KoF/ÖB 2024

Faculty of Science and Technology

Research Program Self-Evaluation

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| Research Program: | Theoretical Astrophysics |
| Department: | Department of Physics and Astronomy |
| Section: | Physics |
| Program Responsible Professor: | Paul Barklem |

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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 |

**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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| Parts based on earlier strategic work within department. All program members in all categories were invited to a meeting, important questions identified, input requested. Priorities presented and discussed at a department retreat. Final comments and input solicited from all members two weeks before submission. |

## 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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| Application of theoretical and computational methods to understanding of astronomical objects and their physics. Various physics (mechanics, fluid dynamics, thermodynamics, atomic physics, etc.) are used to build models and simulations, generate predictions, and produce synthetic observables for comparisons. |

## 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 | 2.4 | 0.2 | 0.9 |  |  | 3.5 |
| **Male** | 0.9 | 1.0 |  | 1.9 | 1.0 | (1.0) | 5.6 |  |  | 6.6 |

## 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** | 3.5 | 2.0 | 5.4 | 10.7 | 16.1 | 66% |
| **2022** | 3.4 | 1.9 | 5.3 | 8.6 | 13.9 | 62% |
| **Average** | 3.4 | 1.9 | 5.3 | 9.6 | 15.0 | 64% |

### 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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| Co-funding for Susanne Höfner’s ERC Advanced Grant from vice-chancellor, faculty and department. |

### 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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| FFF is distributed to faculty members based on need (e.g. grant holders may need less FFF), while attempting to keep amounts similar, in connection with actual workloads, and reasonable with respect to research/teaching/admin balance.  Where necessary FFF is used to co-fund long-term non-tenured researchers and bridge between external funding sources. In the past, studiestöd has always been associated to a PhD student who is hired and then selects their project and supervisor; this practice will likely change in future. |

### 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 | 1.4 (31%) | 1.1 (24%) | 0.1 (1%) | 1 (22%) | 0 (0%) | 0.8 (17%) | 0.2 (4%) | 4.5 |
| 2022 | 1.8 (38%) | 1 (22%) | 0 (1%) | 0.8 (17%) | 0 (0%) | 0.8 (17%) | 0.2 (5%) | 4.6 |
| Average | 1.6 (35%) | 1 (23%) | 0.1 (1%) | 0.9 (20%) | 0 (0%) | 0.8 (17%) | 0.2 (4%) | 4.6 |

### 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 | 62% | 30% | 8% | 71% | 13% | 16% |
| Associate (UL) |  |  |  | 35% | 65% | 0% |
| Assistant (BUL) |  |  |  |  |  |  |
| PhD | 46% | 48% | 6% | 0% | 95% | 5% |
| Postdoc | 0% | 100% | 0% |  |  |  |
| Researcher | 30% | 70% | 0% | 0% | 92% | 8% |

### 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) |
| National Academic Infrastructure for Supercomputing in Sweden (NAISS) | National | Sweden | None |
| European Southern Observatory (VLT) | International | Chile | None |
| Double ElectroStatic Ion Ring ExpEriment (DESIREE) | National | Stockholm | None |
| Onsala Space Observatory (Swedish national infrastructure for radio astronomy, including ALMA) | National | Sweden, Chile | None |
| European Space Agency (JWST, Euclid) | International | Space | None |

## 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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| One Associate Professor (UL), Sofia Ramstedt, was employed for most of the review period, but left for a position at the Swedish National Board for Assessment of Research Misconduct during the end of 2021. (Formally left early 2022). One stipend postdoc, Mohammed Kamran, added. |

# 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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| **Project A** (Stars and Environments): Strong existing activity received ERC Advanced grant, VR project grants, VR starting grant. Several PhD students and postdocs hired. **Project B** (Electron transfer with DESIREE): Combining existing theoretical activity with new experimental facility, including successful KAW project nearing completion, VR project grants, VR starting grant, leading to Phys Rev Letter. **Project C** (Physics of Gravitational Wave sources): New activity obtained VR starting grant, PhD student hired, successful collaboration with Stockholm. Unfortunately, main person recently left academia, and activity must shift focus. Goals were appropriate, and ambitious yet realistic, maintaining existing and trying new. |

