KoF/ÖB 2024

Faculty of Science and Technology

Research Program Self-Evaluation

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| Research Program: | Quantum Matter Theory (QMT) |
| Department: | Department of Physics and Astronomy (IFA) |
| Section: | Physics |
| Program Responsible Professor: | Annica Black-Schaffer |

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| **Goals:*** Maintain and strengthen our **research quality**
	+ Through program and department self-reflection on strengths and weaknesses
	+ Through developing program and department priorities for the next 5 years
	+ Through internal and external feedback on our performance and plans
* Strengthen our **collegial culture**
	+ By involving all research staff in the process and ensuring everyone is aware of the results
	+ By being respectful of everyone’s time at the faculty, department, and program levels
	+ By communicating clearly as to why we are doing this and how we expect everyone to contribute
* Improve our **internal understanding**
	+ By collecting information on the different ways programs and departments are funded and operate
	+ By collecting explanations of why we work that way and how it supports our research
* Improve our **resource usage**
	+ By generating bottom-up prioritized research plans at the program, department, section, and faculty-levels
	+ By allocating and re-allocating resources based our priorities and the potential to significantly improve research
	+ By identifying opportunities for intra- and inter-program/department/section collaboration and re-organization
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**Introduction**

Be sure to regularly [check the faculty KoF24 and ÖB webpage](https://www.uu.se/medarbetare/fakultet/teknisk-naturvetenskapliga/utvardering-av-fakultetens-forskning---kof) for updates, clarifications, details, timelines, and answers to common questions.

**Background on KoF and ÖB**

This evaluation combines two processes: the university-wide Quality and Renewal (KoF) process and the faculty-level Review of Base Financing (ÖB). These are being combined to avoid significant duplication of effort. However, they have different goals which makes combining them a challenge. For example, the first three goals above are KoF-focused while the last is ÖB-focused. Most importantly, KoF is a reflective process where we strive to identify both our strengths and weaknesses, while ÖB is an evaluative process where we strive to identify the best opportunities for using our resources.

This causes an inherent concern: will admitting to weaknesses in KoF make us less likely to get resources from ÖB? While there is no way to completely eliminate this concern, this evaluation has been designed with the ÖB portion focusing on identifying Priorities to improve/strengthen/broaden research while the KoF portion focuses primarily on reflecting on our processes.

This provides the ability to be open about weaknesses while ensuring prioritization of high-quality ideas, as

1. Using Priorities allows us to identify concrete opportunities to improve our research, thereby allowing reflection on not just where we are currently excellent but where we can become better, and,
2. Using an internal, bottom-up prioritization process at the program, department, section, and faculty-levels allows us to identify the most promising and high-quality proposal for potential funding at each level.

**Expectations**

There is understandably a strong focus on the “new” funds that will be allocated as part of the ÖB process. However, these funds are small in comparison to the yearly budget, and the Faculty strongly encourages everyone to look to the four goals listed on the first page for the main value of this process. Please be aware that this report will be a public document and will be placed on the faculty website for all employees to access.

**Time period**

This evaluation pertains to the period since the last evaluation: 2019-2023 inclusive. Descriptions provided by the programs should cover the full evaluation period. However, centrally provided statistics on bibliometrics (2017-2021/2022) and financial data (2022-2023) cover slightly different time periods.

**Responsibility**

The Head of Department (HoD) has the overall responsibility for the department self-evaluations and the Program Responsible Professor (PAP) has the overall responsibility for program self-evaluations. This includes ensuring that the information provided is both sufficiently accurate and not misleading. It is important to be open, even about activities that are not as successful as we may wish.

The HoD/PAP is responsible for coordinating meetings with the appropriate people, collecting input, leading appropriately broad and inclusive discussions, prioritizing among suggestions, and summarizing and producing the final text. Most economic and HR data will be provided centrally, but for the information that needs to be collected locally, the HoD/PAP is responsible for coordinating with the appropriate people. The HoD is responsible for ensuring that the programs provide drafts to the department early enough that the department can use them as input to the department’s self-evaluation.

**Panels**

The panels will provide input on how programs and departments can improve, provide new perspectives on potential organizational changes across programs and departments, help in identifying good examples that can be shared across the faculty, and place our research quality in the international context. While this input is extremely helpful for identifying directions, decisions and prioritization will be done within the faculty using the panel’s feedback as one input.

**Instructions**

**Base data**

Base data such as bibliometrics, HR and financial data will be provided centrally. Details on how the data was collected and how to interpret it will be found in the Base Data Information document on the Faculty KoF webpage.

**Note**

While it is understandable that every program and department will want to look as good as possible, this process is most valuable when everyone is open and honest. In particular:

1. Activities (funding, projects, publications, hires etc.) that ended before the evaluation period or started after it should not be included. If it is extremely important to include such, e.g., very recent recruitments that significantly affect future plans, the text must clearly indicate that the activity falls outside the evaluation period and why it is being included.
2. Cramming in more text by changing the font size, layout, margins, text box sizes, etc. will not be accepted. It is understood that the space limitations will lead to the need for careful prioritization.

The four answer sizes used are:

* Very short – 1.4cm tall box, approximately 250 characters
* Short – 3cm tall box, approximately 600 characters
* Medium – 4.7cm tall box, approximately 950 characters
* Long – 10cm tall box, approximately 2000 characters

Do not change the ordering or labeling of the questions in the document, as the final answers will be extracted from the document based on that ordering and labeling.

**Before submission**

[Check the KoF/ÖB webpage on the employee portal for any important updates](https://www.uu.se/en/staff/faculty/science-and-technology/research).

**Hide instructions**
Modify the “Instructions” style so all colored text is hidden in the submitted document. First, check that you have the “Show/Hide Formatting Marks” turned off then right-click on the style “Instructions” in the ribbon at the top of the window. Then select “Modify” and then “Format” at the bottom left. Choose “Font” and turn on the “Hidden” option and click the OK button.

**Navigation panel**

To quickly navigate through the document, you can use the Navigation panel. To see the Navigation panel, click the “View” tab in the ribbon and then check the “Navigation Panel” checkbox in the “Show” button group or choose “Sidebar🡪Navigation” from the “View” menu. In the Navigation Panel you can view the outline of the document and search for specific words or phrases.

**Submission**

Send this document as **a Word file** to your Head of Department latest April 15, 2024. It is important to submit the document as a Word file as we will be extracting text from the tables to put all answers in a database.

**Updates**

* V4
	+ Clarified in table 3.9 that Top-10 external funding shows the amount spent on each financier during the year.
	+ Corrected data for some programs with regard to “UL, promoted from an adjunct” being included in the category “Other Research”. Those concerned have been informed by e-mail.
	+ Updated data for the Instrumentation Research Program including FREIA.
	+ Added a box where the program can ask questions to the panel.
* V3
	+ Revised bibliometrics table to have only one coverage statistic (3.3.2). This statistic reflects the proportion of DiVA publications used for citation statistics calculations by CWTS Leiden, instead of reporting the Web of Science coverage (WoS coverage). For WoS coverage statistics, see the base data document. The intended goal is to put increased focus on the impact indicators and their validity.
* V2
	+ **3.10 External funding sources** - Changed to include all “active” grants during the evaluation period instead of just grants that “started” during the evaluation period. This change is done to make sure that grants that show up in the financial data for 2022 and 2023 will be listed even if they did not start during the evaluation period
* V1 (initial version)

# General information

Responsibility: PAP to communicate with all program members, discuss, prioritize, and collate. All program members to report and discuss.

## Process for creating this self-evaluation

**Instructions**: Describe the process to generate this self-assessment, how it was collegial, and list which categories of employees (e.g., Professors, ULs, BULs, postdocs, PhDs, researchers, etc.) were significantly involved.

Motivation: To emphasize that this is to be a collegial process and that all members of the program should be included.

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| Multiple meetings with all faculty members in the program, discussing all parts. Assigned tasks to all faculty members to help write the evaluation. Researchers, postdocs, and PhD students all invited to discuss and comment both during the process and on the final draft of this document.  |

## Core of the research program

**Instructions**: Describe what makes the program a coherent research program. For example, shared methods, areas, questions, facilities, etc.

Motivation: To understand the essence of the program so that its plans and activities can be better understood in that context.

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| Research in quantum matter theory with a focus on describing quantum mechanical many-body systems and matter using conceptual and effective low-energy models to understand the physics of (condensed) matter, but often not specific materials, on a unifying level.  |

## Personnel (data provided centrally)

**Instructions**: Postdocs who are on stipend should be listed separately in parentheses. (Example: if there are 4 postdocs on salary and 3 on stipend, please enter “4 (+3)”. )

Motivation: To understand the program’s personnel distribution by career stage and gender. This data shows the number of FTEs (full-time equivalent) employees in each category.

Responsibility: Data provided centrally; PAP to review to ensure no significant mistakes are made. Note that stipend postdocs are not present in the university salary system and will need to be manually accounted for if they are to be included. If this table is changed to add stipend postdocs, please note the changes in the “other important program-specific comments” section below as well.

|  |  |  |
| --- | --- | --- |
|  | **Faculty FTEs** | **Non-Faculty FTEs** |
|  | **Professor** | **Associate (UL)** | **Assistant (BUL)** | **Total** | **PhD** | **Postdoc** | **Researcher** | **Other****Research** | **Other** | **Total** |
| **Female** | 1.0 |  |  | 1.0 |  | (+2) |  |  |  | (+2) |
| **Male** | 2.0 | 1.3 | 0.1 | 3.4 | 4.7 | 1.0 (+3) | 4.0 |  | (+1) | 9.7(+4) |

## Finances

### Overall research funding in MSEK (data provided centrally)

Motivation: To understand how a program is funded across the main sources of income. This data shows the long-term internal funding (FFF+SFO) vs. external (grant) research funding.

Responsibility: Data provided centrally; PAP to review to ensure no significant mistakes are made.

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| --- | --- | --- | --- | --- | --- | --- |
|  | **FFF+SFO Internal Research** | **Other Internal Research** | **Total Internal Research** | **External Research** | **Total Research** | **External Research %** |
| **2023** | 4.4 | 3.2 | 7.6 | 4.9+1.5=6.4 | 12.5 14.0 | 46% |
| **2022** | 4.3  | 4.0  | 8.3  | 8.1 +1.5=9.6 | 16.4 17.9 | 54% |
| **Average** | 4.3 | 3.6 | 7.9 | 6.5+1.5=8.0 | 14.4 15.6 | 50% |

### Other internal research funding

**Instructions**: If the other internal resources category above is significant, describe where it comes from: e.g., co-funding for various grants, starting packages for Assistant professors, studiestöd, department resources given, special funds from the vice rector, etc.

