magazine. We hired Clara Nellist, a well-known science communicator with a wide audience, e.g. on TikTok. Ivo van Vulpen, author of the popular science book ‘De melodie van de natuur’, was appointed in 2022 as (part-time) professor by special appointment for Science Communication (at Leiden University).

3.4. SWOT analysis

Strengths

- Clear focus within fundamental science.
- Strong embedding in Nikhef, with its engineering, construction and computing support.
- Proven leadership in a highly competitive field.

- Diverse group with complementary expertise in various subfields.
- High impact and visibility of IHEF members in experimental particle and astroparticle physics, with an internationally competitive publication and citation record.

Weaknesses

- Limited visibility of IHEF within IoP, due to its embedding in a separate building across the street.
- Limited number of spin-offs or commercialization of products.
- Large collaborations make it difficult for young people to stand out.

Opportunities

- Rapid and exciting developments in artificial intelligence, and its application in our research.
- National Growth Fund investment in the Einstein Telescope.
- Participation in the DUNE neutrino experiment will allow us to study novel aspects in neutrino physics, such as lepton CP-violation.
- In the coming years a choice for a future collider will likely be made, after vigorous international debate.

Threats

- Current funding schemes in the Netherlands emphasize short-term projects with immediate societal or economic impact and are poorly suited for fundamental science with very long projects.
- Delays in the realization of large international projects may affect the careers of young scientists.

3.5. Strategy for the next six years

The IHEF strategy follows the international strategies as laid out in the European Strategy for Particle Physics, the APPEC strategy for astroparticle physics, the strategy for large international infrastructure as laid out in the ESFRI roadmap, and the national strategy coordinated by Nikhef.

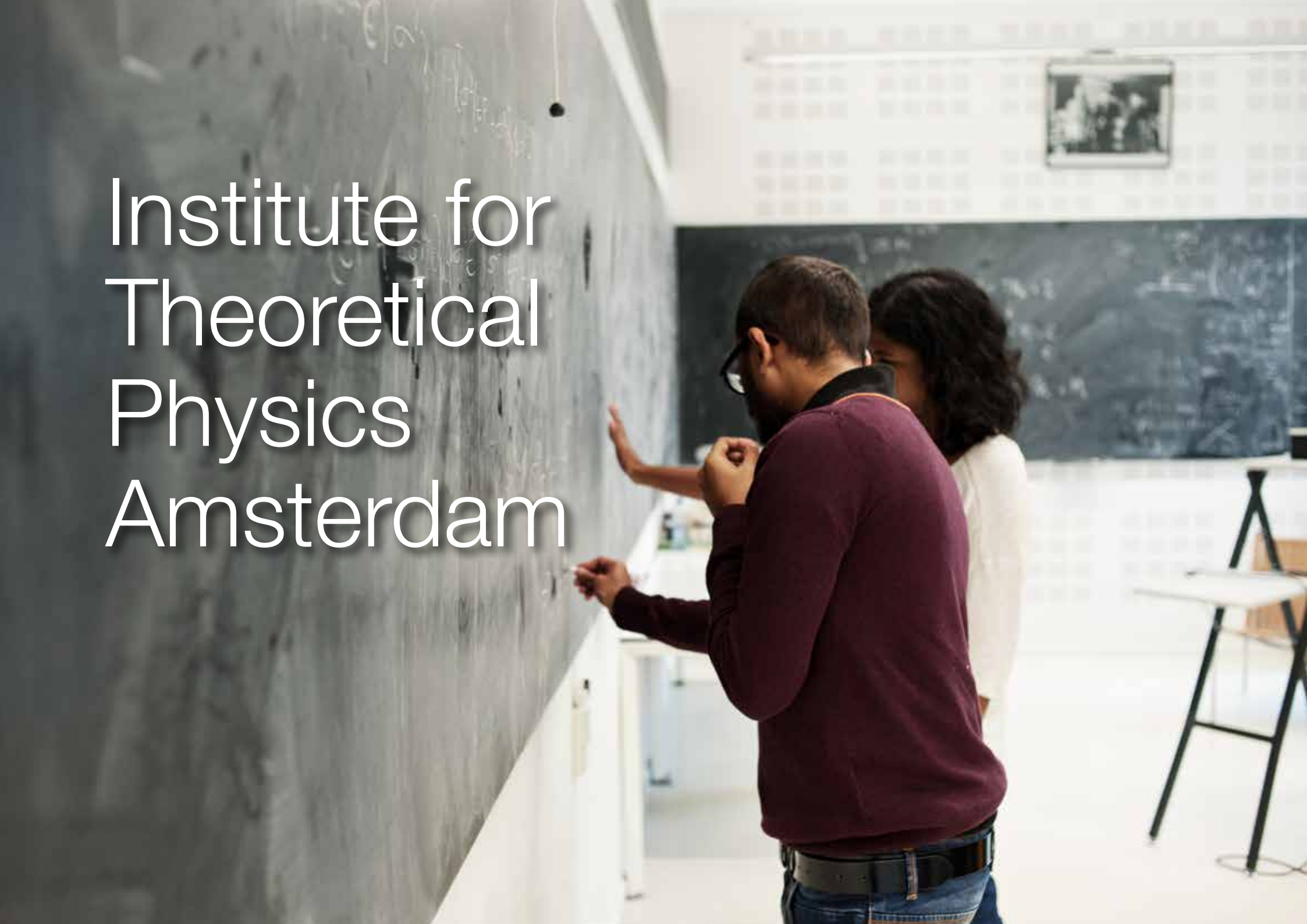
After the recent growth we expect IHEF to remain roughly constant in size in the next years. The challenge for IHEF will consist of maintaining the balance between exploitation of running facilities, construction of detector upgrades, and seizing upon new opportunities in the form of new initiatives. We strive to make significant impact and take leadership in some of the leading experiments in collider- and astroparticle physics, addressing the most pressing research questions formulated in the strategy documents.

Running facilities include ATLAS in LHC Run 3 and beyond (Higgs, top, di-boson physics); KM3NeT (neutrino oscillations, neutrino mass ordering, cosmic neutrino studies); XENONnT (WIMP searches, axion-like particle searches, neutrinoless double beta decay searches) and LIGO-Virgo-KAGRA (binary neutron star mergers studies and numerical modeling). All of these facilities expect a significant increase in scientific data in the next years, and enhanced sensitivity. Ongoing detector construction activities include integration of more KM3NeT detector lines with the ambition to finish the full size of KM3NeT 2.0 as designed, and the assembly of a completely new all-silicon endcap of the ATLAS Inner Tracker. We participate in the research, design and prototyping of the high-granularity timing detector for a future ATLAS upgrade, in the next generation dark matter detector (XLZD/DARWIN), and in the scintillation light readout for the liquid argon Near Detector of the DUNE experiment. Hardware contributions will be matched with contributions to simulation and reconstruction software.

The Einstein Telescope (ET), currently under design, will revolutionize gravitational wave physics and astronomy, and IHEF physicists are taking leading roles in the organizational structure and preparation studies. It is our ambition to also take a leading role in the analysis of ET data regardless of where it will be built, but we support the Euregion Meuse-Rhine option. Also, the space-based LISA mission was recently approved. CERN is preparing for a future beyond the LHC; a strategic discussion at Nikhef has been started with IHEF leadership, with the aim to influence the decision-making process in the next European Strategy update.

IHEF is fully integrated in Nikhef, which fosters close social interactions and collaboration between IHEF members, NWO-funded physicists, and particle physicists from other universities. IHEF follows common Nikhef policies. At the same time, as part of IoP, we strive to expand cooperation with the other IoP divisions and minimize the effects of being located in a different building – less than 500 m way – by common colloquia and (social) activities. The links between the IoP divisions IHEF and ITFA are well-developed, in particular in theoretical high-energy physics. The GRAPPA center-of-excellence provides a stimulating and inspiring environment for collaboration between theory and experiment in astroparticle physics (neutrinos, dark matter, gravitational waves); we plan to organize more GRAPPA activities in the renovated Nikhef building. There are opportunities in expanding the links with WZI and we strive to do so: WZI-developed materials and systems may provide interesting future particle detectors, comprising also quantum sensing technologies. In a larger context we will explore opportunities for quantum computing algorithms and applications in particle tracking, as well as the further use of AI in data analysis and interpretation.

There is an increased focus on technology in the Faculty of Science. IHEF technology is part of the curriculum of the new Science, Technology and Innovation bachelor program, and we plan to offer projects to students of this program, as well as to students from Universities of Applied Sciences elsewhere, with the ambition to attract more technology-oriented students to IHEF/Nikhef. We will increase efforts to connect interested students to the spin-off incubation centers at Nikhef, at CERN and at the UvA.



Institute for Theoretical Physics Amsterdam

4. Institute for Theoretical Physics Amsterdam (ITFA)

The Institute for Theoretical Physics Amsterdam (ITFA) performs world-class research in theoretical physics, and teaches and trains students, PhD candidates, and postdocs accordingly. Within IoP, ITFA stimulates collaboration with external groups, exemplified by its active participation in local initiatives like GRAPPA (GRavitational and AstroParticle Physics Amsterdam) and QuSoft, as well as in national clusters like the Quantum Software Consortium (QSC), the Dutch Institute for Emergent Phenomena (DIEP), and the Delta Institute for Theoretical Physics (Delta-ITP). But ITFA also has a unique culture of fostering theoretical work that transcends the boundaries between different specializations, producing researchers and collaborations that bridge the gaps between different fields of theoretical physics.

4.1. Organization

Researchers at ITFA work around various research themes. One of the strengths of ITFA is that these themes are tightly linked together. In the table below, this is seen through the involvement of staff members in multiple programs. It should be emphasized that these themes do not represent organizational units, and in particular do not have group leaders.

This large theoretical institute is managed with as little hierarchy as possible. Although ITFA has a formal head (currently de Boer), who is also part of the management team of the IoP, we try to take decisions as much as possible by consensus. Biweekly staff meetings and two-yearly retreats ensure the exchange of information between staff and allow for discussion of teaching, funding, organizations, opportunities, and general strategy. Often focus groups are formed to discuss specific themes such as the institute's research or outreach strategies.

Theme	**Current staff** (Part-time appointments in *italic*; new appointments underscored)	**Connects to**
Soft Matter and Complex Systems	Armas, Jabbari-Farouji, Lerner, de Mulatier, van Wezel	WZI Soft Matter; DIEP
Quantum Condensed Matter	Aguilera, Armas, Caux, Corboz, Gritsev, Nieuwenhuizen, Olsson, Safavi-Naini, Schoutens, van Wezel	WZI Quantum Matter; QuSoft; ARCNL
Astroparticle Physics	Ando, Bertone, Freivogel, Mösta, Nieuwenhuizen, de Vries, Weniger	GRAPPA, API, IHEF
String Theory	Armas, Baumann, de Boer, Castro, Cheng, Eberhardt, Freivogel, Hofman, Puhm, van der Schaar, Verlinde, Vonk	DIEP, other national string theory groups
Cosmology	Armas, Baumann, Bertone, Freivogel, van der Schaar	Nikhef, national cosmology program
Mathematical Physics	De Boer, Caux, Cheng, Eberhardt, Gritsev, Verlinde, Vonk	KdVI
Particle Physics	Laenen, de Vries, Waalewijn	IHEF and Nikhef
History and Philosophy of Physics	Van Dongen, de Haro-Ollé	Faculty of Humanities, ILLC
Quantum Information	Lami, Safavi-Naini, Schoutens, van Wezel	QuSoft, KdVI, ILLC

4.2. Mission and strategy

Over the evaluation period, the main mission of ITFA has been to perform world-class research in theoretical physics and to teach and train students, PhD students and postdocs accordingly. Because theoretical physics does not require a large infrastructure and corresponding long-term planning, the approach has been to avoid working with a top-down five-year research plan, and instead view the institute as a facilitator of top-quality research. We aimed to implement this approach by providing broad professional support for staff members and research groups, by encouraging collaborative projects inside and outside the institute, by continuous attention to PhD candidate recruiting and monitoring, by continuously scouting for new (funding) opportunities and new talent, and by maintaining a strong outreach program. In addition, theoretical physics is very much a field driven by grand challenges. These inspired and continue to inspire the research themes at ITFA, and thereby many strategic decisions.

The main strategic focus over the evaluation period was on **fostering connections**, both within ITFA, within IoP, and the wider Amsterdam ecosystem, and on consolidating the attractiveness and reputation of ITFA worldwide. Within this context, some concrete targets were to:

- Increase international visibility and reputation of ITFA;
- Strengthen links between groups in ITFA and other institutes through new hires in gravitational wave astrophysics, quantum control & quantum simulation and Beyond the Standard Model physics;
- Develop a more strategic approach to recruiting;
- Improve HR policy, in particular establish clearer and more transparent goals for career development after tenure;
- Unite Theoretical Physics Amsterdam in one strong institute (division), especially through collaboration with the VU soft matter theory group, with the soft matter experimental group at WZI, with other groups at Science Park, in particular at AMOLF and ARCNL, and with other institutes of the Faculty of Science;
- Further improve the quality of education;
- Ensure that master's and PhD students have a clear view of future possibilities well in advance of finishing;
- Diversify sources of external grants to become less dependent on NWO and ERC grants;
- Take a leading role in establishing European networks and collaborations;
- Maintain a high level of support for grant applications (from colleagues, proof-readers, interview trainer, etc.) and encouragement of the staff to apply for various opportunities; actively scout for funding opportunities;
- Attract more PhD students and postdocs who bring their own funding, attract more high-profile long-term visitors and attract more scientists who take a sabbatical;
- Realize several professorships by special appointment at ITFA.
- Have a more strategic approach to outreach, evaluating the effect of the activities in a quantitative manner and using those results to plan future activities.

In the next section, we will highlight some of these targets and explain how they were concretely achieved.

4.3. Accomplishments during the evaluation period

4.3.1. People and organization

Quality research is performed by quality researchers. The number of staff in ITFA has consistently grown over the evaluation period, as can be seen in table A1.2.

Fluctuations in the numbers (e.g., a peak in postdoc positions around 2020 and a recent increase in PhD positions) are statistical in nature and are explained by the types of grants available at the time. Over the years, ITFA members have consistently been successful in applying for personal research grants (4x NWO Veni, 4x NWO Vidi, 2x ERC StG, 3x ERC CoG; 1x ERC AdG; 1x ERC Syn).

Over the evaluation period, ITFA performed well with regard to the targets described in the previous section, as indicated by the large numbers of publications and citations, the number of invitations to speak at workshops and conferences, and lectures at schools and colloquia. Furthermore, ITFA was successful over the evaluation period in terms of the number of PhD theses completed, individual and collaborative grants obtained, involvement in (inter)national collaborations, and prizes and distinctions. Our ability to attract talent, as evidenced by the number of applications for PhD, postdoc and staff openings, also clearly indicates the high international standing of the institute over the evaluation period.

Both external developments (such as the Sector Plan) and a moderate outbound mobility of staff have provided opportunities for strategic new hires. To connect theory to technology, we have hired e.g.:

- Safavi-Naini to work closely together with Gerritsma at WZI on topics related to quantum computing;
- Olsson (embedded in ARCNL) to work on materials theory and modelling;
- Lami (also embedded in QuSoft) to work on quantum software and technology.

Other new hires, made in accordance with the strategic goals outlined in the previous section, were Armas (working in both Soft and Complex Matter and in String Theory, and coordinator of the DIEP initiative that is highlighted on this page) and De Vries (working on the boundary of Particle Physics and

Highlight **DIEP / Science and Cocktails**

Impressions of past Science and Cocktails events.

The Dutch Institute for Emergent Phenomena (DIEP), founded by Armas, is an interdisciplinary research center across fundamental sciences aiming to uncover how the universe, space, time and the fundamental building blocks of matter emerged from the quantum world, and how these building blocks aggregate forming the nano, molecular and polymeric structures that ultimately give rise to the macroscopic world we experience today.

The initiative also has an outreach component, including the Science and Cocktails events for which Armas received the EPS Outreach Prize. It was a source for new collaborations in the faculty, and more recently led to the funding of a UvA research priority area on the subject of "polarization, segregation and inequality" together with economics, law, and humanities, involving De Mulatier, De Boer and Armas.

Astroparticle Physics, and connecting to Nikhef). Finally, we have hired several people to further broaden the already diverse research portfolio of the institute into exciting new fields: Jabbari and De Mulatier (Soft and Complex Matter), Aguilera (Quantum Condensed Matter), Puhm and Eberhardt (String Theory) and De Haro (History and Philosophy of Physics).

