Evaluation of Mathematics, ICT and Technology (EVALMIT) 2023-2024

Self-assessment for research groups

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Institution (name and short name): University of Stavanger, UiS
Administrative unit (name and short name): Department of Mathematics and Physics, IMF
Research group (name and short name): Geometry and Analysis, GeoAna
Date: Jan. 31, 2024
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Content

1. Organisation and strategy

1.1 Research group´s organisation

Describe the establishment and the development of the research group, including its leadership (e.g. centralised or distributed etc.), researcher roles (e.g. technical staff, PhD, post docs, junior positions, senior positions or other researcher positions), the group's role in researcher training, mobility and how research is organised (e.g. core funding organisation versus project based organisation etc.).

The group is part of the Department of mathematics and Physics (IMF, the administrative unit) at the University of Stavanger (UiS). Researchers at UiS have been working on various aspects of pure and applied mathematics for a long time. The group in **Geometry and Analysis** has crystallised in later years, as the department has grown and internal interactions increased, spurred on by efforts of the University through collaborative grants such as the ISP grant (see below). There are four subgroups within the group:

1. **Algebraic Geometry:** Arguably the second most influential algebraic geometry group in Norway (after UiO). The permanent group members consist of Professors **Martin Gulbrandsen**, **Helge Ruddat**, and Associate Professor **David Ploog**. The members of the group have successful collaborations with international researchers of the highest calibre, as evidenced by their strong research profiles, and several strong national and international grants awarded (see below).

2. **Differential Equations:** Headed by Professor **Steinar Evje**, arguably one of Noway's best researchers within his subfield. The group focuses on mathematical models that are used to gain insight into mechanisms within transport and reaction processes. Professor Evje has several leading research articles and has been a member of many significant research projects, also tied to industry (see below).

3. **Complex Geometry and Analysis:** The permanent members of the group are Professors **Alexander Rashkovskii**, **Alexander Ulanovskii**, and Associate Professor **Tyson Ritter**. They produce high quality research in areas of harmonic analysis, sampling problems, several complex variables, and complex geometry. The group forms an active component of Norway's mathematical analysis network, as evidenced by recent conferences held at UiS in the field, in addition to National grants awarded towards this effort (see below).

4. **Mathematical Physics:** Headed by Professor **Sigbjørn Hervik**, who is arguably Norway's leading researcher within the field of mathematical Relativity, along with Associate Professors **Paul de Medeiros** and **Eirik Eik Svanes**, who's works focuses on geometry, particularly as it relates to supersymmetry and string theory. The group boasts several strong collaborations with other Norwegian institutes, such as the geometry group in Tromsø, and the Topology group at NTNU, in addition to impressive international collaborations, as evidenced by grants awarded (see below).

All staff members are permanent and core funded. Each senior member has their self-determined independent research agenda, supported by national and international research project grants in, addition to PhD students supplemented by the University. All group members are highly active in international collaborations. The group's organization follows a consensus-based decision process rather than relying on a designated leader. At any given time, there are usually a small number of PhD students and postdocs associated with faculty members of the group, where most of the faculty have or is supervising a student. The students enjoy great mobility opportunities and international research relations.

Concerted work is performed by committees of volunteers and initiators with contribution collection from all group members. All faculty members have teaching duties, which does not exceed time spent on research. PhD students and postdocs also take on voluntary teaching roles.

More details like CVs of group members and relevant strategy documents can be found at:
https://www.uis.no/en/about-uis/department-of-mathematics-and-physics/EVALMIT
User: tn-imf@uis.no Password: evalmit

Table 1. List of number of personnel by categories
Instructions: Please provide number of your personnel by categories. Please add new lines or delete lines which are not in use. For institutions in the higher education sector, please use the categories used in DBH, https://dbh.hkdir.no/datainnhold/kodeverk/stillingskoder.

	Position by category	No. of researcher per category	Share of women per category (%)	No. of researchers who are part of multiple (other) research groups at the admin unit	No. of temporary positions
No. of Personnel by position	Professor (1013)	6	0%	0	0
	Associate Professor (1011)	4	0%	0	0
	PhD Student (1017)	5	20%		
No. of **former** Personnel by position	Professor (1013)	0	0%	0	0
	Associate Professor (1011)	3	0%	0	0
	PhD Student (1017)	9	0%		
	Postdoc (1352)	4	0%		

1.2 Research group´s strategy

a) Describe the research group's main goals, objectives, and strategies to obtain these (e.g. funding, plans for recruitment, internationalisation etc. within the period 2022-2032.

The group has identified specific strategic goals, which align with and contribute to the realisation of institutional strategy at departmental, faculty and university level.

The group's primary strategic goal is to maintain and expand the level of scientific activity and excellence while gaining national and international attention and appreciation for what has already been achieved over the last decade. The mathematical physics subgroup is arguably the strongest in Norway, the algebraic geometry subgroup is one of two such groups in Norway (also Oslo) and the complex analysis subgroup is one of four such groups (also Oslo, Trondheim and Bergen). The objectives are:

- Maintaining a good volume of output of strong internationally recognized research, based on core funding and allocated research time from UiS.
- Obtaining further external funding, both by applying on our own, and by partnering with other applicants, nationally and internationally.
- Grow the group with more permanent members in the long term.
- Further strengthen and widen external and internal cooperation, both with methodology-oriented groups and individuals, and by providing statistical expertise to both internal and external research projects in other fields.

