International Partnership for Computing in Science Education (Annen støtte - INTPART)

Application Number: ES595146 Project Number: 0

Applicant

Project Owner

Institution / company (Norwegian name)	University of Oslo
Faculty	Mathematics and Natural Science
Institute	
Department	Physics
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Postal code	0316
City	OSLO
Country	Norway
E-mail	admin@fys.uio.no
Website	http://www.mn.uio.no/fysikk/
Enterprise number	971035854

eAdministration	

Project administrator

First name	Lars
Last name	Bernhardsen
Date of birth	070968
Personal number	
Gender	Male
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Confirmation	✔ The application has been approved by the

International Partnership for Computing in Science Education (Annen støtte - INTPART)

Application Number: ES595146 Project Number: 0

	Project Owner

Project manager

First name	Morten
Last name	Hjorth-Jensen
Date of birth	290761
Personal number	
Gender	Male
Institution / company (Norwegian name)	University of Oslo
Faculty	Mathematics and Natural Science
Institute	
Department	Physics
Address	Sem Sealands veg 24
Postal code	0316
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Country	Norway
Position/title	Professor of Physics
Academic degree	PhD
Preferred language	English
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Project info

Project title

Project title	International Partnership for Computing in Science Education

Primary and secondary objectives of the project

Primary and secondary objectives	The first objective is to develop common initiatives where computing in science courses is introduced in a

	coherent way at both partner universities, from undergraduate to graduate studies. This objective will be linked closely with (our second objective) science education research at both universities, providing thereby unique and novel insights to the scientific community on the introduction of computing in science courses. The results and insights gained from the introduction of computing in physics courses, can be transferred to other disciplines in order to foster the understanding of computations and simulations as important scientific tools. The third objective of this partnership is the development of courses that target university teachers and teaching assistants. These will be intensive one-week courses and will include teaching practices and learning material that can aid university teachers in including computational exercises and projects.

Project summary

Project summary	Computing forms now an integrated and central part of essentially all aspects of modern science and engineering, from basic research to industrial and societal applications. It has become clear that a large fraction of theoretical and experimental science requires a high level of computational sophistication to competently pursue many scientific problems, a trend that is likely to grow with time as computers increase in power and experimental data sets grow exponentially. These observations are applicable to essentially all disciplines in the Sciences. Beyond its increasing centrality in research, the use of computational modeling in the classroom setting provides students with insights that can go well beyond those resulting from pencil-and-paper manipulation of equations. In particular, the ability to closely examine the behavior of systems that are too complex to be easily analytically tractable, or that have no analytic solutions (i.e., many systems of practical interest), helps to develop intuition that is unavailable to many students from analytic calculation. It is in this context this proposal finds its rationale. We aim at uniting the strengths of research and educational activities at the involved universities. Through workshops, new learning material, courses for university teachers, exchange of faculty and students at all levels, the establishment of this network has the potential to add significant new insights and experiences on how computing can be integrated in a seamless way in our basic science education. The outcome of the various research and educational projects are expected to be of great importance and transferable to universities worldwide. The outcome of this project is of strategic importance for both

	partners. It prepares the ground for the integration of computing in education and thereby how to design our education for the future.

Funding scheme

Supplementary info from applicant

Programme / activity	INTPART
Application type	Annen støtte
Topics	
Other relevant programmes/ activities/projects	
Discipline(s)	Physics, Mathematics, Computer Science, Bioscience
If applying for additional funding, specify project number	
Have any related applications been submitted to the Research Council and/or any other public funding scheme	No
If yes, please provide further information	

Progress plan

Project period

From date	20180101
To date	20201231

Main activities and milestones in the project period (year and quarter)

Milestones throughout the project	From		To	
Computing for mechanics course	2018	1	2018	4
Exchange of researchers and students	2018	1	2020	4
Intensive courses for university teachers	2018	1	2020	4
Computing for electromagnetism course	2018	3	2019	2

Computing in basic physics for life science	2018	3	2020	4
Annual workshops on Computing in Science edu	2018	4	2020	4
Assessment program for undergraduate courses	2018	4	2020	4
Computing for advanced lab course	2019	1	2019	4
Computing for quantum mechanics course	2019	1	2019	4
Computing for statistical physics course	2019	1	2019	4
Graduate courses in computational science	2019	1	2020	4
Graduate courses in computational physics	2019	1	2020	4
Assessment program for graduate courses	2019	3	2020	4

Dissemination of project results

Dissemination plan	The partnership has as deliverables several textbooks on computations in science courses, with an emphasis on physics courses as well as graduate courses on Computational Science. These textbooks will be published as open access books. Similarly, the teaching material that will be developed will be fully available via version control repositories and Internet hosting services like GitHub. This material will also be disseminated through the National Science Foundation sponsored PICUP project, a project that has as a central objective the integration of computing in university education. The results from various assessments developed by the partnership is also an essential part of our dissemination. These results will be published in international journals with a peer review system and presented at international conferences. Along similar lines, teachers who introduce computing and numerical modeling in their courses, will be encouraged to disseminate their results. Results on improved learning outcomes from new assessment technologies are also of interest to the broad public as well as to government, funding institutions and to industry where learning and assessment is becoming increasingly important to transform the workforce, in particular in areas related to the use of computing. Results from this project will be included in CCSE's communication to all these groups.

Budget

International Partnership for Computing in Science Education (Annen støtte - INTPART)

Application Number: ES595146 Project Number: 0

Cost plan (in NOK 1000)

	2018	2019	2020	2021	2022	2023	2024	2025	Sum
Payroll and indirect expenses	364	375	386						1125
Procurement of R&D services									0
Equipment									0
Other operating expenses	1500	1500	1500						4500
Totals	1864	1875	1886	0	0	0	0	0	5625

Specification	The budget includes own efforts totaling 20 per cent of the total budget. The other operating expenses deal with the organization of annual workshops, exchange and mobility of university teachers and students and organization and planning of courses and research on learning.

Cost code (in NOK 1000)

	2018	2019	2020	2021	2022	2023	2024	2025	Sum
Trade and industry									0
Independent research institutes									0
Universities and university colleges	1864	1875	1886						5625
Other sectors									0
Abroad									0
Totals	1864	1875	1886	0	0	0	0	0	5625

Funding plan (in NOK 1000)

International Partnership for Computing in Science Education (Annen støtte - INTPART)

Application Number: ES595146 Project Number: 0

	2018	2019	2020	2021	2022	2023	2024	2025	Sum
Own financing	364	375	386						1125
International funding									0
Public funding									0
Private funding									0
The Research Council	1500	1500	1500						4500
Totals	1864	1875	1886	0	0	0	0	0	5625

Specification	The budget covers own efforts as well as the organization of workshops, schools and exchange of students and researchers.