4.3.2. Research quality

Through new hires as well as the choice of research topics, ITFA has kept up with recent developments in both theoretical physics and society. The strengthened connections with QuSoft (quantum software) and ARCNL (nanolithography) are examples of this, as is the foray into the topic of emergence, among other things through the hire of Armas and the founding of DIEP, the Dutch Institute for Emergent Phenomena. In this case the strategy was the driving factor rather than the funding: indeed, DIEP was founded before any external funding was available. Finally, in this context let us mention the extension of our research profile to topics related to data science, AI and machine learning, for example in the work of Weniger (Cosmology) and Cheng (Mathematical Physics).

As several of the new hires extend our efforts in computationally oriented research directions, ITFA invested in computational infrastructure, often in collaboration with other institutes. Besides using the national supercomputer Snellius hosted by SURF, there are now also smaller dedicated clusters within IoP for Computational Soft Matter and Complex Systems research, ITFA research in general, as well as for educational needs within IoP.

In the remainder of this subsection, without being exhaustive but to give a flavor of the breadth of ITFA research, we highlight a few other research accomplishments.

Highlight: Quantum approximate optimization algorithm. The paper Solving correlation clustering with QAOA and a Rydberg qudit system: a full-stack approach grew out of a master's project of an external student (from Twente University) who ended up winning the Lorentz Afstudeerprijs for the work. It addresses a problem from industry, connects theory and experiment, and besides ITFA authors also has authors from WZI as well as CWI and IvI (both in Amsterdam), Twente University and the company Bosch.

Highlight: Discovery of a quantum magnetic analogue to the critical point of water. Water can freeze from liquid to solid ice or boil into a gas. In the kitchen, these so-called phase transitions are not smooth, but at high pressure their discontinuous nature is smoothed out. An international team of physicists, including Corboz and Crone, has discovered the same behavior in certain quantum magnets. The research was published in Nature.

Highlight: Resurgence and nonperturbative physics. Over the past three years, the Amsterdam Resurgence Group came into existence. This small group, embedded in the Mathematical Physics group, is one of the leading groups worldwide on this upcoming topic that uses the mathematical techniques of resurgence to study nonperturbative physics in applications ranging from toy models to QED and QCD. The research so far has led to four papers, and within IoP to an ITFA/IHEF collaboration with PhD student Marinissen, supervised by Laenen and Vonk.

Highlight: From quantum chaos to quantum gravity. Inspired by the decades-old drive to understand the black hole information paradox and the nature of quantum gravity, the past few years have seen an enormous interest in low-dimensional models such as JT gravity, where these questions can in fact be understood and answered through surprising links with quantum chaos, the mathematics of moduli spaces, matrix models and nonperturbative physics.

Highlight **Topology and broken hermiticity**

A new non-conservative metamaterial designed in Coulais' lab.

In recent years, there has been a considerable push to explore the consequences of topology and symmetries in non-conservative, non-equilibrium or non-Hermitian systems. A plethora of driven artificial materials has been reported, blurring the lines between a wide variety of fields in physics and engineering.

The groups of Van Wezel (ITFA) and Coulais (WZI) studied this topic, leading to several publications including one in Nature Physics which is cited almost daily. They discuss the latest advances, emerging opportunities and open challenges for combining these exciting research endeavors into the new multidisciplinary field of non-Hermitian topological systems.

String Theory group members, in particular the groups of De Boer and Verlinde, have made many contributions to this exciting new field, among others through international collaborations with e.g. the group of Sonner in Geneva. With the recent new hires of Eberhardt and Puhm, the group intends to continue exploring these avenues.

4.3.3. Societal relevance

Theoretical physics research often finds important societal relevance through outreach and science popularization, contributions in the media, involvement in high school education, contributing to open access research, etc. ITFA's societal relevance over the evaluation period can be gauged from the broad attendance at activities for high-school students and teachers it organized, as well as the large number of activities (popular books, lectures, (social) media presence, events, website columns) aimed at the general public.

Industrial collaborations are often less trivial to realize for theoretical physicists. However, the research center for quantum software QuSoft and the significant external funding it helped unlock (most notably the 615 M€ National Growth Fund subsidy for the Quantum Delta Netherlands, QDNL) has greatly helped create industrial collaborations (e.g. with Bosch, IBM, Toyota) on quantum technology, specifically quantum algorithms and quantum computation protocols. A first spin-off activity (Hydra Computing) was launched in 2023 and obtained proof-of-concept funding from IXA.

Two important other societal contributions originating from ITFA are mentioned in the case studies: the DIEP initiative centered around emergent phenomena and the open publishing platform SciPost (presented as a case study in the first chapter). Below, again without being exhaustive, we mention a few other highlights of ITFA's involvement in society.

Highlight: Black hole exhibition. At Rijksmuseum Boerhaave in Leiden, Van Dongen and Skulberg have co-curated a major exhibition on the astrophysics of black holes. The exhibition was partially funded by the NWA grant for the Dutch Black Hole consortium.

Highlight: Outreach towards high school teachers and pupils. ITFA is particularly active and successful in organizing outreach activities for high school teachers and pupils. Projects such as the Natk4All teacher courses, the Quantum Master Classes and the Quantum Universe website (all described in more detail in section 2.8.4) have proven to be very effective ways to interact with teachers and pupils, and ultimately to enthuse potential physics students for our field.

Highlight: Media attention for thermalization by a synthetic horizon. The paper Thermalization by a Synthetic Horizon, co-authored by Mertens, Morice and Van Wezel, discusses how black hole horizons can be mimicked and studied in the lab. The press release about the topic created an incredible amount of attention in media worldwide.

4.3.4. Reflection on recommendations of previous evaluation

Recommendation 1: *Prepare a strategic hiring plan, accounting for the current lack in expertise on Gravitational Wave physics and possibly also in Beyond the Standard Model physics and the subcritical size of the soft condensed matter theory group.*

Some of the new hires (in particular through the Sector Plan) were strategically selected to address these topics. For example, with De Vries working on the boundary of Particle Physics and Astroparticle Physics, and Puhm working on aspects of gravitational wave physics from a string theory perspective. In addition, several staff members (mostly in GRAPPA) have embraced gravitational wave physics as one of their research topics.

Recommendation 2: *Strengthen the collaboration of the condensed matter theory groups with relevant tabletop experiments in the Netherlands, also anticipating the possible formation of a larger soft condensed matter group in the Amsterdam region.*

Several strategic new hires (again, in particular through the Sector Plan) address this need. For example, Olsson (embedded in ARCNL) and Aguilera both work on materials theory and modelling that is directly relevant for ongoing experiments in Amsterdam and beyond. They also complement existing research directions of for example Caux and Van Wezel, making them more amendable to tabletop type experimental predictions. Similarly, De Mulatier complements the soft matter and complex systems portfolio of for example Lerner and Jabbari-Farouji, laying the groundwork for further collaborations.

Recommendation 3: *Give more visibility to the very good efforts that the research unit undertakes that are relevant to society, for example by showcasing the work on the QuSoft project and the SciPost initiative.*

The SciPost and QuSoft initiatives are highlighted separately in other parts of this document. The IoP and ITFA support for these efforts is primarily showcased by the individual researchers contributing to them. For example, Caux represents SciPost and IoP's support for it in open publishing fora the world over. Successes involving QuSoft and IoP staff are highlighted in shared press releases such as those on a new method for quantum computing (January 2022) and the award of an NWA grant to research social impact of quantum cryptography (May 2022).

4.4. SWOT analysis

Strengths

- High quality of researchers and research output, resulting in successes in attracting talented staff, postdocs and PhDs, in occupying leading positions in for example GRAPPA and QuSoft, and in securing project funding and individual grants.
- Shallow hierarchical structure, with lots of individual freedom to pursue research lines and high staff involvement through consistent meetings with rotating chairs, and ad hoc focus groups that are initiated bottom-up.

Weaknesses

- The size of the institute as well as the breadth of its research portfolio result in scientific fragmentation and a certain level of disconnect between some subgroups, affecting especially researchers with primarily external collaborators.
- Highly asymmetric distribution of master student projects over ITFA faculty.

Opportunities

- The rapidly emerging field of artificial intelligence offers fruitful connections to our physics themes that can be exploited. Several researchers at ITFA are already working in this area.
- Our leading and coordinating roles in GRAPPA and QuSoft, and our connections with CWI, KdVI, ARCNL and IvI provide opportunities for both funding and collaboration.
- The pending renovation of the building presents opportunities to redesign the institute to support our strategic aims, enhancing collaboration and fostering connections.

Threats

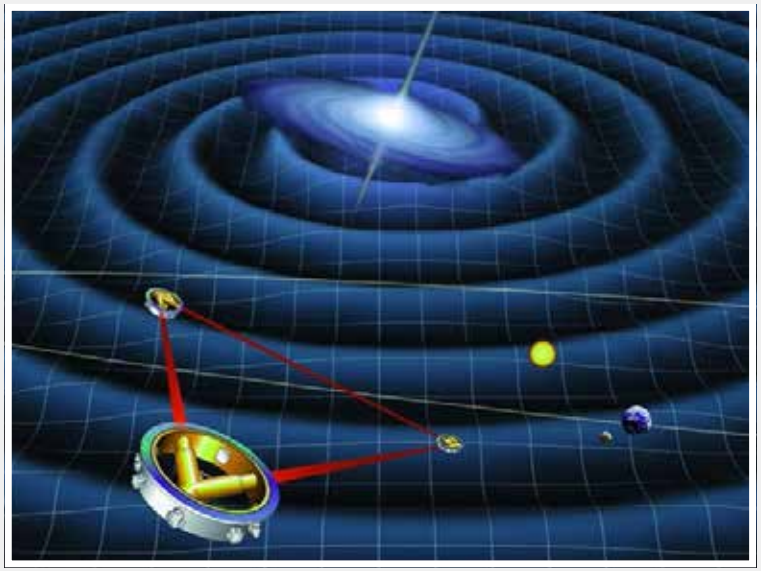
- We currently rely on a relatively small set of funding instruments.
- Lack of obvious societal impact (or communication thereof) may threaten finding new funding opportunities.
- The Delta-ITP program will not be renewed, and a follow-up is currently lacking.

4.5. Strategy for the next six years

We do not expect to grow (much) in size over the next few years, as the total funding for theoretical physics in the Netherlands has its limits. Nevertheless, it is important to formulate our ambitions for the future **scientific profile** and derive an actionable plan to achieve it in terms of hiring, in view of several upcoming retirements. While the specific research areas are to be determined, e.g. research that can connect with societal challenges could be interesting, as it may also open up new sources of funding. These plans should be flexible enough to adapt to new developments while ensuring that researchers will not be(come) isolated.

In terms of **research connections**, our goal is to further strengthen scientific ties within ITFA and beyond. We plan to incorporate more science into staff meetings through presentations and/or scientific speed dating. Everybody at ITFA should know at least in broad terms what everybody else is working on. Other ideas are to create thematic research initiatives involving multiple groups (recommended by IoP's Scientific Advisory Panel), have graduating PhDs present to the entire institute, and facilitate the use of MSc research projects to initiate collaborations.

Highlight **Disks, spikes and clouds around black holes**



Artist's impression of the envisioned space-based LISA experiment detecting a gravitational wave. This technology will allow us to a peek into a black hole's back yard. Image: NASA.

The detection of gravitational waves produced by the merger of black holes is teaching us a lot about the properties of these extreme objects. A team of researchers in the group of Bertone is devising new techniques to extract information, not just about black holes themselves, but also about their surroundings.
A new analysis led by Cole, and published in Nature Astronomy, revealed that with future space-based gravitational-wave detectors such as LISA, it will be possible to distinguish the presence of disks of gas, dark matter and new light particles around black holes.

Also, a robust long-term visitor program could help strengthen connections. To grow our leading role in multidisciplinary initiatives, we need to develop specific approaches. Further fostering connections within ITFA and beyond will open up new opportunities for consortium funding.
Focusing on **social cohesion** within ITFA, our goal is to strengthen connections. We propose achieving this through social activities such as coffee gatherings, cookies, and 'borrels', with the hope that it will also increase participation in scientific activities. However, we emphasize the need to avoid overburdening schedules. The upcoming renovation presents an opportunity to create spaces that are more conducive to interactions.

The rapid **increase in the amount** of available data in many scientific fields, including the social sciences and humanities, offers unique opportunities for ITFA. Theoretical physics offers a broad range of techniques and methods, such as those of statistical physics, to analyze complex systems, distinguish relevant from irrelevant degrees of freedom, diagnose phase transitions, connect different scales via the renormalization group, etc. Emerging fields such as sociophysics and econophysics are clear evidence of this. We plan to use part of the next ITFA retreat to critically analyze our current position in this landscape and to discuss our future strategy in this respect. A further investment in these areas may well put us in a better position to showcase the importance of theoretical physics, its societal relevance, and to enable a broader participation in multidisciplinary consortia.

Van der Waals-Zeeman Institute

5. Van der Waals-Zeeman Institute (WZI)

The van der Waals-Zeeman Institute for Experimental Physics (WZI) carries out world-leading experimental research in the field of experimental physics, provides education within the physics and other curricula, transfers knowledge, and generates enthusiasm for experimental physics to society, both in the form of collaboration with industrial partners as well as in terms of boosting interest in physics in general and in its study in particular.

WZI research is powered both by a fundamental, knowledge-based drive, as well as an ambition to maximize the transfer to and exploitation of results in industry and society in general. Several WZI professors by special appointment with industry affiliations help to connect to industry.

5.1. Organization

The WZI comprises three research groups: Quantum Materials / Hard Condensed Matter (QM), Soft Matter (SM), and Quantum Gases & Quantum Information (QGQI). In the table below we outline our current staff per group. We have strong research links with the Advanced Research Center for Nanolithography (ARCNL), the joint institute between ASML, NWO, UvA and VU. The WZI was strongly involved in the conception of ARCNL and continues to be an important partner, with several ARCNL group leaders formally embedded in WZI.

To run this experimental physics division, a number of major cost factors for the experimental research taking place at WZI, such as technical staff costs, workshop time in the faculty's Technology Center and purchasing of chemicals and cryogenic liquids are not split up and distributed on a research group level. This policy simultaneously ensures the necessary continuity in the technical support for the institute and fosters a culture of solidarity.

Research group	**Current staff** (Part-time appointments and professors by special appointment in *italic*; new appointments underscored)	**Connects to**
Quantum Materials	Anna Isaeva, Mark Golden, Jorik van de Groep, Erik van Heumen, Anne de Visser, Roland Bliem (ARCNL), Paul Planken (ARCNL), Albert Polman (AMOLF), *Femius Koenderink* (AMOLF), *Erik Garnett (AMOLF)*	ARCNL, AMOLF, ITFA, VU, QuSoft
Soft Matter	Daniel Bonn, Antoine Deblais, Corentin Coulais, Joshua Dijksman, Mazi Jalaal, Peter Schall, Noushine Shahidzadeh, Rudolf Sprik, Bart Weber (ARCNL), *Krassimir Velikov (Unilever), Cees van Rijn (Medspray), Ellen Backus (U. Vienna), Mischa Bonn (MPI Mainz)*	JMBC, CSM, ARCNL, AMOLF, ITFA, AI4SMM, DIEP, NICAS, Unilever, Medspray
Quantum Gases and Quantum Information	*Philippe Bouyer*, Klaasjan van Druten, Rene Gerritsma, Florian Schreck, Robert Spreeuw	QuSoft, ITFA, QSC, ARCNL, VU, TU/e, AMOLF

5.2. Mission and strategy

Over the period 2017-2023, the WZI aimed to:

- Make the WZI organization more robust, professional and attractive;
- Achieve research excellence across themes in experimental physics;
- Cover a balanced set of research areas ranging from strongly fundamental

work with a long-term applications horizon to full-value partnerships with the private sector.
- Increase the international visibility and reputation of the WZI;
- Play a constructive and even leading role in the local, national and international physics communities and act as ambassadors for physics to the general public;
- Identify, initiate and grow connections within IoP and the Faculty of Science, as well as with VU Physics and Astronomy and the institutes located in the Science Park Amsterdam;
- Inspire and enable new generations of students, PhD researchers and postdocs to reach their full potential.

5.3. Accomplishments during the evaluation period

5.3.1. People and organization

Over the evaluation period the WZI has done well, as is evident from the growth in staff, the high amount of external (personal) funding acquired, and the scientific output. At present, all three groups enjoy international renown, and all have a critical mass of academic staff with a healthy spread in seniority. There is also an important 'family feeling' in the WZI, visible in the solidarity between the different pillars of the institute: we share costs for TC (workshop services), we help each other with grant proposals, we keep a mentoring eye on each other's PhD researchers, we have a weekly staff lunch, we have joint efforts in outreach etc.