In education, the group's main goal is to contribute to excellent research-based education in mathematics at Ph.D., Master and Bachelor level, and at foundational level within the faculty'a wider education portfolio.

The departmental strategy most recently realigned in 2022:
www.uis.no/sites/default/files/2024-01/221127-Strategy%20IMF.pdf

b) Please describe the benchmark of the research group. The benchmark for the research group should be written by the administrative unit in collaboration with the research group. The benchmark can be a reference to an academic level of performance (national or international) or to the group's contributions to other institutional or sectoral purposes.

Example: A benchmark for a research group is related to the research groups' aim which again is included in the strategy for the administrative unit. A guidance for the administrative unit to set a benchmark for the research group(s) can e.g. be: What do the administrative unit expect from the research group(s)?

The benchmarks set for the Research Group follow from the Department strategy document. We indicate for each strategy point the subsections addressing the relevant activities of the group:

Department goal:

* The Department of Mathematics and Physics will produce outstanding research and research-based education in mathematics and physics, thereby providing the workforce of the future with both broad and specialized knowledge and skills in the natural sciences.

Overall strategy:

* The department will provide a strong academic environment for excellent research in mathematics and physics at the Faculty of Science and Technology (FacST), that is attractive to students and researchers nationally and internationally, and contributes to an overall strengthening of the faculty.

Strategy in Research:

* Conduct research to high international standards which is published in highly-ranked international journals, creating national and international visibility and recognition.

* Strengthen and consolidate the existing academic groups.

* Conduct research that supports the strategic goals of the FacST and the University of Stavanger (UiS), and contributes foundational skills and knowledge that drives and informs the research activities at the other departments at the faculty.

* Continue to attract prestigious international conferences to the department and increase the number of international and national workshops.

Strategy in Researcher training:

* Offer high-quality Ph.D. education in mathematics and physics, with at least 15 active doctoral students with an average of four dissertations per year (over the entire Department).

Further information may be found in the referenced Strategy documents above.

c) Describe the research group contribution to education (master's degree and/or PhD).

As of 2022, the 23.2 permanent staff positions at the Department of Mathematics and Physics are assigned to 43 lectured course units (10 ECTS or 5 ECTS) each year and supervision of 20-30 theses (at bachelor and master level). The remaining work time is allocated to research and administration, including Ph.D. courses and supervision.

The educational activities of the group include:

* Provision of geometry and analysis courses at bachelor, master, and PhD level in the following study programs at the department: 1-year program in Mathematics, 5-year master's in teacher training for secondary education, 5-year master's in mathematics and physics, and a PhD specialization.

* Provision of basic calculus courses for the engineering students, and courses in algebra, geometry and analysis to all the engineering and natural science bachelor's degree programs, and a majority of the master programs at the faculty.

* In addition to teaching all algebra, geometry and analysis courses at Faculty of Science and Technology, the group also contributes towards the pre-engineering mathematics courses.

* The group contributes substantially to the supervision of students on all levels (Bachelor, Master, and PhD).

* Group member Tyson Ritter is one of only a handful of UiS staff who is a "merited lecturer". Sigbjørn Hervik received the Olav Thon Foundation national prize for teaching excellence in higher education in 2022.

Averaged over the department, teaching, research, and administration counts for approximately 40%, 40% and 20% of the total allocated time. However, the geometry and analysis group has a particularly high teaching load with only 10 ECTS courses, multiple courses with many students (2 with around 350-600 students, 3 with around 100-150) and high lecturer workloads due to very student-active teaching methods and non-standard evaluation methods. The permanent group members are doing the entire pipeline, course planning, lecturing, and running exercise classes and grading exams and assignments – in some courses with some assistance from student assistants or PhD students.

d) Describe the support the host institution provides to the research group (i.e., research infrastructure, access to databases, administrative support etc.).

The host institution provides support and funding for:

- Positions, including some PhD positions.
- Resources for travel.
- Access to medium scale (faculty-level) high-performance computing facilities.
- Access to library services, including direct access to the most important journals.
- Proprietary software when needed.
- Administrative support in grant application development.

Very little additional support is sought or needed due to the theoretical nature of the research.

1.3 Relevance to the institutions

Describe the role of the research group within the organisation. Consider the group's contribution towards the institutional strategies and objectives and relate the group`s benchmark to these.

The group is very well integrated into the activities at the Faculty of Science and Technology, both in terms of teaching and research. As described in point 1.2c the group provides mathematics courses across the faculty's degree portfolio, particularly basic calculus and other courses for the engineering students. The group spans over two departments at the Faculty of Science and Technology.

The research and dissemination activity of the group (research output, publications, competitive grants, public dissemination) contributes to:

* the Faculty strategy of promoting "Outstanding research and education".

* the University strategy of promoting and providing lifelong learning through the teaching activities described in §1.2c.

* the Department strategy through the Benchmarks described in 1.2.

1.4 Research group´s resources

Describe the funding portfolio of the research group the last five years (2018-2022).

In general, the unit's economy is based on both basic and external funding.