# 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 | Studies of evolved stars and their winds | ~55 | ~1 | Basic |
| 2 | Atomic astrophysics and spectroscopy | ~35 | ~1 | Basic |
| 3 | Galaxy – Dark matter connection | ~10 | 0 | Basic |
| 4 |  |  |  |  |

## 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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| The goal of the theoretical astrophysics program (TAP) is to make fundamental contributions to basic questions in modern astrophysics, especially to understanding the cosmic matter cycle, i.e. the origin and distribution of the chemical elements. This question is intimately related to unravelling how galaxies and planetary systems are formed, and thus the conditions for life in the universe. To make progress on these larger questions requires a sound understanding of astrophysical objects and processes from first principles, and this is a common thread of the work done in the program. In particular, the emergence of high- performance computing has opened the way to modelling astrophysical objects without simplifying assumptions such as hydrostatic and thermal equilibrium, by simulating physical processes in detail.  A major part of the activity is focused on physical properties of evolved stars, in particular dynamical processes such as pulsation and stellar winds, and the formation of stardust. These processes play a critical role for stellar and galactic chemical evolution, for physical properties of supernova progenitors, and for producing the building blocks of terrestrial planets and life. To understand these phenomena, we work on developing advanced radiation-hydrodynamical models and comparing the results to observations.  Another part of the activity centres around the study of stellar atmospheres and the chemical composition of late-type stars including the Sun, which are tracers of chemical evolution in the local universe. In particular, we study the physics governing stellar spectra, in order to be able to accurately infer the chemical compositions of the Sun and similar stars, and make robust inferences on the larger questions above. A focus is the composition of the Sun, and the study of the Milky Way in detail via “Galactic archaeology”.  A third research activity focuses on large-scale structure of the Universe, and its connection to astrophysics and fundamental physics, including investigating the first generations of galaxies, and galaxy distributions. |

## 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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| **Area 1:** Freytag & Höfner (2023, A&A 669, A155) presented the first global 3D radiation-hydrodynamical models of evolved stars and their dust-driven winds. These models enable understanding of the emergence of structures seen in high-angular resolution observations, and a quantitative description of mass loss. An accurate mass-loss prescription gave new insights into carbon star formation (Marigo++ 2020, Nature Astronomy 4, 1102). **Area 2:** Calculations, with experiments at DESIREE, allowed significant progress on the effect of inelastic H atom processes on elements such as Li, Na, Mg, C, N, O, Ca, Ti, Mn, Fe and Eu, (e.g. Grumer++ 2022, PRL 128, 033401). Combination with 3D non-LTE radiative transfer led to improved inference of solar abundances (e.g. C & N: Amarsi++ 2020, A&A 636, A120) and stellar abundances in large surveys of the Milky Way (e.g. Amarsi++ 2020, A&A 642, A62), shedding light on the structure and evolution of stars and galaxies (e.g. Buder++ 2022, MNRAS 510, 2407). **Area 3:** Established future cosmic void surveys as an important tool for constraining neutrino and dark energy models (Sahlen 2019, PRD 99, 063525). |

### 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.)

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| --- | --- | --- |
|  | Type of Indicator | 2017-2022 |
| Number of publications, full publication set (full / fractional counts) | Quantity | 262 / 53 |
| Proportion of publication fractions at the Norwegian model level 2 (%) | Impact | 73% |
|  |  | 2017-2021 |
| Coverage (fractionalized): Proportion of publications from DiVA included in citation statistics, weighted by fractional counts | Coverage | 73% |
| Mean normalized number of citations per publication (MNCS) | Impact | 1.66 |
| Proportion of frequently cited publications (top 10%) (PP(top 10%)) | Impact | 15% |

### 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 |
| Astronomy and Astrophysics | 116 | 44.3 |
| Monthly Notices of the Royal Astronomical Society | 71 | 27.1 |
| The Astrophysical Journal | 10 | 3.8 |
| Physical Review A: Atomic, Molecular, and Optical Physics and Quantum Info. | 5 | 1.9 |
| The Planetary Science Journal | 5 | 1.9 |
| The Astrophysical Journal Letters | 4 | 1.5 |
| The Astronomical Journal | 3 | 1.1 |
| The Astrophysical Journal Supplement Series | 3 | 1.1 |
| Geophysical Research Letters | 3 | 1.1 |
| Nature Astronomy | 3 | 1.1 |