In the context of making the organization more robust, professional and attractive, our actions were:

- We consolidated and rejuvenated the three pillars of the WZI by new hires;
- We strengthened the ties with ARCNL by embedding the (also partly new) relevant staff within the WZI;
- With the new hires, a large number of new activities emerged, allowing the WZI to remain at the forefront of the different fields it covers and to assure sufficient funding for these;
- We developed a large number of valorization activities and new collaborations with industry, allowing also to secure new sources of funding;
- We organized the technical support of the three pillars by hiring a new technician (in 2017, 2022 and 2024) for each of them;
- We co-founded the Computational Soft Matter lab, strengthening the ties with ITFA, and the Chemistry and Informatics Institutes;
- We co-founded the AI for sustainable molecules and materials (AI4SMM) research priority area (RPA) of the faculty, which succeeds the Soft Matter RPA. IoP was highly successful in the first round of the AI4SMM call;
- We strengthened the ties with our Technology Center (TC, mechanical and electronics workshops) by having regular informal meetings and presentations of our staff at the TC, and through the newly hired technicians;
- The training of PhD students was taken up more professionally, by adhering to either ITN networks or Doctoral schools such as the J.M. Burgerscentrum;
- We acquired personal grants including NWO Vidi for Coulais and Van de Groep, and NWO Vici for Gerritsma. At the European level there were ERC Starting Grants for Jalaal, Bliem, Weber, Coulais and Van de Groep, as well as an ERC Advanced Grant for Bonn. Awards included the APS Soft Matter prize for Coulais, KNAW membership and APS fellowship for Bonn, Physica prizes for Bonn and Schreck, and Soft Matter Emerging Investigator award for Deblais.

Over the evaluation period, three staff members left: Katerina Newell (QM) left for a teaching position at Amsterdam University College, Ben van Linden van den Heuvel retired, and Tom Gregorkiewicz sadly passed away while employed parttime beyond his retirement. Staff scientist Yingkai Huang, responsible for the crystal growth facilities of QMat, retired in 2023. Most of his activities are continued on by the new group technician.

5.3.2. Research quality

All three pillars of the WZI have grown substantially, both in permanent staff and in the number of PhD candidates and postdocs. The research infrastructure is excellent, as is the technical support of the Technology Center. The atmosphere is collegial; research equipment is routinely shared within and between the research clusters, and there are several joint projects both within and between the three clusters. All three are well embedded nationally, with many international collaborations. As a mere example, several **international conferences** were organized in the Amsterdam region by WZI staff, including SCES2022 and five Lorentz workshops. A few more are still in preparation, such as metamaterials conference, several other Lorentz workshops, and the European Conference on Ion Trapping (ECTI).

The **Quantum Gases & Quantum Information (QG&QI) group** has grown substantially to about 35 people (including PhD candidates and postdocs) and enjoys strong national and European funding (ERC, NWO Veni/Vidi/Vici, NWO ENW XL program, QDNL, etc.). A number of new experimental setups have become operational and are now bearing fruits; they provide the group with worldwide unique physical systems (e.g. Rb-Sr, a continuous Bose-Einstein condensate, Rydberg atoms in optical tweezer arrays, Li-Yb^+ atom-ion mixture, 2D ion trap, optical atomic clocks), giving an excellent perspective for high-impact work. The group enjoys close collaboration with theory colleagues within IoP.

Highlight **President Macron and King Willem-Alexander**

President of France Emmanuel Macron and King Willem-Alexander of the Netherlands visit the QG&QI labs. Photo: Freek van den Berg.

The QG&QI group at WZI studies ultracold atoms. Through an intricate combination of laser cooling and trapping, ultrahigh vacuum, and advanced optical imaging techniques, atoms can be cooled to temperatures close to absolute zero. This opens a window onto the fundaments of physics that can also be harnessed to build new quantum sensors, quantum simulators, quantum computers, as well as the most accurate clocks in the world.

QG&QI hosts the European Quantum Flagship project AQuRA which aims to develop a prototype of a commercial optical atomic clock. In April 2023, French president Macron visited the QG&QI laboratories, together with His Majesty King Willem Alexander, to learn all about this topic. Profs. Florian Schreck and Philippe Bouyer showed the multiple applications of ultracold atoms for atomic clocks, quantum computers and much more.

The QG&QI group plays an active role within the rapidly developing quantum ecosystem in the Netherlands and Europe, interacting with many partners, ranging from within IoP to the international scene. Within the framework of Quantum Delta NL (QDNL, which was awarded 615 M€ from the National Growth Fund in April 2021), Philippe Bouyer led the CAT-3 Ultracold Quantum Sensing Testbed, and recently joined the QDNL board. QG&QI also participate in the Quantum Software Consortium (QuSoft), a Gravitation project (together with the universities of Leiden and Delft, CWI and VU) funded by the Dutch Research Council. QG&QI also hosts the European Quantum Flagship project aQuRA which aims to develop a prototype of a commercial optical atomic clock.

The work of QG&QI is stirring interest in the international community, resulting in fruitful collaborations with theorists and experimentalists abroad, as can be seen in joint publications, grant applications and participation in European networks. The recent recruitment of Bouyer (jointly appointed at Eindhoven University of Technology) strengthens our position in quantum sensing. The group has monthly joint seminars together with sister groups at the VU and ARCNL.

Highlight: Continuous Bose-Einstein condensation. Bose–Einstein condensates are macroscopic coherent matter waves that have revolutionized quantum science and atomic physics. A long-standing constraint for quantum gas devices has been the need to execute cooling stages time-sequentially, restricting these devices to pulsed operation. As published in Nature, we demonstrated continuous Bose–Einstein condensation by creating a continuous-wave condensate of strontium atoms that lasts indefinitely. This proof-of-principle demonstration provides a new, hitherto missing piece of atom optics, enabling the construction of continuous coherent-matter-wave devices.

Highlight: Buffer gas cooling of a trapped ion to the quantum regime. Both trapped ions and atomic gases are used for high-precision measurements at the lowest possible temperatures. We pioneered trapped ytterbium ions in an ultracold lithium gas. Our results open up numerous opportunities, such as the exploration of atom–ion Feshbach resonances.

The **Quantum Materials (QMat) group** is thriving and growing in international visibility. Its excellent lab infrastructure and well-chosen, modern themes in solid-state and materials physics attract a strong team of international young researchers. Collaboration (leading to jointly supervised MSc and PhD students and joint papers) with IoP's CMT group at ITFA is on the up, and we have concrete and growing links with ARCNL (near field optics, materials science), AMOLF (nanophotonics, nanophotovoltaics), VU Physics and Astronomy (nanophotonics & semiconductor nanostructures for natural and artificial photosynthesis) and QuSoft (quantum information for quantum matter). QMat's two new staff recruits van de Groep and Isaeva bring new energy and directions to the group and help maintain a good balance between fundamental and more applied research approaches. An open and international recruitment process is ongoing for the replacement of Anne de Visser who is retiring soon. The focus here is on bridging the different parts of the cluster, and working on more applied subjects, because the funding there is likely to be easier.

Highlight: First clue of physics far beyond the usual model of metals. In 2009, it was discovered that the electrons in cuprates form a new type of structure, different from that in ordinary metals, and the term 'strange metal' was born. Surprisingly, the theoretical machinery of string theory turned out to be able to predict certain phenomena occurring in strange metals. WZI's Van Heumen was part of an NWO Open Competition project on strange metals, yielding publications such as in Nature on incoherent transport across the strange-metal regime of overdoped cuprates.

Highlight: New magnetic materials for quantum technologies at room temperature. Magnetic topological insulators are a new class of semiconductors that may revolutionize electronics thanks to their quantized surface conductivity and exotic emergent phenomena. In 2019, Isaeva fabricated the first material hosting this quantum state intrinsically and presented it in a cross-disciplinary studies with theory and spectroscopy in Nature (> 900 citations), Chem. Mater. (250) and Phys. Rev. B (150). In 2021-2023, follow-up material's surface studies by Golden and structure optimizations by Isaeva enabled a substantial extension of the magnetically ordered phase up to 70 K, nearing the technologically relevant range of temperatures.

The **Soft Matter group** is thriving and broadly recognized as internationally leading; it is a very large (~60 people), lively group with a strong publication output, many international visitors, excellent experimental facilities and very good funding. The new hires bring a number of interesting new themes (metamaterials, active matter, biophysics) into the group. This is also leading to collaborations, e.g. with UvA chemistry and informatics (also through the Computational Soft Matter group) or biology but also with other institutes such as ARCNL and AMOLF.

Highlight: Living worms as active polymers. Active polymers are of considerable interest due to their prevalence in biological systems on multiple length scales. Understanding the non-equilibrium statistical mechanics of such active systems is a major challenge, both experimentally and theoretically. We use living polymer-like worms (Tubifex tubifex) and active chains made of self-propelled bots as an experimental platform to investigate the physics of active polymers. Recent papers include a PRL on the rheology of entangled worms, a PRL on phase separation by entanglement of worms, and one Science Advances on chromatographically separating worm mixtures, all highlighted in various media.

Highlight: First observation of the non-Hermitian 'skin effect'. Topological edge modes are excitations that are localized at the materials' edges and yet characterized by a topological invariant defined in the bulk. This allows robust electronic, electromagnetic, and mechanical transport properties across a wide range of systems. We were the first to identify and observe a form of bulk–edge correspondence for a particular non-Hermitian topological phase. Our results, published in PNAS, open avenues for the field of non-Hermitian topology and for manipulating waves in unprecedented fashions.

5.3.3. Societal relevance

WZI has a strong and direct societal relevance through the knowledge utilization of many of its research lines. Over the current evaluation period the importance of valorization has increased strongly, and it is now a strength across all three WZI groups. The obvious and most important one is ASML through our involvement in ARCNL; several WZI staff members are also affiliated full-time with ARCNL (Bliem, Planken, Weber). In addition, two professors by special appointment from industry or with direct connections to industry were appointed to reinforce our connections to industry: Cees van Rijn (Medspray) and Krassimir Velikov (Unilever).

The societal relevance is also visible in the large number of other industrial collaborations and contracts with industries and societally relevant partners; with industry a non-exhaustive list includes Michelin, Unilever, Medspray, Witec/ Oxford Instruments, Tata Steel, Shell, SKF, DSM, GreenA, Medspray, Pepsico, Evodos, AkzoNobel, Nouryon etc. Societally relevant collaborations are with the major Amsterdam art museums (Rijksmuseum, Van Gogh museum) within NICAS, research collaborations and joint publications with the Amsterdam University Medical Center (AUMC) and several projects related to the covid pandemic, e.g. investigations of mitigation measures for virus transmission,

for the Dutch parliament, the Ministry of Science and Education, and within the large industrially co-funded NWO project MIST. Besides industrial collaborations, WZI shows a growing research portfolio in sustainable energy and circularity, including solar foils (Schall), photovoltaics (Van de Groep, Schall), and thermal energy storage (Shahidzadeh, Van de Groep). In addition, WZI staff members are embedded in the newly funded National Growth Fund consortium SolarNL, aimed at stimulating photovoltaics manufacturing in the Netherlands and Europe.

The evaluation period has also seen a steep increase in the number of spinoff activities from WZI, presently including:

- SolarFoil (Schall; incorporated): semi-transparent films containing engineered quantum dot nanomaterials "shape" the solar spectrum in greenhouses to match the optimal growth conditions of plants;
- GreenA (Bonn; incorporated): unique agricultural adjuvant that prevents surface water pollution with pesticides (the largest source of future drinking water pollution in the Netherlands) by suppressing small droplets that drift away with the wind into the surface waters. By now this is a successful (profitable) company that is market leader in the Netherlands and has bought out its investor;
- EddyTec (Sprik; incorporated): transforming defect detection in carbon fiber composites with a sensing technique based on eddy currents to make it fast, simple and affordable with the goal to facilitate resource efficiency;
- Firefly Quantum (Schreck; pre-incorporation, participant in Demonstrator Lab): Firefly Quantum is making optical circuits as easy as electronic circuits;
- TrapIQ (Gerritsma and Safavi-Naini; pre-incorporation): merging the precision control of optical tweezers with the accuracy of trapped ions to advance Quantum Computing research;
- SpectriS-Dot (Dohnalova-Newell; incorporated): silicon-based quantum dots as non-toxic and green alternatives for tunable light emitters in display, lighting, and optical communications technologies.

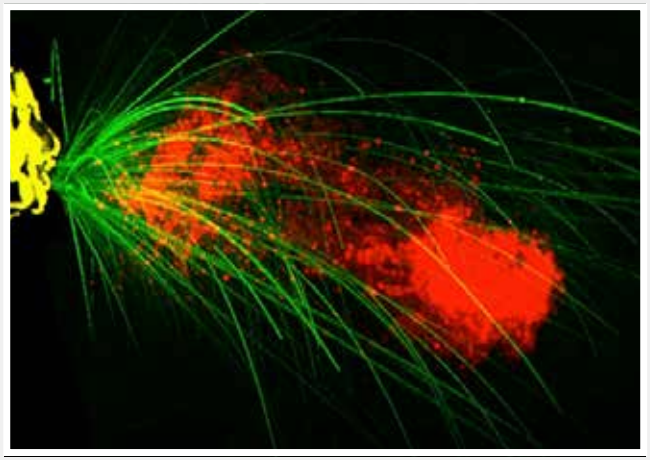
Our strong focus on collaborative research with industry has resulted in the acquisition of several valorization-related grants: ERC Proof of Concept grants (Bonn, Coulais), IXA Proof of Concept grant (Sprik, Schreck, 2x Schall, Gerritsma), NWO TTW Open Technology Programs (Coulais, van de Groep, Schall), an NWO ENW Industrial Partnership Program (Medspray), and an NWO Emerging Key Enabling Technologies (KIC) grant (Coulais). The QG&QI group hosts the EU Quantum Flagship project AQuRA to develop a prototype of a commercial optical atomic clock. The work on atomic clocks is also the basis for strong connections with the Ministry of Defence, TNO and VSL. Some of these public-private partnerships will likely sprout new spin-off activities.

5.3.4. Reflection on recommendations of previous evaluation

Recommendation 1: *Stick to the current strategy of reserving money for strategic reinvestments, hiring promising young PI's and seeking strong partnerships with neighboring institutions on Science Park and VU.*

Several young PIs were hired, mostly enabled by the Sector Plan. Some new ARCNL staff are embedded in WZI and new collaborations with ARCNL have emerged. The same goes for AMOLF, with which multiple joint and successful PhD projects are carried out. The QG&QI group has monthly joint group seminars and joint research projects with sister groups at VU and ARCNL. There is strong collaboration between QG&QI and ITFA, as well as with CWI, IvI within the QuSoft and Quantum Delta consortia, leading to numerous joint projects and publications.

Highlight **Impact corona transmission research**



High-speed imaging of a sneeze: in green the trajectories of single large drops, in red a jet of humid, warm air containing many small droplets of saliva and mucus. Bonn showed that a cloud of these droplets can remain in the air for many minutes. Image: Lydia Bourouiba (MIT).

WZI's research into small droplets took center stage when the corona pandemic hit. As early in the pandemic as April 2020, Daniel Bonn and his collaborators warned for the airborne transmission of the coronavirus and the importance of ventilation in this respect. Bonn appeared in more than a dozen national TV programs and the worldwide media reach of this research in the written press was over 600 million people. However, it took more than a year for the World Health Organization and the national authorities to recognize this transmission route. Eventually, the 'ventilation' icon was added to the guidelines from the Dutch government.

Recommendation 2: *One of the strengths of WZI is in the balance between the three topical groups (hard condensed matter, soft condensed matter and quantum gases). Make sure that in the further development of WZI this balance is preserved, and prevent that one of the topical groups becomes subcritical in size.*

The hiring of the new staff led to a significant reinforcement and rejuvenation of the three axes of the WZI. The Soft Matter group grew the most, and their weekly group meeting now has an attendance of ~60 people. The QGQI group was reinforced with a full professor (Philippe Bouyer) who plays a pivotal role in the Quantum Delta NL project. The QM (Hard Condensed Matter) group was also significantly reinforced with Jorik van de Groep and Anna Isaeva, and a new vacancy because of the retirement of Anne de Visser is currently being filled.

