

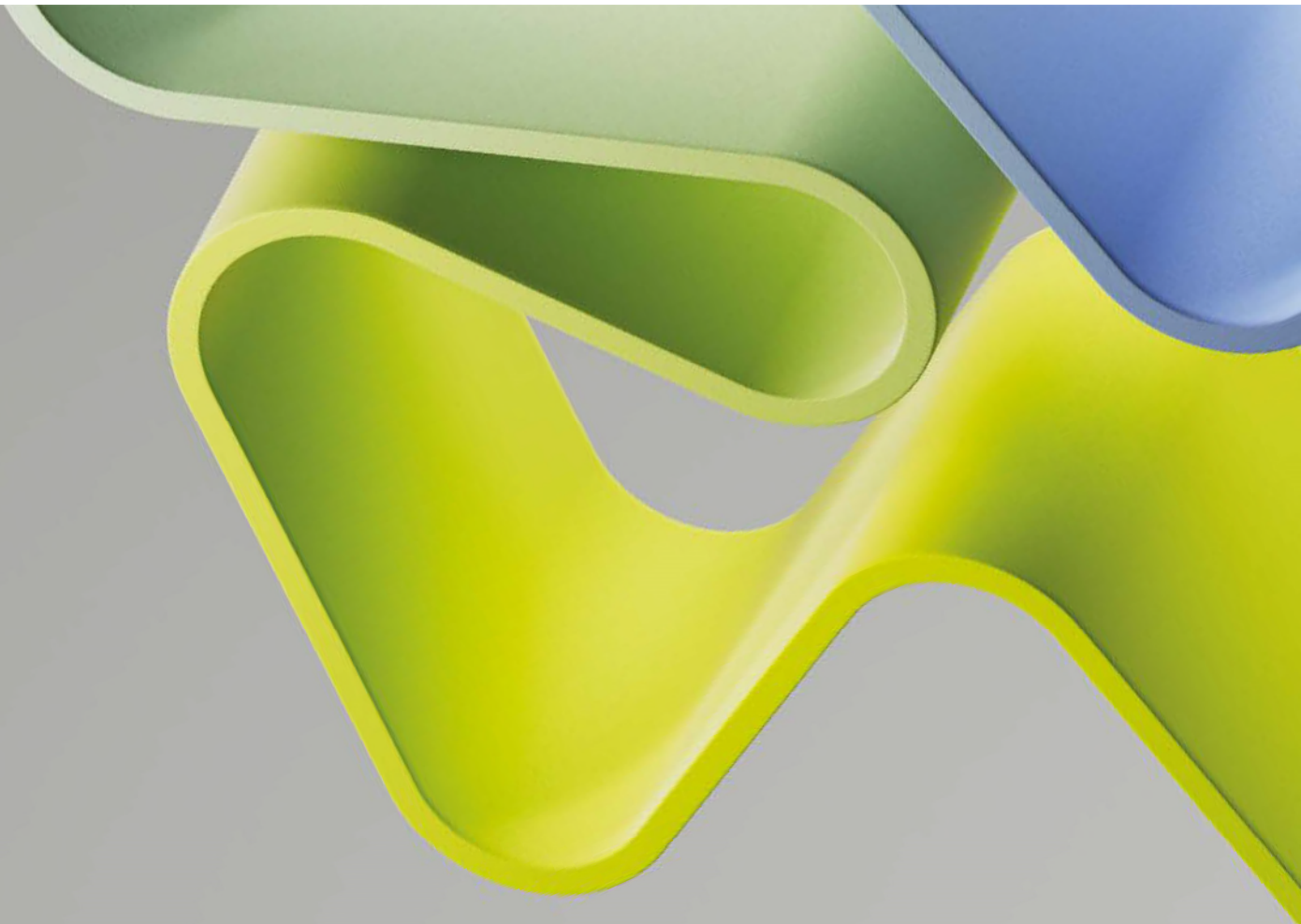
Evaluation of Natural Sciences 2022-2024

Evaluation report

Department of Theoretical Astrophysics

University of Oslo

January 2024



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Statement from Evaluation Committee I