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| Most is co-funding (faculty & vice chancellor’s office) of excellence grants: 3 ERC and 3 Wallenberg Fellow grants, i.e., only exist because of our external grants and is not permanent. Also due to 1 Prof serving as assistant department head and 1 UL as SNIC director. The rest is studiestöd funding for Ph.D. students.  |

### Basic funding expectations and policy for using internal resources

**Instructions**: Explain the standard funding distribution between internal research funding (FFFs), external grants, and teaching that faculty (Assistant, Associate, Professor) and non-tenure staff (researchers, adjuncts) receive. Describe the policy for distributing internal resources (FFFs and other 210 funds, including studiestöd, startbidrags, and co-funding). Include a description of how faculty members at each level (Assistant, Associate, Professor) receive research support and are funded. Explain any implicit or explicit policies regarding holding external grants and allocation of internal resources. Include a brief overview of other uses of internal resources, for example: extra support for particular roles (e.g., PAP, FUAP), startup packages (for new faculty), allocation of studiestöd, department policies for FFFs or institution resources, funding of joint facilities/infrastructure, co-funding for grants, paying for PhDs/postdocs, etc.

Motivation: To understand how programs use their internal resources to support members and activities.

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| Each Prof,UL,BUL receive 40% salary support on FFFs. Remaining salary is to be covered by external grants and/or teaching. Additional 15% for the PAP+bFUAP role and 30% for Division Head (shared with Materials Theory). Minor grants requiring co-funding of overhead can also be supported on FFFs, but most co-funding has to be taken out of that individual’s 40% FFF salary support due to lack of resources. All researchers, PDs, Ph.D. students are fully funded on external grants (+ internal co-funding tied to grants), except 2 PhD students on studiestöd, distributed in a collegial process. Data in 1.4.4-5 widely distorted due to 1 Prof as assistant dept head, VR grants needed to be used (Covid-19 effects) and 1 UL being SNIC director at 70%. |

### Use of internal research funds in MSEK (data provided centrally)

Motivation: To understand how the program is using internal research funding.

Responsibility: Data provided centrally; PAP to review to ensure no significant mistakes are made.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Faculty Salary | Non-Faculty Salary | Other Personnel Costs | Premises | Equipment Depreciation | Overhead | Running Costs | Total |
| 2023 | 2.8 (44%)  | 1.4 (22%)  | 0.1 (2%)  | 0.5 (8%)  | 0 (0%)  | 1.3 (20%)  | 0.3 (4%)  | 6.5  |
| 2022 | 2.3 (44%)  | 1.3 (25%)  | 0.1 (2%)  | 0.4 (8%)  | 0 (0%)  | 1 (19%)  | 0.2 (3%)  | 5.2  |
| Average | 2.6 (44%)  | 1.4 (23%)  | 0.1 (2%)  | 0.5 (8%)  | 0 (0%)  | 1.1 (20%)  | 0.2 (4%)  | 5.9  |

### Personnel funding (data provided centrally)

Motivation: To understand how funding is used across different employment categories and genders. This data shows how staff are funded on average across internal and external research funding as well as teaching.

Responsibility: Data provided centrally; PAP to review to ensure no significant mistakes are made.

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| --- | --- | --- |
|  | Female | Male |
|  | Internal | External | Teaching | Internal | External | Teaching |
| Professor | 70% | 30% | 0% | 20% | 57% | 24% |
| Associate (UL) |  |  |  | 69% | 0% | 31% |
| Assistant (BUL) |  |  |  | 0% | 100% | 0% |
| PhD |  |  |  | 39% | 51% | 10% |
| Postdoc |  |  |  | 0% | 100% | 0% |
| Researcher |  |  |  | 9% | 91% | 0% |

### Major infrastructure usage

**Instructions**: Identify the five most significant research infrastructures used by the program. For this purpose, infrastructures are resources that are too expensive for an individual PI to afford and are therefore organized and funded as shared resources. Specify the level of sharing (program, department, university, national, or international) and whether it is located at Uppsala or elsewhere. Provide the approximate amount spent to pay for development of or access to the infrastructure each year, including both program funds and PI grant expenditures. Infrastructure costs should not include travel to the infrastructure (as travel for research is not infrastructure-specific) nor salary time while using the infrastructure (as research time is not infrastructure-specific), but can include salary costs of engineering staff and explicitly agreed upon in-kind salary contributions. If infrastructure is paid for outside of the program, specify who pays for it instead of the cost. (E.g., write “Faculty” or “VR”.) Note that it is not necessary to provide exact values, but please make an effort to be within ~10%.

Motivation: To understand what important infrastructure is being used and how much it costs and to support the faculty’s ongoing work on developing an infrastructure policy

Responsibility: PAP in discussion with program members, economic administrator for costs.

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| --- | --- | --- | --- |
| Infrastructure | Sharing | Location | Approximate Yearly Cost(MSEK) |
| NAISS, National Academic Infrastructure for Supercomputing in Sweden (former SNIC), we are small/medium users only. | Nationally | Sweden | State/VR |
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## Other important comments

**Instructions**: Explain any important issues not addressed above or misrepresented by the above data that need to be clarified for the panel to give valuable feedback. If the program has an important role in supporting the university or department, such as a mandate from the government or university, please describe it here. Please keep these precise and relevant.

Motivation: To bring important and special issues to the view of the panel and department.

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| Corrections: A) Faculty (2023) = 3 Prof, 1 UL (listed as 0.3 above due to SNIC directorship), 0.1 BUL (moved to the UK) + 1 UL 100% on leave (still listed as 1.0 UL). B) 5 postdocs on stipends+1 guest professor, added in 1.3. C) External funds (+1.5 MSEK) added in 1.4.1 is a KAW grant wrongly accounted for in the MT program.  |

# Follow up on goals set in the last evaluation

Responsibility: PAP to communicate with all program members, discuss, prioritize, and collate. All program members to report and discuss.

## Reflections on accomplishments and setting goals this time

**Instructions**: Reflect on whether the goals from the last evaluation (ÖB Section D1 for programs and KoF17 Section 1b for departments) were appropriate in retrospect, what has been accomplished towards them since the evaluation, and what we can learn from them about setting effective goals this time. The previous evaluations [are available on the faculty KoF webpage](https://www.uu.se/en/staff/faculty/science-and-technology/the-facultys-research-evaluation---quality-and-renewal---kof24) to support this reflection for the programs, departments, and panels.

Motivation: Try to learn from what we did last time to be able to set more effective goals this time.

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| The QMT program was created as a consequence of a split of the Material Theory (MT) program, proposed and enacted upon through ÖB19. The proposal was originally that 1.5FFF will be added from the faculty, but only 0.5FFF was made available. The current funding of the QMT program (1.79FFF) was negotiated such that the MT and QMT programs covered the same amount of tenured faculty salaries (Prof and UL) at the split, but the BUL in our program was never covered. The creation of the QMT program has led to a clearer profile at UU for quantum matter theory research, which has benefited recruitments, grant success, and organization. The limited funding made available by TekNat however means a perilous funding situation. |

# Area 1: Research Quality (evaluation of outcomes and processes)

Responsibility: PAP to communicate with all program members, discuss, prioritize, and collate. All program members to report and discuss.

## Main research areas

**Instructions**: List the largest research areas in the program, including approximately what percent of the program’s total research they cover, the approximate number of FTE faculty (Assistant/Associate/Professor, split according to their approximate activities and not double-counted), and whether the research is mostly Applied, Basic Science, or Mixed. These four areas combined should be broad enough to cover at least 75% of the program’s research activities.

Motivation: To understand the program’s research heterogeneity and how the program sees its own research profile and to help in assigning panel members.

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| --- | --- | --- | --- |
| Main Research Areas | % of program | FTE Faculty | Type |
| 1 | Unconventional and topological superconductivity, incl non-Hermitian | 75% | 1 | Basic |
| 2 | Quantum information | 10% | 1 | Basic |
| 3 | Spin-based phenomena, non-equilibrium | 10% | 1 | Basic |
| 4 | Complex and unconventional magnetism | 5% | 1 | Basic |

## Research Activities

**Instructions**: Describe the key research activities in the program. This should focus on the types of research done, with the important results described later in the Research Results section. Briefly describe how the research is important for science and society. Describe how the program balances incremental (e.g., safe, easy-to-publish) research with higher-risk projects with more potential for breakthroughs. Note that the limited space will require prioritizing the text based on the main research activities listed above.

Motivation: Provide a more detailed view of the key research directions in the program.

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| Our research concerns fundamental physics, intended to understand Nature, but at the same time with potential impact for future quantum technologies, which all need new quantum materials. Our research (especially funding for all younger members) is entirely driven by external funding. Some larger grants allow for higher-risk projects but that has to be balanced with us always staying competitive for future external funding. A substantial amount of our research is focusing on mechanisms and properties of unconventional and topological superconductors, with an overall aim of discovering and understanding the behavior of exotic forms of quantum matter. Current topics novel combinations of global topology and local superconducting order, including systems with Majorana fermions, behavior of spatial inhomogeneity in superconductors (e.g., disorder, moiré patterns, and superconducting phase modulations), odd-frequency superconductivity, and non-Hermitian superconductors modeling open or dissipative systems. Another topic within the program is effective modeling of various spin and magnetism related phenomena under non-equilibrium conditions, presently with a strong focus on the interplay between chirality and spin in combination with particle-particle interactions and with application to electrochemistry, electro-catalysis, and the origins of life. This is high risk in the sense of employing methods from condensed matter physics in chemistry and because of the relatively limited knowledge of many of the basic mechanisms in chemical processes. We also develop models of complex and unconventional magnetism, with either complex order of magnetic moments or order of higher spin multipoles, for relativistic materials with significant spin-orbit coupling. This includes developing novel methods to accurately calculate magnetic interaction parameters for studying superconducting magnetic materials. Finally, our work on quantum information focuses on theoretical proposals for experimental realizations of quantum computation. This includes quantum entanglement in magnetic systems, in particular magnons in antiferromagnets, geometric and topological descriptions of quantum states, and analysis of error resilience of quantum gates using techniques to study open quantum systems.  |

## Research Results

### Contributions to the field

**Instructions**: Describe the research results that the program is particularly proud of that indicate the quality and breadth of the research. Explain the importance of the program’s contribution to the field in the international context.

Motivation: Identify the results the program is most proud of and provide the program’s perspective on how important they are. This allows the panel to see how the program sees itself and provide feedback to help the program better understand how it is viewed internationally.