Fellowship

Type of fellowship	
From date (yyyymmdd)	
To date (yyyymmdd)	

Partners

Partners under obligation to provide professional or financial resources for the implementation of the project

1

Institution/ company	Michigan State University
Department/ section	
Address	220 Trowbridge Rd
Postal code	MI 48824
City	East Lansing
Country	United States of America

International Partnership for Computing in Science Education (Annen støtte - INTPART)

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Enterprise number	
Contact person	Phil Duxbury
Contact tel.	00151788456
Contact e-mail	Duxbury@pa.msu.edu
Partner's role	Research activity

2

Institution/ company	UNIVERSITETET I OSLO
Department/ section	
Address	Postboks 1072 Blindern
Postal code	0316
City	OSLO
Country	Norway
Enterprise number	971035854
Contact person	
Contact tel.	
Contact e-mail	
Partner's role	Financing and Research activity

Attachments

Project description

Filename	ApplicationMain.pdf
Reference	ES595146_001_1_Prosjektbeskrivelse_20170524

Other items

International Partnership for Computing in Science Education (Annen støtte - INTPART)

Application Number: ES595146 Project Number: 0

Filename	CaballeroCV.pdf
Reference	ES595146_010_1_Annet_20170523

Filename	HenriksenCV.pdf
Reference	ES595146_010_2_Annet_20170523

Filename	MaltheSorenssenCV.pdf
Reference	ES595146_010_3_Annet_20170523

Filename	MorkenCV.pdf
Reference	ES595146_010_4_Annet_20170523

Filename	CommitmentINTPART_UIO.pdf
Reference	ES595146_010_6_Annet_20170523

Filename	WTellefsenCV.pdf
Reference	ES595146_010_7_Annet_20170523

Filename	SawtelleCV.pdf
Reference	ES595146_010_8_Annet_20170523

Filename	INTPART-MSU-PA-support-for-MortenHJ.pdf
Reference	ES595146_010_9_Annet_20170523

Filename	OsheaCV.pdf
Reference	ES595146_010_10_Annet_20170523

Filename	HjorthJensenCV.pdf
Reference	ES595146_010_11_Annet_20170523

Filename	CommitmentCCSE.pdf
Reference	ES595146_010_12_Annet_20170524

International Partnership for Computing in Science Education (Annen støtte - INTPART)

Application Number: ES595146 Project Number: 0

1 International Partnership for Computing in Science Education (CSE)

This document describes an INTPART partnership between the University of Oslo and its center of excellence in education **Center for Computing in Science Education** (CCSE) and Michigan State University in the USA.

The project leader is Morten Hjorth-Jensen, professor of physics at Michigan State University and the University of Oslo. The main institutions are the University of Oslo (UiO) with its Faculty of Mathematics and Natural Science, its newly established center CCSE and the Department of Physics and Michigan State University (MSU), Michigan, USA, and its College of Natural Science and the Department of Physics and Astronomy.

The present proposal on **Computing in Science Education (CSE)** spans several educational initiatives in computational science and computing in science education, the latter being one of the strategic innovations in education of the Faculty of Mathematics and Natural Science at the University of Oslo. This initative was recently rewarded with the status as center of excellence in education, the Center for Computing in Science Education, established December 1, 2016. The present proposal is central to the thematic focus of CCSE as well as actual education research and new initiatives at Michigan State University.

The participants are Morten Hjorth-Jensen (MSU, UiO, CCSE), Marcos Daniel Caballero (MSU, UiO, CCSE), Anders Malthe-Sørenssen (UiO, CCSE), Ellen Karoline Henriksen (UiO, CCSE), Knut Mørken (UiO, CCSE) Brain O'Shea (MSU), Vashti Sawtelle (MSU) and Cathrine Walstrøm Tellefsen (UiO, CCSE).

2 The project's relevance to INTPART

2.1 Project summary and motivation

The goal of this partnership is to build a lasting world-leading educational and research activity focusing on computing in science education.

The recently established Center of Excellence in Education at the University of Oslo (UiO), the Center for Computing in Science Education (CCSE), has as a central mission to introduce, develop and assess the introduction of computing in science education. This INTPART project will extend and build on the experiences of the CCSE together with the Physics Education Research Group at Michigan State University (MSU). The CCSE has the ambition to develop educational activities where computing is integrated in basic science courses across disciplines. The study programs in the Physical Sciences and Mathematics at UiO are unique in combining efforts in mathematics, computer science and physics to provide an integral experience for the students. This provides a unique environment to study the effects of integration of computing on student learning outcomes. However, UiO and the CCSE need to build a stronger activity in science education research. Michigan State University has built a leading activity in Science, Technology, Engineering and Mathematics education research. The Physics Education research group at Michigan State University has developed systematic studies concerning the effect of integrating computing in science education. There are therefore significant synergies from developing a long term international partnership between CCSE and MSU: MSU will get access to a strong program where computing is integrated across disciplines. This is very useful since MSU is in the process of redesigning its study programs in order to systematically include computing, whereas UiO and CCSE will gain from teaming up with a leading science education research program at MSU.

Strategic relevance The integration of computing across all science disciplines is a key element in the educational strategy of the Faculty of Mathematics and Natural Science (MN-Fac) at the University of Oslo. Computational Science is highly prioritized by the MN-Fac and is reflected in the establishment of a new cross-disciplinary Master of Science program at the University of Oslo. The project is also highly relevant to the strategic goals of both institutions. The University of Oslo's Strategic Plan 2020 [1] has as an overarching goal: *The University of Oslo will strengthen its international position as a leading research-intensive university through a close interaction across research, education, communication and innovation.* This partnership meshes also well with the newly established Norwegian initiative *Research and higher education* [2], where a closer integration between education and research is a central goal. At MSU, a new cross-disciplinary initiative called *Computing across the curriculum* has recently been established. The latter initiative, as well as the strategic establishment of the new Department of Computational Science, Mathematics and Engineering (CSME) `https://cmse.msu.edu/` at MSU, mesh well with the present partnership.

Education for the future, the strategic importance of computing in science education Through workshops, new learning material, courses for university teachers, exchange of faculty and students at all levels, the establishment of this network has the potential to add significant new insights and experiences on how computing can be integrated in a seamless way in our basic science education. The outcome of the various research and educational projects are expected to be of great importance and transferable to universities worldwide. The outcome of this project is of strategic importance for both partners. It prepares the ground for the integration of computing in science education and thereby how to design our education for the future. Computational skills are highly requested by industry and the rest of society. The present partnership lays thus the foundation for an educational training that will strengthen the standing of our students in the future labor market.

3 The scientific quality of the partnership

The innovative educational and research activities described here are organized around the newly established Center for Computing in Science Education (CCSE) at the University of Oslo, Norway, a center of excellence in education. The center is a cross-disciplinary collaboration between science educators, educational science researchers and partner institutions, and provides a unique environment to introduce computing and computational topics in our science education, as well as developing and testing assessment methods for computing in science education. The center aims at developing a leading international educational research activity based on the almost fifteen years long experience with the **Computing in Science Education** project at UiO. This project has introduced computational elements in many basic mathematics and natural science courses at UiO and represents a unique and coherent integration of computations in science education, both nationally and internationally. In order to strengthen these activities, in particular concerning research on science education and the role of computing in basic science courses, the present project aims at developing a collaboration with MSU and the Physics education group at MSU. The combination of educational and research activities at UiO and MSU, will provide a unique environment to study the effects of the integration of computing on student learning outcomes, spanning the spectrum from undergraduate students to graduate students. In particular, we aim at answering whether computing will aid in increasing the students' understandings and insights about a specific discipline and thereby gain a deeper understanding of the scientific methods involved.

The project manager, Morten Hjorth-Jensen, has a shared position between MSU and UiO, a feature

which will facilitate the success and sustainability of this partnership. He spends half the year in the USA and the other half in Norway and works closely with most researchers involved in this proposal. The project manager has spent almost two decades on the development of computations and numerical simulations in basic and advanced science courses. Together with colleagues at the University of Oslo, he initiated the **Computing in Science Education** initiative in 2003, an initiative which has been rewarded with several educational prizes in Norway. He works also closely with colleagues at MSU on the introduction of computing in central undergraduate physics courses. In addition he initiated and chairs the new Master of Science program in Computational Science at UiO. He conducts research on computational nuclear physics and computational quantum mechanics at both universities.

Anders Malthe-Sørenssen (UiO) is the director of CCSE and has extensive research and educational leadership experience across disciplines. He is part of an internationally leading research activity in the physics of geological processes and cross-scale modeling in physics. He has a solid track record in developing new educational programs.

Ellen Karoline Henriksen (UiO) has considerable research leadership experience from international (EU) and national projects with 15 years of experience in teacher education, with an emphasis on physics and science teachers.

