KoF/ÖB 2024

Faculty of Science and Technology

Research Program Self-Evaluation

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| Research Program: | Space and Plasma Physics |
| Department: | Department of Physics and Astronomy |
| Section: | Physics |
| Program Responsible Professor: | Yuri Khotyaintsev |

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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

## Process for creating this self-evaluation

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| The staff in the program employed by UU, PhD students in space physics at UU or the Swedish Institute of Space Physics (Institutet för rymdfysik, IRF), and staff at IRF were involved. IRF is a governmental research institute employing 36 persons in Uppsala, including 24 scientists and 12 engineers. |

## Core of the research program

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| We focus on understanding plasma processes in space using in situ measurements. Our projects share engineering resources for design and operation of scientific instruments on solar system space missions. We improve understanding of near-Earth space, the rest of the solar system, the rest of the visible universe. |

## Personnel (data provided centrally)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Faculty FTEs** | | | | **Non-Faculty FTEs** | | | | | |
|  | **Professor** | **Associate (UL)** | **Assistant (BUL)** | **Total** | **PhD** | **Postdoc** | **Researcher** | **Other**  **Research** | **Other** | **Total** |
| **Female** |  | 0.3 |  | 0.3 |  |  |  |  |  |  |
| **Male** |  |  |  |  | 1.0 |  |  |  |  | 1.0 |

## Finances

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **FFF+SFO Internal Research** | **Other Internal Research** | **Total Internal Research** | **External Research** | **Total Research** | **External Research %** |
| **2023** | 0.8 | 0.5 | 1.2 | - | 1.2 | 0% |
| **2022** | 0.7 | 0.3 | 1.0 | - | 1.0 | 0% |
| **Average** | 0.8 | 0.4 | 1.1 | - | 1.1 | 0% |

### Other internal research funding

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| Most of the PhD students are employed by IRF and are not included in the table above. PhD students are employed by IRF or UU, and are all affiliated with UU. Some students are employed by IRF, but with shared funding from UU and IRF. This has turned out to be an efficient way to join financial resources. |

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

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| UU funding is used for (part of) one senior (UL) scientist, one PhD student employed by UU, and two PhD students employed by IRF and jointly financed by UU and IRF. This model encourages cooperation and joint projects between UU and IRF. This is also a flexible and efficient way to combine resources to be able to guarantee funding for PhD students. We note the activity of the UL is reported in a KoF report of another program. Most of the PhD students in the program are externally funded and employed by IRF. The Uppsala IRF funding of about 35 MSEK includes salaries for IRF scientists and engineers and instrument hardware, most of the salary costs for PhD students associated with UU, via external grants to IRF (VR, SNSA, SSF). |

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

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Faculty Salary | Non-Faculty Salary | Other Personnel Costs | Premises | Equipment Depreciation | Overhead | Running Costs | Total |
| 2023 | 0.2 (11%) | 0.5 (28%) | 0.6 (33%) | 0.1 (6%) | 0 (0%) | 0.4 (20%) | 0 (2%) | 1.8 |
| 2022 | 0.2 (12%) | 0.5 (30%) | 0.5 (28%) | 0.1 (5%) | 0 (0%) | 0.4 (20%) | 0.1 (4%) | 1.8 |
| Average | 0.2 (12%) | 0.5 (29%) | 0.6 (31%) | 0.1 (5%) | 0 (0%) | 0.4 (20%) | 0.1 (3%) | 1.8 |

### Personnel funding (data provided centrally)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Female | | | Male | | |
|  | Internal | External | Teaching | Internal | External | Teaching |
| Professor |  |  |  |  |  |  |
| Associate (UL) | 100% | 0% | 0% |  |  |  |
| Assistant (BUL) |  |  |  |  |  |  |
| PhD |  |  |  | 95% | 0% | 5% |
| Postdoc |  |  |  |  |  |  |
| Researcher |  |  |  |  |  |  |

### Major infrastructure usage

|  |  |  |  |
| --- | --- | --- | --- |
| Infrastructure | Sharing | Location | Approximate Yearly Cost (MSEK) |
| 4 ESA Cluster spacecraft, ESA providing platform and operations | international | Earth orbit | 1 MSEK |
| 4 NASA MMS spacecraft, NASA providing platform and operations | international | Earth orbit | 1 MSEK |
| ESA Solar Orbiter, ESA providing platform and operations | international | Orbiting the Sun | 0,5 MSEK |
| ESA JUICE, ESA providing platform and operations | international | Transit to Jupiter | 3 MSEK |
| ESA Swarm, ESA providing platform and operations | international | Earth orbit | 0,5 MSEK |