The funding portfolio for the Department of Mathematics and Physics (the administrative unit) is shown in Table 2. It has not been possible to break down the budget at research group levels. The budget shown is therefore the total budget for the whole unit including all four research groups under evaluation:

- Statistics
- Geometry and Analysis
- Theoretical Subatomic Physics and Cosmology (EVALNAT, 2022)
- Materials Physics (EVALNAT, 2022)

Basic funding primarily covers salary for the 23.2 permanent staff (in 2023). Salary for phds, postdocs and researchers is not included in these numbers.

Table 2. Describe the sources of R&D funding for the research group in the period 2018-2022.

	2018 (NOK)	2019 (NOK)	2020 (NOK)	2021 (NOK)	2022 (NOK)
Basic funding	19 452 000	18 774 000	25 075 000	25 642 000	27 100 000
Funding from industry and other private sector sources	2 313 208	1 859 246	1 350 859	1 081 689	
Commissioned research for public sector					
Research Council of Norway	2 037 358	2 079 239	2 697 328	5 898 485	6 548 230
Grant funding from other national sources					
International funding e.g. NIH, NSF, EU framework programmes					
Other					

1.5 Research group´s infrastructures

Research infrastructures are facilities that provide resources and services for the research communities to conduct research and foster innovation in their fields. These include major equipment or sets of instruments, knowledge-related facilities such as collections, archives or scientific data infrastructures, computing systems communication networks. Include both internal and external infrastructures.

a) Describe which national infrastructures the research group manages or co-manages.

None

b) Describe the most important research infrastructures used by the group**.**

The most important research infrastructures are access to high quality library services and high-performance computing facilities. Currently these services are well provided by the university/faculty.

1.6 Research group´s cooperations

Table 3. Reflect on the current interactions of the research group with other disciplines, non-academic stakeholders and the potential importance of these for the research (e.g. informing research questions, access to competence, data and infrastructure, broadening the perspectives, short/long-term relations).

Interdisciplinary (within and beyond the group)	**ISP project** The geometry and analysis group has an ongoing umbrella project titled "Geometry", with funding provided by the faculty and department, roughly 190k NOK per academic year until 2024. The project has stimulated increased contact and cooperation across those of the research groups at the department that work with geometric questions, and contributed to a common identity, both among master's/PhD students and employees at the department. For more details, see the website: https://www.uis.no/en/research/geometry-and-analysis **Quantum Technology reading group** Quantum computing is an important part of the current digitalisation drive. In an attempt at cross-disciplinary self-study, physicist **Alexander Rothkopf** and mathematician and group member **David Ploog** started a long-running reading seminar on quantum computing and quantum error correction. The project started very modest but has now progressed to a level where serious research articles are read on these topics. **Work on the Strominger-Yau-Zaslow conjecture** **Helge Ruddat**'s international collaboration with Diego Matessi, Cheuk Yu Mak, Ilia Zharkov is supported by Fellowships by Mathematisches Forschungsinstitut Oberwolfach and follows the goal to solve a central mathematical problem bridging symplectic and complex geometry.
Collaboration with other research sectors e.g. higher education, research institutes, health trusts and industry.	**N-PACT** There is also overlap of research interest between members of the group and other researchers of the department, particularly within theoretical (particle) physics and cosmology. Sigbjørn Hervik, Paul de Medeiros, and Eirik Eik Svanes, who specialise in mathematical physics, are also members of the Norwegian N-PACT network. This network represents the Norwegian activities across institutions in the fields of theoretical particle physics, theoretical astroparticle physics, as well as theoretical cosmology, with a goal to foster exchange among researchers in the respective fields, and to provide means of improving the education of the next generation of theoretical physicists by organizing schools and common educational programs. For more information, see: https://npact.uis.no/. In relation to this collaboration network, Eirik Eik Svanes is also co-supervising the PhD student Vegard Undheim, who's main research focus is in gravitational waves. **Tyson Ritter** was lead organiser of mathematics outreach activities at the "Wonderful World Science and Philosophy Festival", Stavanger

Transdisciplinary (including non-academic stakeholders) *Transdisciplinary research involves the integration of knowledge from different science disciplines and (non-academic) stakeholder communities with the aim to help address complex societal challenges.*	**Financial Master Student** In the academic year 2023/2024 **Eirik Eik Svanes** of the mathematical physics group is supervising a master student **Tomasz Kamil Szabluk**, who is doing his master part time from his job in finance. In recent years, the intersection of geometry and mathematical physics with finance has witnessed a remarkable surge, transforming the landscape of financial research and analysis. Traditional financial models often grapple with the inherent complexity and uncertainty of markets, prompting the integration of advanced mathematical techniques rooted in geometry and physics. The collaboration between these communities has proven highly beneficial, as the fusion of geometric methods with financial models enhances our ability to capture and interpret complex financial phenomena. In this regard, Tomasz' thesis focuses on how geometry and heat kernel methods have been applied to stochastic volatility models in finance, and the benefits of this approach.

2. Research quality

2.1 Research group's scientific quality

Describe the research profile of the group and the activities that contribute to the research group´s scientific quality. Consider how the group's work contributes to the wider research within the group's field nationally and internationally.