Cathrine Walstrøm Tellefsen (UiO) has extensive experience with science and physics teacher education at the University of Oslo and is a prize-winning university teacher. She is particularly interested in student-active teaching approaches in large classroom settings. She has written several science and physics textbooks for high-school students.

Knut Mørken (UiO) has a broad experience as an educational and research leader, in particular with cross-disciplinary educational developments. He has extensive experience as a teacher in basic and advanced mathematics courses, with an emphasis on computational mathematics. Since 2012, he is the project leader for a broad reform that aims at redesigning bachelor and Master of Science programs at the MN-Fac of the University of Oslo. reform to redesign bachelor and master of Science programs.

Brian O'Shea (MSU) is a highly awarded and well-known computational and theoretical astrophysicists, with a strong interest in computing in science education. He is one of the co-founders of the new department of Computational Mathematics, Science and Engineering at MSU. He has played a central role in establishing both an undergraduate program and a graduate program in computational science. His research involves numerical simulations and analytical modeling of cosmological structure formation, the cosmic web, galaxy clusters, high-redshift galaxies, and Milky Way-type galaxies.

Marcos Daniel Caballero (MSU, UiO, CCSE) is a leading education researcher in the field of integration of computing in science education. Caballero is an adjunct professor at CCSE. Together with colleagues at MSU, the Physics Education group forms a strong research environment on physics and science education.

Vashti Sawtelle (MSU) is also a member of the Physics Education group at MSU and leads a central initiative on computing in basic physics courses for life science students. She conducts research on the perception of physics include among female students. She is presently developing a diagnostic survey tool that can be administered in introductory physics, biology, and chemistry classes to examine the content and practice connections students make across these disciplines. The research of Caballero and Sawtelle brings in a strong expertise in physics education directed towards the integration of computing in science education. This activity is an important factor in order to build an internationally leading activity in the field of education research.

The research background of the participants represents an excellent complementary mix of basic research in computational science and education research, combined with a strong experience in developing courses and academic programs. Caballero, Sawtelle, Henriksen and Tellefsen will lead the education research components, but all participants will actively take part in the development of courses, aca-

demic programs and learning material. Undergraduate and graduate students from both universities will participate in the various projects through a series of exchanges and research stays.

4 The academic quality of the partner's research and education

The University of Oslo has during the last fifteen years integrated numerical methods and computing in several science courses via the Computing in Science Education initiative. The **Computing in Science Education (CSE)** initiative has changed radically the way science is taught and has inspired many colleagues nationally and worldwide. This initiative led to the recent establishment of a center of excellence in education, the Center for Computing in Science Education.

The Physics and Astronomy department at MSU is in the process of implementing several of the CSE ideas developed at UiO. A close collaboration here between MSU and UiO will benefit both institutions. MSU has strong science education groups in almost every department. These groups conduct research in university education, with important consequences for our basic understanding of science education and what works or not. Such a research activity is often missing at European universities, where the focus is mainly on K12 education (high-school or middle school). The collaboration with MSU will thus bring to Norway important and new competences on education research at the university level.

Researchers from MSU are expected to conduct surveys of various educational aspects of the CSE initiative at UiO as well as at MSU. This has important pedagogical consequences since a firm and research-based evaluation of computing in science education in general is much needed. Several educational collaborations involving the CSE initiative are thus expected to result from this project.

The partnership aims at bringing together and thereby strengthen in a mutual way the educational expertise and experiences of both universities. The activities described below aim at developing common initiatives on introducing computing in science courses in a coherent way at both universities. These initiatives will be linked closely with science education research at both universities, providing thereby unique and novel insights to the scientific community on the introduction of computing in basic science courses. The results and insights gained from the introduction of computing in physics courses, can be transferred to other disciplines in order to foster the understanding of computations and simulations as important scientific tools. It will in particular strengthen education research in both countries and provide novel research material on students' perception of computing in science.

The integration of computing in courses and academic programs as presented in this proposal allows us to combine our research backgrounds in order to develop educational programs with a content that reflects the skills and competences needed for new scientific breakthroughs.

The two universities have also developed mutual student exchange agreements at all levels, with full credit transfer. This facilitates stays of students at the other university, in particular since they can also follow courses at each university and get full transfer of grades and credits.

5 Objectives, aims and milestones

5.1 Objective 1: Computing in science education, from undergraduate to graduate studies

The first activity aims at developing common initiatives on computing in physics and computational science courses at both universities. These initiatives will be linked closely with education research, providing thereby unique and novel insights to the scientific community on the introduction of computing in science courses. The results and insights gained from the introduction of computing in for example

physics courses, can be transferred to other disciplines in order to foster the understanding of computations and simulations as important scientific tools.

The first objective has three different but strongly connected subgoals.

Subgoal 1: Coherent introduction of computing and computational topics in basic physics courses at the undergraduate level. This subgoal includes the development of a large set of exercises, projects, learning outcomes on computing and examples that will aid physics teachers in including numerical projects and exercises in their physics courses. The PICUP project in the USA, `http://www.compadre.org/picup/`, is an example of a large university-level initiative that includes the development of numerical exercises and projects that can be used in basic physics courses. Researchers at Michigan State University are tightly linked with this project.

Numerical projects, examples and exercises have already been introduced at UiO in many central Natural Science courses, but a coherent introduction of these, together with learning outcomes and proper assessments has not been done yet. The introduction of computing in central physics courses is planned to start from the fall semester of 2018 at MSU, with a special focus on the undergraduate mechanics course.

We have thus singled out as central courses in this partnership the compulsory undergraduate mechanics course, the electromagnetism course, the quantum physics/mechanics course, the statistical physics and the advanced undergraduate laboratory courses at both universities.

In addition to central physics courses at the undergraduate level, we will include introductory physics courses for non-physics students. In particular, we will focus on courses for students in the Life Sciences and other disciplines from the Physical Sciences. Vashti Sawtelle at MSU is teaching and developing such a course at MSU and the experiences made there can be transferred to similar courses at UiO.

The development of learning outcomes on computations in basic physics courses is a central part of this first subgoal. These learning outcomes will be extended to other disciplines towards the second half of the partnership period. The learning outcomes will be central to the assessment program discussed below. At the end of the project period, we aim at transferring these experiences and insights to other disciplines in the Natural Sciences.

An annual workshop is meant to summarize the activities related to the introduction of computing in the abovementioned courses. Furthermore, the annual workshop will also summarize and present the results from our education research as well as other research and educational initiatives related to computing in science education.

The timeline for the development of learning outcomes and computational teaching material is listed in the table here.

Milestones	2018				2019				2020			
Learning outcomes and material for Mechanics	•	•	•	•								
Learning outcomes and material for Electromagnetism			•	•	•	•						
Learning outcomes and material for Quantum Mechanics				•	•	•	•					
Learning outcomes and material for Advanced				•	•	•	•					
Learning outcomes and material for Statistical Physics				•	•	•	•					
Learning outcomes and material for Physics for Life Science			•	•	•	•	•	•	•	•	•	•
Annual workshop on computing in science education		•				•				•		

The site for the annual workshop will alternate between the two universities. We estimate the cost of each annual workshop to 500 kNOK, totaling 1500 kNOK for the whole period. Undergraduate and graduate students involved in the project are encouraged to attend the annual workshop. We expect at least ten students per year attending the workshops.

We expect in addition at least two researchers traveling to the partner university for stays up to one month each. For the whole project period this amounts to a total of six months.

Subgoal 2: Collaboration on curricula development in Computational Science. Both universities are developing graduate programs in computational science. These programs are by nature cross-disciplinary and involve the development of courses which can be followed by students from many disciplines. The students form thus a rather heterogenous group and this poses pedagogical challenges on content, aims and learning outcomes.