## Other important comments

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| Most of the activities in space and plasma physics at the Ångström laboratory are related to staff at IRF, funded by IRF or external funds to IRF. IRF benefits from cooperation with the astronomy division and UU, from PhD students associated with UU, and from teaching and other contacts with undergraduate students. |

# Follow up on goals set in the last evaluation

## Reflections on accomplishments and setting goals this time

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| Launch, commissioning and start of science operations of Solar Orbiter, completion and launch of JUICE, work on design of Comet interceptor. Continued operations of Cluster, MMS, Swarm. Archiving of Rosetta data. Participation in the ESA M7 processes, M-MATISSE (Mars) and Plasma Observatory (fundamental plasma physics) with major instrument contributions from IRF are among the 3 candidate missions. A number of impactful studies on kinetic plasma physics, including magnetic reconnection, shocks and dusty plasmas. Research on space weather including models and observations of coronal mass ejections, geomagnetically induced currents (Swedish power grid). H2020 SHARP project on collisionless shocks. |

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

## Main research areas

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| --- | --- | --- | --- | --- |
| Main Research Areas | | % of program | FTE Faculty | Type |
| 1 | Kinetic plasma processes, incl. turbulence, reconnections and shocks | 40 | 4,2 | basic |
| 2 | Planetary ionospheres, Mars, Saturn, Venus, Earth | 40 | 5,9 | basic |
| 3 | Cometary plasma physics | 15 | 1,8 | basic |
| 4 | Space weather | 5 | 1 | mixed |

## Research Activities

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| Our research in space science encompasses two primary avenues. The first centers on fundamental plasma physics in space and its associated phenomena, with a particular emphasis on investigating small-scale kinetic processes that hold significant implications for larger scales and higher energies. Notable examples include the examination of energy transfer and magnetic topology changes occurring within phenomena such as magnetic reconnection, shocks, turbulence, and dusty plasmas. These investigations are often conducted in environments characterized by minimal particle-particle collisions, thus highlighting the importance of electromagnetic interactions. This line of research relies on high-resolution observations from multi-spacecraft missions in Earth orbit and other spacecraft. These include Cluster (4 SC), Magnetospheric Multiscale (MMS, 4SC), Swarm (3 SC), and Solar Orbiter.  The second line of research focuses on the exploration of other solar system bodies, unexplored parameter regimes, and entirely new phenomena. This includes investigations into the environments of space bodies such as comet 67P, the moon Enceladus, and the rings of Saturn, where dusty plasmas are prevalent. This line of research depends on observations by interplanetary spacecraft, using high-tech, low-mass instruments. These include Cassini (Saturn), Rosetta (comet 67P), BepiColombo (Mercury), Mars Express (Mars) and MAVEN (Mars), and Solar Orbiter (Venus).  We commonly use computer simulations and findings from astrophysical, laboratory-based, and fusion plasma studies to enhance our understanding of the complex dynamics and phenomena observed in space.  We aim to better understand Space Weather and related effects on technology and society. Particular topics include propagation and evolution of coronal mass ejections (CMEs) in the inner heliosphere and the geomagnetically induced currents (GICs) and their effect on the power grid in Sweden. |

## Research Results

### Contributions to the field

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| We are one of the world leading groups in observations of kinetic plasma processes. We made important contributions to understanding of magnetic reconnection. We identified Cherenkov emission from electron-scale structures (Steinvall, PRL, 2019). We reported that Debye-scale turbulence affects electron heating (Khotyaintsev, PRL, 2020). We reported fast ion isotropization in reconnection jets (Richard, PRL, 2023). We found that plasma processes operate even at scales smaller than the electron gyroscale (Li, Nature Comms., 2020). We presented direct observations of anomalous resistivity and diffusion – major collisionless processes suggested theoretically in the 1950s (Graham, Nature Comms., 2022). We also made contributions to the field of collisionless shocks. We reported evidence of nonstationary (Dimmock, Science Adv., 2019) and reformation (Johlander, GRL, 2022). We developed a machine learning technique to classify plasma regions, and constructed a database of shock crossings by MMS (Lalti, JGR, 2022). We found that electron heating occurs at larger scales than previously thought (Johlander, GRL, 2023). |

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

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| --- | --- | --- |
|  | Type of Indicator | 2017-2022 |
| Number of publications, full publication set (full / fractional counts) | Quantity | 88 / 12 |
| Proportion of publication fractions at the Norwegian model level 2 (%) | Impact | 50% |
|  |  | 2017-2021 |
| Coverage (fractionalized): Proportion of publications from DiVA included in citation statistics, weighted by fractional counts | Coverage | 64% |
| Mean normalized number of citations per publication (MNCS) | Impact | 0.92 |
| Proportion of frequently cited publications (top 10%) (PP(top 10%)) | Impact | 9% |