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| Established importance of odd-frequency superconductivity (ERC funded). Contributions to field of topological superconductivity, incl systems with Majorana fermions or chiral d-wave superconductivity (WAF, WAFx, and VR funded). Established realistic non-Hermitian effects in superconductors (KAW funded and resulted in new KAW Scholar grant and VR StG grant). Detailed atomic-scale modeling of superconductivity in twisted bilayer graphene (resulted in new ERC and VR CoG grants). Theoretical descriptions of the chiral induced spin selectivity effect and vibrationally stabilized ferromagnetism, in close collaboration with experimentalists (VR funded). Explanation of small magnetic moments or even hidden orders of magnetic materials with strong spin-orbit coupling, mainly U-based magnets, in terms of higher spin-multipoles, with general description of how to calculate the magnetic interactions (resulted in new VR grant). Proposal of non-adiabatic Berry phase-based quantum gates for quantum computation (VR funded), leading to a number of high-profile experiments. Developed the quantum metric for mixed states (Sjöqvist metric). |

### Bibliometrics for 2017-2021/2022 (data provided centrally)

Motivation: Provide an overview of how the program is performing that is reasonably comparable to other programs and departments. (See the Base Data definitions file for the meaning of each statistic.)

|  |  |  |
| --- | --- | --- |
|  | Type of Indicator | 2017-2022 |
| Number of publications, full publication set (full / fractional counts) | Quantity | 186 / 102 |
| Proportion of publication fractions at the Norwegian model level 2 (%) | Impact | 66% |
|  |  | 2017-2021 |
| Coverage (fractionalized): Proportion of publications from DiVA included in citation statistics, weighted by fractional counts | Coverage | 87% |
| Mean normalized number of citations per publication (MNCS) | Impact | 1.15 |
| Proportion of frequently cited publications (top 10%) (PP(top 10%)) | Impact | 13% |

### Most frequent publishing channels (raw data provided centrally)

**Instructions**: Using the provided raw data of publication frequency per channel (a channel is the name of a conference or journal) for each program, list the most frequent publishing channels with more than two publications during the evaluation period. This data can be found in the Base Data Excel document.

Motivation: To see where the program is most frequently publishing.

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| --- | --- | --- |
| Channel | Number  | % of Total Publications |
| Physical Review B | 82 | 44% |
| Physical Review A | 14 | 7% |
| Physical Review Letters | 10 | 5% |
| Scientific Reports | 7 | 4% |
| Physical Review Research | 5 | 3% |
| Journal of Physical Chemistry C | 4 | 2% |
| Nature Physics | 3 | 2% |
| Journal of Physical Chemistry Letters | 3 | 2% |
| New Journal of Physics | 3 | 2% |
| Physical Review E | 3 | 2% |

### Most important publishing channels

**Instructions**: Provide the most important publishing channels (a channel is the name of a conference or journal) according to the program, the number of publications in each channel during the evaluation period, and the % of the total publications based on the centrally provided bibliometrics. For each channel, specify both the total number of publication and the number where a program member was the lead-author. (The lead-author is the primary driver of the particular publication, which is often denoted as the “corresponding” author or the first author in the publication list, and is typically the originator of the core idea of the work and/or the person who wrote the majority of the text in the publication.)

Motivation: Enable the program to indicate what publishing channels they see as most important and how much they publish in them for panel feedback.

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| --- | --- | --- | --- | --- |
| Channel | Number  | % of Total Publications | Lead-author  | Lead-author % of Total  |
| Phys. Rev. A/B/E/Materials/Research (APS) | 107 | 58% | >4/5 | >80% |
| Phys. Rev. Lett. (APS) | 10 | 5% | >4/5 | >80% |
| J Phys Chem Lett/ACS Nano/Nano Letters (ACS) | 7 | 4% | ~4/5 | ~80% |
| Nature/Nat. Phys./Science | 4 | 2% | 0 | 0% |
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### Publishing impact on the field

**Instructions**: Describe the impact of the program’s publishing on the field by elaborating on the provided bibliometrics, the most frequent publishing channels, and the self-identified most important publishing channels. Explain the importance of the program’s contribution to the field in the international context. (See the Base Data definitions file for the meaning of the bilbiometric statistics.)

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| Considering our small size, our publication track record is excellent: we publish in the leading journals in our field (APS and ACS journals) with 2/3 of our publications at the Norwegian level 2 (top-3 of 67 programs in the faculty) and our work is highly cited with both MNCS and top10% among the absolute top in the whole department, showing high relevance and reach of our work. We interpret “most important” as those journals standard in our fields (APS and ACS journals). Work that fits within a letter format or are performed in larger collaborations often with experimentalists, we often publish in more interdisciplinary journals. Our publications often have few authors and program members are often both first and last authors (leads). |

### Participation, recognition, and leadership in the field

**Instructions**: Describe how the program interacts with the larger field in terms of its participation (e.g., through collaborations, professional organizations, positions of trust, etc.), recognition (e.g., through awards, keynote presentations, etc.), and leadership (e.g., through steering positions in international organizations, professional bodies, etc.) in the field. Explain the importance of the program’s contribution to the field in the international context.

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| Editorial board at Phys. Rev. Lett. & J. Phys.: Condens. Matter, and 2 Profs are also APS Outstanding referees. On-site review panels 5x in Germany (SFB centers etc). Grant review work for ERC, KAW, DFG, DoE, NWO, SNSF, NCCR, FWF, NSERC, ISF, SFI, EU-MCSA, etc. 14 invited talks only in 2023, e.g. Plenary speaker at SCES2023. Conf organization since 2018: Nordita x 4 & 1 WEH Bad Honnef. Nordita governing board. Intl. Scientific Committee for MagTop, Polish Academy of Sciences. SNIC Director. Management committee COST Actions SUPERQUMAP and NANOCOHYBRI. PhD opponent/external expert 10+ times. External reviewer of director appointment in Julich and Professor promotions: Max Planck + many national. Rudbeck medal 2023. |

## Synergies within the research program

**Instructions**: List up to three examples of synergies (interactions that provide more value than the individual contributions alone) within the research program itself that can be seen through specific on-going collaborations. Synergies can include using similar or complementary methods, facilities, partners, goals, etc. Briefly describe the synergy and extent of the current collaboration. Due to the limited, programs will need to work internally to identify the collaborations that are most important to the program.

Motivation: Identify how the program’s diversity supports its research.

|  |  |  |
| --- | --- | --- |
| 1 | Type of synergy | Collaboration that took advantage of two methods with very different views of magnetism. |
|  | Specificcollaboration | Generalized magnetic interactions and their interpretations. Specifically, the role of spontaneous spin-currents, either of relativistic or non-collinear magnetic origin. |
| 2 | Type of synergy | Collaboration that used knowledge of topological superconductivity and non-Hermitian physics.  |
|  | Specificcollaboration | Adding the effect of external leads on a topological superconductor through a non-Hermitian treatment and identifying new physical phenomena. |
| 3 | Type of synergy | Collaboration combining quantum information techniques and magnetism. |
|  | Specificcollaboration | Studying quantum entanglement and squeezing in antiferromagnets and magnons (also in collaboration also with Materials Theory). |

## Synergies across research fields

**Instructions**: List up to three examples of synergies (interactions that provide more value than the individual contributions) the research program has with research fields other than those of the program itself. Synergies can include using similar or complementary methods, facilities, partners, goals, working across theory/experimental, grants together with people in different fields, etc. These synergies can be here in Uppsala or at other universities. Provide the university (cross-field synergies within Uppsala are fine) and the different field, and briefly describe what the synergy is and the extent of the specific current collaboration. Due to the limited space, programs will need to work internally to identify the collaborations that are most important to the program.

Motivation: Identify current activities that are broader than the research programs to promote broader research initiatives and understand what is done across Uppsala vs. externally.

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| --- | --- | --- |
| 1 | University and Field | Collaboration with the Materials Theory (MT) program. |
| Type of synergy | Model developments complemented with accurate computations of specific materials from the MT program. Large synergy effects: joint publications, grants, supervision etc. |
| Specificcollaboration | Studying magnetic interactions of complex magnets, magnon-phonon interactions, topological materials, quantum information platforms. |
| 2 | University and Field | Theory collaborations outside UU.  |
| Type of synergy | Synergy effects achieved by combining different experiences, based both on different methods and research fields. |
| Specificcollaboration | Nordita, SU, KTH, Chalmers, Lund, Paris-Saclay, MPI Halle, Forschungsz. Jülich, Saskatchewan, NTNU, Shandong, CQT Singapore, Nagoya, Tokyo, Kyoto, MPI-FKF, Utrecht,Konstanz |
| 3 | University and Field | Experimental collaborations outside (and historically also within) UU. |
| Type of synergy | Combining theoretical predictions with experimental measurements, with synergy effects in the analysis and for more accurate effective model building. |
| Specificcollaboration | Weizmann Inst, HUJI, Univ. at Buffalo, MPI-FKF, Radboud University, Autonomous U. Madrid, TU Munich/Walther-Meissner-Institute |

### Reflections on synergies across research fields

**Instructions**: Reflect on the program’s initiatives and challenges with regards establishing research activities that cross between the program’s field and other fields. Are there particular benefits to such collaborations or particular costs? Describe the formal and informal initiatives the program takes to encourage these and the pros and cons of working within and outside of Uppsala.

Motivation: Understand how the program views its synergies across research fields.

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| The MT program have many interests overlapping with ours, especially magnetism and superconductivity, but the research is complementary both in methods and approaches (material specific versus our more generic approach), so inter-program collaboration has very beneficial synergy effects. This is also true for collaborations with other theory groups, including those closely geographically (SU,KTH,Nordita). For a theory activity it is also valuable to have collaborations with experimental groups. We have developed collaborations with many international groups, since in-house experiments are seldom addressing the same materials and properties. More in-house exp activities in quantum matter would be beneficial for us.How to encourage more? |

## Reflections on ensuring good research ethics

**Instructions**: Reflect on the program’s initiatives and challenges with regards to ensuring good research ethics. Describe the formal and informal initiatives the program takes to teach and promote good research ethics across all research staff, and what particular challenges the program faces in these regards.

Motivation: Understand how the university’s priority for ensuring good research ethics is addressed.

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| Ethics course for all Ph.D. students and now also for supervisors (in March 2024).Continuous discussions with younger group members when ethical issues arise, from publication practices to how to report results and data. |

## Reflections on creating and ensuring research freedom

**Instructions**: Reflect on the program’s initiatives and challenges to create and ensure research freedom. Describe the formal and informal initiatives the program takes to create opportunities for research freedom across all research staff, and what particular challenges the program faces in these regards.

Motivation: Understand how the university’s priority for ensuring research freedom is addressed.

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| Faculty members are free to formulate their own research agenda, supported internally with 40% research funding to be able to do this. PDs and PhD students are tied to external grants held by their supervisor. Reliance on external grants make grant agencies steer research, although ERC,VR,KAW allow some freedom. |

## Reflections on research program size

**Instructions**: If the research program has 4 or fewer faculty (Assistant, Associate, Professor), describe the program’s process for ensuring a sufficient critical mass of faculty long-term, current and planned activities in this direction, and discuss whether there are other programs where collaboration could be of assistance. Similarly, if the research program has 10 or more faculty members, describe how the program works to develop a coherent research agenda and collaborations. If the program has between 5 and 9 faculty, describe if increasing or decreasing the size could be beneficial.

Motivation: A reasonable number of faculty members is required for research programs to achieve their purpose of providing a collegial environment that can develop and support diverse ideas and knowledge around a shared core research direction. For research programs with very few faculty, or very many, it is important to reflect on how this can be achieved.