Since the last EVALMIT evaluation, the group has educated 10 PhDs to completion, and has 5 more current PhD students. Between 2012 and 2022, the group has published 129 peer-reviewed journal articles and 6 book publications. The topics are ranging over Relativity and gravitational theory, Fluid mechanics, Differential geometry, Complex and Harmonic analysis, Algebraic geometry, Partial differential equations, Numerical and functional analysis, Convex and discrete geometry and Quantum theory. Listed below are 10 representative example publications by current group members from the last 5 years. The entire list can be found with this filter-link on Mathscinet:

Every year, group members organize 1-2 international conferences hosted at UiS. The most recent events are N-PACT 2022, Julemøte 2022, Daylight 2023, Strings 2023. Three Nordfjordeid summer schools were organized by group members between 2012 and 2022. These summer schools are prestigious international schools for master and PhD students in mathematics that attract significant international attention in the mathematical science community.

The list of grants and projects is given in Table 4 below, notable mentions include Gulbrandsen's "Young Research Talent" and Hervik's "ToppForsk Research".

The 5-year Master program and PhD program in Mathematics and Physics were newly established at the time of the previous EVALMIT. Both programs, the master and the PhD have flourished and the group members are very active in teaching and mentoring these programs.

Significant exchange and collaborations are ongoing with members of the theoretical physics groups at the same department, regularly leading to joint publications. With respect to mobility, the group members travel regularly to conferences and shorter-term research stays. The group also hosts national and international visitors regularly, most recently under the umbrella of the ISP project. Recent activities are listed on the group web page, link given below.

The previous EVALMIT report's emphasis on regular sabbaticals on a rotating basis has mostly been implemented, although not every group member has yet had the opportunity since joining the group.

Please add a link to the research group`s website:

https://www.uis.no/en/research/geometry-and-analysis

Table 4. List of projects

Instructions: Please select 5-10 projects you consider to be representative/the best of the work in the period 1 January 2012 – 31 December 2022. The list may include projects lead by other institutions nationally or internationally. Please delete tables that are not used.

Project 1: FRIPRO (FRINATEK) Unge forskertalenter (Fellesløftet: 50/50 funding NFR/UiS) Title: "Coherent sheaves on abelian varieties: moduli, derived categories and stability conditions" Period: 2014-2018	**Project owner(s)** (project leaders organisation)	**Martin G. Gulbrandsen**, University of Stavanger
	Total budget and share allocated to research group	Budget: ca 6.5 MNOK, 100% to research group
	Objectives and outcomes (planned or actual) **and link to website**	The primary objective is research results within the project's theme. This has been achieved to about the same extent as expected, in the form of publications in peer-reviewed journals as well as lectures at seminars and workshops. The project has largely contributed to developing an algebraic-geometry environment at UiS of high quality and with international recognition. Two recent workshops in Stavanger financed by the project have been of significant importance. Website: https://prosjektbanken.forskningsradet.no/project/FORISS/230986
Project 2: FRIPRO (FRINATEK), Forskerprosjekt (Fellesløftet: 50/50 funding NFR/UiS) Title: "Pseudo-Riemannian Geometry and Polynomial Curvature Invariants: Classification, Characterisation and Applications." Period: 2016-2023	**Project owner(s)** (project leaders organisation)	**Sigbjørn Hervik**, University of Stavanger
	Total budget and share allocated to research group	Budget: ca 16.6 MNOK, 100% to research group
	Objectives and outcomes (planned or actual) **and link to website**	For some metrics, all the (local) information of the metric is given in the polynomial curvature invariants. However, other metrics are degenerate in the sense that many metrics have the same value of their invariants. This project had the goal to classify all spaces not being characterised by the invariants and will thus provide a better understanding of the interrelation between the set of curvature scalar invariants and the metric for pseudo-Riemannian geometries. Website: https://prosjektbanken.forskningsradet.no/project/FORISS/250367

Project 3: EPSRC and University of Hertfordshire Title: "Geometric structures and twisted supersymmetry" Period: 2023-2026	**Project owner(s)** (project leaders organisation)	Charles Strickland-Constable, University of Hertfordshire
	Total budget and share allocated to research group	Budget: ca 5.2 MNOK, 30% allocated to research collaboration (travel/joint workshops/etc) with **Eirik Eik Svanes** in UiS research group.
	Objectives and outcomes (planned or actual) **and link to website**	Recently, a new mathematical notion of geometry, "generalised geometry", providing an elegant description of general solutions of string theory. In the special case of Calabi-Yau manifolds there exist simplified string theories, called topological string theories, whose physics are more tractable and directly encode interesting mathematical features of the geometries. There are signs that such theories exist in more general situations, and that generalised geometry is the natural way to approach their constructions. This project aims to construct analogues of topological string theories in this wider context and to use these to discover new topological invariants, which will become key objects in both the mathematical and physical understanding of these spaces. Website: https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/X014959/1
Project 4: DFG Sachbeihilfe Title: "Hilbertschemes of logarithmic points" Period: 2023-2026	**Project owner(s)** (project leaders organisation)	**Helge Ruddat** (UiS) and Christian Liedtke (TU Munich)
	Total budget and share allocated to research group	Budget: ca 2,5 MNOK, 50% allocated to Helge Ruddat of UiS research group.
	Objectives and outcomes (planned or actual) **and link to website**	Degenerations of algebraic varieties are key ingredients in the compactification of moduli spaces. Gulbrandsen, Halle and Hulek constructed a well-behaved degenerating family of Hilbert schemes of points of a Type II degenerating family of K3 surfaces using expanded degenerations. This project seeks to give an alternative construction of this degeneration using log-theoretic methods, with an aim to construct a Hilbert scheme of logarithmic points on a general simple normal crossing pair. The ultimate goal is to construct well-behaved degenerations also for Hilbert schemes of points of Type III degenerations of K3 surfaces. This will yield concrete examples of Type III degenerations of hyperkähler varieties and provide insight into how hyperkähler varieties fit into the Gross-Siebert Mirror Symmetry program. Website: https://gepris.dfg.de/gepris/projekt/516701553