Recommendation 3: *Stimulate the further development of the recently started PI's which have the potential of becoming world leading.*

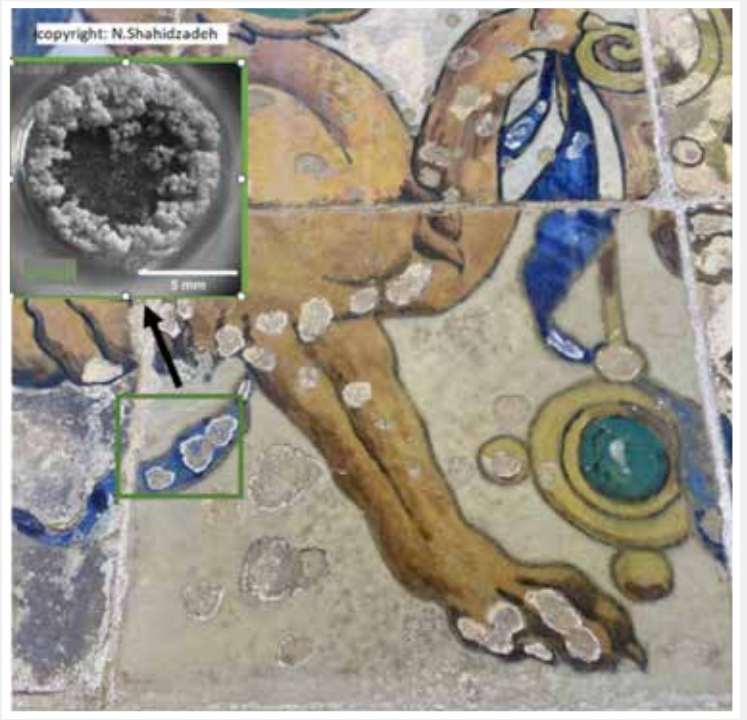
As mentioned above, the new hires were highly successful in attracting funding (ERC Starting, NWO Vidi) with very high success rates also due to a very structured support network in grant application preparation. Senior PIs have made space for the expansion of the activities of young group members, and the new hires are happy and internationally very visible, as evident e.g. from their large numbers of invited talks.

Recommendation 4: *Strengthen the ties with the condensed matter theorists at ITFA and other relevant theory groups, especially anticipating the larger collaborative effort on soft condensed matter.*

Since the previous evaluation, we founded the Computational Soft Matter (now Soft and Complex Matter) group which not only bridges the WZI Soft

Highlight **Consolidation stone buildings and artwork**

Salt crystallization damage on a statue and glazed tiles.



The white stains often seen on brick and stone buildings and artworks are salts that are mobilized by water (rain); if the water subsequently evaporates again the salt can 'creep' out of the stones, cover the stone surfaces and the salt crystallization may damage the porous material. This has been studied by Noushine Shahidzadeh and collaborators in a number of projects that aim at better conservation of our cultural heritage. Shahidzadeh is member of the scientific board of NICAS, a collaboration between UvA, Rijksmuseum, and the Dutch National Organization for Cultural Heritage (RCE), TU Delft and NWO for interdisciplinary research, applying insights from the natural sciences to conservation and restoration of artworks. The aim is to develop an integrated approach for investigating, modeling, and analyzing the decay mechanisms of artworks due to salt and ice crystallization. Examples are frescoes, glazed tiles, ceramics, and degradation of historical monuments. Scientists develop reliable testing methods to foresee material durability with respect to salt and ice damage and propose adequate consolidation strategies.

Matter group with a number of ITFA staff but also with new computational colleagues hired between ITFA, HIMS (chemistry) and IvI (informatics). The IoP call for PhD students funded a number of joint WZI/ITFA projects, e.g. van Wezel and Coulais published a very highly cited PNAS paper on non-Hermitian topology. The QM group incorporated multiple ITFA staff members in the QM colloquium series (van Wezel, Olsson, Aguilera). Multiple collaborative projects initiated from these increased interactions, combined with a growing number of joint WZI-ITFA MSc projects offered to students in the QM cluster.

Recommendation 5: *Provide full support for and set up a shared strategy with LaserLaB to come to further exchange and collaboration, either (ideally) in one location, or by means of exchange of (sub)groups and the construction of a direct fiber link.*

The further attempts to relocate (part of) the LaserLaB groups and WZI were not successful. There is still a strong interaction between QG&QI and the LaserLaB colleagues with a regular joint discussion meeting. Moreover, the fiber link for frequency comb distribution between the LaserLaB AMO groups and QG&QI has been realized and is actively used as a research collaboration.

5.4. SWOT analysis

Strengths

- We have a broad research portfolio with recognized high quality, with strong connections to the NWO Institutes on Science Park (CWI, ARCNL, AMOLF).
- Our staff is of high quality, as evidenced by for example outstanding successes in prestigious funding schemes (ERC, NWO) across all three sub-groups, combined with excellent scientific output.
- The WZI has very good facilities and lab space, supported by newly expanded technical staff.
- There is a large valorization impact as evidenced by large number of public-private partnerships, involvement in start-ups, industrial visitors, and part-time professors.
- The WZI is an attractive place to work, as evidenced by our recent success in attracting excellent new (mostly young) group leaders (Weber, Dijksman, Bliem, Bouyer, Coulais, Jalaal, Deblais, van de Groep, Isaeva) and in the fact that a significant fraction of AMEP MSc students continue to do their PhD at the WZI.

Weaknesses

- The fraction of female staff at the WZI is currently underwhelming.
- The overall funding of the Quantum Materials group could be better (i.e. average number of PhD students per PI is low).

Opportunities

- Sustainability, renewable energy, and circularity are highly urgent societal themes, towards which the impact of WZI's research portfolio can grow significantly.
- WZI staff embedded in ARCNL offer opportunities for even more extensive and long-term collaborative research lines.
- Nearby UvA departments such as theoretical physics (ITFA), computer science (IVI), chemical physics (HIMS), as well as IHEF/Nikhef and VU offer opportunities for many more fruitful collaborations.

- Even more valorization potential could be achieved by pushing the developments towards applied technology. Research in the QM group offers opportunities to tap into the increasingly innovation and technology oriented Dutch funding landscape.

Threats

- There is not enough influx of MSc and subsequently PhD students from our own MSc program, as the experimental MSc track (AMEP) is too small.
- The national shift towards a more applied funding landscape puts pressure on obtaining funding for large capital investments that are required to remain state-of-the-art.
- A similar large national trend towards large collaborative consortia grants with a strong and direct societal relevance makes it more challenging to fund basic and fundamental research projects.
- There is uncertainty about UvA-internal rules for collaboration with specific (a.o. fossil fuel) industries.

5.5. Strategy for the next six years

We will continue to pursue **research excellence** through our combination of external funding success, very good experimental facilities, and core critical mass in the permanent research staff. To this end, we aim to be successful and leading in funding applications for large consortia, e.g. NWO Gravitation, National Growth Fund, or large European collaborative projects. This requires that very visible PIs from the institute organize their research field well in advance of such applications.

Inspired by grand challenges, we aim for a **balanced research portfolio** from strongly fundamental work with a long-term applications horizon to full-value partnerships with the private sector (PPPs). This spectrum enables strong partnerships with theory (e.g. ITFA), with NWO institutes and with market parties, all driven by the intrinsic passion of the PIs at the WZI for their research subject matter. While maintaining our strong foundation in fundamental physics, this means that we need to keep a keen eye on opportunities for novel technological applications, as well as for contributions to sustainable development goals in the fields of materials and the energy transition. In order to maintain a healthy balance between the three main pillars of WZI, we will ensure that the Quantum Matter group stays supercritical. A new staff member is currently being recruited. We also aim to promote new links between existing group members.

Building a **bridge towards the fields of sustainability and molecular and materials** science will allow us to predict quantitative structure-property relationships in the broadest sense: from functionality to degradability and interactions with the molecular or biological environment. This is also one of the main drivers of the faculty's Research Priority Area AI for sustainable molecules and materials, of which WZI is one of the founders.

We will further increase the **international visibility, and national leadership role and reputation** of the WZI. We aim to be ambassadors for physics to the general public, whether locally, nationally or internationally.

We aim to foster and initiate **connections** and build more bridges with VU Physics and Astronomy and with the para-university institutes located in the Science Park Amsterdam, and to be inspired by and take advantage of the full breadth of the Science faculty in whose building we are housed. The establishing of new links, strengthening and deepening of existing links, and taking inspiration from WZI colleagues already connected, are focal points for

the coming period. Given the proximity of many relevant researchers, WZI will concretely steer towards a strengthening of ties, joint PhD students and grants, joint visiting professorships, the exchange of guests and seminar information.

We aim to attract **more undergraduate students** into and from our own curriculum. A committee is currently in place to propose changes to the MSc program; one change that WZI will advocate for is a more thematic division of the tracks, instead of the now existing separation of theoretical and (small-scale) experimental physics, leading to arguably too many students in the theory track and certainly too few in AMEP. In addition, we will attract more talented students to WZI using internships and/or summer schools at WZI that are advertised on an international level. We are actively involved in efforts to increase the faculty's technology profile in the Bachelor, for example through the new BSc program Science, Technology & Innovation (starting September 2024).

We will inspire and attract **new and more diverse generations of early-career researchers**, and support them to reach their full potential while learning and doing research with us. The first steps to a better training of PhD students, e.g. by connecting to a specific doctoral school, have been taken. We are also planning to organize more 'soft skill' training such as presentation and scientific writing classes. One of the staff members (Shahidzadeh) developed a highly oversubscribed MSc course 'Effective communication and presentation' that we intend to deploy for our PhD students/postdocs as well.

Appendices

6. Appendices

Appendix 1: Staff composition

Table A1.1: Development of IoP staff

	2017		2018		2019		2020		2021		2022		2023	
IoP	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**
Scientific staff														
Assistant professor	11	11,0	10	10,0	11	11,0	16	16,0	19	19,0	22	22,0	21	21,0
Associate professor	17	17,0	20	20,0	22	22,0	20	20,0	21	21,0	20	19,6	23	22,1
Full professor	24	20,7	21	17,9	18	17,8	20	19,8	18	17,8	19	18,8	20	18,6
Postdocs	36	35,0	40	39,4	48	47,4	53	52,3	61	59,7	39	37,4	50	48,3
PhD candidates	61	61,0	70	69,6	72	71,6	86	85,3	108	107,1	115	114,6	118	117,8
Total research staff	**149**	**144,7**	**161**	**156,9**	**171**	**169,8**	**195**	**193,4**	**227**	**224,6**	**215**	**212,4**	**232**	**227,8**
Support staff	16	10,8	14	9,2	11	7,7	14	10,1	14	10,0	16	12,5	21	14,7
TOTAL STAFF	**165**	**155,5**	**175**	**166,1**	**182**	**177,5**	**209**	**203,5**	**241**	**234,6**	**231**	**224,9**	**253**	**242,5**

Table A1.2: Development of scientific staff per division

	2017		2018		2019		2020		2021		2022		2023	
Division: IHEF	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**
Assistant professor	2	2,0	3	3,0	3	3,0	6	6,0	6	6,0	7	7,0	7	7,0
Associate professor	3	3,0	3	3,0	3	3,0	2	2,0	3	3,0	2	1,8	2	1,8
Full professor	5	4,8	5	4,8	4	3,8	5	4,8	4	3,8	5	5,0	5	5,0

	2017		2018		2019		2020		2021		2022		2023	
Division: IHEF (cont.)	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**
Postdocs			3	3,0	5	5,0	6	5,4	7	7,0	3	3,0	5	5,0
PhD candidates	1	1,0	2	2,0	7	7,0	8	8,0	19	19,0	21	21,0	21	21,0
TOTAL STAFF IHEF	**11**	**10,8**	**16**	**15,8**	**22**	**21,8**	**27**	**26,2**	**39**	**38,8**	**38**	**37,8**	**40**	**39,8**

	2017		2018		2019		2020		2021		2022		2023	
Division: ITFA	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**
Assistant professor	4	4,0	3	3,0	2	2,0	4	4,0	6	6,0	8	8,0	9	9,0
Associate professor	10	10,0	12	12,0	13	13,0	13	13,0	12	12,0	11	11,0	12	11,3
Full professor	8	8,0	6	6,0	7	7,0	7	7,0	7	7,0	7	7,0	7	6,3
Postdocs	23	22,5	27	26,4	32	31,4	29	28,9	30	29,7	21	20,6	23	22,5
PhD candidates	32	32,0	39	38,8	32	31,8	36	35,6	41	40,5	40	40,0	44	44,0
TOTAL STAFF ITFA	**77**	**76,5**	**87**	**86,2**	**86**	**85,2**	**89**	**88,5**	**96**	**95,2**	**87**	**86,6**	**95**	**93,1**

	2017		2018		2019		2020		2021		2022		2023	
Division: WZI	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**	**#**	**FTE**
Assistant professor	5	5,0	4	4,0	6	6,0	6	6,0	7	7,0	7	7,0	5	5,0
Associate professor	4	4,0	5	5,0	6	6,0	5	5,0	6	6,0	7	6,8	9	9,0
Full professor	11	7,9	10	7,1	7	7,0	8	8,0	7	7,0	7	6,8	8	7,3
Postdocs	13	12,5	10	10,0	11	11,0	18	18,0	24	23,0	15	13,8	22	20,8
PhD candidates	28	28,0	29	28,8	33	32,8	42	41,6	48	47,6	54	53,6	53	52,8
TOTAL STAFF WZI	**61**	**57,4**	**58**	**54,9**	**63**	**62,8**	**79**	**78,6**	**92**	**90,6**	**90**	**88,0**	**97**	**94,9**

Table A1.3: Gender balance scientific staff

	2017		2018		2019		2020		2021		2022		2023	
IoP	**% m**	**% v**	**% m**	**% v**	**% m**	**% v**	**% m**	**% v**	**% m**	**% v**	**% m**	**% v**	**% m**	**% v**
Assistant professor	82	18	70	30	64	36	50	50	53	47	50	50	52	48
Associate professor	82	18	85	15	86	14	90	10	86	14	90	10	83	17
Full professor	96	4	95	5	94	6	95	5	94	6	95	5	95	5
Postdocs	85	15	86	14	81	19	76	24	74	26	73	27	69	31
PhD candidates	83	17	80	20	79	21	70	30	69	31	79	21	80	20
Total research staff	**86**	**14**	**84**	**16**	**81**	**19**	**75**	**25**	**74**	**26**	**75**	**25**	**74**	**26**

Figure A1.4: Age distribution of (permanent) scientific staff (2023)

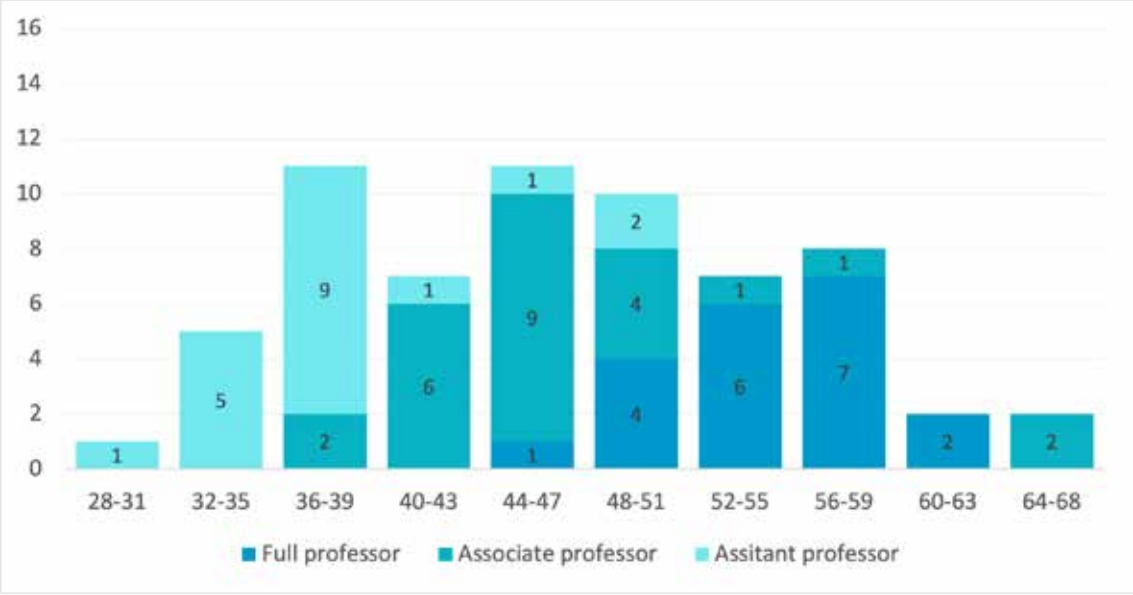


Table A1.5: Nationalities scientific staff (2023)