### 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 |
| Astronomy and Astrophysics (A&A) | 116 | 44.3 | 25 | 22 |
| Monthly Notices of the Royal Astronomical Society (MNRAS) | 71 | 27.1 | 2 | 3 |
| The Astrophysical Journal (ApJ) | 10 | 3.8 | 3 | 30 |
| Physical Review A: Atomic, Molecular, and Optical Physics and Quantum Info. (PRA) | 5 | 1.9 | 1 | 20 |
| The Astrophysical Journal Letters (ApJL) | 4 | 1.5 | 1 | 25 |
| Nature Astronomy (NatAstr) | 3 | 1.1 | 0 | 0 |
| The Astronomy and Astrophysics Review (A&AR) | 2 | 0.8 | 2 | 100 |
| Physical Review D: Particles and Fields (PRD) | 2 | 0.8 | 2 | 100 |
| Physical Review Letters (PRL) | 1 | 0.4 | 1 | 100 |
| Nature (Nat) | 1 | 0.4 | 0 | 0 |

### 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 bibliometric statistics.)

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| A&A is the main journal for European astronomy, and default for our publishing. We collaborate significantly with groups outside Europe for whom MNRAS or ApJ is the default. As appropriate, some papers are sent to ApJL, NatAstr, & Nat, and some work is published in the physics literature, PRA, PRD, or PRL. Two invited reviews in A&AR were published; an additional two reviews, one in A&AR (2016) and one in Annual Reviews of Astronomy and Astrophysics ARA&A (2024) fell just outside the counted period. A focus on quality is encouraged, and the impact indicators in 3.3.2 demonstrate the high quality and impact of the published research. |

### 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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| Published four invited expert reviews in A&AR or ARA&A in the last decade (Barklem, Höfner, Gustafsson, Amarsi). Höfner was awarded an ERC advanced grant (2020), Wallenberg Scholar (2024), is a member of the Swedish Royal Academy (KVA), Uppsala Royal Society of Sciences (KVS), gives regular invited reviews, and e.g. sat in the computing allocation committee for SNAC/NAISS. Barklem is vice-chair of the Observing Proposal Committee for the European Southern Observatory, president of the IAU commission B5 Laboratory Astrophysics, sits on the boards of A&A, 4MOST, and the Swedish Institute for Solar Physics. Barklem was awarded the Strömer-Ferrnerska Prize (KVA, 2019) and Thuréus Prize (KVS, 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 | Complementary methods and data: Opacities and equation of state |
|  | Specific  collaboration | Opacities and the equation of state underlie all stellar atmosphere modelling, and there is significant knowledge transfer between different problems and codes |
| 2 | Type of synergy | Complementary methods: 3D modelling and radiative transfer |
|  | Specific  collaboration | Knowledge and methods on multi-dimensional modelling and the propagation of radiation through stellar atmospheres is transferable between different problems and codes |
| 3 | Type of synergy | Common goals: Origin of the elements |
|  | Specific  collaboration | The program works on the origin of the elements from different angles, production in evolved stars, traced in stellar populations, and dialogue between these is stimulating. |

## 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 | Uppsala University, Observational Astrophysics |
| Type of synergy | Theory-observation connection. Complementary methods, facilities and goals. |
| Specific  collaboration | High-resolution stellar spectroscopy including the Gaia-ESO project, the 4MOST survey, and the future ELT high-resolution spectrograph ANDES. |
| 2 | University and Field | Stockholm University, Atomic Physics |
| Type of synergy | Theory-experiment connection. |
| Specific  collaboration | Experiments done at DESIREE facility, compared with theoretical calculations and physics and astrophysical implications investigated. |
| 3 | University and Field | Chalmers University, Radio Astronomy |
| Type of synergy | Theory-observation connection. |
| Specific  collaboration | High-spatial-resolution observations of evolved stars with ALMA and other telescopes, comparison of models; predicting synthetic observables for upcoming instruments. |

### 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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| Close collaboration with observational projects and experiments is a crucial part of the scientific activity, which has the advantage of detailed use and understanding of state-of-the-art instruments and empirical data, and drastically increases the impact of theoretical work. The main challenge we perceive is to focus activity in this respect, and not overextend into too many observational and experimental projects/facilities. |