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| Only 4 faculty, spread over several distinct areas of QMT, making us too thinly spread to create a strong and synergistic environment throughout the program. A concentration of external grants in one part (1 Prof current has 12 students and postdocs) makes program very lopsided. More faculty would be beneficial. |

## Top external funding sources (data provided centrally)

Motivation: To see the amount spent on each financier during the year.

|  |  |  |  |
| --- | --- | --- | --- |
| Funding Agency | 2022 | Funding Agency | 2023 |
| European Research Council (H2020) | 3.9  | Wallenberg Foundation (KAW) | 1.7 +1.5=3.2 |
| Swedish Research Council (VR) | 3.3  | Swedish Research Council (VR) | 1.5  |
| Wallenberg Foundation (KAW) | 0.7 +1.5=2.2 | European Research Council (H2020) | 1.4  |
| Olle Engkvist Foundation | 0.1  | ERC Horizon Europe | 0.1  |
| Uppsala University Foundations Management | 0.1  | Uppsala University Foundations Management | 0.1  |
| Carl Trygger Foundation | 0.0  | Carl Trygger Foundation | 0.1  |
| Chalmers Tekniska Högskola AB | 0.0  | Olle Engkvist Foundation | 0.0  |
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## External funding sources

**Instructions**: List the source and number of significant research grants to the program during the evaluation period. Include only grants that awarded at least 3M SEK to a program member and were active (used) during the evaluation period (2019-2023, inclusive). If a program member was awarded at least 3M SEK, but was not the PI on the grant, list the grant on a separate line and state “Co-PI”.

Motivation: This list complements the top external funding sources by providing consistent data for significant (>3M SEK) basic science grants available to all programs and by identifying the number of PIs vs. the total amount of funding. This is important as the absolute amount of money available to different fields varies enormously.

|  |  |
| --- | --- |
| Grant | Number of awards to PIs in the program |
| Basic science grants (available to all fields in the faculty) |
| ERC-StG, ERC-CoG, ERC-AdG, ERC-SyG | 3 (2 x ERC-StG-2017, 1 x ERC-CoG-2022) |
| KAW Project |  |
| KAW Scholar | (1 x KAW-Scholar-2024) |
| WAF/WAFx | 3 (2 x WAF-2014, 1 x WAFx-2019) |
| VR Project | 6 (1 x VR-2015, 2 x VR-2017, 1 x VR-2018, 1 x VR-2022, 1 x VR-CoG-2022) |
| VR Starting | 2 (1 x VR-2014, 1 x VR-2021) |
| Other grants (may include field-specific grants and Co-PIs) |
| KAW project, Co-PI | 3 (1 x KAW-2013, 1 x KAW-2019, 1 x KAW-2020) |
| KAW WISE PhD student | 1 (1 x WISE-2023) |
| VR Consolidator Grant (CoG) | 1 (replaces VR project grant with >2x funding, also included above) |
| Olle Engkvist Foundation | 2 (211-0054, 228-0307) |
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## Reflections on external funding

**Instructions**: Reflect on what the program expects from its staff (Assistant, Associate, Professor, postdoc, and researcher levels) in regards to applying for and receiving external funding, how the program communicates those expectations, how the program supports staff in applying for funding through feedback and mentoring, and what opportunities and challenges the program sees in the future for continued and new external funding. Describe initiatives the program takes to form consortia to apply for larger grants.

Motivation: Connect how the program works with external funding to the achieved funding results.

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| Our long-term internal resources can only cover ~40% of 5 faculty salaries (teaching is also underfunded so 60% teaching salary support amounts to >100% teaching duties), which also have to be used for co-funding. Our research is too fundamental for larger funding except from VR, ERC, and KAW, where we have been extremely successful: 3 ERC since 2017, 8 KAW since 2013, 8 VR since 2014, likely top in whole faculty considering our small size. Main challenge is how to sustain this. All members are aware of the perilous situation and continuously apply for funding, supported by weekly seminar series to share ideas and work progress. Feedback on all larger applications. Mentoring of younger members for their first grants. |

## Reflections on what is working well

**Instructions**: From the above, reflect on what is working well and should be continued over the next 5 years.

Motivation: Require programs to identify where current activities are successful. This will provide the panel with insights into our own self-assessment.

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| Creating the QMT program by splitting the old MT program has been good for overall visibility of our researchers and research, both internally within UU and towards the outside world. The split also resulted in two smaller programs where it is easier to discuss and collaborate. We have a well-functioning program seminar series (each student/postdoc gives a talk per semester + external speakers), a weekly division seminar series with the MT program, and ongoing collegial discussions within the program, while we still collaborate with the MT program. Overall, we keep an open atmosphere in the program allowing for informal collegial discussions that are very fruitful. We have been extremely successful in attracting excellence grants, ERC, KAW, VR, including new ERC-CoG, VR-CoG, and KAW-Scholar (Black-Schaffer), keep a high level on our publications, and have extensive national and intl collaborations. We are active reviewers, conference organizers, and serve on a number of international boards and do internal service and successful in mentoring young members who reliably get VR-StG (at UU and Nordita) or faculty positions abroad. |

## Reflections on what needs to be improved

**Instructions**: From the above, reflect on what needs to be improved over the next 5 years. Please focus on areas that need improvement and do not list areas that could be improved but where it is not needed.

Motivation: Require programs to identify where they feel that they need to invest. This will both provide the panels with insights into our own self-assessment as well as help us improve.

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| Considering that our program is new and small, it is important that we grow in faculty numbers to more permanently establish the program. We have recently lost 1 BUL and 1 UL, but only have internal resources to replace the UL, as the BUL was never given any internal resources. Further, having almost all of our research funded by external grants make us have no long-term stability, even down to not being able to provide faculty salaries. The problem is exacerbated by KAW and ERC not covering all overhead so a large part of our FFFs is currently used for such co-funding (TekNat used to provide this co-funding but stopped). In fact, the full internal research salary contribution for 1 Prof will the next few years instead be spent on such co-funding, meaning 0% unrestricted research time in the position. With most of our combined research time spent on externally funded projects, it is hard to develop synergies within the program. Low internal funding and concentration of grants (1 Prof (Black-Schaffer) is alone supervising 12 PhDs and PDs on external funding) means it is challenging to provide a high level of supervision in some fields.   |

# Area 2: Career Paths (evaluation of processes)

Responsibility: PAP to communicate with all program members, discuss, prioritize, and collate. All program members to report and discuss.

## Career stage distribution implications and plans for the next 5 years

**Instructions**: Describe the implications of the current distribution of faculty across career stages (e.g., Assistant, Associate, Professor from Section 1) for the program currently and in the next 5 years. In particular, identify up-coming faculty retirements and/or recruitments and discuss and how the program plans to work with those changes to maintain the program’s core strengths as well as evolve in new directions.

Motivation: Provide perspective on the current status and future changes in personnel in the program.

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| 2024 status: 3 Prof, 1 UL (1 BUL moved abroad 2023 with his ERC grant and 1 UL resigned 2023). Also 2 permanent researchers, 1 guest professor, 7 PhD students, and 8 postdocs.Future: Recent resignation of 1 UL opens for a new UL recruitment, aiming for a reasonably young candidate (UL position and not BUL to also be inclusive to our permanent researchers). Together with Nordita we are also recruiting a BUL in quantum information, QI (offer made). The position is funded by Nordita at 80% for 5 years + start up package. This will allow us to strengthen our QI activity despite no internal money available. This BUL will replace our current 1 Prof in QI when retiring. Also 1 UL retirement in 7-10 years. |

## Reflections on the process for identifying recruitment needs and focusing areas

**Instructions**: Pick a specific faculty-level recruitment during the evaluation period reflect on how the process of identifying the need for recruitment and focusing the research area worked. First describe the recruitment, e.g., Assistant/Associate/Professor-level and research area. Then discuss how the program worked to identify the need for a recruitment in this area, including discussing how the need was identified, how was it discussed and revised in the program, who was involved in the discussions, etc. For focusing the research area, describe how the balance between continuing existing areas vs. choosing new ones was discussed, who was involved in the discussions, what criteria were discussed to ensure that this direction would strengthen the program, etc. If the program has not done any faculty recruitments during the evaluation period, please reflect on how they would be undertaken.

Motivation: Explain how recruitments are currently motivated and decided

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| We have identified an urgent need to strengthen our quantum information/computing (QI) research (we have only 1 faculty member in QI throughout UU), but no internal resources have been available. By working with Nordita and their Wallenberg funded WINQ initiative we have been able to still attract sufficient resources for a BUL position, funded by WINQ at 80% for 5 years + generous start-up package. The position was open for the whole QI field to attract the most promising candidates world-wide to help us build a new activity. While this new research group will be primarily at Nordita the first 5 years, it will also strengthen our activities, including teaching, in QI. |

### Initiatives to recruit and retain top researchers/teachers

**Instructions**: Describe:

* How the program defines what a top researcher/teacher is and how that is used in recruiting (criteria, descriptions, search groups, subject representative, addressing younger recruits who have the potential to become top, etc.),
* How the program balances recruiting external talent vs. promoting internal staff, and who is involved in these discussions and decisions,
* How gender and career stage balance is considered in program planning and recruitment decisions, and,
* What the program does to identify and encourage strong external recruits to join.

Motivation: Provide details as to what efforts are made to recruit and retain the best staff.

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| Considering our very limited internal long-term funding, any new faculty member needs to be able to attract substantial external funding, even to support a large part of their own salary. The realistic way to attract younger talent is therefore to recruit those holding ERC, WAF, or VR Consolidator grants, which will provide substantial funding and a good start at UU. We nominate candidates (internal and external) within our research areas for these grants. We further encourage promising postdocs to apply for VR-StG to start develop independence (currently 1 such grant) to then be competitive for the larger grants. Retaining top researchers is hard due to our limited internal funding, and we recently lost 1 BUL with an ERC-StG.But can provide good international environement at the forefront. Closeness to Nordita helps.External recruits: scan potential candidates, esp Europe, esp. women. Talk about external grant possibilities.  |

## Career support

### Career support activities for non-tenure-track staff (beyond standard employee dialogs)

**Instructions**: Describe the activities for supporting non-tenure-track (PhDs, postdocs, researchers, adjuncts, etc.) staff in their careers and development. For example: financial support for personal development, mentoring, grant assistance, feedback, career planning, help with job searches, etc.. Explicitly address what support is provided for obtaining the docent and distinguished teacher qualifications for post-PhD staff. Specify if activities are informal (e.g., expected as part of advising/mentoring) or formal (e.g., part of a regular process).

Motivation: Provide details as to how the program works with career development for non-tenured staff and encourage the program to reflect on whether it is providing the right type and amount of support.