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

|  |  |  |
| --- | --- | --- |
| Channel | Number | % of Total Publications |
| JOURNAL OF GEOPHYSICAL RESEARCH - SPACE PHYSICS | 18 | 20 |
| ASTRONOMY AND ASTROPHYSICS | 14 | 16 |
| PLASMA PHYSICS AND CONTROLLED FUSION | 9 | 10 |
| MONTHLY NOTICES OF THE ROYAL ASTRONOMICAL SOCIETY | 8 | 9 |
| GEOPHYSICAL RESEARCH LETTERS | 6 | 7 |
| ANNALES GEOPHYSICAE | 3 | 3 |
| PHYSICAL REVIEW B | 3 | 3 |
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### Most important publishing channels

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Channel | Number | % of Total Publications | Lead-author | Lead-author % of Total |
| JOURNAL OF GEOPHYSICAL RESEARCH - SPACE PHYSICS | 20 | 20 | 8 | 44 |
| ASTRONOMY AND ASTROPHYSICS | 16 | 16 | 7 | 50 |
| MONTHLY NOTICES OF THE ROYAL ASTRONOMICAL SOCIETY | 8 | 9 | 5 | 55 |
| GEOPHYSICAL RESEARCH LETTERS | 6 | 7 | 4 | 75 |
| PHYSICAL REVIEW LETTERS | 2 | 2 | 1 | 50 |
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### Publishing impact on the field

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| We note that the publication database contains only the publications by the program’s PhD students and some retired UU plasma scientists. IRF-Uppsala published 396 refereed publications between 2019 and 2023. The statistics including IRF looks rather similar. Overall, we most often publish in the most important space plasma publishing channels, JGR and GRL, with PRL for extra high-profile results and more specifically for planetary and cometary science A&A, MNRAS, AJ and PSJ. |

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

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| Former PAP and one of the senior scientists at IRF are members of the Royal Academy of Sciences (KVA). IRF early career scientist was awarded the Zeldovich Medal by COSPAR. IRF scientists are PIs on major international space missions currently in space (Cluster and JUICE). IRF scientists were one of the key proposers for the ESA M7 missions, which were recently selected for Phase-A study (Plasma Observatory and M-MATISSE). IRF scientists have been appointed by ESA to be on the science study teams for (Plasma Observatory and M-MATISSE). PAP is a PI of a successful KAW project (Extreme Plasma Flares). |

## Synergies within the research program

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| 1 | Type of synergy | Applying reconnection physics to study cometary plasma environment |
|  | Specific  collaboration | Plasma Density and Magnetic Field Fluctuations in the Ion Gyro-Frequency Range Near the Diamagnetic Cavity of Comet 67P |
| 2 | Type of synergy | Using Solar Orbiter to study planetary magnetospheres |
|  | Specific  collaboration | Solar Orbiter Data-Model Comparison in Venus' Induced Magnetotail |
| 3 | Type of synergy | Using instrument technology |
|  | Specific  collaboration | Using instrument technology developed for Comet Interceptor also to Mars (M-Matisse) and Earth (Plasma Observatory) missions |

## Synergies across research fields

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| --- | --- | --- |
| 1 | University and Field | Chalmers, KTH |
| Type of synergy | Synergy between simulations, fusion and magnetospheric plasma research |
| Specific  collaboration | KAW project: Extreme plasma flares |
| 2 | University and Field | Univ of Amsterdam, Ben Gurion University of the Negev, UCLA, Finnish Meteorological Inst. |
| Type of synergy | Synergy between theory, simulations, astro, planetary and magnetospheric observations |
| Specific  collaboration | EU H2020 SHARP project to study collisionless shocks |
| 3 | University and Field | École Polytechnique/LPP, Imperial College, Sorbonne/LESIA, Tohoku, Polish Acad. Sci./CBK, Czech Acad. Sci./IAP, Orléans/LPC2E, KTH, etc. |
| Type of synergy | Joint instrumentation consortium for exploration of the Jovian magnetosphere and the Galilean moons from 2031 (we are leading the consortium) |
| Specific  collaboration | The Radio and Plasma Wave Instrument (RPWI) of the Jupiter Icy Moons Explorer (Juice) |

### Reflections on synergies across research fields

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| Overall, space activities are very international, we in all our studies use data from international space projects (infrastructure), and almost always have international collaborators on our projects. On the program level we strive to identify similarities between the plasma processes in different plasma environments (planets, comets, solar wind). We often involve external simulation support to better interpret the observations. Overall, we try to expand the applicability of the in-situ based results to astro- and lab/fusion plasmas, where it is not possible to reach the level of detail provided by in situ observations. |