## 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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| Ethical considerations around authorship, particularly in the context of the rise of large collaborations in astronomy, and focus on bibliometrics in evaluation, are often discussed. Generally, we try to promote a culture of quality over quantity, and that authorship implies responsibility. |

## 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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| At the basic level, the division tries to ensure open discussion and an accepting environment, e.g. students ask questions first at seminars and division assembly, open discussion of topics bordering research such as research ethics, gender in STEM, impact of astronomical infrastructure on the environment, SETI, etc. |

## 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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| The program has had 3-4 faculty over the review period, and is embedded in the Division of Astronomy and Space Physics, including the Observational Astrophysics and Space and Plasma Physics programs. Our everyday work (e.g. seminars, weekly assembly, “fika”) is within this larger structure. |

## 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) | 4.0 | European Research Council (H2020) | 5.2 |
| Swedish Research Council (VR) | 2.5 | Swedish Research Council (VR) | 2.2 |
| Swedish National Space Agency | 1.2 | Wallenberg Foundation (KAW) | 1.9 |
| Wallenberg Foundation (KAW) | 0.8 | Swedish National Space Agency | 1.2 |
| Royal Swedish Academy of Sciences | 0.0 | Uppsala University Foundations Management | 0.1 |
| Carl Trygger Foundation | 0.0 | Carl Trygger Foundation | 0.1 |
| Uppsala University Foundations Management | 0.0 | Privatpersoner, svenska - KDB | 0.0 |
| Privatpersoner, svenska - KDB (Schönbergs donation) | 0.0 | Other private foundations | 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.

|  |  |
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| 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 | 1 ERC-AdG (Höfner) |
| KAW Project |  |
| KAW Scholar |  |
| WAF/WAFx |  |
| VR Project | 4 (2 x Höfner, 2 x Barklem) |
| VR Starting | 3 (Amarsi, Bladh, Grumer) |
| Other grants (may include field-specific grants and Co-PIs) | |
| KAW Project co-PI | 1 (Barklem) |
| Swedish National Space Agency | 1 (Sahlen) |
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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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| Faculty are expected to apply for VR projects regularly, and other grants (e.g. ERC and KAW) as appropriate. Postdocs and researchers are encouraged to apply for early-mid career grants (VR and ERC) if they meet the criteria, and the nearest senior colleague should provide support (e.g. advice on most appropriate grants, feedback on the application). External funding is necessary for the program to keep research/teaching ratios at optimal levels, to fund PhD students and postdocs, and in the case of dedicated researchers to fund a significant part of their salary. The challenge is retaining important competence that has been built up within the program. |

## 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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| The research activity is successful relative to its size in terms of publications, impact, collaboration with other fields, and external funding across various levels through grants to senior and early-career researchers. Recent awards of a Wallenberg Academy Fellow (WAF, Thomas Nordlander) and KAW Scholar (Susanne Höfner) will mean this momentum is maintained. |

## 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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| The publication data shows that while we drive many publications, a significant fraction is driven externally. We should reflect on whether the proportion of projects/publications driven by us versus driven externally is optimal; there may not be a simple answer and it may be group/activity dependent (e.g. depending on degree of collaboration in large observational projects). It could be beneficial to encourage more focus on projects driven by us, including by early career researchers. |

# 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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| One Associate Professor (Sofia Ramstedt) left during 2021 and another (Bengt Edvardsson) will retire in June 2024, leaving the program with 2 professors, and no Associate Professors. Thomas Nordlander from Australian National University, was recently awarded a Wallenberg Academy Fellowship (WAF), and will join us in late 2024, and will have the right to promotion to Associate Professor, for which he will apply during the coming years. At least one more faculty hiring in the next 5 years would create a more optimal career stage distribution, and this is planned as one of our priorities. |

## 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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| Based on coming retirements and departures, during 2022 the Division of Astronomy and Space Physics identified the need for, and possibility to fund, an Associate Professor position. A recruitment was discussed with all faculty members, and a broad announcement made. The position attracted 52 applicants, and based on the scientific direction of the new Associate Professor’s activity, combined with the above-mentioned WAF recruitment, it was decided to place the new Associate Professor in the observational program. The broad announcement posed several challenges, e.g. finding external experts and unconflicted internal subject representatives with relevant knowledge. |