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| Mentoring, feedback on applications, career advice for junior researchers. Mostly informal within program, but several faculty members are also active in mentoring at Junior Faculty grant writing workshops and providing feedback on ERC applications through the TekNat grants office, also for researchers in other fields. Several faculty members are also active as mentors in the TekNat mentorship program for young researchers. We encourage all docent-competent staff to apply for the docent degree (1 current such application). The division (i.e. together with MT program) tries to provide teaching opportunities for all permanently employed researchers to build their pedagogical portfolio. |

### Career support activities for tenure-track staff (beyond standard employee dialogs)

**Instructions**: Describe the activities for supporting tenure-track staff (Assistant Professors) in their careers and development. For example: financial support for personal development, startup packages, mentoring, grant assistance, feedback, career planning, co-advising, etc. Include discussions of support for promotion (Assistant to Associate) as well as docent and distinguished teacher qualifications. Specify if activities are informal (e.g., expected as part of advising/mentoring) or formal (e.g., part of a regular process). If there are very few staff in this category, please reflect on why that is and if that is something that should be addressed.

Motivation: Provide details as to how the program works with career development for tenure-track staff and encourage the program to reflect on whether it is providing the right type and amount of support.

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| We have no current BULs. We have 1 BUL in-coming with salary and start-up package from Nordita. Here we will provide annual career development talks, help with grant feedback and co-advising, in addition to the support given through Nordita. Pedagogical coaching is provided at the dept level (e.g. pedagogical consultations with Director of Studies). |

### Career support activities for tenured staff (beyond standard employee dialogs)

**Instructions**: Describe the activities for supporting tenured staff (Associate Professors and Professors) in their careers and development. For example: financial support for personal development, mentoring, grant assistance, feedback, career planning. Include discussions of support for promotion (Associate to Professor) as well as docent and distinguished teacher qualifications. Specify if activities are informal (e.g., expected as part of advising/mentoring) or formal (e.g., part of a regular process).

Motivation: Provide details as to how the program works with career development for tenured staff and encourage the program to reflect on whether it is providing the right type and amount of support.

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| We provide feedback on each other’s grant applications. Our program is in charge of organizing the dept seminar series in condensed matter/materials where we also do a ‘pitch your VR idea’ before the annual VR deadline. All current faculty members are currently docents and can also apply for Prof promotion if interested. All pedagogical coaching is provided at the dept or TekNat level. |

## Reflections on what is working well

**Instructions**: From the above, reflect on what is working well and should be continued over the next 5 years.

Motivation: Require programs to identify where current activities are successful. This will provide the panel with insights into our own self-assessment.

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| --- |
| Multiple good VR-StG applications by promising younger researchers of which 1 is currently funded. Several of our former postdocs have also landed faculty or permanent staff positions (UU, Nordita, India x3, US, Iran). In addition, we have nominated several external WAF candidates, including 2 females in the last 7 years, although not granted by KAW. Using opportunities to fund young researchers and even tenure-track faculty fully on external grants has been a successful way to renew our activities. |

## Reflections on what needs to be improved

**Instructions**: From the above, reflect on what needs to be improved over the next 5 years. Please focus on areas that need improvement and do not list areas that could be improved but where it is not needed.

Motivation: Require programs to identify where they feel that they need to invest. This will both provide the panels with insights into our own self-assessment as well as help us improve.

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| Currently our financial situation is only long-term sustainable with a success rate at VR and other funding agencies higher than at the present time (all faculty members would effectively need to have a VR grant for the finances to be long-term sustainable). Thus, most of our career planning and support must be focused on attracting external funding. The only way to change this dependence on external funding is more long-term internal research funding or that teaching actually pays for the hours spent teaching. We can currently provide 40% salary on internal research funding (which also needs to be spent on co-funding), but teaching for the remaining 60% would be a >100% position, which is not sustainable. |

# Area 3: Collaboration and Outreach (evaluation of processes)

Responsibility: PAP to communicate with all program members, discuss, prioritize, and collate. All program members to report and discuss.

Collaboration and outreach (“samverkan” in Swedish) should be interpreted to mean activities that reach outside of the university to non-academic partners. Specifically, academic collaborations with other research organizations within academia should be considered part of our research and not collaboration and outreach for this evaluation. To help with this section, here is a partial list of the types of collaboration and outreach that we are striving to achieve:

* Joint research projects, student/PhD/postdoc/researcher/faculty exchanges/sabbaticals, etc.
* Advising/consulting, spreading research results/insights, popular science outreach and publications, press interviews, expert panels, etc.
* Interactions with industry, government, schools, society, media, etc.
* Academic entrepreneurship, including creating, joining, and advising startups and companies, etc.
* Feedback of external ideas, challenges, relevant questions, etc., into program(s) or departments.

## Specific collaboration and outreach examples

**Instructions**: Provide up to three specific examples of collaboration and outreach activities connected to the program’s research. Under “Example and connection” describe the activity and person or organization with whom the collaboration or outreach took place. (e.g., “Expert advice on SUBJECT for COMPANY”, “Popular science book on SUBJECT aimed at AUDENICE”, or “Interview on PROGRAM about SUBJECT”.) Specify the value to the program (e.g., “exposure to new challenges and issues that COMPANY experience on a practical level” or “making the SUBJECT expertise of our researchers visible to the nation”) and the value to the partner (e.g., “insight into how COMPANY can model the physical properties from the chemical composition” or “addressing public concern over the impact of SUBJECT on the environment”). Keep in mind the broad range of collaboration and outreach listed above.

Motivation: Provide a list of specific examples of collaboration and outreach activities to motivate the self-reflection below and to serve as a source of examples for others.

|  |  |  |
| --- | --- | --- |
| 1 | Example and connection | Comments and discussion of physics in national media: radio (SR) and TV (Vetenskapens värld, SVT) |
| Value to the program | Exposure of our research and expertise. |
| Value to the partner | Education and spreading new results in physics research to the general public, nation-wide spread. |
| 2 | Example and connection | Popular science lectures within 13x13 physics lecture series (all 3 Profs have given talks in this lecture series the last three rounds, in total 5 talks) |
| Value to the program | Popularizing our research, reaching an interested local audience. |
| Value to the partner | Education and spreading scientific developments. |
| 3 | Example and connection | Popular science articles for journals such as Forsking&Framsteg, Kosmos (Annual publication of the Swedish Physical Society), also in neighboring countries, Finland, Poland etc. |
| Value to the program | Popularizing our research, reaching an interested public nation-wide. |
| Value to the partner | Education and spreading scientific developments. |

### Reflections on overall aims and strategies for collaboration and outreach

**Instructions**: Use the above examples, as appropriate, to reflect on the program’s overall aims and strategies for collaboration and outreach and discuss what enabled the above examples (e.g., how were they first identified and initiated? How did they fit into the overall aims and strategies? etc.) and what it takes to keep them functioning well (e.g., staff, networking, meetings, equipment/labs/supplies, etc.).

Motivation: Understand what we need to create and maintain collaboration and outreach

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| Based on the fundamental science research profile of our program, the primary aim with our collaboration and outreach work is public outreach; to engage and educate the general public (Swedish: folkbildning). This works currently well because all faculty members believe this is important and contribute actively, e.g. by seizing opportunities that are available (saying yes to interviews, writing popular science pieces etc). As theorists we have no labs or equipment to show-case or use in public outreach.We have also taken part in some very initial discussions on quantum information/computing with companies through BigScience Sweden. |

## Support for outreach and collaboration

**Instructions**: Describe the specific support resources and processes available to program members for outreach and collaboration towards non-academic actors, such as collegial discussions, meetings with external actors, etc. Describe whether the activities are formal or informal and whether they are managed by the research program, department, or faculty.

Motivation: Understand what support the program has for outreach and collaboration.

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| --- |
| Encouraging all program members to engage in public outreach and also other meetings with external actors, if relevant to our research. Examples of the latter is (and will likely be more in the future) quantum information/computing.The program does not have resources to contribute with some more formal management or support, but this is considered part of the 40% internal research funding we can currently provide (if not already used for co-funding external grants).  |

## Reflections on what is working well

**Instructions**: From the above, reflect on what is working well and should be continued over the next 5 years.

Motivation: Require programs to identify where current activities are successful. This will provide the panel with insights into our own self-assessment.

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| --- |
| Well-engaged faculty and younger group members who contributes and are generally very positive to outreach work. The department has a communicator who is a very valuable resource to get feedback from and coordinate some activities, including helping with press releases for new research results. |

## Reflections on what needs to be improved

**Instructions**: From the above, reflect on what needs to be improved over the next 5 years. Please focus on areas that need improvement and do not list areas that could be improved but where it is not needed.

Motivation: Require programs to identify where they feel that they need to invest. This will both provide the panels with insights into our own self-assessment as well as help us improve.

|  |
| --- |
| There is very little support, financially, content-wise, and administratively, for any collaboration or outreach effort at any level, from program and up throughout the university. This makes it hard to undertake more than occasional events and tasks for individual researchers or programs.We currently have no overlap with industry, but with more developments within quantum information and computing taking place outside academia we foresee that this may change in the future. Our current BUL recruitment through Nordita will also increase our research within this area. |

# Area 4: Connection between Research and Teaching (evaluation of processes)

Responsibility: PAP to communicate with all program members and the director of studies, discuss, prioritize, and collate. All program members to report and discuss.

The types of connections between research and teaching that we are striving to achieve include, but are not limited to:

* Activities that lead to a scientific approach and student progression in learning how to apply the scientific method within courses and throughout education programs
* Teachers who are active researchers take opportunities to develop their pedagogical skills
* Researchers who are active teachers and take opportunities to develop their pedagogical skills
* Students being trained to find, use, and evaluate research results
* Students being active in on-going research projects
* Integration of research results, methods, and facilities in teaching

## Main teaching areas

**Instructions**: List up to four teaching programs, course packages, or contract/continuing education that the research program’s members contribute to. Specify the level (e.g., bachelor’s or master’s), how much the members of the research program contribute to the teaching program based on the number of full courses taught and whether the teaching program is managed (e.g., the program coordinator/director is in the research program) by members of the research program (yes/no). For the number of courses taught, exact values are not needed. Instead estimate the teachers’ contribution in terms of full courses taught (e.g., 1.0 means the teacher taught the equivalent of one full course) and use the ranges of: <1, 1-5, >6 to simplify accounting.

Motivation: To show what subjects the program primarily teaches in.

|  |  |  |  |
| --- | --- | --- | --- |
| Teaching program, course package, or contract/continuing education | Level | Courses Taught | Managed |
| Master program in Quantum Technology | MSc | 3 | Representative in council |
| Master program in Material Science  | MSc | 3 | N |
| Bachelor level, general physics | BSc | 1-5 | N |
| Master theses in Physics, Quantum Technology, Material Science etc  | MSc | 3-5 theses/year | N |

## Infrastructure use in teaching

**Instructions**: Please list any major research infrastructures that are used in teaching, the courses that use it, the education level, and the approximate number of students who use it each year.