## Reflections on ensuring good research ethics

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| PhD students take an obligatory scientific ethics course. We commonly discuss research ethics issues at the group meetings. One very common example is the co-author policy when it comes to instruments and data provided on international space missions. |

## Reflections on creating and ensuring research freedom

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| PhD students typically have a freedom to suggest and define the research project at the later stage of the PhD. Scientists at IRF lead their own research projects and apply for funding. Challenges include the fact that the funding is likely to be granted in relation to the space projects with Swedish participation. |

## Reflections on research program size

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| The program at UU is very small, but this is complemented by 36 persons at IRF-Uppsala, including 24 scientists (professor, professor emeritus, 4 associate prof., scientists, and 5 PhD students) and 12 engineers (hardware and software). |

## Top external funding sources (data provided centrally)

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| --- | --- | --- | --- |
| Funding Agency | 2022 | Funding Agency | 2023 |
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## External funding sources

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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 |  |
| KAW Project | 1 |
| KAW Scholar |  |
| WAF/WAFx |  |
| VR Project | 1 |
| VR Starting |  |
| Other grants (may include field-specific grants and Co-PIs) | |
| SNSA | 10 |
| H2020 | 1 |
| SSF | 1 |
| MSB | 1 |
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## Reflections on external funding

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| In addition to the list above we obtained 4 grants from SNSA for 2-year postdocs which are below 3 MSEK. We also have a number of smaller running contracts with ESA for calibration and archiving of data from our instruments in space. External funding is very important for us, it covers ~80% of funding for PhD students, and 100% of funding for postdocs. Overall, we are rather successful in getting external funding, and having a significant increase in it would be difficult to digest without hiring more staff. Senior scientists are expected to apply for external funding (i.e. to have 1-2 running projects). PAP and other senior members support younger colleagues in writing applications (mentoring). |

## Reflections on what is working well

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| The team is rather successful in getting external funding, and the team members are rather enthusiastic to write applications. We will continue with sharing the available funding opportunities, and supporting each other with writing the application (incl. mentoring). |

## Reflections on what needs to be improved

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| We have not applied for any ERC grants. This is largely because the staff is already very busy, and writing such big applications requires a significant effort. This shall be improved in the future. Also, a large part of the funding is coming from SNSA and is connected to current active space projects with Swedish hardware contribution. After a project is finished, some staff members who were largely invested in that project end up in a certain vacuum. We will need to address this by planning for such situations, and making sure alternative funding sources and scientific directions are available before the situation occurs. |

# Area 2: Career Paths (evaluation of processes)

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

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| There is a close and well-established cooperation between UU and IRF. In this section UU program staff and IRF are discussed together. To keep multiple high profile international hardware projects running, we must keep a minimum critical mass of staff, with some margin so that loss of individual key persons does not interrupt ongoing missions. This has been successful. However, new recruitments at senior level (UL, professor) have not been possible for many years. An obvious way to broaden the research in space and plasma physics, and to increase cooperation with both observational and theoretical astrophysics, is to employ a senior scientist (UL) in plasma astrophysics. |

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

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| The previous FUAP and PAP in space and plasma physics was employed by IRF but acted also on behalf of UU. When he retired, a new FUAP and PAP was needed. An updated agreement between UU and IRF was signed 2022. This includes the possibility that professors at IRF can act as FUAP and PAP at UU. The procedure to be recruited as professor, or promoted to professor, when employed by IRF is very similar to the procedure at UU. A professor from UU is part of the formal process. After discussions between the DG of IRF and the head of IFA at UU, an agreement was signed that the new FUAP and PAP (a professor employed at IRF) can be employed part-time (10%) at UU, and hence can act within both UU and IRF. |

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

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| We have not had funding to recruit any UU staff during the evaluation period.    Should we get the opportunity to search for an UL in astro-plasma physics, we will:  Advertise widely, on an international level, and encourage known good possible candidates to apply.  When we advertise, we will clearly define what expertise and experience we expect, in a reasonably defined area of science. The new person is supposed to interact with present staff, not to define his/her own isolated research. |

## Career support

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

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| The PhD students are all associated with UU. All students early on become parts of international teams, often around multiple sets of observations from multiple instruments. To be first author of a scientific paper, they also become (under supervision) team leaders. One clear possible career path for students that are Swedish citizens is to go to the Swedish Defense Research Agency (FOI). FOI has recently asked for a list of graduated students and seems to be actively searching for new doctors from our program. In addition to overall high quality, it seems that experience with complex and highly underdetermined problems, which still needs to be solved at least approximately within reasonable time, is valued very highly. |