### 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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| A strong motivation for the broad recruitment described above was that the division might either attract a top external candidate, or retain one of the excellent internal candidates (at the time 3 VR starting grants, 1 Space Agency career grant). A search group identified 34 applicants, 9 currently employed at UU, 15 outside Sweden, 41% women. As well as direct recruitment, excellence grants such as WAF, ERC starting and consolidator grants, provide an alternative path for recruitment, including external renewal. The program professor, in discussion with senior faculty, attempts to identify internal and external candidates for such applications, and help them with their applications and interviews. |

## 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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| Informal mentoring from nearest senior faculty member, such as encouragement and advice around what external funding to apply for, and feedback on applications. The program does its best to enable early career grant holders (e.g. VR starting grant, Space Agency career grant) to have a PhD student and/or postdoc.  Non-tenured staff are encouraged to teach for career development, often ~10%, and when qualified to apply for promotion to docent. |

### 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 Assistant Professors. As a small program presently with several non-tenured staff with external grants (VR starting grant, Space Agency career grant) it would be difficult to prioritize such a recruitment, limited to 5 years from PhD, over a broader Associate Professor position with no such restrictions. |

### 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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| Informal mentoring, generally by closest senior colleague. The program gives priority to Associate Professors in an earlier career development phase in the allocation of faculty funded PhD students. |

## 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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| Dialogue, collaboration and coordination within the Division of Astronomy and Space Physics, especially with the Observational Astrophysics program.  It should be noted that though some program members continue in academic careers, the majority of program members end up in non-academic careers. Our graduates and researchers are sought after, not least by the Swedish Defense Research Agency (FOI). |

## 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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| A constant challenge in a small program is to ensure continuity through a somewhat flat distribution with academic age/position, in addition to attaining gender balance, enabling opportunities for early career researchers to build a career in the program, as well as bringing in impulses from the outside. Some of these issues are alleviated by the larger context of the division, and the department. |

# 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.

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| 1 | Example and connection | Dimming of Betelgeuse during the end of 2019 and 2020 captured much media attention, and our evolved star group (Höfner, Freytag) was heavily involved in media outreach. |
| Value to the program | Visibility for astronomical expertise of our researchers. |
| Value to the partner | Stimulating interest in STEM subjects in society. |
| 2 | Example and connection | About 80% of questions to researchers at the Physics Department are about astronomy, hundreds per year. Bengt Edvardsson answers all these questions. |
| Value to the program | Visibility for astronomical expertise of our researchers. |
| Value to the partner | Stimulating interest in STEM subjects in society. |
| 3 | Example and connection | Collaboration between Martin Sahlen and Swedish National Space Agency on outreach events: lecture at city library, panel discussion in Uppsala Cathedral, Gothenburg Book Fair. |
| Value to the program | Visibility for astronomical expertise of our researchers. |
| Value to the partner | Stimulating interest in STEM subjects in society. |

### 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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| Astronomy plays a very important role in making Science, Technology, Engineering and Mathematics (STEM) visible to the general public, not least in getting children interested; Astronomy is sometimes referred to as a “STEM attractor”. The theoretical astrophysics program plays an important role in this outreach work, coordinated at the division. Program members participate in a broad range of activities: public talks and discussions, school visits, science fairs, media interviews, popular articles, podcasts, answering questions, telescope shows etc. |

## 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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| The division allocates significant time and resources to activities such as those examples described above, and which have important impact in society. The support is not formalised, and is done as part of overall duties of employees. The key conditions for sustaining a high level of activity around public interest in astronomy, are a stimulating intellectual environment, and culture in which such activities are valued and actively implemented. |

## 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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| Program members do a very significant amount of outreach, and find this enjoyable, motivating, and rewarding. |

## 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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| The vacuum left by Bengt Edvardsson in terms of answering questions from the public will need to be filled within the division. Such work is often not sufficiently appreciated compared to research and teaching (i.e. visibility and reward in terms of academic career development, and external funding), and the program and department can do its part to improve this. |

# 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.

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| --- | --- | --- | --- |
| Teaching program, course package, or contract/continuing education | Level | Courses Taught | Managed |
| Bachelor’s program in Engineering (Mechanical/Electrical/Medical Tech) | Bachelor | 1-5 | No |
| Master’s program in Physics | Master | 1-5 | No |
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## 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 |
| None |  |  |  |
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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.