Project 5: DFG Emmy-Noether Program Grant Title: "Degenerations of Calabi-Yau manifolds and related geometries" *Period: 2015-2022*	**Project owner(s)** (project leaders organisation)	**Helge Ruddat** (now UiS, previously JGU Mainz at the course of project)
	Total budget and share allocated to research group	4 postdoc positions, 1 PhD position, 1 project leader position Budget: close to 1M EUR (11,2 MNOK) 100% allocated to **Helge Ruddat**
	Objectives and outcomes (planned or actual) **and link to website**	a) Combining the deformation theory by Barannikov-Kontsevich with log differential forms b) Study (Berkovich) skeleta, homological mirror symmetry, general type mirrors c) Tropical methods in the theory of Calabi-Yau degenerations and conifold transitions. The actual outcome in b) was marginal but a) and c) made good progress plus an additional fourth theme was developed with a sequence of research publications: d) Log Gromov-Witten theory https://www.agtz.mathematik.uni-mainz.de/algebraische-geometrie/emmy-noether-kolloquium/
Project 6: Event Support Funding, Norwegian Research Council Title: "For conference NORDAN 2018 in complex analysis" Period: May 2018	**Project owner(s)** (project leaders organisation)	**Tyson Ritter, Alexander Rashkovskii**, **Alexander Ulanovskii**
	Total budget and share allocated to research group	100 kNOK, 100% to research group
	Objectives and outcomes (planned or actual) **and link to website**	Support of NORDAN 2018, the Nordic conference on complex analysis and related topics. https://sites.google.com/view/nordan-2018
Project 7: Awarded by Research Council of Norway Title: "The National IOR	**Project owner(s)** (project leaders organisation)	University of Stavanger, NORCE, and IFE
	Total budget and share allocated to research group	Total Funding: 385 MNOK Share allocated to Research group: Total share is hard to estimate, but **Steinar Evje** was connected to the project, and was awarded a postdoc (**Pål Østebø Andersen**, 2014-2018, ca. 4MNOK or more).

Centre of Norway" Period: 2013-2021	**Objectives and outcomes** (planned or actual) **and link to website**	Objectives: To provide solutions for improved oil recovery on the Norwegian continental shelf through academic excellence and close cooperation with the industry. https://www.uis.no/en/research/the-national-ior-centre-of-norway
Project 8: UHR-MNT education project, University of Stavanger Title: "Innovative teaching methods for increasing students' in-depth understanding in mathematics and natural sciences", Period: 2021-2022	**Project owner(s)** (project leaders organisation)	**Tyson Ritter**
	Total budget and share allocated to research group	100 kNOK, Awarded to **Tyson Ritter** of research group.
	Objectives and outcomes (planned or actual) **and link to website**	The Department of Mathematics and Physics (IMF) at the engineering faculty planned a series of meetings/seminars in autumn 2021 and spring 2022. The purpose of the gatherings was for lecturers at the faculty to gain a better understanding of subject renewal in the sector, so that they could get tips for further development of their own teaching in light of the subject renewal and that they should be able to exchange experiences across the board.
Project 9: TEKNAT faculty education project, University of Stavanger Title: "Digital Assessment in Mathematics with STACK" Period: Jul 2019 - Dec 2020	**Project owner(s)** (project leaders organisation)	**Tyson Ritter**
	Total budget and share allocated to research group	255 kNOK Awarded to **Tyson Ritter** of research group.
	Objectives and outcomes (planned or actual) **and link to website**	This project involved the introduction of digital formative and summative assessment tasks into the mathematics course MAT300 Vector Analysis at the University of Stavanger with the aim of enhancing the learning outcomes of students. The tasks were implemented in the powerful, modern, and flexible computer-aided assessment software package STACK, and made available to students in autumn semester 2020.

All publications are availabe in the attached zip folder: UiS_IMF_GeoAna_Table5_Publications.zip

Table 5. Research group's contribution to publications

Instructions: Please select 5-15 publications from the last 5 years (2018-2022) with emphasis on recent publications where group members have a significant role. **If the publication is not openly available, it should be submitted as a pdf file attached to the self-assessment.** We invite you to refer to the Contributor Roles Taxonomy in your description: https://credit.niso.org/.
Cf. Table 1. List of personnel by categories: Research groups up to 15 group members: 5 publications. Research groups up to 30 group members: 10 publications. Research groups above 30 group members: 15 publications.
Please delete tables that are not used.