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

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| All senior scientists are encouraged to apply for their own funding for various types of projects. This ranges from funding for own research (if UU employed), funding for PhD students or post-doc on well-defined projects, to archiving of already obtained data sets and also leading complete scientific spacecraft missions on ESA level. Applications are discussed before submission. We have noted that the open discussion concerning applications, also when competing for the same funding from the same agency, has been very surprising to visiting international scientists. We have found this spirit of openness valuable and fruitful.  Scientists at IRF can become docent at UU. This is actively supported by IRF. |

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

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| Similar to 4.3.2.  On this level, in particular input to major hardware missions is encouraged.    Also, pedagogical training, supervision courses, leadership courses. |

## Reflections on what is working well

|  |
| --- |
| The overall goal to design and operate scientific instruments on spacecraft, and to use observations to build models of processes in space, is working well and should be continued.  The IRF institute format has a clear advantage that significant funding and staff resources can be used for long term (tens of years) projects. Scientific results from some projects typically overlap with development of coming projects.  The co-location of IRF with UU gives excellent opportunities for IRF staff to interact with students and for UU students to use unique data sets together with experienced supervisors. |

## Reflections on what needs to be improved

|  |
| --- |
| Cooperation between UU and IRF could be intensified.    IRF experience from space plasma physics (obtained in situ in the planetary system) can be broadened and applied to plasma astrophysics (in a much wider context). Since all involved teams are already very busy with ongoing complex projects, the reasonable way to start this is to employ a dedicated senior scientist (UL). (See also 4.1)    IRF can to some extent be more involved in teaching at UU. The course Space Mission Design, now on hold, will start again in fall 2024. At least guest lectures in other courses should increase. This is a way to increase interest not only in space physics and astronomy, but in natural science. This is also a way to give young scientists experience in undergraduate teaching, which can be good for their future career. |

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

## Specific collaboration and outreach examples

|  |  |  |
| --- | --- | --- |
| 1 | Example and connection | Presentation about space research at “Astronomy Day and Night” at Technical Museum, SciFest Uppsala |
| Value to the program | Interaction with general public, getting broader perspective on our research |
| Value to the partner | Getting insight into world-leading space research produced in Sweden |
| 2 | Example and connection | Collaboration on space weather with the Swedish Defence Research Agency (FOI) |
| Value to the program | Getting access to the models developed by FOI |
| Value to the partner | Getting access to the experts in the field of space weather |
| 3 | Example and connection | Collaboration on probe coating for the JUICE mission with Linköping University |
| Value to the program | Getting access to experts in material deposition |
| Value to the partner | Extending their portfolio to space applications |

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

|  |
| --- |
| Space research is generally very interesting to the general public and media and we use all opportunities to give public lectures, be on TV and radio. We encourage our research and PhD students to participate in outreach activities. Near-Earth space environment concerns several governmental agencies apart from IRF, such as Swedish Civil Contingencies Agency (MSB), FOI. We had a research project on space weather funded by MSB and have continued interaction since then. FOI employs a number of program’s former PhD students, so they are well aware of the expertise available and happily use it. |

## Support for outreach and collaboration

|  |
| --- |
| We have a small group dedicated to outreach, which coordinates most of the outreach activities. PhD students are encouraged to participate, and they are indeed very active. For the collaboration we have a natural interaction point with the external actors when it comes to building instruments, as there are many aspects which can only be done externally. |

## Reflections on what is working well

|  |
| --- |
| The outreach activities are popular among our researchers and PhD students. There is usually a good turnout to such activity and a lot of enthusiasm. We will support and maintain this positive spirit in the future.  We see constantly increasing interest in space weather from different actors. We are very interested in the practical application of our research and will provide the necessary scientific expertise. We expect this will lead to increased funding of space weather research.  The design and manufacturing of space instruments at IRF involves industrial partners at different scales. This will continue in the future. |

## Reflections on what needs to be improved

|  |
| --- |
| We need to increase our presence on social media (YouTube, Instagram, X, Facebook). Also, it would be good for several key people to get training in outreach. Furthermore, the IRF outreach activities would benefit from more resources specifically aimed at outreach. IRF and this program’s research has often not been fully visible at the University level, for example when discussions arise surrounding public-facing displays and materials in the Ångström laboratory. IRF is a significant contributor to physics at Ångström and increased visibility would be beneficial also for UU students. For example, we have a large-scale model of the JUICE spacecraft (~3m diameter) that could be moved to a more public location.  IRF-UU cooperation sometimes also meets strange administrative obstacles on the UU side. For example, despite all PhD students employed by IRF Uppsala are associated with UU, limitations in the UU IT systems have for several years made it impossible to advertise such positions on the UU web pages. This decreases visibility to UU students, to detrimental effect on them as well as on IRF recruitment. |