Motivation: To understand what infrastructure is being used in teaching and to support the faculty’s ongoing work on developing an infrastructure policy

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| --- | --- | --- | --- |
| Infrastructure | Courses | Level | Students |
| - |  |  |  |
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## Specific teaching/research connections

**Instructions**: Provide up to four specific examples of how the program’s research has been incorporated into teaching activities or strengthened courses, and/or how teaching activities have been incorporated into the program’s research activities or strengthened the program’s research. Under “Example” describe the connection (e.g., “lab exercise using the facility X that exposes students to research technique Y”). Under “Course Info” specify the course name, program, level (introduction/advanced), and the approximate number of students taking it each year. Describe the value to the teaching experience from the research connection (or vice versa).

Motivation: Provide a list of specific examples of teaching/research connections to motivate the self-reflection below and to serve as a source of examples for others.

|  |  |  |
| --- | --- | --- |
| 1 | Example | Existence of quantum information and quantum computing courses at UU. |
| Course Info | Master in Quantum Technology (QT) and as free-standing courses (fristående), ~15 students yearly |
| Value to teaching/research | Education in one of the fastest growing scientific fields for UU students. Without our program we would not be able to teach QI/QT at UU with any research connections. We also attract Master students doing research with us during their thesis work, often leading to publications. |
| 2 | Example | Existence of quantum field theory for materials and quantum materials courses, ~10 students total per year |
| Course Info | Master programs in Quantum Technology and Material Science |
| Value to teaching/research | High level theory courses in materials research. Without our program we would not be able to teach quantum field theory for materials or many-body physics at UU. We also attract Master students doing research with us during their thesis work, often leading to publications. |
| 3 | Example | Teaching general undergraduate physics courses |
| Course Info | Courses within Bachelor program in Physics or physics courses within the Civilingenjör programs. |
| Value to teaching/research | All our facultly members are active researchers. Teaching general undergraduate courses gives students exposure to active researchers in a range of physics courses. |
| 4 | Example | Supervising Master and Bachelor theses. |
| Course Info | Master and Bachelor theses in Physics, Quantum Technology, Materials Science etc |
| Value to teaching/research | Gives the students direct hands-on experience with finding, producing, using, and evaluating research results. Between 3-5 theses (or similar) per year within the program. The results are often published as a research paper (e.g. in PRA/B), with the student as first author. |

### Reflections on overall aims and strategies for connections

**Instructions**: Use the above examples, as appropriate, to reflect on the program’s overall aims and strategies for teaching and research connections and discuss what enabled the above examples (e.g., How were they first identified and initiated? How did they fit into the overall aims and strategies? etc.) and what it takes to keep them functioning well (e.g., staff, networking, meetings, equipment/labs/supplies, etc.).

Motivation: Understand what we need to create and maintain connections

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| Our aim is to provide relevant high-level physics courses in our research field and provide interesting thesis projects which can lead to a publication for the student. Currently the demand is increasing for quantum information/computing courses and we aim to increase our footprint there (see also our 5-year priorities) to meet the local and global demands in this expanding field, also with increasing industry demands. Without our program UU would not have any teaching in quantum information/computing or quantum field theory for condensed matter. Being present in the program council (programråd) for the QT Master’s program will help direct future developments.  |

## Support for integrating teaching and research

**Instructions**: Describe the support resources and processes for integrating teaching and research available to program members such as collegial discussions, meetings with students, course reviews, teaching follow-up, etc. Describe whether the activities are formal or informal and whether they are managed by the research program, department, faculty, or teaching program. If there are no such resources or processes in the research program, then please reflect on whether that is something the research program or department should address under reflections below.

Motivation: Explain what support there is for improving the research and teaching connection.

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| Teaching is primarily organized by the department, including allocations, course-reviews, teaching follow-up. Currently at the program level we are trying to build up and provide more education in quantum information/computing and in quantum matter by collegial discussions on what we can teach and what is useful to teach (e.g. in terms of number of students), both in our program and division and through program councils. For more basic physics education we believe it is best the department has a unified approach and that this is not handled separately in the programs or divisions. Each program can then be responsible for providing their research expertise to develop more advanced courses. |

## Reflections on what is working well

**Instructions**: From the above, reflect on what is working well and should be continued over the next 5 years.

Motivation: Require programs to identify where current activities are successful. This will provide the panel with insights into our own self-assessment.

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| Considering we have only one faculty member in QI we are doing what can be expected in teaching in that area, including developing entirely new courses to meet student demand. Further, our teaching of quantum field theory and many-body physics is currently at the level to meet student demand. Here we have recently reorganized the quantum field theory courses together with the theoretical physics program such that the department now offers one unified introductory theory course for both condensed matter and high-energy inclined students. This we believe is better for the students as it gives both more choice and exposure. More such coordination with theoretical physics may be beneficial in the future.We have a number of BSc and MSc students each year doing their thesis work with us and many of these also result in a published paper with the student as first author. This demonstrates that we are good at providing teaching at the advanced level that is directly tied to the current research front.  |

## Reflections on what needs to be improved

**Instructions**: From the above, reflect on what needs to be improved over the next 5 years. Please focus on areas that need improvement and do not list areas that could be improved but where it is not needed.

Motivation: Require programs to identify where they feel that they need to invest. This will both provide the panels with insights into our own self-assessment as well as help us improve.

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| Being able to offer a larger course package in advanced quantum technologies would be helpful but also require more faculty members to teach and develop such curriculum. We would also like to reach a larger student body, including students in the F program (civilingenjör/MSc engineering physics), who are often not encouraged or even aware of courses in advanced quantum technology which may interest them. Further, many of our best thesis students come through ERASMUS exchange programs to Uppsala and more visibility there could likely attract even more students.Most importantly, funding for teaching is currently not sustainable. E.g. a course that pays 5% teaching time will regularly take twice as much time to teach and we often also teach Master level courses entirely without compensation (i.e. no faculty salary is paid on the teaching budget). This means we are paying faculty salaries on FFF funding for time they spend in the classroom teaching and thus FFFs that are meant to pay for research time is instead spent compensating for our teaching being underfunded. |

# 5-year Priorities

**Instructions**: Identify, describe, and motivate specific Priorities that have a high likelihood of meaningfully strengthening or meaningfully broadening research over the next 5 years. The Priorities should be well-motivated and have sufficiently developed plans that it is clear what needs to be done to accomplish them and how to evaluate if they are successful. The Priorities can cover a wide range of activities with the overall goal of strengthen research, and do not need to require additional expenses. These can include, but are not limited to:

* Strengthening existing areas (e.g., to adapt to future challenges in the field or are necessary to maintain high quality, including by investing in new equipment, facilities, or staff, etc.)
* Investing in new areas (e.g., to adapt to changes in the field or new developments, by including investing in new equipment, facilities, or staff, etc.)
* Changing research organization by splitting, merging, closing, or moving research programs/departments (e.g., to improve collaboration or use of facilities or resources, etc.)
* Changing research policies (e.g., to address funding/co-funding, multi-disciplinary work, or recruiting, etc.)
* Changing research support (e.g., to improve grant success rates, recruiting, management, adoption of new techniques/technologies, etc.)

Building upon existing strategic plans is encouraged and co-funding/support from the program or department is expected to demonstrate commitment to the plan. There will be a yearly lightweight follow up process to see what progress has been made for each Priority with an opportunity to revise/change them as needed. The goals are to both ensure that we follow up on our stated Priorities and that we always have clear Priorities at each level in the faculty.

Each program is allowed to propose 3 Priorities: one that can be fully accomplished within the program, one that may require support at the department level, and one that may require support at the faculty level. This done to ensure that all programs will have at least one Priority they can work on as the very limited faculty funding available means only a few programs will receive additional resources.

Prioritization at the department level: Each department will review the Priorities from all of its programs and consider which to include in the department’s own list of Priorities, along with department’s own Priorities.

Motivation: Identifying Priorities encourages strategic analysis and medium-term planning within the program, and makes it easier for the department and panel to understand the programs’ own assessments of their needs and opportunities. Requiring two of the Priorities to be able to be accomplished within the program and the department emphasizes the need to work locally as well as at the faculty level.

Responsibility: PAP in discussion with program members.

# Priority 1 of 3: An activity that can be accomplished within the program

## Description of the Priority

**Instructions**: Provide the department name (since these will be collected at the section/faculty level) and the program name (if this is a program Priority), the title of the Priority, and whether it may require department support (Yes/No) and/or faculty support (Yes/No).

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| Department: | Physics and Astronomy (IFA) |
| Program: | Quantum Matter Theory (QMT) |
| Title: | New UL recruitment  |
| Support: | May require department support: | No (Yes) | May require faculty support: | No |

### Goal

**Instructions**: Specify the goal of the Priority, for example, to strengthen a specific existing activity or start a new one.

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| Strengthening our quantum matter theory research, reaching a more sustainable faculty member level |

### Expected meaningful research improvement

**Instructions**: Provide a description of the research that investing in this Priority will accomplish over the next 5 years. Explain how it has the potential to significantly strengthen or broaden the program for program proposals or department for department proposals. Specifically, this should go beyond continuing or slightly enlarging current activities by having a clear description of what change it will accomplish.

Motivation: The overall goal is to strengthen our research. As a result, the Priority should deliver meaningful improvements in research quality and/or breadth.

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| We recently had one associate professor (Swe: UL) resign their position. Our goal is to replace this faculty member at the UL level to ensure enough senior faculty members in the program for long term stability. Due to the current imbalance of faculty to younger members in the program, we have judged that we either need to strengthen our current larger research activities and/or for the new member to be active in closely neighboring fields where clear collaborative connections exist. This will provide much needed longer-term sustainability of our larger research activities and also strengthen our supervision capabilities within these activities. Due to our perilous internal funding situation any new faculty member needs to have a proven track record of obtaining external research funding to both fund part of their own salary and any students or postdocs. Recruiting into our already larger research activities may provide a small temporary buffer due to already secured external funding, but is not a long-term funding solution, since it is tied to individual PIs. Within the next 5-10 years we need to do one more faculty recruitment due to a retirement. |

### Implementation plan

**Instructions**: Provide a brief description of specifically what is planned to be done over the next 5 years to realize the potential of this Priority. For example: new hires, investments in equipment, starting collaborations, closing down existing activities, moving resources from existing activities, etc. Use the limited space provided here to discuss the most important aspects of how this activity will be carried out.

Motivation: For a Priority to be credible, there must be a plausible plan and what needs to be accomplished must have been thought through. It is understood that these plans will change over the next 5 years, however.