The members of this Evaluation Committee have evaluated the following administrative units at the higher education institutions within natural sciences in 2022-2023 and submitted a report for each administrative unit:

- Geophysical Institute, University of Bergen
- Department of Earth Sciences, University of Bergen
- Department of Physics and Technology, University of Bergen
- Department of Chemistry, University of Bergen
- Department of Theoretical Astrophysics, University of Oslo
- Department of Geosciences, University of Oslo
- Department of Physics, University of Oslo
- Department of Chemistry, University of Oslo

The members of the Evaluation Committee are in collective agreement with the assessments, conclusions and recommendations presented in this report. None of the Evaluation Committee members has declared any conflict of interest.

The Evaluation Committee has consisted of the following members:

Prof. James Kirchner (chair)
ETH Zurich, Switzerland

Prof. Florencia Canelli
University of Zurich, Switzerland

Prof. Thors Hans Hansson
University of Stockholm, Sweden

Prof. Gideon Henderson
University of Oxford, United Kingdom

Prof. Isobel Hook
University of Lancaster, United Kingdom

Prof. Nicola Hüsing
University of Salzburg, Austria

Prof. Dieter Schinzer
University of Magdeburg, Germany

Description of the administrative unit

University of Oslo (UiO), Institute of Theoretical Astrophysics (ITA) is divided into two “Sections” corresponding to distinct research areas (Solar and Stellar Astrophysics – currently run as Rosseland Centre for Solar Physics (RoCS), and Cosmology and Extragalactic Astrophysics (CosmoExtra)). In 2021 ITA had 79 employees, out of which 13 were professors, 7 associate professors, 3 researchers, 15 postdoctoral and research fellows, 32 PhD research fellows and 9 senior engineers.

ITA aligns its work with the strategic goals outlined in "Strategy 2030: Astrophysics for Excellence." These goals include maintaining and enhancing ITA's status as an international leader in research related to solar and stellar physics, cosmology, and extragalactic astrophysics. The administrative unit states its aims as being to actively encourage new ideas and research opportunities through a bottom-up approach, aiming to attract and retain internationally renowned researchers while ensuring access to outstanding local and international research infrastructures. These objectives are closely tied to the Faculty of Mathematics and Natural Sciences' overarching goals, emphasizing long-term research excellence, international competitiveness, and the development of academic groups that lead in their respective fields. ITA's research is structured into two equal sections: Solar and Stellar Astrophysics and Cosmology and Extragalactic Astrophysics. Solar and Stellar Astrophysics focus on the solar atmosphere and interior, along with stellar astrophysics, while Cosmology and Extragalactic Astrophysics concentrate on analysing observations of the sky, fundamental cosmology, and the study of galaxy formation and evolution. Both sections rely heavily on data analysis and large-scale numerical simulations, with ITA's IT infrastructure supporting these efforts. Additionally, ITA actively collaborates on international projects and contributes to the design of future telescopes. The administrative unit strategically adjusted its academic positions over time, prioritizing cosmology and extragalactic astrophysics while maintaining a strong presence in solar physics.

The Institute primarily aims to contribute to humanity's general knowledge base, aligning with the sector-specific objective outlined in the draft Development Agreement between the University of Oslo and the Ministry of Education and Research for 2023-2026. Their main focus is to maintain and enhance their international leadership in research within solar and stellar physics, cosmology, and extragalactic astrophysics, aligning with UiO's aim of becoming a leading European university through long-term basic research. Their research addresses fundamental questions about the universe, the Sun, and planets, generating widespread interest, particularly among young people, and driving student engagement in the physical sciences. Moreover, they emphasize how their work in astronomy and astrophysics historically has yielded valuable basic science results with technological applications, offering students and early career scientists essential transferable skills, particularly in data and computational science.

ITA sees that their strengths lie in their commitment to long-term strategies, successful development of research in cosmology and extragalactic astrophysics and in solar and stellar astrophysics, recruitment of young researchers, and securing external funding. However, their heavy reliance on external funding makes them vulnerable to fluctuations. Their historic building enhances identity but limits growth. Uneven age and gender distributions among permanent faculty are challenges. Opportunities come from future ESA missions, international space collaborations, and projects like the European Solar Telescope and Atacama Large Aperture Submillimetre Telescope (AtLAST). Threats include inadequate space science funding, user fees for HPC resources, and limited access to international observatories for solar physics and cosmology research.