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

## Main teaching areas

|  |  |  |  |
| --- | --- | --- | --- |
| Teaching program, course package, or contract/continuing education | Level | Courses Taught | Managed |
| Physics | Master | Space Physics, Electromagnetic field theory, Physics of Planetary Systems |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

## Infrastructure use in teaching

|  |  |  |  |
| --- | --- | --- | --- |
| Infrastructure | Courses | Level | Students |
| In-situ spacecraft data from Solar Orbiter, DSCOVR, Rosetta, etc. | Space Physics, Physics of Planetary Systems | Master | 10-15 |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

## Specific teaching/research connections

|  |  |  |
| --- | --- | --- |
| 1 | Example | Analysis of most recent (~days to weeks) of space weather observations and simulations from Earth-orbiting satellites and forecasting software |
| Course Info | Space Physics 1FA255, Advanced Level, 10-15 students, Program: TFY2M, ASTR |
| Value to teaching/ research | Students get experience in analysis of real-time space weather, using data from missions such as Solar Orbiter, DSCOVR, and more, searching for Earth-impacting structures and relating these observations to forecasts and eventual impacts to Earth systems (such as, auroral observations) |
| 2 | Example | In a lecture covering comets and their properties students are shown close-up images of comet 67P/Churyumov-Gerasimenko as well as data from in situ measurements from instruments onboard Rosetta. |
| Course Info | Physics of Planetary Systems 1FA226, 10 hp, Advanced level, 10-15 students. Program: ASTR |
| Value to teaching/ research | Incorporating recent data in the teaching, along with phrasing such as ”when we first saw this we were surprised because…”, may help students to realize e.g., i) that the plasma environment around comets remains an active area of research, ii) that IRF contributes to that research, and iii) that there may be opportunities for themselves to delve into data available. It has happened several times that students from the course later on have done project works at IRF focusing on cometary science. |
| 3 | Example |  |
| Course Info |  |
| Value to teaching/ research |  |
| 4 | Example |  |
| Course Info |  |
| Value to teaching/ research |  |

### Reflections on overall aims and strategies for connections

|  |
| --- |
| To briefly present parts of our own research to students from time to time helps to not forget about ”the bigger picture” and reminds us to reflect about how one's own research fits into it. |

## Support for integrating teaching and research

|  |
| --- |
| We use state of the art research data in teaching when possible. Giving guest lectures on current hot research topics, e.g. space weather. |

## Reflections on what is working well

|  |
| --- |
| We are teaching specific space-plasma related courses in Space Physics and Physics of Planetary Systems, where we use our specific competence, and use state of the art data from the current space missions (infrastructure). We also are teaching one general physics course (Electromagnetic Field Theory), which has a very close connection to the research of the program. As part of the course, we often try to have a guest lecture on space related topics. Also, we often give a guest lecture in the lower-level Electromagnetism course. In addition, we contribute to the Space Resources course taught at the Geocentrum. Overall, this gives good exposure of the students to space research, and gives a possibility to recruit students for various degree projects (master, etc). |

## Reflections on what needs to be improved

|  |
| --- |
| have a course on Space Mission Design which was put on hold for several years. This course needs to be resumed and new teachers need to be involved.  We also need to provide a better integrated set of courses in and around space and plasma physics.  Several years ago, we had a course on Electronics in Extreme Environments, focusing on electronics design under extreme radiation, temperatures, etc. After the responsible teacher retired, the course has been moved to a different department, and now is discontinued as far as we know. We need to consider resuming the course, as here IRF has unique world-class expertise. |

# 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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Department: | Physics and Astronomy | | | |
| Program: | Space and Plasma Physics | | | |
| Title: | Planetary and cometary PhD | | | |
| Support: | May require department support: | [Yes] | May require faculty support: | [No] |

### Goal

|  |  |
| --- | --- |
| Strengthen planetary and cometary plasma research. |  |

### Expected meaningful research improvement

|  |
| --- |
| Swedish National Space Agency is the primary funding agency for space research and funded a vast majority of PhD positions in the program. However, the funding is often connected to active space missions with Swedish hardware contributions. We currently have a number of very successful space missions which have been completed (Cassini, Rosetta), and a number of missions for which the science data will become available in several years (for example BepiColombo in 2026, Comet Interceptor in 2030+, JUICE in 2032). This creates a natural gap in the funding and thus the continuity of research (as the PhD students are the primary drivers of it in the program). With this proposed activity we intend to bridge this gap. |