The aim of this subgoal is to develop learning outcomes and course content and material for three graduate courses on Computational Science. These are courses of general interest and form part of the compulsory requirements of the Master of Science program Computational Science at the University of Oslo. Similar courses are offered at MSU and the aim here is to develop courses which can be taken by students from both universities, as well developing course material. The courses are 1) **Data analysis and machine learning**, 2) **High-Performance Computing with Numerical Projects**, and 3) **Mathematical modeling in Science**. The timeline for this subgoal is shown here.

Milestones	2018				2019				2020			
Learning outcomes and material for CS graduate courses				•	•	•	•	•	•	•	•	•

This subgoal aims at developing learning outcomes and teaching material for the above courses, spanning from lecture notes to numerical and computational projects. It will involve teachers from both universities. We estimate visits of one month per year for one university teacher each year, in total three months during the whole partnership period.

Subgoal 3: Development of advanced computational physics courses at both universities. Both universities offer selected advanced computational physics courses. The University of Oslo offers two advanced graduate courses, one on computational quantum mechanics and one on computational statistical mechanics, whereas MSU offers more topical courses on advanced topics, spanning from Computational Astrophysics to a more general course on computational physics.

This subgoal aims at offering a series of courses on computational physics which can be followed by students at both universities, either online or via the exchange program between MSU and UiO. The courses we will develop are 1) **Advanced Computational Quantum Mechanics**, 2) **Advanced Computational Statistical Mechanics** and 3) **Computational Astrophysics**. The timeline is shown here.

Milestones	2018				2019				2020			
Learning outcomes and material for graduate courses in Comp. Phys				•	•	•	•	•	•	•	•	•

We estimate visits of one month per year for one university teacher each year, in total three months during the whole partnership period.

This objective involves efforts from all participants. In order to achieve these goals we will organize annual workshops in addition to the exchange of university teachers and students that will be involved in the development of course material. The annual workshops will also involve the PICUP project in the USA and interested university teachers from other universities as well.

The deliverables from this objective will also consist of new textbooks. The exercises, examples and projects that will be developed will form the basis for a textbook to be published by Springer's series Undergraduate Texts in Physics. The preliminary title is **How to introduce computing in basic physics courses** [3]. Along similar lines, new textbooks that include computing will be published. One textbook on Mechanics has already been published [4], while one textbook on Waves and Motion [5] and one on Statistical Physics [6] have been accepted for publication in Springer's series **Undergraduate Texts in Physics**. A new textbook on quantum physics with computations is planned for 2019 [7].

These books will all be open access and will provide our community with new educational resources and textbooks that implement a computational perspective in basic physics education.

5.2 Objective 2: Education research and development of an assessment program

Subgoal 1: Developing an assessment program. An important aspect of this project is to establish new assessments and new assessment methods that address several issues associated with integrating computation into science courses. The issues include but are not limited to how well students learn computing, what new insights students gain about the specific science through computing, and how students' affective states (e.g., motivation to learn, computational self-efficacy) are affected by computing. Broadly speaking, these assessments should provide deeper insights into the integration of computing in science education in general as well as provide a structured framework for assessment of our efforts and a basis for systematic studies of student learning. The central questions that our research must address are 1) How can we assess the effect of integrating computing into science curricula on a variety of learned-centered constructs including computational thinking, motivation, self-efficacy and science identity formation, 2) how should we structure assessments to ensure valid, reliable and impactful assessment, which provides useful information to our program and central partners, and finally 3) how can the use of these structured assessments improve student outcomes in teacher-, peer-, and self-assessment.

Addressing these questions requires a combination of qualitative techniques to construct the focus of these assessments, to build assessment items and to develop appropriate assessment methods, and quantitative techniques, including advanced statistical analysis to ensure validity and reliability of the proposed methods as well as to analyze the resulting data.

The learning objectives and learning outcomes for computational methods developed as part of the first objective form parts of the basis for the assessment program, and we will also investigate the assessment of non-content learning goals such as self-efficacy and identity formation. We will develop assessment methods that determine how students master and achieve the learning goals and how the integration of computing affects students more broadly.

The effect of integration of computational methods into basic science courses have been sparsely studied, primarily because the practice is sparse. Further progress depends now on the development of assessments that can be used for investigative, comparative and/or longitudinal studies and to establish best practices in this emerging field. Some assessments will be developed for specific courses, but we will aim for broad applicability across institutions.

The timeline for this subgoal is listed here.

Milestones	2018				2019				2020			
Assessment program for undergraduate courses in Computational Science			•	•	•	•	•	•	•	•	•	•

Subgoal 2: Research on learning at the graduate level. Our first objective outlined an extensive program on development of learning outcomes for the introduction of computations in science courses, with an emphasis on Physics. Based on the learning outcomes for the advanced computational science courses discussed here, we aim in this subgoal to define an educational research approach to graduate courses. The emphasis will be on the transfer of knowledge and skills from the undergraduate level to explicit research training and applications to advanced scientific problems. This links the development of a research learning environment at the graduate level with many of the same topics we described above at the undergraduate level. Further, non-content assessments will be particularly useful here as the graduate population in science is different from the general student population.

The timeline for this subgoal is listed here.

Milestones	2018				2019				2020			
Assessment program for graduate courses in Computational Science							•	•	•	•	•	•

This objective will include mutual research visits and efforts from all participants. This includes also graduate students and post-doctoral researchers at both universities. In total we estimate two student/post-doctoral exchanges of up to two months each per year and exchanges of two researchers every year with duration of one month per stay. In total this amounts to 18 months during the whole period.

5.3 Objective 3: Developing intensive courses for university teachers.

An important deliverable of this partnership is the development of courses in Natural Science that include computations and numerical modeling. The target groups are university teachers, students and teaching assistants. These will be intensive one-week courses preferentially taught during the summer breaks at both universities. These courses will include teaching practices and learning material that can aid university teachers in including computational exercises and projects. The courses will also include an introduction to basic programming elements, with an emphasis on pedagogical aspects.

Based on the course material to be developed, this subgoal includes the development of new textbooks and will constitute one of the deliverables of this proposal. The abovementioned textbook with preliminary title **How to introduce computing in basic physics courses** [3]. This textbook will be published by Springer's **Undergraduate Texts in Physics**. The developed material and the textbooks will be freely accessible.

The intensive course will be organized annualy at each partner university. The timeline is listed here The timeline for this subgoal is listed here.

Milestones	2018				2019				2020			
Intensive course for university teachers		•				•				•		

This objective will include efforts from all participants. In addition we expect that both undergraduate and graduate students will contribute to the development of learning material and participate actively in all subgoals. The estimated amount of participants per year is approximately 15-20 university teachers and students.

5.4 Budget

The activities include mobility of researchers and students, the organization of annual workshops on Computing in Science Education and annual courses for university teachers held at both universities. We estimate at least fifty or more participants for each annual workshop and at least 15-20 university teachers and students attending the intensive courses. The budget includes the organization of these activities, see the table below.

The budget includes also planning and exchanges of teachers and students in order to write new textbooks and learning material as well as participating in education research at both universities. For the latter we expect that PhD students at both universities will spend time at the other university in order to conduct research on various assessment approaches. In total we estimate that each annaul workshop will cost 500 kNOK. We have in total 30 months of exchanges, of which we estimate twelve to be exchanges of students and/or post-doctoral fellow. We estimate these expenses to total 1500 kNOK. Finally the development of courses and schools and planning research exchanges amount to the remaining 1500 kNOK. Own efforts total 1125 MNOK.