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| --- | --- | --- |
| 1 | Example | Use of astronomical examples from current research in teaching mechanics (e.g. black hole collisions, neutron star spin) |
| Course Info | Mechanics HI, Bachelor of Engineering program |
| Value to teaching/ research | Stimulates students |
| 2 | Example | Use of knowledge of current research in cosmology in teaching. |
| Course Info | Three Views on Cosmology. |
| Value to teaching/ research | Most popular free-standing course in the department. |
| 3 | Example | Use of ALMA data in student projects |
| Course Info | BSc degree project C in Physics |
| Value to teaching/ research | Students experience analyzing real data. Sometimes leads to research results. |
| 4 | Example | Computational project on radiation and matter |
| Course Info | Theoretical Astrophysics |
| Value to teaching/ research | Students learn modern computational techniques to solve problems. |

### 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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| Astronomical subjects can be used to provoke interest from students in non-astronomy courses, e.g. stimulate interest in mechanics, numerical methods, or in philosophy of science.  In advanced astronomy courses, the aim is to stimulate interest and generate motivation through real problems, methods and data (rather than contrived ideal situations often encountered in basic courses), as well as start training students towards research. |

## 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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| Only informal processes. Often teachers are motivated to develop new courses because the research field has become important, or because it interests them. For example, last year we started a course in astrochemistry, because the field has become important, and teaching such a course broadens the knowledge of the program and its research. A course on different views of cosmology both broadens the horizons of non-astronomy students, and of the teachers involved. |

## 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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| We are able to integrate our expertise and real examples into teaching, which stimulates interest, and trains future scientists. We are also able to use teaching as a mechanism for broadening knowledge and experiences of the program members. |

## 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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# 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 | | | |
| Program: | Theoretical Astrophysics | | | |
| Title: | Exploring possible synergies in Multi-Messenger Astrophysics | | | |
| Support: | May require department support: | No | 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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| Stimulate activity on multi-messenger astrophysics |

### 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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| Research relevant to multi-messenger astrophysics (combining astronomy in the electromagnetic spectrum, with neutrino and gravitational wave astronomy) is found in four research programs in the Department of Physics and Astronomy: theoretical astrophysics, observational astrophysics, high-energy physics and nuclear physics.  Increased interaction, understanding each other’s problems, expertise and methodologies, may present opportunities for new science and collaboration, and teaching. Stimulating this interaction would benefit the programs and department both in terms of possible broadening of research and by attracting students interested in multi-messenger astrophysics. Individual programs may have existing expertise that is relevant for this field, e.g. non-equilibrium radiative transfer is a mature field for stars, but not for supernovae and kilonovae (neutron star mergers). |

### 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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| Already we have a long running master’s/PhD level course in nuclear astrophysics, which was initiated between nuclear physics and astronomy. This now includes a lecture on neutrino astronomy and a lecture on kilonovae, given by researchers from high-energy physics and the theoretical astrophysics program (TAP), respectively.  Concrete steps in the near term would be to further 1) develop the multi-messenger astrophysics components of the nuclear astrophysics course, and 2) actively discuss and invite possible seminar speakers that would be of interest across activities, and coordinate such seminars to optimise attendance. A small group has been formed, and we will meet to discuss ideas and plan joint activities. |

### 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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| Two hirings in astro-particle physics, and an incoming Wallenberg Academy fellow in TAP, with research interests from different perspectives on supernovae. Existing contacts and collaborations with the supernova and kilonova activity at Stockholm; includes organizing a workshop on kilonovae together with Stockholm in late 2023, where Barklem led the summary discussion on atomic physics of kilonovae. TAP has a PhD student working on the atomic physics of r-process elements (produced in kilonovae), in both kilonovae and stars, who gave a talk at the above workshop. Thus, there are related strands, from which synergies might emerge. |

## 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 activity is distributed across TAP, observational astrophysics, high-energy physics and nuclear physics. |

### 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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| Requirements are support for the nuclear astrophysics course, and possibly some funding for inviting speakers. In the long term we could consider hiring PhD students or post-docs at the interface between the different activities, if a compelling science case arises.  arise. |