### Implementation plan

|  |
| --- |
| Hire a PhD funded by the program, or co-funded together with IRF. The research will be based on public data from already completed and currently active space missions and prepare for exploitation of the future data. In many cases data calibration and processing take substantial time, so there is more high-quality data available after mission completion, and therefore are greater possibilities to use a combination of high-quality data from different instruments.  Possible projects: re-analysis of ROSETTA (comet 67P), Cassini data (Saturn and its moons), combined reanalysis of MarsEXpress+MAVEN (Mars) data, further analysis of Solar Orbiter and Parker Solar Probe data from Venus, combined data-simulations project (any of the planes above).  How to select the project: Internal mini-proposals for possible projects. |

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

|  |
| --- |
| We had 6 PhD theses defended in planetary and cometary space physics in the last 10 years. All the supervisors are still in place. |

## Current status of the area at Uppsala University

|  |
| --- |
| We are the only group at UU doing planetary plasma research, so there is no overlap. |

### Current and planned contributions to support the initiative

|  |
| --- |
| IRF will provide co-funding (50%) for the PhD student, and will cover project related travel and computer costs. |

## Strategic value

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

|  |
| --- |
| Understanding our nearest space and possible origins of life on our planet is of great interest for society. We have conducted space experiments addressing unique space plasma environments (e.g. comet 67P). In most cases, new data will not be available any time soon (50+years), so the existing data must be exploited. |

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

|  |
| --- |
| There is active research on planets at IRF and exoplanets in the astrophysics programs. Also, there are master and PhD level courses on planetary physics. This project will strengthen the field. |

## Contributions needed for success

|  |
| --- |
| Fund a PhD student. Expertise is in place at IRF and several competent supervisors are available, spacecraft data is already available. |

### Success indicators

|  |
| --- |
| We propose 2 indicators: (1) a PhD thesis close to completion (in 5 years from today, April 2024), (2) external funding obtained for 1-2 new PhD positions in planetary and cometary research (e.g. for Bepi Colombo arriving to Mercury in 2026). |

### First steps that can be taken today

|  |
| --- |
| The first step is to identify a short list of possible projects which can be used as a base for the PhD project, and also can be used in applications for external funding in the coming years. |

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

## Description of the Priority

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Department: | Physics and Astronomy | | | |
| Program: | Space and Plasma Physics | | | |
| Title: | AI4Physics | | | |
| Support: | May require department support: | [Yes] | May require faculty support: | [Yes] |

### Goal

|  |  |
| --- | --- |
| Strengthen space physics research through increased AI literacy, method development, and applications. |  |

### Expected meaningful research improvement

|  |
| --- |
| Artificial intelligence (AI) has led to an imminent paradigm shift in physics. New machine learning (ML) methods are already used to reform massive data analysis for experiments at all energy scales. IRF have use AI in several pilot projects. IFA also has many scientists interested in the field. But the potential spans all of physics. This initiative, already formulated at IFA 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 for space physics spans from enabling statistical analysis of large space- and ground-based datasets to implementation of AI in space instruments for future space missions. For example, AI can be used to select of interesting events on-board the spacecraft using high-resolution data, so that the high-resolution data can be transmitted to the ground; this will allow to use the available bandwidth (typical bottleneck) in a more efficient way. |

### Implementation plan

|  |
| --- |
| We support the plan collegially by IFA which 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. 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. D) Incorporation of AI within both the department’s teaching and outreach (collaboration). |

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

|  |
| --- |
| 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. Physicists have generally all the necessary background to be agile AI users: math, programming, and data. In space physics, we have large data sets, which wait be analyzed with advanced methods. We already had a very successful application of AI to space data analysis, where we have trained a convolutional neural network classifier to predict plasma regions crossed by the Magnetospheric Multiscale Mission (MMS) on the dayside magnetosphere (Olshevky et al., 2021). This classification was used to compose an database of shocks events observed by MMS (Lalti et al., 2022). |

## Current status of the area at Uppsala University

|  |
| --- |
| AI4Research exists, but is only available for already AI users, while our majority faculty members do not yet actively use AI. Further, connections within the program already exists to the IT dept, computer science at KTH, but they all have complementary goals to this initiative. |

### Current and planned contributions to support the initiative

|  |
| --- |
| Supervisors time for PDs, plus all other local support. In particular, IRF will have available GPU-based computational resources. |

## Strategic value

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

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

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

|  |
| --- |
| 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. |

## Contributions needed for success

|  |
| --- |
| Interest and time commitment from the program members is strong as this is collegially identified top priority. |

### Success indicators

|  |
| --- |
| Dramatically increased AI use in all the program’s research, necessary for future success both in established fields and for AI-developments in space-based instrumentation. |

### First steps that can be taken today

|  |
| --- |
| A), B), and D) will be implemented during 2024-25 on the IFA level. At the program level we already plan several AI-related activities during 2024-25. We are procuring server equipped with several GPUs to be used for AI-related computations. We included AI-related projects in some of the funding applications in 2024. |