Activities	2018	2019	2020	Total INTPART	Total project cost
Expenses due to researcher and student mobility	500	500	500	1500	1500
Annual workshops, seminars and conferences	500	500	500	1500	1500
Development of courses and schools	400	400	400	1200	1200
Planning and development of research exchange	100	100	100	300	300
Own efforts	364	375	386		1125
Total (in kNOK)	1864	1875	1886	4500	5625

6 The project's feasibility, risk analysis and risk-prevention measures

The technological and financial risks are low. Financing is approved by the contributing partners and the center of excellence in education **Center of Computing in Science Education** will oversee the developments and progress of the various milestones. Fellowships for PhD students and post-doctoral fellows that will participate in the assessment program and the development of learning material will be financed by the participating units. We see essentially no problems in recruiting good students who will participate in the research programs since we can hire exceptional programming talent from our computational science and physics programs at UiO and MSU, as well as from other institutions.

Organizational risks for the implementation of educational change in higher education is often non-negligible. However, we have a strong culture for spreading and effectuating educational innovations through the CCSE center. The present project is part of the strategic vision of CCSE and its management, administration and teaching faculty are fully committed to the outlined activities and objectives.

7 Plans for dissemination of knowledge and results from the partnership

The partnership has as deliverables several textbooks on computations in science courses, with an emphasis on physics courses as well as graduate courses on Computational Science. These textbooks will be published as open access books. Similarly, the teaching material that will be developed will be fully available via version control repositories and Internet hosting services like GitHub. This material will also be disseminated through the National Science Foundation sponsored PICUP project, a project that has as a central objective the integration of computing in university education.

The results from various assessments developed by the partnership is also an essential part of our dissemination. These results will be published in international journals with a peer review system and presented at international conferences. Along similar lines, teachers who introduce computing and numerical modeling in their courses, will be encouraged to disseminate their results.

Results on improved learning outcomes from new assessment technologies are also of interest to the broad public as well as to government, funding institutions and to industry where learning and assessment is becoming increasingly important to transform the workforce, in particular in areas related to the use of computing. Results from this project will be included in CCSE's communication to all these groups.

8 Additional perspectives

8.1 Relevance and benefit to society

The learning material developed by the partnership can be used by any higher-education institution that focuses on the integration of computing in science education. Combined with the learning outcomes and assessments developed to address the effect of computing in science education, this project will provide

unique opportunities as programming and the use of computational methods are integrated in educations nationally and internationally. The partnership between the newly established center of excellence in education CCSE and MSU has the potential to add significant new insights and experiences on how computing can be integrated in a seamless way in our basic science education. The outcome of the various research and educational projects are expected to be of great importance and transferable to universities worldwide.

8.2 Environmental impact

This project and its realization has no significant environmental impacts.

8.3 Ethical perspectives

Ethical aspects concerning student data, results and surveys and the use of results will be addressed by reporting to the National Centre for Research Data (NSD) in Norway and through our collaborators existing practices in the US. Here, all measurement methods, consent forms, and practices for presentation of data will be presented and reviewed. Ethical aspects of intervention studies with randomized methods for formative feedback will be carefully addressed throughout the study. We will not initiate interventions that do not have high probability for good learning outcomes for the students.

8.4 Gender issues

The project will consist of both male and female researchers, and we will actively recruit female students and researchers for the various activities. Attitudes and learning outcomes when computing is integrated in science education is of particular interest for gender related issues. The assessments will include questions that address such issues specifically through studies of partecipation of female students in computing.

References

[1] See `http://www.uio.no/english/about/strategy`.

[2] See `https://www.regjeringen.no/en/dokumenter/meld.-st.-16-20162017/id2536007/`

[3] Marcos Daniel Caballero and Morten Hjorth-Jensen, *How to introduce computing in basic physics courses*, planned published as University Texts in Physics, Springer.

[4] Anders Malthe-Sørenssen, *Elementary Mechanics Using Python; A Modern Course Combining Analytical and Numerical Techniques*, Undergraduate Lecture Notes in Physics, (Springer, 2015).

[5] Arnt Inge Vistnes, *Waves and Motion with a Computational Perspective*, University Texts in Physics, Springer, accepted for publication.

[6] Anders Malthe-Sørenssen and Dag Kristian Dysthe, *Thermal and Statistical Physics Using Python*, University Texts in Physics, Springer, accepted for publication.

[7] Morten Hjorth-Jensen, *Quantum Physics with a Computational Perspective*, planned published as University Texts in Physics, Springer.

Curriculum Vitae

Marcos D. Caballero[1,2] (caballero@pa.msu.edu)

[1]Department of Physics and Astronomy, Michigan State University
[2]Department of Physics, University of Oslo

April 4, 2017

A. Professional Preparation.

Institution	Location	Major/Area	Degree & Year
University of Texas at Austin	Austin, TX	Physics	B.S., 2004
Georgia Institute of Technology	Atlanta, GA	Physics	M.S., 2006
Georgia Institute of Technology	Atlanta, GA	Physics	Ph.D., 2011
University of Colorado Boulder	Boulder, CO	Physics Education	2011 - 2013

B. Appointments.

- 2017 - Now : Associate Professor, Department of Physics, University of Oslo
- 2013 - Now : Assistant Professor, Department of Physics and Astronomy, Michigan State University
- 2013 - Now : Leadership Faculty, CREATE for STEM Institute, Michigan State University
- 2011 - 2013: Science Teaching Fellow, Department of Physics, University of Colorado Boulder
- 2011 - 2013: Research Affiliate, School of Physics, Georgia Institute of Technology
- 2005 - 2011: Graduate Teaching and Research Assistant, Georgia Institute of Technology

C. Products. *(i) Recent products most closely related to the proposed project*

- M.D. Caballero and S.J. Pollock, *A Model for Integrating Computation in Undergraduate Physics: An example from middle-division classical mechanics*, Am. J. Phys., 82, 231, 2014.
- M.D. Caballero and S.J. Pollock, *Assessing Student Learning in Middle-Division Classical Mechanics/Math Methods*, 2013 Proceedings of the Physics Education Research Conference, 81, 2014.
- M.D. Caballero, J.B. Burk, J.M. Aiken, S.S. Douglas, E.M. Scanlon, B.D. Thoms, and M.F. Schatz, *Integrating Numerical Computation into the Modeling Instruction Curriculum* , Phys. Teach., 52, 38, 2014.
- M.D. Caballero, M.A. Kohlmyer, and M.F. Schatz, *Implementing and assessing computational modeling in introductory mechanics* , Phys. Rev. ST Phys. Educ. Res. 8, 020106, 2012.
- M.D. Caballero, M.A. Kohlmyer, M.F. Schatz, et al., *Comparing large lecture mechanics curricula using the Force Concept Inventory: A five thousand student study*, Am. J. Phys., 80, 7, 2012.

(ii) Other significant products

- M.M. Cooper, M.D. Caballero, D. Ebert-May, C.L. Fata-Hartley, S.E. Jardeleza, J.S. Krajcik, J.T. Laverty, R.L. Matz, L.A. Posey, and S.M. Underwood *Challenge faculty to transform STEM learning*, Science, 350 (6258), 281-282, 2015
- L. Ding and M.D. Caballero *Uncovering the hidden meaning of cross-curriculum comparison results on the Force Concept Inventory*, Phys. Rev. ST Phys. Educ. Res., 10, 020125, 2014.
- B.R. Wilcox, M.D. Caballero, and S.J. Pollock, *Analytic framework for students' use of mathematics in upper-division physics*, Phys. Rev. ST Phys. Educ. Res. 9, 020119, 2013
- S.V. Chasteen, R.E. Pepper, M.D. Caballero, S.J. Pollock, and K.K. Perkins, *The Colorado Upper-Division Electrostatics (CUE) diagnostic: A conceptual assessment for the junior level*, Phys. Rev. ST Phys. Educ. Res. 8, 020108, 2012.
- M.A. Kohlmyer, M.D. Caballero, M.F. Schatz, et al., *A Tale of Two Curricula: Performance of two thousand students in introductory electromagnetism*, Phys. Rev. ST Phys. Educ. Res. 5, 020105, 2009.