## 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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| Multi-messenger astrophysics, combining traditional astronomy with neutrino and gravitational wave astronomy, will be an important area of future astrophysics research. |

### 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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| Multi-messenger astronomy already does, and in future certainly will attract students to physics and astronomy, and STEM subjects in general. |

## 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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| Teachers for nuclear astrophysics course, plus a small amount of dedicated time from staff across the four research programs. |

### 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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| Regular seminars between astronomy and astro-particle physics, potentially new collaborations. |

### 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 a first joint seminar booked in for May 2024, Nikhil Sarin from Nordita. We aim for at least one such seminar per semester. |

# 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 | | | |
| Program: | Theoretical Astrophysics | | | |
| Title: | AI4Physics | | | |
| 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 all physics research through increased AI literacy, method development, and applications. |

### 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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| Artificial intelligence (AI) has led to an imminent paradigm shift in astrophysics. New machine learning (ML) methods are already used to reform massive data analysis of observations, especially in large surveys e.g in 4MOST where 10’s of thousands of stellar spectra will be observed, classified and analyzed, every night.  This initiative, already formulated internally a year ago, will dramatically increase AI use and literacy throughout the department, in all fields. As physicists we have the math and programming background to both be agile users and drivers of the field, and data that needs advanced analysis. Expected research improvement spans from a natural integration of AI/ML methods throughout our research in fields where it is not yet prominent to development of physics-inspired AI methods, including exact science, interpretable AI with error estimations, and quantum mechanical applications. |

### 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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| As a large department with research spanning from theory to large-scale experiments, we have varied needs. Still we have collegially identified four key components of our AI4Physics initiative: A) Faculty AI courses: 1 course/year for education of faculty members. Progression from intro/basic to more advanced topics. With internal and external teachers. Possible mentoring program. B) Seminar activity with international speakers/visitors (incl industry) for exposure to state-of-the-art use of AI in physics. C) AI-focused postdocs (PDs) to drive new research projects using AI. Tied to identified needs within each of the dept’s 3 units. PDs form their own group, with critical mass, but are distributed across dept and will help with A) and B). If needs are identified and long-term FFF funding already exists, recruitment can also be at the permanent research engineer or faculty level with explicit AI focus. D) Incorporation of AI within both the department’s teaching and outreach (collaboration). Collaboration will be aimed toward industry, including possibilities of industry PhD students. Primarily funded through other channels, ie TUFF projects. |

### 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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| The need for an AI initiative within IFA was identified as a key future priority by all three units already in Spring 2023 within our dept-wide strategy process. IFA has had the most AI4Research fellows beyond IT showing high level of already active AI users. Also several grants, e.g from WASP and as key parts of VR and ERC projects already incorporate AI/ML methods. This initiative will broaden this success to the whole department. Physicists have generally all the necessary background to be agile AI users: math, programming, and data. They also make mathematical models based on fundamental principles, which can advance the AI field itself towards exact science and interpretable AI with error estimation. |

## 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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| AI4Research exists, but is only available for already AI users, while our majority faculty members do not yet actively use AI. Further, connections in dept already exists to the IT dept, CIM, and eSSENCE graduate school, but they all have complementary goals to this initiative. Our dept teaches the AI courses 1FA370, 1FA006. |

### 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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| Programs: Supervisors time for PDs, plus all other local support. Several faculty members do AI research already on external grants, which is important for a fast in-house building up of expertise. |

## 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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| AI is triggering a transformative change in how research and education is done in physics and astronomy. With this initiative the whole department will be in the forefront of this development and we can also pursue new opportunities for AI, explicitly in physics. |

### 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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| AI4Physics focuses on the need and opportunities of the whole Physics Section. It is highly complementary to AI4Research and national AI initiatives (WASP, DDLS) due to its dual focus on creating AI literacy and physics aspects of AI. Also, AI4Physics creates a common goal for a very large and diverse department. |

## 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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| Interest and time commitment from faculty members is strong as this is collegially identified top priority. |

### 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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| Dramatically increased AI use in all the Section’s research, necessary for future success both in established fields and for AI-developments in physics. Increased grant income throughout department, including excellence grants (VR,KAW, ERC) and through AI-initiatives, e.g. WISE-WASP. |