Overall assessment

The Evaluation Committee finds that the AU performs very well on all the evaluation criteria. The AU is the only major astrophysics group in Norway and is highly performing at an international level as evidenced (for example) by publications and the award of six ERC grants during the evaluation period. The Rosseland Centre for Solar Physics (RoCS) is a Centre of Excellence at the national level. The scope of research is overall well matched to the resources in funding and staffing. Although the AU's name indicates a focus in *theoretical* astrophysics, the AU also makes use of large amounts of *observational* data. The AU has a thought-through strategic plan and acted wisely to replace older activities with new fields of research, leaving the AU well poised for the future.

The Evaluation Committee notes that the AU has concerns regarding declining funding for space sciences. Future membership of ESO is a further strategic issue that should be discussed once the status of ESO involvement in AtLAST becomes clear. The Evaluation Committee considers that the decision-making processes of the AU and gender imbalance in publication productivity are two areas for the AU to pay attention to in the future. Nevertheless, the Evaluation Committee finds that the AU is relatively advanced in its approach to equality and diversity.

The Committee considered the points raised by the administrative unit in their Terms-of-Reference document and have commented on many of the issues raised in that document. Where no comments are provided, this generally reflects a lack of relevant information in the Self-Assessment to allow the Committee to reach a view.

Recommendations

1. Generally, the AU is operating at a very good/excellent level and should continue to update and follow its well-developed strategy.
2. At an organisational level, care should be taken to ensure that the full faculty is represented in the decision-making processes. The process for selecting staff for key leadership roles such as heads of the two scientific sections, and allocation of teaching should be made clear to staff. Guidelines on the appropriate channels of input into such decisions could be developed for future Heads of Institute to follow.
3. The CosmoExtra Research Group report recommends setting up an Outreach team. The Evaluation Committee agrees with this recommendation.
4. The Evaluation Committee recommends conducting a review of the advantages and disadvantages of pursuing ESO membership once the status of ESO participation in AtLAST is known.

1. Strategy, resources and organisation of research

The AU's strategy is clear and is being followed. This has enabled the AU to adapt and pursue new research directions. The AU is performing very well, particularly given its relatively small size. The organisation of research is very strong and was commended in the reports of both RoCS and CosmoExtra. However, as noted above, the Evaluation Committee has some recommendations regarding the decision-making processes of the AU.

The AU has been very successful in obtaining competitive research funding. At present, the AU has sufficient funding from UiO, the RCN and European sources. The AU is heavily reliant on external funding and is sensibly seeking funding through diverse routes.

The AU makes effective use of international collaborations and participates in selected, major projects at a high level. Arguments for and against Norway joining ESO are being considered by the AU. It is appropriate that the AU pays attention to this issue, given the significant impact that it would have on the administrative unit's activities in the future.

1.1 Research Strategy

Clear strategies exist both at the AU and faculty level, and these are well aligned with each other. The strategy of the AU, as described in the document "Strategy 2030: Astrophysics for Excellence", is detailed and ambitious. An important point is to make sure that the Roseland Centre for Solar Physics (RoCS) can be maintained even after the present centre of excellence is no longer financed. Another major goal is to obtain a Centre of Excellence in Cosmology and Extragalactic Astrophysics, which is the other major research area of the AU. The AU also list a number of possible new engagements in international collaborations via ESO, ESA etc. Since the AU is a heavy user of advanced computing facilities, another important strategic goal is to ensure sufficient computing capacity using both national and European infrastructure. The AU also has a detailed plan for achieving excellence in education and for having a societal impact not only from forming a knowledge base, but also by contributing specialized knowledge in instrumentation and data science.

The SWOT analysis is thorough and identifies the prospect of shrinking funds for space science, together with the introduction of user fees for national computing resources (Sigma2), as major threats. The AU rightly points out its ability to develop and reach strategic goals and mentions the closing of groups in plasma physics and celestial mechanics that allowed it to build a group in extragalactic astrophysics. It is precisely this kind development which is needed to keep an institute at the forefront of research. As a weakness is mentioned that Norway is not a member of any ground based observational facility. The research council should take this point very seriously (see also comments in section 1.4 of this report).