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

## Description of the Priority

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Department: | Physics and Astronomy | | | |
| Program: | Space and Plasma Physics | | | |
| Title: | URAC: Uppsala Rymd- och AstrofysikCentrum | | | |
| Support: | May require department support: | [Yes] | May require faculty support: | [Yes] |

### Goal

|  |  |
| --- | --- |
| Strengthen the connection between research on astrophysics and in-situ plasma research |  |

### Expected meaningful research improvement

|  |
| --- |
| IRF experience in space plasma physics (obtained in situ) can be broadened and applied to plasma astrophysics (in a much wider context). Since all involved teams are already very busy with ongoing complex projects, the reasonable way to start this is to employ a dedicated senior scientist (UL). (See also 4.1). New recruitments at senior level (UL, professor) have not been possible for many years. Younger scientists, usually after long international experience or recruited from other teams, have gradually successfully taken responsibility for science and hardware projects. In this environment it is hard to start a significantly different type of research. A way to broaden the research in space and plasma physics, and to increase cooperation with both observational and theoretical astrophysics, is to employ a senior scientist (UL) in plasma astrophysics. Subjects include the relevance of plasma effects for winds from red giant stars and the influence of stellar winds on magnetized and unmagnetized exoplanets (significance for the formation of life). A plan for the next 5 years is to extend ongoing space plasma physics beyond the planetary system. |

### Implementation plan

|  |
| --- |
| Draft a text used to advertise a UL in plasma astrophysics. The text should be open enough to attract good international candidates, but limited enough to assure that the successful candidate will have some connection to already ongoing research (see 10.1.4).  Start a master-level course in plasma astrophysics (can be done with present UU and IRF staff). This will increase already ongoing cooperation, and will attract more students.  When the UL is selected, submit joint proposals (staff from UU and IRF, led by UU) for specific projects, guided by the interests of the new UL. |

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

|  |
| --- |
| There is presently no scientist working full-time on plasma astrophysics, while there is significant interest and ongoing part-time projects. The basic mechanisms behind winds from AGB (Asymptotic Giant Branch) stars can be well understood from radiation pressure on dust grains. For red super-giants the situation is less clear, and plasma effects may well be essential for wind formation. UU and IRF has collaborated on the similarities between the rings of Saturn (observations by IRF instrument onboard Cassini) and accretion disks around young stars (UU). Observational astrophysics is making detailed observations of exoplanets. This can be compared with spacecraft observations of the solar wind interaction with planets in our solar system. |

## Current status of the area at Uppsala University

|  |
| --- |
| There is knowledge on astrophysics, space and plasma physics, including master level courses in space physics (given by IRF staff) and plasma physics (UU). There are significant teams, clearly successful in space physics and astrophysics. The missing part is a senior person initiating projects and coordinating efforts. |

### Current and planned contributions to support the initiative

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| --- |
| The program has limited financial resources and cannot support a new hire. The program can allocate resources for one PhD student. UU and IRF can jointly provide several data sets, from remote sensing and in situ spacecraft observations, and related scientific guidance. IRF can provide co-supervisors to PhD students. |

## Strategic value

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

|  |
| --- |
| Recent progress in observations makes it natural to join science disciplines that for a long time have been separated. Uppsala is in a very good position to join recent efforts in this direction, since we have all components needed already in place: in situ space observations, observational and theoretical astrophysics. |

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

|  |
| --- |
| Direct relevance of plasma effects for winds from red giant stars (essential to spread material needed for the formation of planets and life) and the influence of stellar winds on magnetized and unmagnetized exoplanets (and the possible significance for the formation of life). |

## Contributions needed for success

|  |
| --- |
| Funding is needed for one UL in plasma astrophysics. A PhD student can be funded by the program with present resources. Senior staff with knowledge in both plasma and astrophysics is already in place. Observations from both remote sensing and in situ spacecraft instruments are already in place. |

### Success indicators

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| --- |
| Three years after starting the new UL should have published four papers in the area of plasma astrophysics. A PhD student should have reached two years into graduate studies. A master course in plasma astrophysics should be led by the new UL. The new UL should have contributed to observation and funding proposals. |

### First steps that can be taken today

|  |
| --- |
| PAP and PhD student will attend workshop at ISSI (Bern) on Electron Astrophysics 2024.  Previous PAP will participate in a national workshop on stellar winds from evolved stars 2024.  Emphasize astrophysical applications in ongoing and proposed space plasma projects. |

# 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.

|  |
| --- |
| (approximately 600 characters)  Question 1:  Question 2:  Question 3: |