Nationality	#	Nationality	#
American	7	Iranian	4
Argentinian	2	Italian	17
Australian	2	Japanese	1
Austrian	3	Korean	1
Belgian	2	Kosovar	1
Bengali	1	Luxembourger	1
Brazilian	3	Maltese	1
British	7	Moldovan	1
Canadian	4	Nepali	1
Chilean	1	Portuguese	3
Chinese	10	Romanian	1
Croatian	1	Russian	7
Cuban	1	Slovakian	1
Czech	3	South African	1
Danish	1	Spanish	3
Dutch	97	Swedish	2
French	16	Swiss	2
German	20	Taiwanese	1
Greek	4	Ukrainian	1
Indian	18	Vietnamese	1

Appendix 2: Funding

Table A2.1: Funding

	2017		2018		2019		2020		2021		2022		2023	
IoP	**FTE**	**%**	**FTE**	**%**	**FTE**	**%**	**FTE**	**%**	**FTE**	**%**	**FTE**	**%**	**FTE**	**%**
Funding														
Direct funding	58,0	40,1	61,9	39,4	72,9	42,9	78,6	40,6	96,8	43,1	99,6	46,9	107,6	47,2
Research grants	50,4	34,8	56,6	36,1	54,7	32,2	63,0	32,6	81,0	36,0	69,5	32,7	70,8	31,1
Contract research	36,3	25,1	38,4	24,5	42,2	24,9	51,8	26,8	46,8	20,9	43,3	20,4	49,5	21,7
Other	-	-	-	-	-	-	-	-		-	-	-	-	-
TOTAL FUNDING	**144,7**	**100**	**156,9**	**100**	**169,8**	**100**	**193,4**	**100**	**224,6**	**100**	**212,4**	**100**	**227,9**	**100**

Expenditure														
Personnel costs	k€ 9.507		k€ 9.674		k€ 11.283		k€ 13.467		k€ 15.583		k€ 15.730		k€ 16.732	
Material costs	k€ 1.947		k€ 1.768		k€ 2.809		k€ 2.778		k€ 1.455		k€ 3.897		k€ 3.206	
Other costs	k€ 5.129		k€ 6.041		k€ 6.852		k€ 6.483		k€ 6.707		k€ 7.387		k€ 9.009	
TOTAL EXPENDITURE	**k€ 16.584**		**k€ 17.483**		**k€ 20.944**		**k€ 22.729**		**k€ 23.744**		**k€ 27.014**		**k€ 28.947**	

Appendix 3: Enrolment and success rates of PhD candidates

Table A3.1: PhD candidates

		PhD enrolment			Success rates: graduated within... (#|%)						
Starting year	**Category**	**M**	**F**	**Total**	**<4y**	**<5y**	**<6y**	**<7y**	**> 7y**	**Not yet finished**	**Discont.**
	Employed	13	5	**18**	4|22%	12|67%	15|83%	16|89%			2|11%
	Scholarship	4		**4**	1|25%		4|100%				
	External	11	4	**15**	4|27%	13|87%		14|93%			1|7%
Total		**28**	**9**	**37**	**9|24%**	**26|70%**	**32|86%**	**34|92%**			**3|8%**
2015	Employed	14	6	**20**	6|30%	14|70%	18|90%				2|10%
	Scholarship										
	External	9	1	**10**	3|30%	7|70%	8|80%	9|90%	10|100%		
Total		**23**	**7**	**30**	**9|30%**	**21|70%**	**26|87%**	**27|90%**	**28|93%**		**2|7%**
2016	Employed	13	1	**14**	3|21%	11|79%	12|86%				2|14%
	Scholarship	1	1	**2**	1|50%	2|100%					
	External	14	6	**20**	2|10%	14|70%	17|85%	19|95%		1|5%	
Total		**28**	**8**	**36**	**6|17%**	**27|75%**	**31|86%**	**33|92%**		**1|3%**	**2|6%**
2017	Employed	15	2	**17**	5|29%	12|71%	14|82%			2|12%	1|6%
	Scholarship										
	External	11	4	**15**	2|13%	13|87%				2|13%	
Total		**26**	**6**	**32**	**7|22%**	**25|78%**	**27|84%**			**4|13%**	**1|3%**

		PhD enrolment			Success rates: graduated within... (#|%)						
Starting year	**Category**	**M**	**F**	**Total**	**<4y**	**<5y**	**<6y**	**<7y**	**> 7y**	**Not yet finished**	**Discont.**
2018	Employed	20	7	**27**	6|22%	20|74%	21|78%			5|19%	1|4%
	Scholarship	1		**1**		1|100%					
	External	13	5	**18**	2|11%	11|61%	12|67%			6|33%	
Total		**34**	**12**	**46**	**8|17%**	**32|70%**	**34|74%**			**11|24%**	**1|2%**
TOTAL	**Employed**	**75**	**21**	**96**	**24|25%**	**69|72%**	**80|83%**	**81|84%**		**7|7%**	**8|8%**
	All	**139**	**42**	**181**	**39|22%**	**131|72%**	**150|83%**	**155|86%**	**156|86%**	**16|9%**	**9|5%**

Table A3.2: Average duration of PhD trajectories

Graduation year	Average duration (months)
2017	56,7
2018	53,1
2019	56,0
2020	55,8
2021	57,4
2022	52,1
2023	58,1
Average	**55,7**

Appendix 4: Highlights bibliometric analysis

Introduction

The bibliometric analysis and international benchmark have been independently prepared by Kasper Abcouwer (Scientific Information specialist at the UvA's University Library) and Laura Compier-de Block (Policy and Information Management Advisor at the Faculty of Science). The present appendix contains a few highlights from their analysis, which is available online in a separate document in combination with an online interactive *Tableau* report.

With the 2023 publication data not yet consolidated at the time of preparation of the analysis, it was concluded to leave 2023 out of the analysis (which thus covers the period 2017-2022).

Selected data from the bibliometric analysis

Table A4.1: Number of publications by IoP, per type

SEP output type	2017	2018	2019	2020	2021	2022	Total per type
Refereed article	**343**	**368**	**402**	**400**	**374**	**379**	**2266**
PhD thesis	27	27	26	20	34	30	164
Book			2		2		4
Book chapter	4	2	3	2	2	5	18
Conference paper	4	4	1	5	5	4	23
Conference paper	4	2	5	5	2	2	20
Professional publication	3	1	5	2	2	2	15
Publications aimed at the general public	5	2			4	1	12
Other research output	6	10	10	4	5	9	44
Total per year	**396**	**416**	**454**	**438**	**430**	**432**	**2566**

Table A4.2: Number of publications per division

Division	2017	2018	2019	2020	2021	2022
IHEF	218	201	227	229	228	166
ITFA	158	173	208	188	202	193
WZI	123	118	134	149	149	158
Total per year	**499**	**492**	**569**	**566**	**579**	**517**

Please note: papers with multiple affiliations are listed separately under each research group

Figure A4.3: Open access status of publications

Figure A4.4: Joint publications within IoP

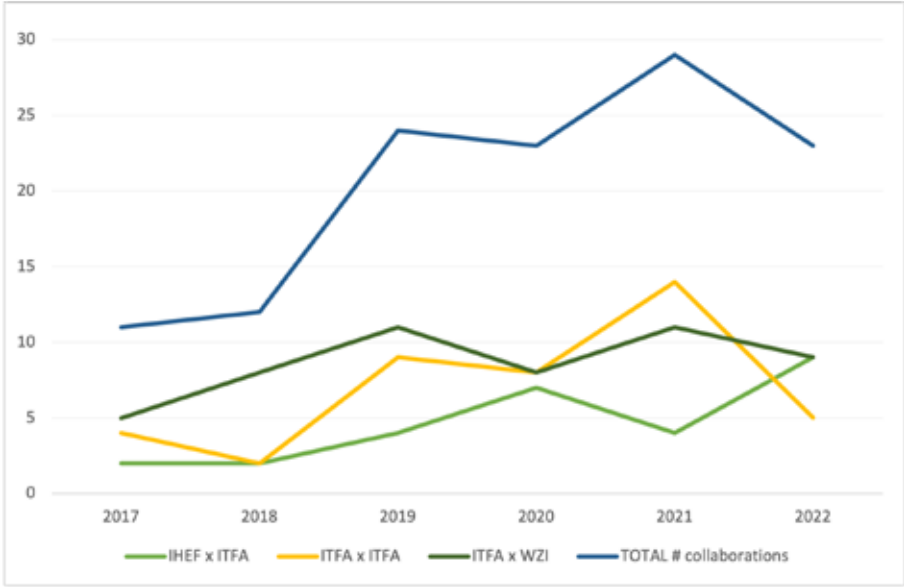
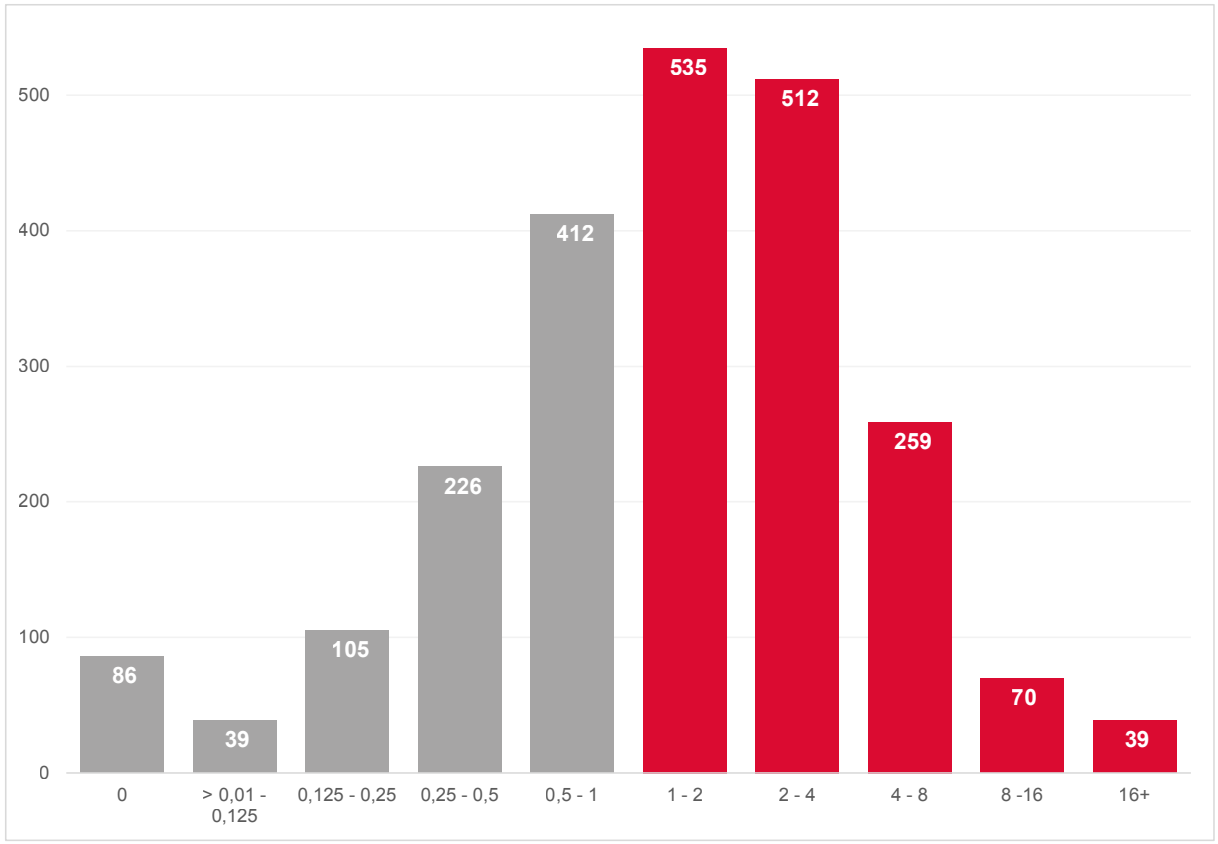


Figure A4.5: Number of publications with a FWCI below/above world average



Observations bibliometric analysis

- Collaborations (joint publications) across IoP's divisions show a positive trend over time, related to introduction of the IoP-internal project funding (section 2.9.2): researchers increasingly find overlapping interests.
- IoP exhibits an overall Field-Weighted Citation Impact (FWCI) of 2.71, indicating that IoP publications are on average cited 2.71 times the global average for similar publications.
- Nearly 62% of IoP publications have received more citations than the global field average (i.e. from 1.01 to 133.09 times the world average).
- Average FWCI per division: WZI: 1.41; ITFA: 1.98; IHEF: 4.73. Relevant to add here is that most IHEF publications are with large consortia, biasing the FWCI to higher values.
- [In Tableau overview] On a global level, IoP scientists have collaborated with colleagues of at least 1,177 distinct non-Dutch institutions.
- [In Tableau overview] IoP collaborates with all but one fellow institute within UvA's own Faculty of Science. IoP scientists work most closely with colleagues from the Chemistry department and the Astronomy department.
- [In Tableau overview] According to analysis of Altmetrics data, IoP publications generate significant online activity, with at least 4,194 news mentions and 24,326 Twitter/X mentions.
- [In Tableau overview] A substantial number of bronze articles (classified as closed access, in accordance with UNL guidelines) still generate considerable online attention as do a number of closed articles (see right-hand visualization on d_Altmetrics (2) of the accompanying Tableau-visualization).

Observations international benchmark analysis

The international benchmark provided online contains a comparison of IoP's publication volume and impact with peer institutions worldwide. We repeat the summary of that analysis below:

- IoP ranks 10th among European academic institutions in terms of the number of publications in the IoP Core Area;
- Globally, IoP holds the 27th position among academic institutions for the number of publications in the IoP Core Area;
- IoP is positioned 15th globally and 8th in Europe based on Field Weighted Citation Impact (FWCI) within the top 30 and top 12 institutions, respectively, in the IoP Core Area;
- IoP's publications typically involve fewer co-authors and collaborations with other institutions, significantly affecting the university's ranking for both fractional FWCI scores within the top 12 European institutions in the IoP Core Area. It ranks fourth for FWCI per authors and third for FWCI per institutions within the European top 12;
- The IoP Core Area has witnessed a remarkable surge in activity, with the number of publications increasing exponentially from 385 in 1996 to 14,209 in 2022;
- The global average FWCI in the IoP Core Area has fluctuated from 1.7 in 2004 to a peak of 3.3 in 2014, before decreasing to around 1.5 in 2022. In contrast, UvA has demonstrated a gradual increase in FWCI during the same period, rising from just above 3 to 3.5, indicating an impact three times higher than the global average in 2004 and three and a half times higher in 2022;
- IoP primarily collaborates with European universities in the IoP Core Area for its publications.