The Institute has a long history of collaboration with the Department of Physics at UiO. In 2020, a closer formal collaboration started, involving common funds to hire PhD students. They have applied jointly for RCN funding several times.

A call is expected in 2 years' time for new Centres of Excellence. A proposal will be developed for a new Centre of Excellence for the CosmoExtra area. The group is preparing for this, for example by seeking partners, and is aware of the need to demonstrate excellence (for example, by winning ERC grants). Discussions are also underway regarding a possible follow-on from the RoCS. The CoE funding rules prevent further renewal, so a new Centre would need to be proposed. The Evaluation Committee found this approach to be sensible given the present the circumstances.

1.2 Organisation of research

The organisation is well suited to conducting its research and innovation activities. A common theme between the two sections is the use of large amounts of data (both use ALMA and participate in future AtLAST project). Both the RoCS and CosmoExtra sections are operating at an excellent level. However, the Evaluation Committee notes that the CosmoExtra expert panel report warns against fragmentation, and suggests engaging in fewer, major projects/collaborations.

Administrative and technical support appears to be at a good level for the number of research/Academic staff (6-7 IT engineers for a group of 15 academics).

Formally, following UiO rules, the HI is responsible for budget and strategic decisions. Leaders of the two sections and head of Office (HO), who is HR responsible are appointed by the Head of the Institute (HI), and report directly to him/her. The head of studies, who is also appointed by the HI is responsible for education. According to both expert panels, the organisation of the research groups get the highest grades (rank 5).

As noted above, leaders of the two scientific sections and head of studies are appointed by the HI. Similarly, teaching duties are distributed by the head of education, seemingly without any fixed quantitative rules. It is not clear to the Evaluation Committee that such an informal system can ensure a fair treatment of the faculty. However, the Board, which has representation from staff and students, is involved in appointments, and informal input is sought to decisions such as appointment of heads of sections. There are other informal routes of communication within the institute, and the sections have their own communication channels. The Evaluation Committee felt that these could be made more uniform from section to section, and perhaps the processes for consultation on important decisions could be formulated as guidelines for future HIs to follow.

1.3 Research funding

The Evaluation Committee agrees with the two expert panels, that the AU is very successful in obtaining, and makes an excellent use of, competitive research funding. At present, the AU has a sufficient and sound funding from UiO, the RCN and European sources. Income from ERC is particularly impressive, with 6 awards in 9 years. However, as pointed out in the self-assessment the heavy dependence on external funding means that the institute is sensitive to changes in both national and European funding policies. An important issue is the future of the RoCS (see section 1.1).

The self-assessment shows very good awareness of the AU's role in the Norwegian (and international) research ecosystem as articulated in the SWOT analysis. The self-assessment expresses a clear concern about RCN funding for space science, and about introduction of fees for Sigma2 CPU-hours. The institute's approach is to apply for funding through as many routes as possible. The Evaluation Committee notes that an appropriate balance must be maintained at the National level between funding of subscriptions for major facilities and funding of their scientific use.

1.4 Use of infrastructures

The AU does not host any national or international infrastructure. The AU relies on Sigma2 for computing and on data from ESA (SOHO, Hinode, IRIS, Planck, and Euclid), and other international space and ground based observational facilities. This infrastructure is essential for the research in the AU.

One concern is that Norway is not a member of ESO or ALMA (major international observatories) but only the smaller Nordic Optical Telescope (NOT). ITA scientists compete for international telescope time on major facilities on a best effort bases, but with typically < 5% success rate. They participate in the MOONS instrument and obtain some VLT time through that route.

The AU considers that the potential for ESO membership is linked to the AtLAST project, which they lead. If ESO decides to enter and operate AtLAST, then Norway could negotiate membership of ESO. Otherwise, the AU felt that the case for joining ESO is less clear. Norway already has access to ALMA in international time and can gain Guaranteed Time on ESO telescopes by participating in individual instrument projects (as for MOONS above). The Evaluation Committee recommends a review of this issue when the status of ESO participation in AtLAST is known.