Publication 1: *"Period integrals from wall structures via tropical cycles, canonical coordinates in mirror symmetry and analyticity of toric degenerations", Publ. math. IHES 132, 2020, DOI:10.1007/S10240-020-00116-Y, URL:https://link.springer.com/article/10.1007/s10240-020-00116-y*	**Authors** (Please highlight group members)	**Helge Ruddat** and Bernd Siebert
	Short description	We give a simple expression for the integral of the canonical holomorphic volume form in degenerating families of varieties constructed from wall structures and with central fiber a union of toric varieties. The cycles to integrate over are constructed from tropical 1-cycles in the intersection complex of the central fiber. One application is a proof that the mirror map for the canonical formal families of Calabi-Yau varieties constructed by Gross and the second author is trivial. We also show that these families are the completion of an analytic family, without reparametrization, and that they are formally versal as deformations of logarithmic schemes. Other applications include canonical one-parameter type III degenerations of K3 surfaces with prescribed Picard groups. As a technical result of independent interest we develop a theory of period integrals with logarithmic poles on finite order deformations of normal crossing analytic spaces.
	Research group's contribution	Distribution of contributions among authors is even, at all stages.
Publication 2: *"A GIT Construction of Degenerations of Hilbert*	**Authors** (Please highlight group members)	**Martin G. Gulbrandsen**, Lars H. Halle, and Klaus Hulek

Schemes of Points", Doc. Math. 24, 2019, *DOI:10.4171/DM/685 URL:https://ems.press/journals/dm/articles/8965618*	**Short description**	We present a Geometric Invariant Theory (GIT) construction which allows us to construct good projective degenerations of Hilbert schemes of points for simple degenerations. A comparison with the construction of Li and Wu shows that our GIT stack and the stack they construct are isomorphic, as are the associated coarse moduli schemes. Our construction is sufficiently explicit to obtain good control over the geometry of the singular fibres. We illustrate this by giving a concrete description of degenerations of degree n Hilbert schemes of a simple degeneration with two components.
	Research group's contribution	Distribution of contributions among authors is even, at all stages.
Publication 3: *"Tilting chains of negative curves on rational surfaces", Nagoya Math. Journal 235, 2019, DOI:10.1017/nmj.2017.40 URL:https://www.cambridge.org/core/journals/nagoya-mathematical-journal/article/abs/tilting-chains-of-negative-curves-on-rational-surfaces/19D96A4DA5CD28E6D17CB25D1FCAD352*	**Authors** (Please highlight group members)	Lutz Hille and **David Ploog**
	Short description	The homological algebra in this research ("exact tilting objects") are motivated by algebraic geometry: a chain of negative rational curves on a good (e.g. rational) surface gives rise to a tilting bundle for a geometrically interesting subcategory with peculiar properties: not just the derived categories are equivalent but already the abelian categories are. This result has been used by Kalck and Karmazyn to construct new non-commutative Knörrer periodicity results.
	Research group's contribution	The work was shared evenly.
Publication 4: *"Mathematical analysis of two competing cancer cell migration mechanisms driven by interstitial fluid flow", Journal of Nonlinear*	**Authors** (Please highlight group members)	**Steinar Evje** and Michael Winkler
	Short description	Purpose is to show the asymptotic behaviour of a two-phase model that describes the competition between two different cell migration mechanisms.

Science 30, 2020, DOI:10.1007/s00332-020-09625-w URL:https://link.springer.com/article/10.1007/s00332-020-09625-w	**Research group's contribution**	Evje provided the model formulation and formulated the problem to solve. Technical tools were provided by Winkler.
Publication 5: *"A soft Oka principle for proper holomorphic embeddings of open Riemann surfaces into (C∗)^2", Journal für die Reine und Angewandte Mathematik 745, 2018 DOI:10.1515/crelle-2015-0116 URL:https://www.degruyter.com/document/doi/10.1515/crelle-2015-0116/html*	**Authors** (Please highlight group members)	**Tyson Ritter**
	Short description	Let X be an open Riemann surface. We prove an Oka property on the approximation and interpolation of continuous maps X → (C*)^2 by proper holomorphic embeddings, provided that we permit a smooth deformation of the complex structure on X outside a certain set. This generalises and strengthens a recent result of Alarcón and López. We also give a Forstnerič–Wold theorem for proper holomorphic embeddings (with respect to the given complex structure) of certain open Riemann surfaces into (C*)^2 .
	Research group's contribution	Paper is single authored by Tyson Ritter.
Publication 6: *"Higher Lelong numbers and convex geometry", J. Geom. Analysis 31, 2021 DOI: 10.1007/s12220-020-00362-w URL:https://link.springer.com/article/10.1007/s12220-020-00362-w*	**Authors** (Please highlight group members)	Dano Kim and **Alexander Rashkovskii**
	Short description	We prove the reversed Alexandrov–Fenchel inequality for mixed Monge–Ampère masses of plurisubharmonic functions, which generalizes a result of Demailly and Pham. As applications to convex geometry, this gives a complex analytic proof of the reversed Alexandrov–Fenchel inequality for mixed covolumes, which generalizes recent results in convex geometry of Kaveh–Khovanskii, Khovanskii–Timorin, Milman–Rotem and Schneider on reversed (or complemented) Brunn–Minkowski and Alexandrov–Fenchel inequalities. Also for toric plurisubharmonic functions in the Cegrell class, we confirm Demailly's conjecture on the convergence of higher Lelong numbers under the canonical approximation.