Appendix 6: Selected organizational activities, awards and prizes

Irene Aguilera (ITFA)

Organizational activities:

- Organizer of the 2023 Workshop of the European Theoretical Spectroscopy Facility (ETSF) (2023)
- Member of the NWO Physics subcommittee Materials Physics (2022-)
- Staff member of the IoP Diversity and Inclusion council (2023-)
- Co-organizer of the DRSTP PhD School (Theme 2 SPTCM), May 2023, Callantsoog (2023)
- Co-organizer of the DRSTP PhD School 2024, May 2024, Wageningen (2024-)

Flavia de Almeida Dias (IHEF)

Organizational activities:

- Convener (level 2) of the ATLAS Exotics group (over 80 active analyses and 500 physicists) 53 ATLAS physics results published under my purview during my term as Exotics convener (2021-2023)
- Convener (level 3) of the "Dibosons, Multileptons and Extra Dimensions" ATLAS group (2017-2018)
- Derivation Production Manager (technical managerial role within Software & Computing) (2023-)
- ATLAS Early Career Scientists Board member (role within ATLAS management) (2020-2022)
- Working group leader (WG5) and core group member of the EU COST Action CA22130 - Comprehensive Multiboson Experiment-Theory Action (COMETA) (2023-)
- Management Committee (Netherlands) for the EU COST Action COMETA (2023-)
- Member of the CERN Contact Commissie (advising the Dutch CERN council representative) (2021-)
- Member of the Grant Proposal Reviewing Committee for the USA's Department of Energy (2021-)
- Committee for Volkert van der Willigen Grant for students at the University of Amsterdam (2021-2023)

Shin'ichiro Ando (ITFA)

Organizational activities:

- GRAPPA MSc Track Coordinator (2021-)
- GRAPPA Equity, Diversity and Inclusion Committee, Member and since 2021 chair (2020-)
- Diversity and Inclusion Council (2021-)
- Member of editorial board: Galaxies
- Member of Cherenkov Telescope Array Consortium (2022-)
- Member of PTOLEMY Collaboration (2021-)
- Member of Scientific Advisory Boards, Lorentz Center (2020-)
- Member of Physical Society of Japan

Jácome Armas (ITFA)

Organizational activities:

- External reviewer for Royal Society Grants (2022)
- Member of the hiring committee for the tenure track position at FEB in connection with the research priority area Emergent Phenomena in Society
- Member of the DIEP fellowship hiring committee since 2019 and DIEP PhD positions (2019-2022)
- Main organizer of the DIEP seminars (2020-)

Daniel Baumann (ITFA)

Organizational activities:

- Leader of the Inflation Working Group of the CMBPol Mission
- Member of the COrE Science Team

Prizes and awards:

- Chambliss Astronomical Writing Award (2022)

Stan Bentvelsen (IHEF)

Organizational activities:

- Director of Nikhef (2014-)
- Scientific director of the Dutch National Growth Fund project for the realization of the Einstein Telescope in the EMR region
- PI of FuSE Computing infrastructure for the Dutch National Roadmap for Large Infrastructure (2019-)
- PI of KM3NeT (2017-)
- Coordinator National Science Agenda on

'Bouwstenen der materie en fundamenten van ruimte en tijd' (2016-2022)
- CERN Contact Committee at the Royal Netherlands Academy of Arts and Sciences (2010-)
- Coordinator ESFRI proposal on the Einstein Telescope, together with Zoccoli (INFN) (2020-)
- Board member of EGO - European Gravitational Observatory, Cascina/VIRGO (2022-)
- Chair of the Resources Review Board for the KM3NeT neutrino experiment (2020-)
- Dutch representative member of the ECFA (European Committee for Future Accelerators)

Gianfranco Bertone (ITFA/IHEF)

Organizational activities:
- Director, European Consortium for Astroparticle Theory (EuCAPT) (2019-)
- Topic Leader, "Dark matter and primordial Black Holes" COST Action CA16104 Gravitational waves, black holes and fundamental physics (GWVerse) (2017-2021)
- Member, Committee for Astroparticle physics in the Netherlands (CAN) (2013-2019)
- Member, External Advisory Committee, International Doctorate in Particle Physics, Astrophysics and Cosmology (IDPASC) (2014-)
- Member, Physics Research Committee advisory board, DESY, Germany (2017-2019)
- Editorial Fellow, SciPost open access publication portal (2019-)

Roland Bliem (WZI/ARCNL)

Organizational activities:
- ARCNL Management Team (2022-)

Jan de Boer (ITFA)

Organizational activities:
- Member board Science Domain, NWO (2017-2020)
- Member board Netherlands eScience Center (2017-2020)
- Member board Stichting Physica (2017-)
- Member Institute Advisory Council ARCNL (2019-2020)
- Member Institute Advisory Council NIKHEF (2019-2020)
- Member, steering group Dutch Institute for Emergent Phenomena (DIEP) (2019-)
- Chair of board of Science Domain, NWO (2020-)
- Member, Executive board, NWO (2020-)
- Chair, governing board ARCNL (2021-)
- Chair, governing board NIKHEF (2021-)

Daniel Bonn (WZI)

Organizational activities:
- Member IoP directorate (2011-)
- Director Institute of Physics (2011-2017)
- Member of the Scientific Advisory Committee of the Norwegian Academy of Sciences (2017-)

Prizes and awards:
- Physica Prize (2021)
- Elected member of the Royal Netherlands Academy of Arts and Sciences (2022-)

Philippe Bouyer (WZI)

Organizational activities:
- QDNL - CAT3 leader (2022-2023)
- QDNL - Director Science and Technology - Member of the board (2023-)

Ronald Bruijn (IHEF)

Organizational activities:
- Member Exam Committee (2019-2023)
- Cosmic Ray Physics group leader KM3NeT experiment (2019-)
- Projectleader DOM integration at Nikhef (2014-)
- Member of the Institute Board of the KM3NeT experiment, representing UvA (2015-)
- Member of Nikhef WAR (wetenschappelijke advies raad) (2022-)

Jean-Sébastien Caux (ITFA)

Organizational activities:
- Founder and Chair of SciPost (2016-)
- Plan S Ambassador (2019-)
- Member of the Governing Board of the Free Journal Network (2020-)
- Member of the Advisory Board of Radboud University Press (2023-)
- Member of the Open Science NL Advisory Panel on Open Scholarly Communication (2024-)

- Coordinator of the master program in Physics and Astronomy, track Theoretical Physics (2015-2018)
- Chair of the ERC Starting Grant PE2 Panel (2022)
- Member of the ERC Starting Grant PE2 Panel 2018, 2020
- Chair of the FOM COMOP (condensed matter and optical physics) (2017-2019)
- Member of the Governing Board of the Dutch Research School of Theoretical Physics (2023-)

Miranda Cheng (ITFA/KdVI)

Organizational activities:

- Guest editor for the special volume on "Moonshine and String Theory", SIGMA, 2019 (2019)
- Scientific Committee member for the Conferences "String–Math 2016, 2018, 2020, 2022, 2023, 2024", "String Theory Summer Workshop 2022" (2016-)
- Award Selection Committee for the Weyl-Wigner Award 2022 (2022)

Auke Pieter Colijn (IHEF)

Organizational activities:

- Member of the Beta-Gamma program committee (2024-)
- Director of the Graduate School of Sciences (2018-2022)
- Member of the OSAF program committee (2022-)
- Member of the program committee "Natuur- en Sterrenkunde" (2012-2018)
- Technical coordinator for the XENONnT experiment (2017-)
- Member of the DARWIN collaboration (2015-)
- Founding member of the PTOLEMY collaboration (2017-)
- Co-leading a cryo-lab at Nikhef (2010-)
- Founded a collaboration with Nikhef, Purdue, Zurich and Bern universities to study seasonal fluctuations in radioactive decays with table-top experiments (2015-)
- Nikhef project leader to upgrade the ATLAS tracking detector (2016-2018)

Philippe Corboz (ITFA)

Organizational activities:

- Member of the European Tensor Network
- Member of the Delta Institute for Theoretical Physics
- Associate member of the Fugaku project on "Basic science for emergence and functionality of quantum matter" led by Prof. Masatoshi Imad (Waseda University, Japan)
- Member of the program committee of the SCES 2022 conference (2022)
- Member of the program committee of the Veldhoven meeting 2020 (2020)
- Organizer of the "Amsterdam Summer Workshop on low-D Quantum Condensed Matter 2019", University of Amsterdam (2019)
- Co-organizer of the focus topic "Frustrated magnetism" at the 2019 APS March Meeting (2019)
- HPC committee at the Faculty of Science, UvA (2023-)
- Editorial Fellow of SciPost Physics (2021-)

Corentin Coulais (WZI)

Organizational activities:

- Coordinator of the honours program of the Bachelor of Physics and Astronomy (UvA-VU) (2020-)
- Member of the committee for the design of a new Bachelor track "Science and Design" at the University of Amsterdam (2019-)
- Co-Author of the data management plan of the Institute of Physics (2018)
- Member of the committee of the NWO theme "Materials" (2023-)
- Patent "Metamaterials for shock absorption applications and methods for producing said metamaterials" Coulais C., Ennis B. and Liu W (2023-)

Prizes and awards:

- APS Early Career Award for Soft Matter Research (2023)

Antoine Deblais (WZI)

Organizational activities:

- Soft Matter Emerging Investigator (2023-)
- Member of the Program Committee (2022-2025)
- Stirring Committee (2022-)

Patrick Decowski (IHEF)

Organizational activities:

- Committee for Astroparticle Physics in the Netherlands (2011-2019)
- Scientific Committee INFN - Laboratori Nazionali di Frascati (2017-2023)
- UniversiteitsForum (2018-2022)
- Faculty of Science Works Council (2018-2021)
- Chair of Particle and Astroparticle Physics Research Community (2018-)
- Dutch Physics Council Executive Board (2019-2023)
- Round Table Physics (2022-)
- Beta's in Bestuur en Beleid (2021-)
- Permanent Committee for Large-Scale Research Infrastructure (2023-)

Joshua Dijksman (WZI)

Organizational activities:

- Gordon Research Conference, Granular Materials, elected co-chair (2022-)
- Online Gordon Research Conference, Granular Materials, co-chair (2020)
- Focus Session, American Physical Society March Meeting, Soft Matter in Industrial Applications, co-organizer (2018-2019)
- Physics@Veldhoven, Program Committee (2020-)

Prizes and awards:

- Excellent Education Award (2017)

Jeroen van Dongen (ITFA)

Organizational activities:

- Confidential advisor Academic Integrity (2018-)
- Co-Director, Vossius Center for History of Humanities and Sciences (2016-)
- Editor of book series "Studies in the History of Knowledge" (Amsterdam University Press) (2019-)
- "Expert", evaluations of completed ERC projects in history and philosophy of science (2020-)
- Guest curator, Rijksmuseum Boerhaave, Leiden (2022-)

Klaasjan van Druten (WZI)

Organizational activities:

- Chair Program Committee MSc Physics&Astronomy, joint degree UvA-VU (2017-2019)
- Member of the Scientific Committee of the AMO section of the NNV (Netherlands Physical Society) (2017-)
- Co-organizer Joint UvA-VU AMO seminar (2020-)

Lorenz Eberhardt (ITFA)

Organizational activities:

- Organization of internal research seminars at IAS Princeton (2021-2023)
- Organizer for the workshop "Speakable and Unspeakable in Quantum Gravity" at Institut Pascal, Saclay (joint with D. Maźač, E. Perlmutter and I. Zadeh) (2024-)
- Organizer for the workshop "String Amplitudes at finite α' " at IAS Princeton (joint with N. Arkani-Hamed and S. Mizera) (2023)

Prizes and awards:

- Prize for the best junior talk at "Integrability in Gauge and String Theory" in Stockholm, Sweden (2019)
- SwissMAP Innovator Prize "for important insights into string theory on AdS3 and its dual 2d CFT" (2019)
- Prize for the best junior talk at "String Theory and Quantum Gravity" in Ascona, Switzerland (2017)
- ETH Medal for an outstanding Master Thesis (2017)

Ben Freivogel (ITFA)

Organizational activities:

- Member Institute of Physics Diversity and Inclusion Council (Chair 2020-21) (2020-)
- Program Committee, Bachelor Physics and Astronomy (2016-)

Rene Gerritsma (WZI)

Organizational activities:

- Committee for NWO Vidi grants (2023)
- Co-organized Lorentz Center workshop on Compound (Atomic) Quantum Systems (2019)
- Co-organized Lorentz Center workshop on New Directions in Cold and Ultracold Chemistry (2023)
- Jury member NWO Projectruimte (2018)
- Laser safety coordinator (2022-2023)

- Co-organizing monthly IoP colloquium (2021-2023)

Mark Golden (WZI)

Organizational activities:

- Member of the Scientific Advisory Board: DFG Research Unit QWAST (2022-)
- Member of the Governing Board of Advanced Research Center for Nanolithography ARC-NL (2018-)
- Member and since 2021 chair of the Scientific Advisory Board of IFW Dresden (2018-)
- Member of the Senate of the University of Amsterdam (2016-2022)
- Member of the Scientific Advisory Committee of the French synchrotron SOLEIL (2015-)
- Member of the Dutch Physics Council (2020-)
- Chair of the Dutch national Platform Academische Natuurkunde (2016-2020)
- One of four founding Editors-in-Chief: Amsterdam Science magazine (amsterdamscience.org) (2014-2018)
- Program co-director, UvA Research Priority Area Quantum Matter & Quantum Information (2013-2016)
- Member, beamtime review committee for DIAMOND (2013-2018)

Vladimir Gritsev (ITFA)

Organizational activities:

- Co-organizer of the Amsterdam Summer Workshop on Low-Dimensional Quantum Condensed Matter (2015, 2019)
- Co-organizer of the regular triangular meeting "Quantum and Topological" in the framework of the Delta Institute for Theoretical Physics

Jorik van de Groep (WZI)

Organizational activities:

- Symposium Organizer CLEO (2022)
- General program committee member Physics at Veldhoven (2022)
- Organizer of Quantum Materials Colloquium Series (2020-)

Sebastian De Haro Ollé (ITFA/ILLC)

Organizational activities:

- Member of the committee, Fund for History of Science and History of the University of Amsterdam, Faculty of Humanities, UvA (2016-)
- Member, board of the section Philosophy of Physics of the Dutch Physics Association (2017-)
- Member of the BSA (Binding Study Advice) committee (2020-)
- Vossius Center for the History of Humanities and Sciences, member (2017-)
- Member editorial board, Philosophies (2017-)
- European Philosophy of Science Association (EPSA19), Biennial Conference, Geneva 2019. Member of the Program Committee (2019)
- Member, Trinity College, Cambridge (2017-)
- Member, Trinity College Mathematical Society
- Member, British Society for the Philosophy of Science
- Member, European Philosophy of Science Association

Aart Heijboer (IHEF)

Organizational activities:

- Elected Physics and Software Coordinator of the KM3NeT collaboration (2021-)
- Leading Vici group dedicated to the analysis of high energy neutrino telescope data (2018-)
- Member of KM3NeT Management Team (2017-)

Erik van Heumen (WZI)

Organizational activities:

- Coordinator Physics & Astronomy master program review (2023-)
- Coordinator Advanced Matter & Energy Physics track in Physics & Astronomy MSc program (2019-)
- Proposal Review Committee, Swiss Light Source, PSI Switzerland (2019-)

Misha Isachenkov (ITFA/KdVI)

Organizational activities:

- NWO Physics@Veldhoven 2022 poster prize selection committee (2022)

Anna Isaeva (WZI)

Organizational activities:

- Women in the Faculty of Science (2021-)
- Focus session organizer and chair at Physics@ Veldhoven (2023)
- International project expertise for NCN Poland (2020-)
- International reviewer for Alexander von Humboldt foundation (2022-)
- Organizer and session chair of the Session "Topological quantum materials" at the International Conference on Crystal Growth and Epitaxy (ICCGE-20) (2023)

Sara Jabbari Farouji (ITFA)

Organizational activities:

- Member of Master of Physics and Astronomy Strategy committee at UvA/VU (2023)
- Member of NWO Vidi committee (2023)
- Reviewer of Alexander von Humboldt Postdoctoral fellowship (2022)

Mazi Jalaal (WZI)

Organizational activities:

- Reviewer for European Research Council (ERC) Advanced Grant (2019)
- Confidential Advisor for PhD students (2023-)
- Project Leader: Optics for all: an open hardware for biophysics education (2019-2020)
- Associate Member: Tankstation: an international cultural centre (2017-2019)

Prizes and awards:

- Isaac Newton Trust Fellowship to Support Leverhulme (2020)
- Wellcome Trust Interdiciplinary Fellowship (2020)
- The University of Cambridge Public Engagement Starter Award (2019)
- The UK's Women's Engineering Society Public Engagement Award (2019)
- Cambridge BioMaker Grant (2019)
- Best Presentation Award, Annual European Rheology Conference (2019)
- Young Scientist Award, J.M. Burgerscentrum (2018)

Paul de Jong (IHEF)

Organizational activities:

- Member IoP directorate (2014-)
- NWO Platform Universitaire/Academische Natuurkunde (2016-2019)
- CERN EP Fellows and Associates Ranking Committee (2016-2022)
- Director Institute of Physics (2017-2022)
- Particle Data Group (2012-2022)
- NWO Vici committee (2021-2022)
- UvA committee Recognition and Rewards ("Erkennen en Waarderen") (2021-)
- Member Stichting Beta Plus (2019-)
- KM3NeT Infradev Steering Committee (2022-)

Femius Koenderink (WZI/AMOLF)

Organizational activities:

- Department Head "Information Processing Matter" at NWO-I Institute AMOLF, Amsterdam, The Netherlands (2021-)
- Department Head "Center for Nanophotonics" at FOM/NWO-I Institute AMOLF, Amsterdam, The Netherlands (2016-2021)
- Member FOM Werkgemeenschapscommisie Nanofysica & nanotechnologie, and subsequent (2016-2018)
- NWO-ENW NQMP (Nanotechnology, quantum and materials physics) committee (2019-2023)
- Member Directive Council LENS (European Laboratory for Non-Linear Spectroscopy), Florence, Italy (2016-)
- Board Member AMO-section NNV (section Atomic-Molecular and Optical Physics of the Nederlandse Natuurkundige Vereniging) (2012-2021)
- Editorial Board member Physical Review A (adjudicating appeal cases) (2014-2020)
- Member selection committee ACS Photonics Young Lectureship Award (annual international award) (2019-2020)

Prizes and awards:

- Elected member De Jonge Akademie (DJA) of the Royal Academy of Sciences (KNAW) (2012-2017)
- ACS Photonics Young Lectureship Award (2018)