D. Synergistic Activities.

- *Collaborative Research: Fostering integration of computational practices into physics courses - A local communities approach*, NSF DUE #1504786. M.D. Caballero (PI) $40,526. Development of a grassroots computational physics education community.
- *Collaborative Research: Integrating Computation into Undergraduate Physic - Faculty Development Approach to Community Transformation*, NSF DUE #1524128. M.D. Caballero (PI). $503,977. Development, implementation, and study of a community for computational physics instruction.
- *Collaborative Research: Surveying the state and implications of computational physics in courses for physics majors*, NSF DUE #1431776. M.D. Caballero (PI). $21,380. Development, implementation, and assessment of the statement of computational physics education.
- *LEVERS: Leveraging Engagement and Vision to Encourage Retention in STEM*, HHMI, 2013. S. Chivukula (PI), M.D. Caballero (physics project lead). $1,500,000 ($306,743 for physics). Development, implementation, and assessment of physics laboratories.
- *Service Work*: APS GPER Chair 2017 - AAPT RiPE Committee Member 2015 - AAPT Ed. Tech Committee Chair 2013 - 2014; AAPT Ed. Tech Committee Member 2011 - 2014; Am. J. Phys. 5-year review committee 2012

Curriculum vitae – Ellen Karoline Henriksen

Name: Ellen Karoline Henriksen
Born: December 20th, 1968
Nationality: Norwegian
Position: Professor, Department of Physics, University of Oslo
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Web page: http://www.mn.uio.no/fysikk/personer/vit/ekarolin/

Expertise

- Research leadership experience from international (EU) and national projects within physics/science education research
- Extensive knowledge and national and international network within the field of science/physics education research
- 15 years experience of physics/science teacher education and development of courses and course material

Summary
Ellen K. Henriksen is professor of physics education in the Physics Education research section, Department of Physics, University of Oslo. Since 2013 she leads the section. Her work consists of science education research (see below), science teacher education (pre-service and in-service), supervision of masters and PhD students, and science communication and recruitment efforts. Her research falls mainly into three strands: 1) Teaching and learning physics with a special emphasis on modern physics; 2) physics/science teacher education and professional development; and 3) young people's educational choices concerning science and technology higher education. Henriksen led the project IRIS (Interests and Recruitment In Science), which was funded by the European Commission (FP 6) and included 6 partner institutions in 5 European countries. She presently leads project ReleQuant, which combines development of digital learning resources in modern physics for pupils with research on pupils' learning processes and motivation in physics as well as research on how physics teachers and teacher students develop their professional competence through participating in the development project.

Professional experience

1999-	Senior lecturer, then associate professor and since 2014 full professor of physics education at the Department of Physics, University of Oslo
2014	Completed the UiO's Leadership education (10 full course days plus course work in-between)
2013-	Leader of the Physics education research section
2013-	Elected member of the Executive board of the European Science Education Research Association, ESERA – organization with 1400 members from more than 50 countries
2013-	Leader of the research and development project ReleQuant, funded by the Norwegian Research Council, 2 national collaborating partners and 5 partner schools
2012-	Member of the international scientific committee for the Swedish National Graduate School in Science, Mathematics and Technology Education Research
2009-2012	Leader of the EU-funded (FP 7) IRIS research consortium with 6 academic member institutions in 5 European countries
2009-2012	Member of the program council for the 5-year integrated teacher education program, UiO

Education

1999	PhD, Physics education, Department of Physics, University of Oslo
1993	MSc, Physics, Department of Physics, University of Oslo
1987-88:	One year of undergraduate studies in physics, geology and the history of science at the University of Glasgow

Teaching and course planning/development (in collaboration with collegaues):

2014- Developed and implemented continued education in natural science for teachers in years 8-11 (secondary school), altogether 30 credit points/ects

2013 - Developed in-service education in physics for primary school teachers

2009-2013 Developed and implemented an in-service continued education package in physics for upper secondary teachers (60 credit points/ects).

2003 - Developed and implemented two regular physics/science courses (10 ects each) in the science teacher education program, UiO: "Science in practice" and "Experiments in physics teaching"

Grants obtained:

ReleQuant Competence, grant from the Norwegian Research Council, 2015-2018, 4993 kNOK
ReleQuant, research grant (NOK 870 000) from the Olav Thon Research fund in 2015-2016 and "seed grants" from the University of Oslo in 2013 (kNOK 68), 2014 (kNOK 150) and 2015 (kNOK 70).
Project IRIS: EU / FP 7 grant of 999 kEUR, 2009-2012.

Supervision:

- Principal supervisor for 4 and co-supervisor for 2 students who finished PhD degrees (2011-2017)
- Principal supervisor for 2 present PhD students (2015 -)
- Supervisor or co-supervisor for a total of 14 Master's students (2001-2017)

Recent research papers

Jensen, F., Henriksen, EK, Holmegaard, HT, Madsen, LM and Ulriksen, M (2017). Balancing Cost and Value: Scandinavian Students' First Year Experiences of Encountering Science and Technology Higher Education. *Accepted for publication in Nordic Studies in Science Education*.

Bungum, Berit; Henriksen, Ellen Karoline; Angell, Carl; Tellefsen, Cathrine Wahlstrøm & Bøe, Maria Vetleseter (2015). ReleQuant - improving teaching and learning in quantum physics through educational design research. *Nordic studies in science education 11*(2), pp 153- 168

Henriksen, Ellen Karoline; Bungum, Berit; Angell, Carl; Tellefsen, Cathrine Wahlstrøm; Frågåt, Thomas & Bøe, Maria Vetleseter (2014). Relativity, quantum physics and philosophy in the upper secondary curriculum: Challenges, opportunities and proposed approaches. *Physics Education* 49(6), pp 678- 684

Henriksen, EK, Jensen, F and Sjaastad, J (2014). The role of out-of-school experiences and targeted recruitment efforts in Norwegian science and technology students' educational choice. *International Journal of Science Education, Part B,* 1-20. doi: 10.1080/21548455.2014.900585

Bøe,MV & Henriksen, EK (2013). Love it or leave it. Norwegian students' motivations and expectations for post-compulsory physics. *Science Education* Vol 97 (4*) s. 550-573*

Bøe, MV, Henriksen, EK, Lyons, T. and Schreiner, C. (2011). Participation in Science and Technology: Young people's achievement-related choices in late modern societies. *Studies in Science Education, 47*(1), 37-72.

Henriksen, Ellen Karoline & Angell, Carl (2010). The role of "talking physics" in an undergraduate physics class using an electronic audience response system. *Physics Education*. ISSN 0031-9120. *45*, s 278- 284

Books and book chapters

Henriksen, EK, Dillon, J. and Ryder, J. (eds.), 2014: *Understanding student participation and choice in science and technology education.* Dordrecht: Springer. ISBN 978-94-007-7792-7

The book includes the following chapters which I have (co-)authored:

i) Henriksen, EK: Chapter 1: Introduction: Participation in science, technology, engineering and mathematics (STEM) education - presenting the challenge and introducing project IRIS
ii) Bøe,MV & Henriksen, EK: Chapter 2: Expectancy-value perspectives on choice of science and technology education in late-modern societies
iii) Jensen, F. and Henriksen, EK: Chapter 9: Short stories of educational choice – in the words of science and technology students
iv) Henriksen, EK, Dillon, J. and Pellegrini, G.: Chapter 22: Improving participation in science and technology higher education: Ways forward

Angell, C; Bungum, B; Henriksen, EK; Kolstø, SD; Persson, RJ & Renstrøm, R (2011). *Fysikkdidaktikk [Physics education]*. Cappelen Damm Høyskoleforlaget [Norwegian Academic Press]. ISBN 978-82-7634-878-1. 436 pages