The Institute is one of the leading partners in the European Solar Telescope project and will apply for funds for continued participation.

Norway is a member of ESA, but participation in missions requires a contribution to the relevant ground segment or science collaboration. This is done through ESA's PRODEX programme, but national funding for that is under threat.

1.5 National and international collaboration

National collaboration is limited since there are no other major Astronomy and Astrophysics groups in Norway. This may change soon, as a new group at Norwegian University of Science and Technology has recently been formed. Since there is no major national infrastructure in the area of the AU, the national collaboration is limited to a newly initialized project on gravitational waves with the university of Stavanger.

International collaboration is much more important and significant for the AU. Of all the administrative units considered in the publication statistics provided, UiO-ITA has the highest fraction of papers involving international co-authors (92%), but the lowest fraction involving only national co-authors (1%), averaged over 2019-2022.

1.6 Research staff

The AU has 10 full and 5 associate professors, 5 adjunct professors on term contracts, 9 engineers, 15 postdocs and 32 PhD students. The number of staff has increased substantially during the last 10 years and is adequate for the research and teaching tasks of the AU.

The staff age profile shows a gap in the middle range of seniority. The age distribution of publication authors is tending slightly towards younger ages with time, and the distribution has flattened. This is encouraging as it shows that research output is no longer dominated by a group of senior staff members.

The fraction of women is low, particularly at the senior level. However, several women have been hired in the last years which is an encouraging trend.

In addition to the central UiO career programs for postdocs and PhD students, the AU design individual career development plans for all new postdocs during the first month of their tenure. The Evaluation Committee appreciate this measure to help and guide incoming young researchers. However, it was not clear from the documentation whether the initial plans are followed up with regular reviews.

The AU has a good system for sabbatical leave with a full term after 3 years or a full year after 6. The AU gives high priority to economically support sabbatical leaves abroad. Together this vouches for excellent possibilities for mobility for the faculty. No information is given about the possibility for PhD students to spend time at other institutes, but it is likely that they spend time at the various ground-based observational facilities.

2. Research production, quality and integrity

The expert panel reports assess quality of the solar and cosmology activities as 4/5 and 4/4 respectively. The RoCS is among the world-leading groups in simulating magnetic fields and transport in the lower part of the solar atmosphere. The work in the Cosmology and Extra Galactic astrophysics group on the early matter distribution in the Universe, alternative theories of gravitation and galaxy evolution is excellent, especially the Bayesian methods developed to analyse CMB data.

Publication statistics show a roughly average level of productivity in terms of author shares per FTE averaged over 2019-2022 of 0.99 for Men but a low rate of 0.68 for Women. This compares to national averages of 1.13(M) and 1.0 (W) - see section 3 on Diversity and Equality for comments on the gender difference. The overall impact of publications is very high, MNCS= 127, and a 12% share of the 10% most cited publications, ranking the administrative unit 4th/5th out of 20 administrative units under consideration in this evaluation.

From the bibliometric data provided we conclude that the quantity of research output is clearly acceptable, and that the number of publications has roughly doubled since 2012 which is consistent with the growth of the group. The data is too noisy to allow for any other conclusions about trends. The well cited papers are, as expected, from the large collaborations (8 or the 10 listed are from the Planck collaboration). It is good that an increasing number of papers have open access.

2.1 Research quality and integrity

The AU does not seem to have any specific strategy to ensure research integrity, except for referring to the document describing the UiO policy. Very likely, there are aspect of research integrity that are specific to large international collaborations, such as Planck, and these ought perhaps to be targeted more specifically. These collaborations are likely to have their own policies, and we assume these are followed.

Cosmology and Extragalactic Astrophysics (CosmoExtra) research group overall assessment

This is a strong research group, with considerable impact for its size. Its organisation is outstandingly well structured for its research aims and its research has an identifiable style that has generated very good research outputs within large international consortia. It trains good researchers and contributes well to the scientific and cultural environment in Oslo and the wider community.