Eric Laenen (ITFA/IHEF)

Organizational activities:

- Associate Member, Higgs Centre for Theoretical Physics, University of Edinburgh
- Adjunct Professor, IIT Hyderabad (2022-)
- Director, Institute of Physics, University of Amsterdam (2022-)
- Vice President of the CERN Council (2022-)
- Scientific Delegate to the CERN Council for The Netherland (2016-)
- Member of Finance Committee, CERN (2016-)
- Chair of Working Group on Young Scientist Careers as part of European Strategy Update (2019-2020)
- Chair of High Energy Theory network, the Netherlands (-2021)
- Head of Nikhef theory group (-2018)
- Chair of the KNAW CERN Contact Committee for The Netherlands (2016-)

Ludovico Lami (ITFA/KdVI/QuSoft)

Organizational activities:

- Program Committee member (various) (2018-)

Prizes and awards:

- Research Staff Travel Prize of the University of Nottingham (2019)
- Italian Habilitation for Associate Professor in Condensed Matter (2022)

Edan Lerner (ITFA)

Organizational activities:

- Theoretical Physics MSc coordinator (2021-2025)

Frank Linde (IHEF)

Organizational activities:

- PC-GWI (2015-2023)
- Virgo-STAC (Italy) (2015-2017)
- CTS (INFN, Committee Technico-Scientifico, Italy) (2013-2018)

Ben van Linden van den Heuvell (WZI)

Organizational activities:

- Chair Examinations board Physics & Astronomy (2017-2021)
- Philipp Mösta (ITFA/IHEF/API)

Organizational activities:

- Rubicon selection committee (2023)
- FNWI Digital Agenda Task force (2021-2022)

Clélia de Mulatier (ITFA/IvI)

Organizational activities:

- Diversity & Inclusion council (2022-2023)
- Behind the CV: Story from a Physicist (2021-)
- Working group “Parenting and working” under the FNWI Diversity Office (2022-)
- IAS Review, Editorial Board (2021-2023)
- Guest editor, Journal of Computational Science (2022-)
- Main track chair of “International Conference on Computational Science”, editor for proceedings of the conference (2022-)
- Program committee of the Netherlands Platform Complex Systems (2021-)
- Organizer of sessions for APS March meeting (2021-2023)

Clara Nellist (IHEF)

Organizational activities:

- ATLAS Top Mass and Properties Convenor (2022-)
- ATLAS Diversity and Inclusion Contact (2021-2023)
- ATLAS Outreach Coordinator (2019-2021)

Theo Nieuwenhuizen (ITFA)

Organizational activities:

- Main organizer of conference series Frontiers of Quantum and Mesoscopic Thermodynamics (FQMT) in Prague (2017-)
- Member of the Central Works Council of the University of Amsterdam (2020-2021)
- Principle organizer of the Advanced School on Quantum Foundations and Quantum Open Systems in Joao Pessoa, Brazil (2018)

Samaya Nissanke (IHEF/API)

Organizational activities:

- International Fellow, Frankfurt Institute for Advanced Studies, Germany (2023-)
- Research affiliate at the Kavli Institute for the

Physics and Mathematics of the Universe, Kashiwa, Japan (2022-)
- External Review Committee for the Flatiron Institute's Center for Computational Astrophysics (2024-)
- Invited International Scientific Advisory Board Member of the Hessian Excellence Cluster ELEMENTS (2022-2023)
- Invited Editorial Board Member for the new astrophysics for Physical Review D (2022-)
- Invited Executive Committee Member of the AAS Working Group on Time Domain Astronomy (2021-)
- Member of the Jury, Thesis Prize of the Gravitational Waves International Committee (2021)
- Member of the Jury, Amaldi Thesis Prize for GW and Multi-Messenger Astrophysics, Italy (2021)
- Core member and multi-messenger astronomy lead for "Gravitational Wave Probes for Fundamental Physics," JENAS (APPEC-ECFA-NuPECC) (2020-)
- Scientific and Technical Advisory Committee Member for Cherenkov Telescope Array Observatory (2020-)

Prizes and awards:
- Suffrage Science Award 2021 (2021)
- 2020 New Horizon Prize in Physics awarded by the Breakthrough Prize Foundation (shared with Jo Dunkley and Kendrick Smith) (2019)

Emilia Olsson (ITFA/ARCNL)

Organizational activities:
- Veni committee (2023-)
- Organizer of a focus session at NWO Physics (2023)
- Academic supervisor NWO Physics with Industry (2022)
- ARCNL - Organizer Tribology Symposium 2023 together with Bart Weber (2023)
- MATSUS Fall 2024 Symposium organizer (2023-)
- Reworking and formalizing ARCNL PhD track (2022-2030)

Paul Planken (WZI/ARCNL)

Organizational activities:
- Chair of the ARCNL Management Team (2016-2019)
- Associate Editor Optics Express (2016-2019)
- Member of NWO-TTW Vidi (selection) committee (2018-2021)
- Member of the scientific committee of the AMO Section of the NNV (2016-2021)
- Member of the Dutch Physics Council (2020-)

Tina Pollmann (IHEF)

Organizational activities:
- Convener of DARWIN/XLZD WG1 Member of the Nikhef scientific advisory committee Member of the IoP examination committee (2022-)
- DEAP deputy analysis coordinator (2019-2021)
- Chair of the DEAP scientific board (2019-2020)
- Member of the DarkSide-20k speaker's committee (2019-2020)
- Deputy chair of the DEAP scientific board (2018-2019)
- Institutional representative (TUM) in DarkSide-20k collaboration (2018-2021)
- Radiation safety officer for E15 research group at TUM (2016-2020)
- DEAP pulse-shape analysis group leader and database manager (2015-2019)
- Café & Kosmos speaker "Großbaustelle unter Tage: Wie ein neuer Detektor für Dunkle Materie entsteht" (outreach for the general public) (2018)

Prizes and awards:
- Golden chalk teaching award (2020)

Albert Polman (WZI)

Organizational activities:
- Chair Executive Board National Growth Fund program "Circular, integrated high-efficiency solar panels" (898 M€ research, innovation and industrial development program, 312 M€ subsidy) (2023)
- Chair International Evaluation Panel, Faculty of Science and Engineering, Groningen University (2023)
- Member Mission Innovation team Renewable Energy, Ministry EZK (2022-)
- Chair Management Team EU Pathfinder consortium EBEAM (2020-)
- Member Platform Materialen (2019-)

- Chair Steering Committee National SOLARLab initiative (2017-)
- Chair NWO Theme Committee Materials Science (2014-2023)
- Chair National Science Agenda (NWA) Materials Route (2014-2023)
- Member Strategic Advisory Board TNO Energy Transition (2018-2023)

Prizes and awards:

- Highly Cited Researcher (Web of Science, Clarivate Analytics) (2017, 2018, 2019)
- Frew Fellow, Australian Academy of Sciences (2017)
- Research into the Science of Light Prize, European Physical Society (EPS) (2017)

Andrea Puhm (ITFA)

Organizational activities:

- PI Visiting Fellow, Perimeter Institute, Canada (2023-)
- CERN Visiting Scientist, CERN, Switzerland (2022)
- Simons Visiting Scientist, Galileo Galilei Insitute, Florence, Italy (2022)
- BHI Visiting Scholar, Black Hole Initiative, Harvard University, USA (2017-2019)
- International Advisory Committee for Eurostrings 2025 (2023-)
- Scientific Advisory Committee for French Strings Meeting 2023 (2022-2023)
- Scientific Advisory Committee for Eurostrings 2023 (2022-2023)
- Steering Committee for IRN:QFS (2020-2025)
- Scientific Program Committee for Strings 2022 (2021-2022)
- Scientific Advisory Committee International Virtual Seminar Series: Quantum Gravity Across Approaches (2020-)

Arghavan Safavi Naini (ITFA)

Organizational activities:

- Member of Women in Quantum steering committee (2022-)
- Member of the Institute of Physics diversity and inclusion council (2020-)
- Member of quantum for educators committee (2020)
- Member of EQUIP, the EQUS (ARC center of excellence for Engineered Quantum Systems) equity committee (2019-2020)

Jan Pieter van der Schaar (ITFA)

Organizational activities:

- Steering group chair of the faculty's Actieplan Lerarenagenda (2023-)
- Member of the MSc Physics and Astronomy Strategy Committee (2023-)
- Initiator and member of DRSTP research education renewal proposal (2022-2023)
- Vice-chair GRC conference on strings and cosmology (2019)
- Ambassador of the Faculty of Science University of Amsterdam (2013-)
- Coordinator of the Delta Institute for Theoretical Physics (2013-)
- Education director Graduate School of Sciences (FNWI) (2022-)
- Chair route Building blocks of matter and foundations of space and time National Science Agenda (2022-)

Peter Schall (WZI)

Organizational activities:

- Editor European Physical Journal E (2012-)
- Editor of Springer book series "Soft and Biological Matter" (2013-2025)
- NWO committee ENW KLEIN (chair) (2019)
- NWO committee Veni (2021)
- Science for Sustainability Committee (2021-2022)

Kareljan Schoutens (ITFA)

Organizational activities:

- Member of Supervisory Board of foundation Quantum Delta NL (2020-)
- Member for the Netherlands of the Advisory Board of the CERN Quantum Technol- ogy Initiative (QTI) (2021-)
- Member of Management Team of Quantum. Amsterdam (2021-)
- Member of the Scientific Board of the Galileo Galilei Institute, Florence, Italy (2015-2021)

Florian Schreck (WZI)

Organizational activities:

- Chair of European Quantum Technology Flagship Thematic Committee on Quantum Sensing (2013-)
- Member of NWO advisory committee Nano, Quantum, and Materials Physics (2017-2023)
- Leader of Quantum Delta NL Quantum Sensing Catalysis Program (2021-2022)

Noushine Shahidzadeh (WZI)

Organizational activities:

- Member of the Board of Directors of the Interpore Foundation (2016-)
- Member of the Scientific Advisory Board of the Netherlands Institute for Conservation, Art and Science (NICAS) (2014-)
- Member of the technical committee of RILEM-271-ASC: durability of materials with respect to salt crystallization (2016-2023)
- Member of the scientific committee of the International Droplets congress (2019-2023)
- Member of the Editorial Board of the journal CRYSTALS (2018-)
- Member of the Editorial Board of Amsterdam Science Magazine (2015-2018)

Hella Snoek (IHEF)

Organizational activities:

- Board member of Stichting Physica (2020-)
- Chairperson of the section subatomic and astro/particle physics of the Dutch Physical Society (2018-)
- Board member of natuurkunde.nl (2024-)
- Member of program committee Bachelor Natuur en Sterrenkunde (2019-)

Jory Sonneveld (IHEF)

Organizational activities:

- Chair of the Institute of Physics Diversity and Inclusion Council, UvA (2022-2023)
- Program Committee Member, NWO Physics Conference, Veldhoven, Netherlands (2022-2023)
- VISTA30 strategy meeting, Nikhef, Egmond aan Zee (2022)
- Member of the Nikhef Scientific Advisory Board, Nikhef (2022)
- Deputy subsystem run coordinator for CMS pixel, CERN (2018-2020)
- Coordinator for CMS Tracker monitoring (2018-2020)

Robert Spreeuw (WZI)

Organizational activities:

- Scientific committee of international BEC conference (2017-2023)
- Assessment committee NWO ENW-M (2021)
- Faculty works council, vice chair since 2021 (2018-)

Rudolf Sprik (WZI)

Organizational activities:

- Founder of Eddytec B.V.

Wouter Verkerke (IHEF)

Organizational activities:

- Nikhef Program Leader - Dutch ATLAS program (2014-)
- ATLAS Collaboration - member statistics committee (2018-)
- ATLAS Collaboration - member Collaboration Board Chair Advisory Group (2022-2023)
- ATLAS Collaboration - National Contact Physicists for the Netherlands (2019-)
- ATLAS Collaboration - member upgrade advisory board (2019-)

Erik Verlinde (ITFA)

Organizational activities:

- Associate Editor for “Foundations of Physics” (2012-)
- Member of the Editorial Board of “Communications in Number Theory and Physics” (2013-)
- Editor for “Journal of High Energy Physics” (JHEP) (2010-)
- Member of the Editorial Board of “Geometry and Physics” (2020-)
- Chair of the ERC-Advanced Grant PE2 panel (2015-2018)
- Member of Science Advisory Council of Institute de Physique Théorique, Saclay, France (2018-2019)

Anne de Visser (WZI)

Organizational activities:

- Chair and principal organizer of International

Conference on Strongly Correlated Electron Systems, Amsterdam (2022)
- Chair International Advisory Board SCES (2021-2022)
- Member Advisory Board LT29 (2022)
- Member International Advisory Board SCES (2021)
- Member International Advisory Board (2019)
- Member editorial board J. Physics Communications (IoPScience) (2017-2023)

Marcel Vonk (ITFA)

Organizational activities:
- Editor-in-chief Quantum Universe (popular science website) (2012-)

Marcel Vreeswijk (IHEF)

Organizational activities:
- Ambassador "Molecular and Materials Design" committee FNWI (2023-)
- Project Leader for Nikhef Inner Tracker activities (2019-)
- Co-leader of the joint 'Top-Spin' project of the Nikhef-ATLAS and Nikhef-Theory group (2016-)
- Activity coordinator for the Global Support Structure for ATLAS, Co-author Technical Design Report (2014-)
- Chairperson of the BKO committee FNWI (2021-)
- Director of the College of Sciences (Physics&Astronomy, Math, Chemistry (2019-2021)
- Director of the Joint-Degree program Physics and Astronomy UvA en VU (2014-2018)
- Member of the advisory council of Natuurkunde.nl (2021-)
- Member of the advisory council of NNV (Dutch Physics Society) (2012-)

Jordy de Vries (ITFA/IHEF)

Organizational activities:
- Diversity and Inclusion Council (2022-)
- Lead organizer of Institute of Nuclear Theory Program "Beyond-the-Standard-Model Physics with Nucleons and Nuclei" (2022)
- Lead organizer Bethe Forum "Long-Lived Particles" at the University of Bonn (2023)

Ivo van Vulpen (IHEF)

Organizational activities:
- Deputy program leader Atlas-group at Nikhef-Amsterdam, with W. Verkerke (2018-)
- Member IoP 'promotions committee' (2018)
- FNWI representative UvA rondetafel on HR/talent (2018)
- Nikhef: chair of the CGO - Computergebruikersoverleg (2020-)
- ATLAS: responsible for Institutional paper readings for draft publications (2014-)
- NWA project (10 k€, with S.J. van der Molen) for the Leiden wall formula project: fund hours and stimulate (inter)national expansion of the project (2020)

Wouter Waalewijn (ITFA)

Organizational activities:
- National contact person for the Future Circular Collider (2023-)
- Member of works council for Faculty of Science (2021-)
- Board Member of works council for Faculty of Science (2022-)
- Board member of De Amsterdamse Academie (2022-)

Bart Weber (WZI/ARCNL)

Organizational activities:
- Committee member evaluation panel 'M' (2023)
- Member Recognition and rewards committee NWO-I (2021-)

Christoph Weniger (ITFA)

Organizational activities:
- ENW Open Competition M21-1 assessment committee (2021)
- Scientific Reports editor (2018-2022)

Jasper van Wezel (ITFA)

Organizational activities:
- Member of local organizing committee and program committee for SCES 2022, Amsterdam, The Netherlands (2022)
- Co-organized the "Topology and Broken Symmetries" conference at the University of Utrecht, NL (2019)

Appendix 7: Composition of SEP panel

Prof. Gerard van der Steenhoven (Chair)
Gerard van der Steenhoven served as Director General of the Royal Netherlands' Meteorological Institute (KNMI) in the period 2014 – 2023. Before that, he served as dean of the Department of Science and Technology of the University of Twente (2008 – 2013), one of the three technical universities in the Netherlands. During this period, he founded (in 2009) and led the Twente Graduate School, a university-wide organization aimed at streamlining and modernizing graduate education. In 2015 he was re-appointed as extraordinary professor in the domain of meteorology and climatology. Van der Steenhoven was educated in physics at the Vrije Universiteit in Amsterdam, where he defended his PhD thesis in 1987. Thereafter, he obtained a postdoc position at MIT (Cambridge, Massachusetts) at the Laboratory for Nuclear Science. Subsequently, he was employed by the National Institute for Subatomic Physics (Nikhef) in Amsterdam, where he has been involved in – and led – various large international scientific projects in Lund (Sweden), Hamburg (Germany) and Marseille (France). In the year 2000 he was appointed as part-time professor of physics at the University of Groningen.