ROLE IN PROJECT

Project manager ☐ Collaborator ☒

PERSONAL INFORMATION

Family name, First name: Malthe-Sørenssen, Anders

Date of birth: *13.02.1969*

Sex: Male

Nationality: Norway

EDUCATION

1998	PhD: *Disputation date: 24.08.1998.* Department of Physics, University of Oslo, Norway
1994	MSc, Department of Physics, University of Oslo, Norway

CURRENT AND PREVIOUS POSITIONS

2016-	Director, Center for Computing in Science Education, A Center for Excellence in Education, University of Oslo, Norway
2006-	Professor, Department of Physics, University of Oslo, Norway
2012-	Section Leader, Condensed Matter Physics (10 faculty, 10 post-docs, 30 phd-students), Department of Physics, University of Oslo, Norway
2004-2008	Group leader and educational coordinator, Physics of Geological Processes, a Center of Excellence at University of Oslo
2002-2004	Division lead, Physics of Geological Processes, University of Oslo
2001-2002	Vice President of Technology in Photonyx, a company developing a light modulator for use in fiber optics. Raised $7.5 million of venture capital. Inventor of main technology patent. The company went public in 2003 and was at most valued at 1 billion kr.
1999-2001	Post-doc at University of Oslo, Visiting Scholar at Stanford University
1995-2003	Author of FramView, a simulation tool for physics-based forward modeling of geological deformation processes used to detect small-scale fractures.

FELLOWSHIPS AND AWARDS

2015	250kkr, Prize for Best learning environment, University of Oslo
2015	500kkr, National Prize for excellence in education, Thon Foundation
2012-2013	100kkr, Fulbright Scholar
2012	300kkr, Prize for Excellence in Education, Ministry of education, Norway
2011	250kkr, Prize for Best learning environment, University of Oslo
2001	100kkr, Nansen Prize for Young Researchers, Norw. Acad. of Science and Letters
1999	His Majesty the King's Gold Medal for best PhD-thesis in science, UiOo
1995	IBM Prize for excellent achievements in parallel computing

MAJOR COLLABORATIONS AND GRANTS

Principal investigator

2016	1.5 Mkr, Cross-disciplinary research projects for undergraduate students, Thon Foundation
2016	50 Mkr, Center for Computing in Science Education, 1 of 4 national centers in Norway
2015	4.5 Mkr, US-Norwegian collaboration on fluid-consuming transformational processes, International Partnership for Excellence in Research and Education, NRC (25% success rate) collaboration between Columbia Univ., Univ. of Maryland and Univ. of Southern California.
2014	8 Mkr, Coupled Processes in Gas Hydrates, NRC FriPro (5% success rate)
2014	8 Mkr, ShaleSeq - Physiochemistry of CO2 sequestration in Pomerian shales, Polish-Norwegian EU project.
2012	8 Mkr, Multiscale physics on the computer, NRC Institute Strategic Project
2011	3.5 Mkr, Numerical Modeling of shale-gas extraction processes, VISTA
2011	10 Mkr, Tight rocks - fundamentals, Statoil, Norway
2010	5.7 Mkr, Permanent CO2 storage by in situ injection in ultramafic rocks, NRC Climit
2004	4.7 Mkr, Formation of piercement structured in sedimentary basins, NRC Petromaks

Co-principal investigator (selected recent grants)

2016-2020 25Mkr, EarthFlows, Strategic Faculty Project, University of Oslo, responsible for 1 postdoc.

2014-2018 25 Mkr, CINPLA, Center for Integrative Neuroplasticity, Strategic Faculty Program, University of Oslo, responsible for 2 PhD-students.

2016-2020 45 Mkr, DigiBrain, Innovation project from Digital Life Norway directed by Marianne Fyhn, responsible for 1 PhD-student and 1 postdoc.

2016-2020 25 Mkr, BrainMatrix, ToppForsk project directed by Marianne Fyhn, responsible for 1 PhD-student.

2013-2017 8 Mkr, Cross-scale modelling of CO2/hydrocarbon conversion in hydrofractured shale, FriPro project directed by Clas Persson, responsible for 1 postdoc.

MOBILITY

2012-2013 Visiting Professor, Collaboratory for Advanced Computing and Simulations, University of Southern California, USA

SUPERVISION OF GRADUATE STUDENTS AND RESEARCH FELLOWS

Post-doctorate fellows (6): Nicolaas Groeneboom (2016-2017); Alexandru Botan (2014-2016); Ole Ivar Ulven (2014-2017); Maya Kobchenko (2014-2016); Jan Ludvig Vinningland (2009-2010); Henrik Svenssen (2007-2009); Adriano Mazzini (2004-2007, 2010-2011).

Doctorate students (12 finished + 10 current): Andreas Solbrå (2014-2018); Svenn-Arne Dragly (2014-2018); Milad Mobarhan (2014-2018); Elise Holter Thompsen (2016-2019), Solveig Næss (2016-2020); Øyvind Gløersen (2015-2018); Marte Julie Sætra (2016-2020); Anders Hafreager (2014-2018); Henrik Sveinsson (2014-2018); Jørgen Høgberget (2013-2016); Anne Bergsaker (2013-2016); Sigve Skattum (2013-2017); Kjetil Thøgersen (2013-2016); Piyoosh Jaysaval (2013-2016); Jørgen Trømborg (2011-2015); Ole Ivar Ulven (2010-2014); Andreas Hafver (2010-2014); Maya Kobchenko (2010-2013); Anja Røyne (2008-2011); Simon de Villiers (2006-2010); Anders Nermoen (2007-2009); Espen Jettestuen (2001-2005).

TEACHING ACTIVITIES

2011-2016 "Statistical and thermal physics", a bachelor course with 150 students. Developed a 500 pg textbook with integrated numerical methods, accepted for publication by Springer in 2017.

2007-2012 Developed and lectured "Introduction to Mechanics" with 250 students. Developed two 600 page textbooks with integrated numerical methods published by Springer in 2015. The textbooks are among Springers bestsellers with over 80,000 chapter downloads since 2015.

2005-2016 Developed and lectured a new course on Compuational Physics of Disorded Media (Fys4460). Developed Matlab and Python interactive exercises and wrote a 250 page textbook under preparation for international publication.

2003-2007 Developed and headed the new cross-disciplinary master program for PGP. Designed three new cross-disciplinary courses combining geoscience, physics and computer science.

INSTITUTIONAL RESPONSIBILITIES

2017-2021 Member, Board of Faculty for Mathematics and Natural Science, Univ. of Oslo

2011-2017 Leader of Bachelor program in Physics (100 students/yr), at the University of Oslo

2013-2017 Member, Program board for Bachelor program in Mathematics, Univ. of Oslo

2012-2013 Member, Educational Board, Faculty for Education, University of Oslo

2003-2007 Leader, Master program in Physics of Geological Processes, University of Oslo

COMMISSIONS OF TRUST

2013-2016 Editorial Board, Frontiers in Physics

2001-2003 Scientific Advisory Board, Teknoinvest, a major Scandinavian Venture Fund.

2005-2017 Reviewer for Israeli, Dutch and Danish Science Foundations.

MEMBERSHIPS OF SCIENTIFIC SOCIETIES

2016 Elected member of Norwegian Academy of Science and Letters

Track record

My research has focused on fundamental problems in statistical physics (prior to 2000), the physics of geological processes (from 1996) – an interdisciplinary program between physics, geoscience, and computer science – with particular focus on forward modeling and multi-scale models, fundamental studies of friction (from 2009), and the dynamics of liquids confined to nanopores and nanofractures (from 2012). I was instrumental in building a CoE – Physics of Geological Processes (PGP) – and in establishing PGP as a new field of science. The research in the center was based on my collaborations with geoscientists starting in 1996, and my modeling work was a major component in all projects at the center. Both PGP and my modeling work are now internationally recognized brands, synonymous with high-quality quantitative studies of geological processes.