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| We have funding for the standard 40% salary for an UL within the program. The announcement for the position is currently being written, with input from all current faculty members, and we aim for a recruitment process during 2024-25.If the position is offered to someone who does not yet hold a research grant in Sweden, we need to offer additional short-term support, at the very least to cover their own salary (note that a standard or even high level of teaching will not pay 60% of a full-time salary and thus external money is also needed to pay faculty salaries). Currently we do not have any internal resources for providing additional research support. If the person fits scientifically on a larger external grant held by another PI we may make it work in the short-term, but otherwise we have to ask for short-term support (1-2 years) from the department to handle this recruitment. |

### What previous accomplishments indicate a high likelihood of success?

**Instructions**: Describe what recent (last 5 years) accomplishments make it clear that the there is a good chance of success in this project. Use specific examples (e.g., grant X, collaboration Y, paper Z) and explain how those recent accomplishments are evidence of having the competencies needed to be successful in this project.

Motivation: For a Priority to be credible, the expertise and track record needed to support it must be present.

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| We have already identified several promising candidates, including several researchers with VR Starting Grants at Uppsala and elsewhere, who are very interested in this position (note that the 5-year limit set by law on the Assistant professor position (BUL) make most holders of the VR-StG grant too old for our tenure-track system). The overall very high quality of our research, as measured for example in external grants, publications, and general international peer-recognition (see Chapters 1-3 in this KoF report), provides a stimulating and lively work environment, which we believe is our main attraction. |

## Current status of the area at Uppsala University

Instruction: Describe the current status of the area at Uppsala University as a whole. Include any existing funding, support, staff, and success in this area. Explicitly identify any overlap with other existing activities at the program(s), department, section, faculty, and/or university levels.

Motivation: To avoid duplicating efforts, it is important to understand the local Uppsala context when enhancing existing activities or starting new efforts. As part of the evaluation process, the panel will try to identify synergies between proposed Priorities.

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| The area is fully within our own program, where the research is already strong with multiple larger grants (ERC CoG, VR CoG, WAF, KAW Scholar), most running for 5 more years. Synergy also exists with the MT program, but the search profile will be unique for our program. |

### Current and planned contributions to support the initiative

**Instructions**: Describe the current (already in-place and on-going) and planned contributions to this goal from the local level (from the program for program proposals, from the department for department proposals, and from both the program(s) and department, as appropriate, for program proposals selected by the department). For example, co-funding, in-kind support, shared funding of facilities, transfers of FFFs, etc.

Motivation: Evidence of financial commitment from the local environment strongly supports the proposal as being important. Conversely, if the local environment is unable or unwilling to support it, the importance to the environment as a whole is much weaker.

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| We have the FFF to fund 40% of a UL salary within the program due to an earlier resignation. We also have enough studiestöd to provide part of a PhD student as a start-up package. Some 10-30% teaching can also be provided. The remaining faculty salary has to come from external funding. |

## Strategic value

### Strategic value of the area in the global context

Instruction: Describe the importance of the area in the global context. For example: fundamental challenges in research; new developments in research; societal challenges and priorities; global impact and importance.

Motivation: To ensure consideration of the larger context.

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| The area of research is internationally very active and addresses fundamental understanding of contemporary topics within condensed matter physics. Our program already has a good footprint within the field, despite only 4 faculty members. |

### Strategic value of the area at the next level

Instruction: Describe the importance of the area to the department (for program proposals) and for the section and faculty (for department proposals). For example: synergies with other activities, connections to teaching and collaboration, both currently and potential for new ones, etc. Explain the value of this activity beyond any overlapping ones identified above.

Motivation: To ensure that there is awareness of where this activity fits in at the next level up in the organization. This is particularly important if support is to be requested at that level.

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| For our program to thrive or even be sustainable in the longer term, we need to grow with more faculty members. This recruitment will provide a better work environment for our current members and hopefully prevent them from considering leaving Uppsala. |

## Contributions needed for success

**Instructions**: Identify what contributions are needed for success in terms of time, expertise, resources, facilities, staff, etc. Explicitly include estimates of financial resources needed and where they will come from.

Motivation: To ensure the costs and resources required have been thought through, and that they are reasonable given the scope of the benefit.

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| Make sure we can make an acceptable offer to the highest ranked candidate. For this we might need short-term support (1-2 years for salary) beyond the program depending on the candidate’s background, e.g. if they do not have external funding in Sweden, we need to provide more salary support the first few years. |

### Success indicators

**Instructions**: Describe specific results that will indicate success in 5 years. For example: increases in publications in top venues X and Y, publications in new field Z, strengthened or new collaborations with university A, new hires in B, new grants from C, etc.

Motivation: To ensure that the local- and faculty-levels will be able to assess whether this Priority was successful at the next evaluation so that we develop a positive cycle of following up on our strategic planning.

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| The recruitment will be successful if the new UL develops a research activity with external funding, students, postdocs, and with active collaboration with existing faculty members. |

### First steps that can be taken today

**Instructions**: Describe the first concrete steps needed to move in this direction that can be taken today. These should be clear enough that they can be followed up on in a year to see what progress has been made. Identify initial activities that can be started locally to enable progress to help motivate further support for the larger goal. In the exceptional case where no steps can be taken today, explain why a Priority has been chosen that cannot be started.

Motivation: To ensure that there is a clear idea of how to get started and enable easy follow-up of how the Priority is progressing.

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| We have had already a national search group (members from KTH and Lund) helping with formulating the details of the position and call. We are currently finalizing the announcement. We will directly reach out to identified interesting candidates to inform them about the open position. |

# Priority 2 of 3: An activity that may require department support

## Description of the Priority

**Instructions**: Provide the department name (since these will be collected at the section/faculty level) and the program name (if this is a program Priority), the title of the Priority, and whether it may require department support (Yes/No) and/or faculty support (Yes/No).

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| Department: | Physics and Astronomy (IFA) |
| Program: | Materials Theory, Quantum Matter Theory, and Theoretical Physics (all three programs) |
| Title: | More uniform research salary support for faculty members  |
| Support: | May require department support: | Yes | May require faculty support: | No (yes) |

### Goal

**Instructions**: Specify the goal of the Priority, for example, to strengthen a specific existing activity or start a new one.

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| Strengthen existing research by providing more stable support for research for all faculty members in dept. |

### Expected meaningful research improvement

**Instructions**: Provide a description of the research that investing in this Priority will accomplish over the next 5 years. Explain how it has the potential to significantly strengthen or broaden the program for program proposals or department for department proposals. Specifically, this should go beyond continuing or slightly enlarging current activities by having a clear description of what change it will accomplish.

Motivation: The overall goal is to strengthen our research. As a result, the Priority should deliver meaningful improvements in research quality and/or breadth.

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| The amount of faculty funding (for research) available for faculty members at the department is currently entirely dependent on which program one is based in and unfortunately vary hugely within the department, due primarily to historic reasons easily stretching back 20+ years. In fact, faculty members in many new and/or successful programs need to cover a very large part of their own salaries on external grants or teach the equivalent of a full-time teaching position, while in other programs, Profs and ULs have much more internal research support. This is not just unfair work conditions, but also, importantly, prevent us from recruiting and retaining the most talented researchers and hampers developments of new strong research fields. A stronger, more attractive, and more agile physics department would be possible if the internal research support for faculty was distributed more uniformly over the department. With recruiting and retaining the best researchers being the key for future successful research, providing stable and sufficient internal support for research for faculty members should be a main goal of the whole department.  |

### Implementation plan

**Instructions**: Provide a brief description of specifically what is planned to be done over the next 5 years to realize the potential of this Priority. For example: new hires, investments in equipment, starting collaborations, closing down existing activities, moving resources from existing activities, etc. Use the limited space provided here to discuss the most important aspects of how this activity will be carried out.

Motivation: For a Priority to be credible, there must be a plausible plan and what needs to be accomplished must have been thought through. It is understood that these plans will change over the next 5 years, however.

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| The first step is to recognize the differences and determine the level of research salary support a faculty member should be allowed to have in his/her position. A realistic aim could be 60% FFF support for each Prof, which leaves a possibility for 40% of salary from teaching or other paid university service commitments, if external funding is not available. (It is here important to note that teaching is currently underfunded, such that 40% salary on the teaching budget corresponds to much more than a 40% time commitment). The exact numbers should be worked out based on the department’s allocation of both internal long-term research (FFFs) and its teaching budget. Implementation will be difficult, but transitioning over a longer period with possible short-term support for those activities most affected should still make it feasible. A more stable and uniform distribution of research salary support will also help to focus the department’s future recruitments to commonly identify needs and opportunities instead of the current process, which is fractured into each individual program. |

### What previous accomplishments indicate a high likelihood of success?

**Instructions**: Describe what recent (last 5 years) accomplishments make it clear that the there is a good chance of success in this project. Use specific examples (e.g., grant X, collaboration Y, paper Z) and explain how those recent accomplishments are evidence of having the competencies needed to be successful in this project.

Motivation: For a Priority to be credible, the expertise and track record needed to support it must be present.

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| Many programs at the department manage to support their faculty on internal resources at a substantially higher level than all three programs in the Theory unit (MT, QMT, TP). Still, most of our current faculty members did not arrive recently (e.g. the last faculty hired in the QMT program was in 2013), so the lack of internal research support for faculty members is not a new issue, but has plagued us for many years. By recently forming units within the department, which groups several programs together, we have been able to identify common issues such as this. Continuing to work for a more uniform department, and hence stronger department, is the goal of this priority. |

## Current status of the area at Uppsala University

Instruction: Describe the current status of the area at Uppsala University as a whole. Include any existing funding, support, staff, and success in this area. Explicitly identify any overlap with other existing activities at the program(s), department, section, faculty, and/or university levels.

Motivation: To avoid duplicating efforts, it is important to understand the local Uppsala context when enhancing existing activities or starting new efforts. As part of the evaluation process, the panel will try to identify synergies between proposed Priorities.

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| Different internal funding is natural in different programs due to the varied nature of the research. But all programs have faculty salaries to cover and doing so at widely different levels is not good for the department; it hampers recruitment and retainment and creates overall unfair work conditions. |

### Current and planned contributions to support the initiative

**Instructions**: Describe the current (already in-place and on-going) and planned contributions to this goal from the local level (from the program for program proposals, from the department for department proposals, and from both the program(s) and department, as appropriate, for program proposals selected by the department). For example, co-funding, in-kind support, shared funding of facilities, transfers of FFFs, etc.

Motivation: Evidence of financial commitment from the local environment strongly supports the proposal as being important. Conversely, if the local environment is unable or unwilling to support it, the importance to the environment as a whole is much weaker.

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| The department should be able to settle on a common funding structure for its faculty based on its existing allocation of internal resources.  |

## Strategic value

### Strategic value of the area in the global context

Instruction: Describe the importance of the area in the global context. For example: fundamental challenges in research; new developments in research; societal challenges and priorities; global impact and importance.

Motivation: To ensure consideration of the larger context.

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| Attractive conditions for faculty members are key for future success on an increasingly global talent market. This concerns both being successful in future recruitments and retaining our best researchers. It is also very important for the cohesiveness of the department to provide uniform and fair work conditions. |

### Strategic value of the area at the next level

Instruction: Describe the importance of the area to the department (for program proposals) and for the section and faculty (for department proposals). For example: synergies with other activities, connections to teaching and collaboration, both currently and potential for new ones, etc. Explain the value of this activity beyond any overlapping ones identified above.