Over the years, Van der Steenhoven has served in numerous boards and advisory committees. For example, in 2004 he founded the Committee for Astroparticle Physics in the Netherlands. Later he served as president of the Netherlands' Physical Society (2007 – 2013). Other examples include various boards and committees that were initiated by the Department of Economic Affairs in the framework of the so-called top sector policy (2011 – 2013). He has served in various (international) review committees, including as chair of the committee responsible for the previous SEP evaluation (2010-2016) of the Institute of Physics, then jointly with the VU Physics Department.

Prof. Thierry Giamarchi (University of Geneva, Switzerland))
Thierry Giamarchi leads the Quantum Theory of Matter group at the Department of Quantum Matter Physics (DQMP), University of Geneva (Switzerland). He has been a permanent researcher at the CNRS since 1986, and during the period 1990-1992 did a postdoctoral fellowship at Bell Laboratories (USA). In 2002 he became full professor at the University of Geneva, leading the DQMP from 2013 to 2019. Since 2017 he has been vice-president of the Swiss network of researchers working on the physics of novel quantum materials and devices (MaNEP). His research deals with the effects of interactions in low-dimensional quantum systems, such as Luttinger liquids, and on the effects of disorder in classical and quantum systems with works showing the existence of novel disordered phases such as the Bose glass and the Bragg glass. He received the 2000 Abragam prize from the French Academy of Sciences.

In addition to his research activities, he was member of the Research Commission of the University of Geneva (2018-2020), member of the CNRS National Committee for Theoretical Physics (2000-2002), member of the Scientific Committee of the School of Physics of Les Houches (2007-2016) and member of the Scientific Council of the Commissariat à l'Énergie Atomique (CEA) (2015-2018).

Since 2013, he has been a member of the French Academy of Sciences and a Fellow of the American Physical Society. He is the author of about 220 publications, 10 chapters of books, and one monograph "Quantum physics in one dimension" with Oxford.

Dr Liesbeth Janssen (Eindhoven University of Technology , Netherlands)
Liesbeth Janssen leads the Non-Equilibrium Soft Matter group, part of the Soft Matter and Biological Physics (SMB) research unit at the Department of Applied Physics at Eindhoven University of Technology. Janssen studies materials that are far from thermodynamic equilibrium, ranging from

non-crystalline polymers and colloidal glasses to living cell models.

She received her PhD in Theoretical Chemistry (cum laude) from Radboud University Nijmegen. She previously worked in the field of molecular quantum physics, focusing on quantum-mechanical first-principles treatments of molecular photodissociation, scattering processes in an external field, and ultracold controlled chemistry. Following postdoctoral stays at Columbia University, New York and Heinrich-Heine University Düsseldorf, for which she received funding through the Rubicon, Niels Stensen, and Alexander von Humboldt fellowships, she joined Eindhoven University of Technology in 2017 as assistant professor, where she is currently appointed as professor of Soft Matter and Biological Physics. In 2020, she was awarded a NWO Vidi grant, as well as elected member of the Young Academy of KNAW.

Kirsten Kanneworff, MSc (Leiden University (PhD candidate))
Kirsten Kanneworff studied Physics at Leiden University and currently is PhD candidate in the Solid State and High Dimensional Quantum Optics group at Leiden University, led by Wolfgang Löffler. Within the Quantum Software Consortium, she works towards an experimental realization of quantum position verification.

Prof. Jorge Kurchan (École Normale Superieure, Paris, France)
Jorge Kurchan is CNRS research director at the Physics Laboratory of the École Normale Supérieure, Paris (France). His main interests are (working towards an) out-of-equilibrium thermodynamics, glassy physics – he has been a specialist and an advocate of a dynamical treatment – and, most recently, the stochastic treatment of near-integrable dynamical systems.

Kurchan received his PhD degree at the University of Buenos Aires, where he worked on the question of defining quantum moving frames for many-body problems. He was a postdoctoral fellow in the Weizmann Institute (Israel), in Roma La Sapienza, and at the École Normale in Paris. After obtaining a permanent position at the Ecole Normale de Lyon in 1996, he moved to the Ecole de Physique Chimie in Paris in 2000 and more recently back to Ecole Normale in Paris. Kurchan was awarded the Paul Langevin Prize of the French Physical Society in 2002 and the Servant Prize of the French Academy of Sciences in 2005. Previously he was Deputy Director of the Institut Henri Poincare and Director of Laboratoire de Physique Statistique at the Ecole Normale.

Prof. Steven Lowette (Vrije Universiteit Brussels, Belgium)
Steven Lowette is a research professor at the Vrije Universiteit Brussel (VUB), in Belgium. He works at the Interuniversity Institute for High Energies (IIHE), a joint institute between the VUB and ULB universities. His field of research is experimental high-energy physics.

In 2006 he obtained his PhD in experimental particle physics at the VUB, winning the CMS Thesis Award 2007. From 2007 to 2013 he was a post-doctoral researcher at the University of California, Santa Barbara, in the group of Joseph Incandela.

Since long, Lowette has been a member of the CMS experiment at the LHC collider at the CERN laboratory near Geneva, Switzerland, and more recently also joined the milliQan experiment. He has expertise in supersymmetry, dark matter and exotic long-lived particles.

Prof. Fernando Quevedo (University of Cambridge, UK)
Fernando Quevedo is a member of the High Energy Physics group at the Department of Applied Mathematics and Theoretical Physics at the University of Cambridge (UK). His work is mostly on String Theory and its potential phenomenological and cosmological implications.

After research appointments at CERN, Switzerland, McGill University in Canada, Institut de Physique in Neuchatel, Switzerland, and the Los Alamos National Laboratory, USA, and as professor of physics at the National Autonomous University of Mexico (UNAM), Quevedo joined the University of Cambridge in 1998 as Professor of Theoretical Physics and Fellow of Gonville and Caius College.

He has authored more than 150 peer-reviewed papers, and was awarded the 2021 John Wheatley Award from APS, the Royal Society Wolfson Research Merit Award, Doctorate Honoris Causa from Universidad de San Carlos de Guatemala and Universidad del Valle de Guatemala, John Solomon Guggenheim Foundation Fellowship and, alongside Anamaría Font, the 1998 ICTP Prize. He has been a fellow of the World Academy of Sciences since 2010.

Prof. Kate Scholberg (Duke University, USA)
Kate Scholberg is Arts & Sciences Distinguished Professor of Physics at Duke University in Durham, USA. Her broad research interests include experimental elementary particle physics, astrophysics and cosmology.

Scholberg is a researcher in the Super-Kamiokande and Tokai-to-Kamioka (T2K) collaborations, the Deep Underground Neutrino Experiment (DUNE), and the COHERENT detector at the Spallation Neutron Source of the Oak Ridge National Laboratory. She has also been instrumental in the development and coordination of the SuperNova Early Warning System.

Scholberg serves as spokesperson of COHERENT, a multi-detector experiment with the primary physics goal of measuring CEvNS (Coherent Elastic Neutrino Nucleus Scattering) using the high-intensity neutrinos produced by the Spallation Neutron Source at Oak Ridge National Laboratory in Tennessee. She co-founded SNEWS, the SuperNova Early Warning System, an inter-experiment collaboration of detectors with Galactic supernova sensitivity. Scholberg is a Fellow of the American Physical Society (APS) and elected member of the U.S. National Academy of Sciences.

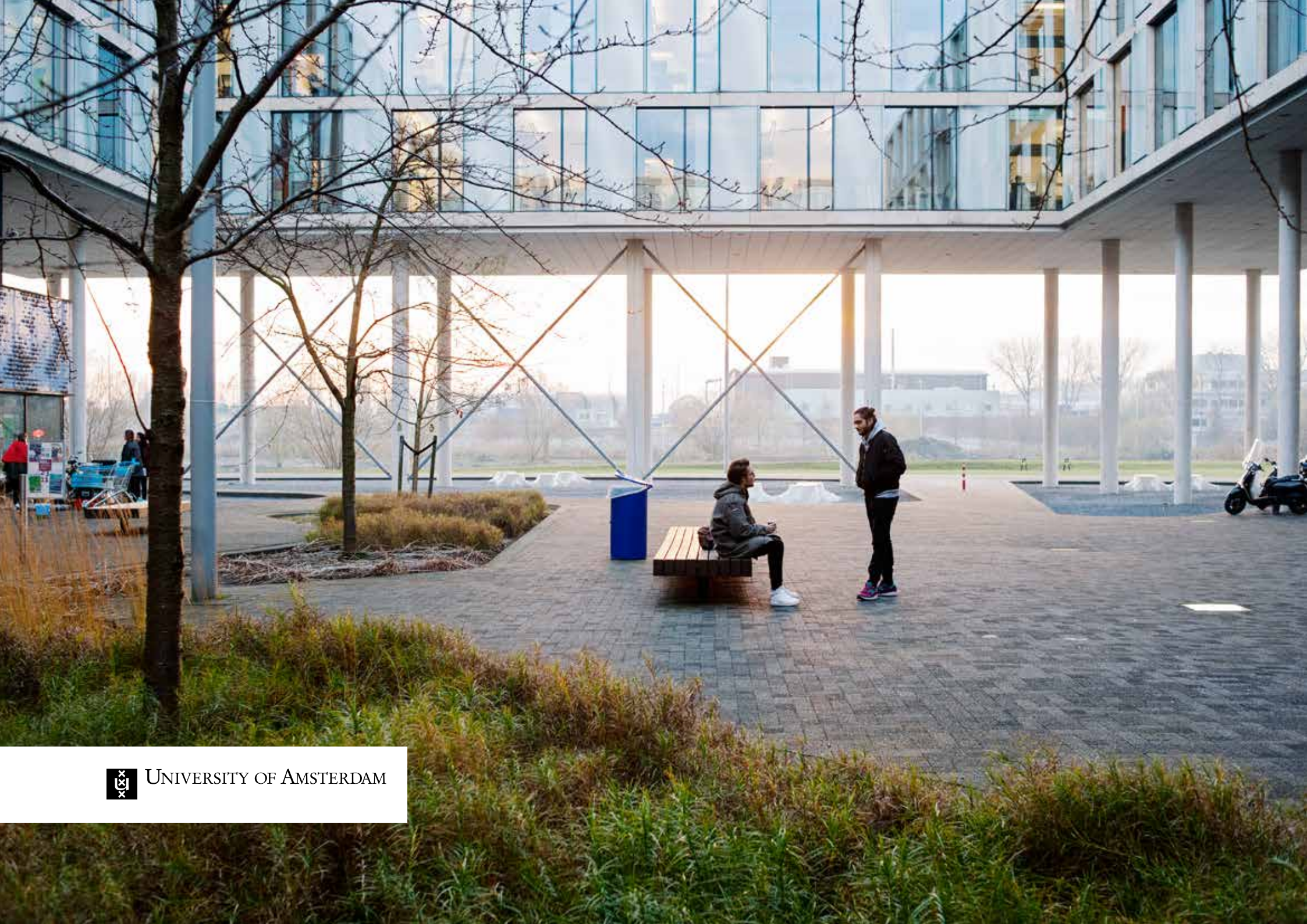
Mariette Huisjes, MSc (secretary to the committee)
Originally trained in Language and Cognition Sciences at the University of Amsterdam, Mariette Huisjes has held various positions in (science) communication, and as journal manager, institutional biographer, science writer, spokesperson, editor and accredited secretary to peer-review committees. She (co-) wrote books on Delft University of Technology and on the research institute for biomedical technology and technical medicine MIRA. Through her self-founded company Huisjes&Co, Huisjes contributes to all facets of science outreach.

Appendix 8: Glossary

ACE	Amsterdam Centre for Entrepreneurship
AI4SMM	Artificial Intelligence for Sustainable Molecules and Materials, a research priority of the Faculty of Science that connects chemists, physicist and computer scientists
AMC	Academic Medical Centre, now part of the Amsterdam University Medical Center or AUMC
AMEP	Advanced Matter and Energy Physics, an experimental physics track in the MSc program Physics and Astronomy
AMOLF	NWO institute for physics of functional complex matter, located at Amsterdam Science Park
API	Anton Pannekoek Institute for Astronomy
ARCNL	Advanced Research Centre for Nanolithography, a research institute founded in 2014 by ASML, UvA, VU and NWO, located at Amsterdam Science Park
AUC	Amsterdam University College, a joint educational institute of UvA and VU offering a Liberal Arts and Sciences program
Delta ITP	Delta Institute for Theoretical Physics – an NWO Gravitation consortium of UvA, Leiden and Utrecht, awarded in 2013
DIEP	Dutch Institute for Emergent Phenomena
DRSTP	Dutch Research School of Theoretical Physics, a research school in which IoP participates through ITFA and (partly) IHEF
EC/ECTS	European Credit (Transfer and Accumulation System); one academic year corresponds to 60 ECTS credits
ENW	NWO's Science Domain, or Exacte en Natuurwetenschappen
ERC	European Research Council
GRAPPA	Gravitation and AstroParticle Physics; RPA / center of excellence
HIMS	Van 't Hoff Institute for Molecular Sciences (UvA's chemistry institute)
HvA	'Hogeschool van Amsterdam', or Amsterdam University of Applied Sciences
IHEF	Institute of High Energy Physics ('Fysica'), a division of IoP
ILLC	Institute for Logic, Language and Computation (joint between Faculties of Science and Humanities)
IoP	Institute of Physics (UvA)
ITFA	Institute for Theoretical Physics ('Fysica') Amsterdam, a division of IoP
IXA	Innovation Exchange Amsterdam, the joint Technology Transfer Offices of UvA, VU, the University of Applied Sciences (HvA) and the two Academic Medical Centers
KdVI	Korteweg-de Vries Institute for Mathematics
KHMW	'Koninklijke Hollandsche Maatschappij der Wetenschappen', the Royal Holland Society of Sciences and Humanities
KNAW	'Koninklijke Nederlandse Akademie van Wetenschappen', the Royal Netherlands Academy of Arts and Sciences (KNAW)
NGF	National Growth Fund, an initiative of the Dutch Ministry of Economic Affairs and Climate Policy and the Ministry of Finance for projects designed to ensure greater economic growth in the Netherlands
NICAS	Netherlands Institute for Conservation, Art and Science, an interdisciplinary institute of UvA, TU Delft, the Rijksmuseum, the Cultural Heritage Agency of the Netherlands (RCE), and NWO
Nikhef	National Institute for Subatomic Physics, a collaboration between NWO and several Dutch universities including UvA, located at Amsterdam Science Park.
NNV	'Nederlandse Natuurkundige Vereniging', Netherlands Physical Society

NWA	'Nationale Wetenschapsagenda', National Research Agenda, see wetenschapsagenda.nl
NWO	'Nederlandse Organisatie voor Wetenschappelijk Onderzoek', Netherlands Organisation for Scientific Research, the national funding agency for scientific research
NWO Gravitation	NWO funding scheme of typically M€15+ grants aimed at stimulating research by consortia of Dutch top researchers
NWO Veni/ Vidi/Vici	NWO funding schemes in for personal grants of order 250k€, 800k€ and 1500k€, respectively
NWO-I	The new Institutes organization of the NWO that comprises (a.o.) AMOLF, ARCNL and Nikhef
OSAF	'Onderzoeksschool Subatomaire Fysica', national research school for subatomic physics in which IoP participates through IHEF
QDNL	Quantum Delta NL, a national consortium funded by a 615M€ government investment in the first National Growth Fund round, in which Amsterdam is one of the five hubs
RPA	Research Priority Area
SEP	Standard Evaluation Protocol, quality assurance protocol formulated and endorsed by the VSNU, KNAW and NWO for evaluation of Dutch universities as well as NWO and KNAW institutes
TC	Technology Centre, UvA Faculty of Science department for workshop support in the fields of mechanical construction, electronics and software
TNO	Netherlands Organisation for applied scientific research
TT, TT'er	Tenure track, tenure tracker
TTW	NWO division for Applied and Engineering Sciences (AES), or Toegepaste en Technische wetenschappen
TU	University of technology, of which four exist in the Netherlands: in Delft (TU Delft), Eindhoven (TU/e), and Twente (UT)

QM&QI	Quantum Matter and Quantum Information, RPA of UvA comprising groups from WZI, ITFA, ILLC and KdVI
QSC	Quantum Software Consortium – an NWO Gravitation consortium of QuSoft plus groups from Leiden and QuTech/TUDelft, awarded in 2017
QuSoft	QuSoft is the Dutch research center for quantum software, launched by UvA, VU, and CWI and structurally funded through RPA QM&QI
UvA	University of Amsterdam
VU	Vrije Universiteit
VUmc	VU Medical Center
WZI	Van der Waals-Zeeman Institute for experimental physics, a division of IoP



University of Amsterdam