Rosseland Centre for Solar Physics (RoCs) research group overall assessment

The Rosseland Centre for Solar Physics is an average size group that has a fruitful organisational environment that strongly supports younger researchers and provides excellent opportunities for career development. One of the research strengths of the group is the effective combination of analysis of data obtained with an array of world-leading observational facilities with numerical simulations of the lower part of the solar atmosphere. The group has excellent publication record. It is not clear whether the group seeks to make all software developed with public funds available as an open source. Following e.g., <https://www.met.no/en/free-meteorological-data/Open-source-code>, the group could improve its research impact by making all software developed with public funds available as open source. The group's contribution to economic, societal, and cultural development in Norway and internationally is very considerable given what is expected from groups in the same research field. However, the group's contribution to user-oriented publications, products (including open-source software etc.) is less clear.

2.2 Open Science

The AU shares data from both the solar and the cosmology observations in accordance with the FAIR principles. However, it is not clear to the Evaluation Committee if there is any control on the institute level that this is implemented. The AU does not have policies concerning ownership, management, and confidentiality of data beyond those of UiO centrally.

The expert panel report for RoCS mentioned a specific weakness in the contribution to user-oriented publications and products (software).

Regarding Open Access publishing, the Evaluation Committee notes that some of the AU's policies, as described in the self-assessment, sound a bit vague, e.g. staff should "do their best" to ensure articles are in repository "as soon as possible" (self-assessment p.18). It is unclear how these aspects are monitored and enforced if at all. Nevertheless, UiO-ITA has one of the very highest rates of OA among its publications – 99% are either Gold or Green open access in the period 2017-2021.

The Institute is the Norwegian sponsor for the journal A&A, which became Open Access in 2022.

3. Diversity and equality

There is an action plan document, with specific targets (good) but no target timeframes or method (i.e. actions) spelled out. However, specific actions are being carried out. For example, when hiring permanent faculty, a 7-point plan is used, which includes identifying and encouraging female candidates to apply and taking parental leave into account for publication activity. As well as gender diversity, the AU works on cultural diversity, and now have cultural diversity seminars every year. The AU includes people with diverse cultural backgrounds on selection committees, which helps in assessing candidate with similar backgrounds, and this has produced excellent results. The Evaluation Committee welcomed these initiatives.

Publication statistics show a large gender difference in productivity in terms of author shares per FTE averaged over 2019-2022: 0.99 for Men, 0.68 for Women. This compares to national averages of 1.13(M) and 1.0 (W) (although it should be noted that the AU reported that they had found several errors in the publication statistics initially provided).

The publication report points out that in general the difference between these metrics for Men and Women may reflect the relative seniority of the two groups (more senior people generally have higher productivity rate). This may be the case here, but the Evaluation Committee was not able to evaluate this from the staff breakdown provided in the self-assessment. On this issue, the AU noted the effect of small numbers: the first woman was hired in 2017, two more in 2018 and 2019. New staff members need time to get settled, and have teaching duties etc. While it is difficult to draw conclusions, the Evaluation Committee was pleased to see that the issue is being monitored by the AU.

As noted in the research staff section, the AU supports sabbaticals overseas and makes excellent use of RCN mobility options for postdocs and students.

Overall, the Evaluation Committee finds that the AU is relatively advanced in its approach to equality and diversity compared to other AUs under consideration in this review.

4. Relevance to institutional and sectorial purposes

The activities of the AU are aligned with UiO strategy to be a leading European University. Its groundbreaking research contributes to human knowledge, the main objective of the HE sector.

The AU also stresses the spin-offs from of the cutting-edge technology and computing that is necessary to do front-line research.

Except for a collaboration to publish an almanac, the AU is not involved in any commercial collaborations, and does not have any strategy in this area beyond what is provided by UiO centrally. The two impact cases are both about outreach programs. The University has policies and mechanisms to support commercialisation, should opportunities arise.

The AU collaborated in modelling the interaction of shock waves with buildings, following the 2011 Oslo terrorist bombing. The self-assessment presents an impressive list of national and international partnerships, mostly with government or higher education sectors (e.g. leading AtLAST and working with CalTech on a CO mapping project).