Motivation: To ensure that there is awareness of where this activity fits in at the next level up in the organization. This is particularly important if support is to be requested at that level.

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| A more uniform treatment of the faculty in the department will help with future recruitment and retaining of talent, which will overall increase the impact of the department’s research and thus of all physics and astronomy research at UU. |

## Contributions needed for success

**Instructions**: Identify what contributions are needed for success in terms of time, expertise, resources, facilities, staff, etc. Explicitly include estimates of financial resources needed and where they will come from.

Motivation: To ensure the costs and resources required have been thought through, and that they are reasonable given the scope of the benefit.

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| A willingness throughout the department to work for the common good to reduce the fractured current system. Short term extra resources might be needed from TekNat to facilitate a smooth transition. |

### Success indicators

**Instructions**: Describe specific results that will indicate success in 5 years. For example: increases in publications in top venues X and Y, publications in new field Z, strengthened or new collaborations with university A, new hires in B, new grants from C, etc.

Motivation: To ensure that the local- and faculty-levels will be able to assess whether this Priority was successful at the next evaluation so that we develop a positive cycle of following up on our strategic planning.

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| A more uniform distribution of internal research support for all of the department’s faculty members. Better ability to recruit and encourage faculty members to excel in top-notch research areas, which are competitive on the global arena. |

### First steps that can be taken today

**Instructions**: Describe the first concrete steps needed to move in this direction that can be taken today. These should be clear enough that they can be followed up on in a year to see what progress has been made. Identify initial activities that can be started locally to enable progress to help motivate further support for the larger goal. In the exceptional case where no steps can be taken today, explain why a Priority has been chosen that cannot be started.

Motivation: To ensure that there is a clear idea of how to get started and enable easy follow-up of how the Priority is progressing.

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| Determining the level of uniform faculty research that would be possible and then analyzing the changes needed within the department. Identifying the best way to administratively handle the new arrangement, possibly with the department centrally paying salaries. Finding a way of handling the transition. |

# Priority 3 of 3: An activity that may require faculty support

## Description of the Priority

**Instructions**: Provide the department name (since these will be collected at the section/faculty level) and the program name (if this is a program Priority), the title of the Priority, and whether it may require department support (Yes/No) and/or faculty support (Yes/No).

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| Department: | Physics and Astronomy (IFA) |
| Program: | Quantum Matter Theory (QMT) |
| Title: | Quantum Information (QI) |
| Support: | May require department support: | Yes | May require faculty support: | Yes |

### Goal

**Instructions**: Specify the goal of the Priority, for example, to strengthen a specific existing activity or start a new one.

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| Strengthen UUs activity in quantum information, quantum computing, and technology (here QI for short) |

### Expected meaningful research improvement

**Instructions**: Provide a description of the research that investing in this Priority will accomplish over the next 5 years. Explain how it has the potential to significantly strengthen or broaden the program for program proposals or department for department proposals. Specifically, this should go beyond continuing or slightly enlarging current activities by having a clear description of what change it will accomplish.

Motivation: The overall goal is to strengthen our research. As a result, the Priority should deliver meaningful improvements in research quality and/or breadth.

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| UU has currently only 1 faculty member in quantum information/computing (our program), despite it being one of the internationally fastest growing fields in science. UU is also, as the only large Swedish university, not included in the large Wallenberg initiative for quantum technology (WAQCT). Within the program we have despite very limited resources tried to remedy this. By using Nordita we have secured external funding for a BUL for 5 years with a generous start-up package (2 PhD students + 1 postdoc), but long-term this will only replace our current Prof retiring. We urgently need to build a stronger presence in this field for both teaching and research. For success it is also important that we expand based on activities where we are already exceptionally strong, such that new recruitments can both grow our QI activities and successfully connect to existing strong research. We thus propose 1) Two new faculty positions in QI specialized towards many-body theory in our program, which will provide a unique niche for our QI research, and 2) Building a cross-section platform with the IT Department on quantum computing.  |

### Implementation plan

**Instructions**: Provide a brief description of specifically what is planned to be done over the next 5 years to realize the potential of this Priority. For example: new hires, investments in equipment, starting collaborations, closing down existing activities, moving resources from existing activities, etc. Use the limited space provided here to discuss the most important aspects of how this activity will be carried out.

Motivation: For a Priority to be credible, there must be a plausible plan and what needs to be accomplished must have been thought through. It is understood that these plans will change over the next 5 years, however.

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| Growing successfully in an expanding field is hard and to succeed we should capitalize on our already existing strong research. New faculty in QI theory towards many-body systems will be firmly within QI and also directly connect to our successful research in quantum matter theory with the latter already having secured substantial external funding (ERC CoG, VR CoG, KAW Scholar) for 5+ years. The topic is further math intensive and could thus also fit within an expanded Geometry&Physics center. With our current Nordita BUL recruitment and existing QI faculty member this will provide an adequate base for UUs QI research. Also, the initiative at Nordita is financed by KAW, so with a larger QI activity we may become part of the WAQCT initiative, important for doing future QI research in Sweden. Further, quantum technologies will likely be the future of computing. With the IT dept we have identified a large interest in joining quantum and computing. To build up such new cross-section activity we propose to form a fixed-term platform, a center, for coordination of new activities: education, seminars, and joint PhD students. Center for Quantum? |

### What previous accomplishments indicate a high likelihood of success?

**Instructions**: Describe what recent (last 5 years) accomplishments make it clear that the there is a good chance of success in this project. Use specific examples (e.g., grant X, collaboration Y, paper Z) and explain how those recent accomplishments are evidence of having the competencies needed to be successful in this project.

Motivation: For a Priority to be credible, the expertise and track record needed to support it must be present.

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| We have existing strong but limited research in QI and we are also exceptionally strong in neighboring quantum matter fields, including activities on topological superconductivity with Majorana fermions that can be used for quantum computation and QI techniques in magnonic systems, both already funded by large external grants (KAW, the latter also with the MT program). Furthermore, together with Nordita we are already broadening our QI activities, at essentially no cost to UU. Finally, QI has been listed in the department strategy work for multiple years as an area of expansion. It is now time to also get support for this activity beyond external grants and other institutes. |

## Current status of the area at Uppsala University

**Instruction**: Describe the current status of the area at Uppsala University as a whole. Include any existing funding, support, staff, and success in this area. Explicitly identify any overlap with other existing activities at the program(s), department, section, faculty, and/or university levels.

Motivation: To avoid duplicating efforts, it is important to understand the local Uppsala context when enhancing existing activities or starting new efforts. As part of the evaluation process, the panel will try to identify synergies between proposed Priorities.

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| 1 faculty member in QI at UU, which is in our program. The neighboring field of quantum matter is also within the same program. The other program in the same division (Materials Theory) has adjacent activities. Most of our current and planned research is only existing due to external grants or Nordita. |

### Current and planned contributions to support the initiative

**Instructions**: Describe the current (already in-place and on-going) and planned contributions to this goal from the local level (from the program for program proposals, from the department for department proposals, and from both the program(s) and department, as appropriate, for program proposals selected by the department). For example, co-funding, in-kind support, shared funding of facilities, transfers of FFFs, etc.

Motivation: Evidence of financial commitment from the local environment strongly supports the proposal as being important. Conversely, if the local environment is unable or unwilling to support it, the importance to the environment as a whole is much weaker.

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| Nordita supports a new BUL with 2 PhD students and 1 postdoc, to be jointly located at UU and Nordita. This connection to Nordita and KAW is also important for larger impact. The QMT program has due to underfunding since its creation no own internal resources to use.  |

## Strategic value

### Strategic value of the area in the global context

**Instruction**: Describe the importance of the area in the global context. For example: fundamental challenges in research; new developments in research; societal challenges and priorities; global impact and importance.

Motivation: To ensure consideration of the larger context.

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| QI is one of the fastest growing scientific fields, spanning from fundamental research to industry and military applications. The societal impact of quantum information and computing will be huge, from accelerating drug design and solving intractable physics problems, to redefining data communication and data security. |

### Strategic value of the area at the next level

**Instruction**: Describe the importance of the area to the department (for program proposals) and for the section and faculty (for department proposals). For example: synergies with other activities, connections to teaching and collaboration, both currently and potential for new ones, etc. Explain the value of this activity beyond any overlapping ones identified above.

Motivation: To ensure that there is awareness of where this activity fits in at the next level up in the organization. This is particularly important if support is to be requested at that level.

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| It is crucial for a large physics department to have a strong activity in QI, 1 faculty for the whole field is not sufficient. New QI activities with strong math components gives possibilities to enlarge the Geometry and Physics excellence center towards QI. Connecting to the IT department is also desirable for the future. |

## Contributions needed for success

**Instructions**: Identify what contributions are needed for success in terms of time, expertise, resources, facilities, staff, etc. Explicitly include estimates of financial resources needed and where they will come from.

Motivation: To ensure the costs and resources required have been thought through, and that they are reasonable given the scope of the benefit.

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| The program needs permanent (FFF) support for faculty hires, ~0.8 FFF (for 60% support) to expand our activity with two new faculty members. Successful interactions with the IT department towards quantum computing requires forming a platform (center) to coordinate seminars, courses, and shared PhD students. |

### Success indicators

**Instructions**: Describe specific results that will indicate success in 5 years. For example: increases in publications in top venues X and Y, publications in new field Z, strengthened or new collaborations with university A, new hires in B, new grants from C, etc.

Motivation: To ensure that the local- and faculty-levels will be able to assess whether this Priority was successful at the next evaluation so that we develop a positive cycle of following up on our strategic planning.

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| Two new faculty recruitments with their own research grant portfolios, students, and publications, with research in close connection to ongoing quantum matter research and the Geometry&Physics center.Increased collaboration between the Physics and IT departments, enlarging QI research towards computing. |

### First steps that can be taken today

**Instructions**: Describe the first concrete steps needed to move in this direction that can be taken today. These should be clear enough that they can be followed up on in a year to see what progress has been made. Identify initial activities that can be started locally to enable progress to help motivate further support for the larger goal. In the exceptional case where no steps can be taken today, explain why a Priority has been chosen that cannot be started.

Motivation: To ensure that there is a clear idea of how to get started and enable easy follow-up of how the Priority is progressing.

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| Maximize the possibilities the new Nordita BUL is giving by incorporating the Nordita QI staff into UU activities. Work on association with WAQCT through Nordita. Expanding interactions with the IT department before formal structure is in place.  |

# Questions to the panel

The panel will provide feedback on research quality, strengths and opportunities for improvement, and comment and give feedback on staffing, funding, and at least one priority area.

**Instructions**: If you have specific questions for the panel that are not covered by those areas, please list up to three of them here. Please note that due to time constraints during the visit, not all questions may be answered.

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