### 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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| A), B), and D) will be implemented during 2024-25 on dept resources. We are asking TekNat to help with half the cost to primarily fund C), which dramatically increase the impact. TAP already has activity in this direction in the 4MOST project with an eSSENCE PhD student. |

# 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 | | | |
| Program: | Theoretical Astrophysics | | | |
| Title: | Strengthening Stellar Astrophysics | | | |
| 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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| Strengthening activity in stellar astrophysics to secure future leadership in the field |

### 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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| As shown in Section 3, TAP has strong activity in the theoretical modelling of evolved and solar-like stars, especially their atmospheres, pulsations and winds, and observables. A core strength of our activity is physics-based modelling that goes beyond standard simplifying assumptions, such as hydrostatic and thermodynamic equilibrium and simple descriptions of microphysics, especially in 3D simulations of stars.  A crucial component of this work is expertise in computational 3D hydrodynamics and non-equilibrium radiative transfer. The program presently has a low level of base funding compared to other programs in the department, and this competence is to a large degree brought to TAP by non-tenured staff on external funding. To strengthen our activity to a level where we can have stable long-term leadership in this field, we need to have a broad base of faculty staff covering the key areas of this research. This will permit a focused long-term strategy in the physics of stellar atmospheres, independent of unpredictable external funding. |

### 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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| With the retirement of Bengt Edvardsson in June 2024, activities directed specifically at development of 1D local thermodynamical equilibrium model stellar atmospheres and the MARCS model atmosphere code – a hugely impactful long-term activity for which Uppsala Astronomy is widely known – will wind down to a lower level, and will be embedded in other projects. TAP will then have two faculty, professors Höfner and Barklem. Wallenberg fellow Nordlander will become Associate Professor during the coming 5 years. At present, Bernd Freytag provides crucial competence in 3D hydrodynamics and the CO5BOLD code. Freytag is non-tenured, and will reach retirement age 2029-2032.  To ensure that critical mass and breadth is attained, we propose to make an Associate Professor hiring at the forefront of stellar atmosphere and radiative transfer modelling, within the coming two years. This would allow the new faculty member to overlap significantly with current staff while building up new activity. |

### 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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| This activity has been successful in obtaining significant external grants during the evaluation period; an ERC Advanced Grant, two KAW projects, four VR projects, and three VR starting grants. During 2024 a Wallenberg Academy Fellow and KAW Scholar were obtained, both in this area of research. A number of important past results were given in 3.3.1.  All of the above indicates we have the competence within TAP to lead and carry out such an activity successfully and at internationally competitive level. |

## 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 field has synergy with observational activities in high-resolution stellar spectroscopy (VLT-CRIRES, ELT-ANDES) and surveys (Gaia, Gaia-ESO, 4MOST) with the observational program, but the theoretical activities are unique within UU. |

### 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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| Base financing (FFF) freed by the retirement of Bengt Edvardsson will be channeled towards this priority. In addition, studiestöd would be earmarked to partially support such a recruitment with a PhD student, though at present levels of studiestöd this requires additional support. |

## 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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| This allows for fundamental contributions to understanding the cosmic matter cycle, i.e. the origin of the chemical elements, a question intimately related to unravelling how galaxies and planetary systems are formed, and thus the conditions for life in the Universe, all major themes in modern astronomy. |

### 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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| Synergy with the observational astrophysics program through state-of-the-art models for interpreting data, connection to teaching in astronomy and computational physics, production of employable PhDs with modelling skills, and visibility of excellent research and researchers at UU such as Susanne Höfner. |

## 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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| Additional base funding (~0.5 FFF) is needed for long term-stability, critical mass, and an internationally competitive hiring. Though some FFF is freed by the retirement, historical decrease in value in real terms, and support requirements in the international marketplace motivates further resources. |

### 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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| One faculty hiring in the field, several completed and new PhD students who overlap in time, science and methods. Maintenance of current levels of external funding, including an additional ERC grant, ideally from a mid- to early- career researcher. |

### 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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| Concrete discussions regarding timing and directions for a possible faculty position, both within the program and in the division. Strengthening of the PhD student cohort in this activity will also take place via hiring of PhD students during spring next year. |

# 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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