	Research group's contribution	The work was shared evenly.
Publication 7: *"Fourier Quasicrystals with Unit Masses", Comptes rendus. Mathematique 358, 2020 DOI:10.5802/crmath.142 URL:http://www.numdam.org/articles/10.5802/crmath.142/*	**Authors** (Please highlight group members)	Alexander Olevskii and **Alexander Ulanovskii**
	Short description	The sum of delta-measures sitting at the points of a discrete set Lambda in the real numbers forms a Fourier quasicrystal if and only if Lambda is the zero set of an exponential polynomial with imaginary frequencies.
	Research group's contribution	Distribution of contributions among authors is even, at all stages.
Publication 8: *" Killing superalgebras for Lorentzian six-manifolds", J.Geom.Phys. 132, 2018 DOI:10.1016/j.geomphys.2018.05.019 URL:https://www.sciencedirect.com/science/article/pii/S0393044018302067?via%3Dihub*	**Authors** (Please highlight group members)	**Paul de Medeiros**, José Figueroa-O'Farrill, and Andrea Santi
	Short description	We calculate the Spencer cohomology of the (1,0) Poincaré superalgebras in six dimensions: with and without R-symmetry. As the cases of four and eleven dimensions taught us, we may read off from this calculation a Killing spinor equation which allows the determination of which geometries admit rigidly supersymmetric theories in this dimension. We prove that the resulting Killing spinors generate a Lie superalgebra and determine the geometries admitting the maximal number of such Killing spinors. They are divided in two branches. One branch consists of the lorentzian Lie groups with bi-invariant metrics and, as a special case, it includes the lorentzian Lie groups with a self-dual Cartan three-form which define the maximally supersymmetric backgrounds of (1,0) Poincaré supergravity in six dimensions. The notion of Killing spinor on the other branch does not depend on the choice of a three-form but rather on a one-form valued in theR-symmetry algebra. In this case, we obtain three different (up to local isometry) maximally supersymmetric backgrounds, which are distinguished by the causal type of the one-form.
	Research group's contribution	Distribution of contributions among authors is even, at all stages.

Publication 9: "*Finite deformations from a heterotic superpotential: holomorphic Chern-Simons and an L-infinity algebra", JHEP 10, 2018 DOI:10.1007/JHEP10(2018)179 URL:https://link.springer.com/article/10.1007/JHEP10(2018)179*	**Authors** (Please highlight group members)	Anthony Ashmore, Xenia De La Ossa, Ruben Minasian, Charles Strickland-Constable, and **Eirik Eik Svanes**
	Short description	We consider finite deformations of the Hull-Strominger system. Starting from the heterotic superpotential, we identify complex coordinates on the off-shell parameter space. Expanding the superpotential around a supersymmetric vacuum leads to a third order Maurer-Cartan equation that controls the moduli. The resulting complex effective action generalises that of both Kodaira-Spencer and holomorphic Chern-Simons theory. The supersymmetric locus of this action is described by an L3-algebra.
	Research group's contribution	Distribution of contributions among authors is even, at all stages.
Publication 10: *"Universal Black Holes", JHEP 02, 2020, DOI:10.1007/JHEP02(2020)047 URL:https://link.springer.com/article/10.1007/JHEP02(2020)047*	**Authors** (Please highlight group members)	**Sigbjørn Hervik** and Marcello Ortaggio
	Short description	We prove that a generalized Schwarzschild-like ansatz can be consistently employed to construct d-dimensional static vacuum black hole solutions in any metric theory of gravity for which the Lagrangian is a scalar invariant constructed from the Riemann tensor and its covariant derivatives of arbitrary order. Namely, we show that, apart from containing two arbitrary functions a(r) and f (r), in any such theory the line-element may admit as a base space any isotropy-irreducible homogeneous space. Technically, this ensures that the field equations generically reduce to two ODEs for a(r) and f (r), and dramatically enlarges the space of black hole solutions and permitted horizon geometries for the considered theories. We then exemplify our results in concrete contexts by constructing solutions in particular theories such as Gauss-Bonnet, quadratic, F(R) and F(Lovelock) gravity, and certain conformal gravities.
	Research group's contribution	The work was shared evenly.

2.2 Research group´s societal contribution

Describe the societal impact of the group's research. Consider contribution to education, economic, societal and cultural development in Norway and internationally.

By actively engaging in service teaching, the group contributes significantly and directly to the development of a large cohort of engineers who possess strong mathematical foundations. This has not only enhanced the quality of engineering education in Norway but has also had ripple effects internationally as these well-trained engineers contribute to various global industries. By actively participating in the development of the mathematics and physics degree programme at UiS, researchers also contribute to producing a workforce equipped with the mathematical acumen required in diverse professional settings. This has a direct impact on economic development, as industries benefit from a skilled pool of mathematicians and physicists capable of addressing complex challenges.

Furthermore, the group is fervently committed to reaching out to high schools students and teachers, recognizing the importance of inspiring and nurturing young minds early in their academic journey. Members of the research team regularly organize visits to Norwegian high schools, where they deliver engaging educational talks and share their passion for mathematics and physics. Schools visited include local schools in Stavanger, but also more widely around Norway such as Kvitsund Gymnas in Telemark, Arendal vgs, Bamble vgs, Gjennestad vgs, Rjukan vgs, Drottningborg vgs, Skeisvang vgs, Strand vgs, Dalane vgs, Molde vgs, Volda vgs, Rauma vgs, Edvard Munch vgs. Oslo, Fyrstikkalleen skole Oslo, Meløy vgs Nordland and more. These interactions not only serve to ignite curiosity and interest in these subjects among students but also provide valuable insights into the exciting possibilities that a career in mathematics and physics can offer. By fostering these connections with the younger generation, the group aims to create a ripple effect, encouraging more students to pursue advanced studies in these fields and contribute to the broader scientific community in the future.