During the period 2011-2022, 37 PhDs were awarded, demonstrating a strong commitment to training of research students. These students make an essential contribution to the research of the AU. The AU is engaged in two master's programs, "Astronomy" and the "Astrophysics option of the Computational science program" at the faculty. This engagement is also based on the research in the AU. All master's students do a 60 ECTS research project which they can choose from a list produced by faculty and postdoc every autumn. 84 master's degrees were awarded from 2011-2022. In the BA courses given by the faculty the students get homework problems that involve or emulate real research, but the time is normally limited for these projects to give publishable results.

The self-assessment convincingly links its societal contributions to the UN Sustainable Development Goals.

5. Relevance to society

The AU rightly emphasises the importance of basic research for building a strong knowledge base in the Norwegian society. The AU points out that their strategy for building an excellent environment for research and education is fully in line with national goals, and they stress that astronomy and space research is of special interest to teenagers, and especially girls. Thus, the outreach activity of the AU is an important way to recruit to STEM studies.

The societal contribution is "average" according to CosmoExtra expert panel report (which in turn quotes the self-assessment). The Evaluation Committee notes that both the AU's impact cases are centred around public outreach related to the core research carried out at the AU. In fact, the AU's impact in society is wider, such as the modelling of the impact of shock waves on buildings.

Comments to impact case 1: From Solar physics research to public outreach

The case describes public engagement activities connected to the administrative unit's research in Solar physics. Engagement has taken place both within Norway and abroad. The activities are commendable.

One aspect of the case was rather confusingly presented. An example of National outreach is presented, where RoCS “followed up” 171 high school students who participated in the European Solar Telescope competition in 2021. In fact, the activity of the AU was more to prepare the students in advance of the competition rather than following their progress.

There are places where more quantitative impact could be given, e.g. download rates for Wikimedia content.

Comments to impact case 2: From cosmology and extragalactic research to public outreach

The case describes public engagement activities connected to the administrative unit’s research in cosmology and extragalactic astronomy. Overall, there is a good mix of outreach in schools (engaging both pupils and teachers) and the general public via talks, blogs, and social media. There is a focus on improving the gender balance in academia.

The case could be improved by providing more quantitative estimates of the number of attendees at events, number of engagements with posts on social media, etc. (a long list of activity is presented but this is not the same thing as evidence of impact).

List of administrative unit’s research groups

Institution	Administrative Unit	Research Groups
University of Oslo - Faculty of Mathematics and Natural Sciences	Department of Theoretical Astrophysics	Cosmology and Extragalactic Astrophysics
		Rosseland Centre for Solar Physics

Methods and limitations

Methods

The evaluation is based on documentary evidence and online interviews with the representatives of administrative unit.

The documentary inputs to the evaluation were:

- Evaluation Protocol (see appendix 3 Evaluation Protocol) that guided the process
- Terms of Reference
- Administrative unit's self-assessment report
- Administrative unit's impact cases
- Administrative unit's research groups evaluation reports
- Bibliometric data
- Personnel and funding data
- Data from Norwegian student and teacher surveys

After the documentary review, the Committee held a meeting and discussed an initial assessment against the assessment criteria and defined questions for the interview with the administrative unit. The Committee shared the interview questions with the administrative unit two weeks before the interview.

Following the documentary review, the Committee interviewed the administrative unit in an hour-long virtual meeting to fact-check the Committee's understanding and refine perceptions. The administrative unit presented answers to the Committee's questions and addressed other follow-up questions.

After the online interview, the Committee attended the final meeting to review the initial assessment in light of the interview and make any final adjustments.

A one-page summary of the administrative unit was developed based on the information from the self-assessment, the research group assessment, and the interview. The administrative unit had the opportunity to fact-check this summary. The administrative unit approved the summary virtually without adjustments.

Limitations

The Committee judged the information received through documentary inputs and the interview with the administrative unit generally sufficient to complete the evaluation.

Appendices (link to website)

1. Description of the evaluation of EVALNAT
2. Invitation to the evaluation including address list
3. Evaluation protocol
4. Self-assessment administrative units
5. Grading scale for research groups

Website: <https://www.forskningsradet.no/tall-analyse/evalueringer/fag-tema/naturvitenskap/>

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