In terms of teacher education, the group's efforts extend beyond foundational aspects, encompassing the development of pedagogical skills and the cultivation of a passion for mathematics. Supported by several grants (see above), and spearheaded by **Tyson Ritter**, who was awarded "Merittert Underviser" for his efforts, the group has introduced novel innovations into teaching based on the mathematics pedagogy research literature, such as computer-aided assessment in mathematics using STACK, and active-learning in mathematics using small-group problem-solving. This broader approach to engineering and teacher education has far-reaching consequences, as empowered educators play a pivotal role in shaping the academic and professional trajectories of countless students, thereby influencing the societal landscape. Tyson Ritter also designed and taught a new course for students

who are becoming mathematics teachers in high schools. The course is about in-depth learning (dybdelæring) and dissemination in mathematics.

The group's involvement as sensors and PhD opponents further underscores its commitment to academic development. By participating in these capacities, the researchers contribute to the growth of the academic community, fostering the next generation of scholars and ensuring the quality of doctoral research. This involvement extends not only within Norway but also on the international stage, strengthening global academic networks.

Finally, the healthy growth of the group over the past decade has contributed towards the preservation of pure mathematics as an active research field in Norway. The establishment of a Norwegian “Mathematical Physics” group, and the shift of the Algebraic Geometry hubs from "UiO and UiB" to "UiO and UiS," is a testament to the group's cultural impact. By nurturing and sustaining a strong Norwegian mathematical heritage, the researchers contribute to the cultural fabric of the nation. This not only maintains Norway's prominence in the global mathematical community but also ensures the continued relevance and vibrancy of this field within the national academic landscape.

Table 7. The research group's societal contribution, including user-oriented publications, products (including patents, software or process innovations

Instructions: Please select 5–10 of your most important user-oriented publications or other products from the last 5–10 years with emphasis on recent publications/products. For each item, please use the following formatting: Please delete lines which are not used.

No.	Name of publication/product	Date of publication/product	Link to the document
1	Matematikk for ingeniørfag - med numeriske beregninger Johannes Kleppe, Tore August Kro, Jon Eivind Vatne, **Martin G. Gulbrandsen** Gyldendal 2013 ISBN/EAN: 9788205432338	2013	https://www.gyldendal.no/faglitteratur/ingenioerfag/fellesemner/matematikk-for-ingeniorfag/p-10012598-no/
2	The Geometry of Viruses (online talk by **Martin G. Gulbrandsen**)	2020	https://www.youtube.com/watch?v=9kBoOHyHbFk
3	**Tyson Ritter** was lead organiser of mathematics outreach activities at the "Wonderful World Science and Philosophy Festival", Stavanger	June 2023	https://www.wonderfulworld.no/

3. Challenges and opportunities

Information about the strengths and weaknesses of the research group is obtained through the questions above. In this chapter, please reflect on what might be the challenges and opportunities for developing and strengthening the research and the position of the group.

The geometry and analysis research group at the University of Stavanger faces a set of challenges that require strategic planning and proactive measures.

Student numbers in the master program have decreased in the past years. Demographic trends may play a role, but the newly-introduced compulsory tuition fees for non-EU students has resulted in far fewer student admissions. (Until 2023, this group accounted for about 30% of the student body.) As master students are a vital component of the group's research, a recently-formed committee is currently analyzing possibilities to overcome these challenges at the departmental level. Mitigation strategies include showcasing the value of the programs, national student recruitment and retention efforts as well as study programme restructuring.

Substantial research funding could be secured by the group in the past despite fairly low success rates of national grant proposals in foundational mathematics research. However, the National Research Council restructured its panel composition in 2023 and the consequences for pure mathematics applications are currently unclear. Pure mathematics projects have not been funded in recent years and there is no pure mathematician in any of the RCN panels. The group will continue to submit 1-2 Fripro proposals per year.

The lack of national recognition for the achieved level of scientific excellence need to be compensated for by regular exchange and travel, nationally and internationally, in order to build and maintain a strong network of scientific collaborations.

Despite these challenges, the group is presented with various opportunities. Stabilizing the current positive trajectory by (modestly) increasing student enrolment and securing additional university support is a viable goal. Pursuing external funding avenues, such as ERC grants and private funding, can provide crucial resources for research initiatives and program enhancements. Several major large Norwegian companies are headquartered in Stavanger (Lyse, Equinor, ..) and could be sources for private sector funding.

Collaborating with other institutions can bring in diverse perspectives, complementary expertise, and expand the research network. Contact with Bergen and Tromsø has been initiated, exploring cross-university collaboration at master level education as an opportunity to enrich the quality, value and competitiveness of the educational programmes and streamline use of teaching resources. Leveraging these opportunities will contribute to the group's continued development and resilience.

The rising societal interest in artificial intelligence creates an opportunity for the group to collaborate with other departments, adding some applied expertise to their strong pure mathematics knowledge. Such a collaboration could be established both scientifically for improving the chances of grant applications as well as at the educational level in order improve student numbers in mid-level mathematics courses.

In conclusion, addressing challenges while capitalizing on opportunities is vital for the growth and sustainability of the small mathematics research group at a small university. By implementing strategic measures in funding acquisition, student recruitment and retention, curriculum reorganization, and collaborative efforts, the group can navigate the evolving landscape of mathematics research and education successfully.