I have published 59 articles in reviewed journals, that have been cited 2998 times, with an h-index of 25. I have published 3 articles in Nature and 1 article in PNAS. In addition, I have published two 600 page international textbooks in physics with over 80.000 paid downloads.

Selected publications: Physics of Geological Processes - Volcanic processes

Volcanic intrusion processes have first order impacts on the evolution of the Earth and its climate, and present fundamental problems in physics and geoscience. My research has led to several breakthroughs, e.g. the front page of Nature in 2004 [CV2]. The work also resulted in breakthrough results in mud volcanism [2] and magma emplacement [3]. The activity formed the basis for Volcanic Basin Petroleum Research, a company with 10 employees, and the ERC Starting grant for my post-doc, Adriano Mazzini [2].

[1] H. Svensen, S. Planke, L. Chevallier, A. Malthe-Sørenssen, F. Corfu, B. Jamtveit. Hydrothermal venting of greenhouse gases causing Early Jurassic global warming, *Earth and Planetary Science Letters* (2007) **256**, 554-566, (**166** cit.).

[2] A. Mazzini, H. Svensen, G. G. Akhmanov, G. Aliosi, S. Planke, A. Malthe-Sørenssen, B. Istadi. Triggering and dynamic evolution of the LUSI mud volcano, Indonesia, *Earth and Planetary Science Letters* (2007) **261**, 375–388, (**154** cit.).

[3] S. Polteau, A. Mazzini, O. Galland, S. Planke, A. Malthe-Sørenssen. Saucer-shaped intrusions: Occurrences, emplacement and implications, *Earth and Plan. Sci. Let.* (2008) **266**, 195, (**80** cit.).

Selected publications: Physics of Geological Processes – Mechano-chemical processes

I have built a world-leading activity in geological processes by developing and applying an understanding of geological fracture processes to understand how fracturing is coupled to chemical reactions and fluid transport across scales. I have built a large team supporting this research and achieved several *breakthroughs* in our understanding of mineralogical processes across scales..

[4] A.Malthe-Sørenssen, B. Jamtveit, P. Meakin. Fracture Patterns in Chemical Decomposition of Solids. *Physical Review Letters* (2006) **96**, 245501, (**42** cit.).

[5] A. Røyne, B. Jamtveit, J. Mathiesen, A. Malthe-Sørenssen. Controls on weathering rates by reaction induced hierarchical fracturing, *Earth and Plan. Sci. Lett.* (2009) **275**, 364–369, (**49** cit.).

[6] B. Jamtveit, C. Putnis, A. Malthe-Sørenssen. Reaction induced fracturing during replacement processes, *Contributions to Mineralogy and Petrology* (2009) **157**, 127–133, (**72** cit.).

Selected publications: Friction

We have been the first to explain a series of high-impact experimental papers on the onset of sliding friction. Experiments showed that sliding occurs through slow fronts that propagate along contacting interfaces. Our multi-scale model [7,8,9] allowed us to explain the experimental results from a microscopic model of individual contacts, and to predict that the traditional friction law of Amontons and Coloumb found in textbooks must be reformulated to include the effect of slip history. This represents a *fundamental breakthrough* in our understanding of friction [9].

[7] J. Trømborg, J. Scheibert, D. S. Amundsen, K. Thøgersen , A. Malthe-Sørenssen. Transition from static to kinetic friction: insights from a 2D model, *Physical Review Letters*, (2011) 107, 074301. (**51** cit.).

[8] D. S. Amundsen, J. Scheibert, K. Thøgersen, J. Trømborg, A. Malthe-Sørenssen. A 1D Model of Precursors to Frictional Stick-Slip Motion Allowing for Robust Comparison with Experiments, *Tribology Letters* (2012) **45**, 357. (**37** cit.).

[9] J. K. Trømborg, H. A. Sveinsson, J. Scheibert, K. Thøgersen, D. S. Amundsen, A. Malthe-Sørenssen. Slow slip and the transition from fast to slow fronts in the rupture of frictional interfaces, *Proceedings of the National Academy of Sciences* (2014) **111**, 8764-8769. (**9** cit.).

Selected publications: Nano-porous systems

In 2012 I initiated an activity on the behavior of confined fluids and their importance for geological processes. In confined spaces the behavior of water and the fundamentals of thermodynamics change. The

first result from this initiative shows that Arrhenius-type transport and reaction rates need to be rethought in nano-porous structures.
[10] A. Shehkar, R. K. Kalia, A. Nakano, P. Vashishta, C. K. Alm, A. Malthe-Sørenssen, Universal stretched exponential relaxation in nanoconfined water, *App. Phys. Lett.* (2014) **105**, 161907 (**2** cit.).

Granted patents
The patent [1] formed the basis of Phytonyx, a high-technology company, and describes an electronically controllable thin polymer film that could be used as a tunable, dynamic optical grating. The company went public as Ignis ASA in 2003 and was later bought by a competitor. It has laboratories in Norway, Sweden, Denmark, Russia and Canada and employs several hundred engineers and researchers. Several new start-ups have spun off from this company.
[1] A. Malthe-Sørenssen, E. Zimmer, T. Natestad, B. Jacobson, Method and device for variable optical attenuator, *US6897995*, Published May 24, 2005. (**9** citations)
The cross-disciplinary work between physics and geoscience resulted in a patented technology and a software platform for forward modeling of geological systems for use in combination with seismic interpretation and analysis.
[2] A. Malthe-Sørenssen, T. Walmann, T. Jossang, J. Feder, H. H. Hardy, Method of modeling of faulting and fracturing in the Earth, *US7089166, US7043410, US7031891*, Publ. Aug 8, 2006. (**26** cit.)

Invited presentations (selected)
[1] B. Jamtveit, O. Plumper, A. Røyne, A. Malthe-Sørenssen, Mechanism of reaction driven porosity and permeability generation, (Keynote) *Goldschmidt Conference*, Montreal, (2012).
[2] A. Malthe-Sørenssen. Anomalous dynamics of water confined in nanoporous silica, Biocomplex presentation series, Niels Bohr Institute (2013).
[3] B. Jamtveit, O. I. Ulven, A. Malthe-Sørenssen, Fluid-driven metamorphism, American Geophysical Union, Fall Meeting (2014).
[4] A. Malthe-Sørenssen, J. K. Trømborg, J. Scheibert, H. Sveinsson, K. Thøgersen, Meso-scale modeling of friction, CECAM workshop, Tel Aviv, (2014).
[5] O. I. Ulven, A. Malthe-Sørenssen. Subarctic physicochemical weathering of serpentinized peridotite, (Keynote) Nordic Geological Society Winter Meeting, Jan 12, (2015).

Prizes/Awards/Academy memberships
[1] University of Oslo Prize for Best Learning Environment (250kkr), 2015
[2] National Prize for Excellence In Education (500kkr), Thon Foundation, 2015. This was the first time this prize was awarded and I received one of the two prizes awarded.
[3] Fulbright Scholar, (100kkr), 2013.
[4] Norwegian Ministry of Education Prize for Excellent Learning Environment (200kkr), 2012.
[5] University of Oslo Prize for Best Learning Environment (250kkr), University of Oslo, 2011.

Major contributions to the early careers of excellent researchers
[1] Adriano Mazzini, my post-doc on mud volcanoes, including the LUSI mud volcano, from 2004 to 2007 and from 2010 to 2011, received an **ERC Starting grant** on "Lusi: a unique natural laboratory for multidisciplinary studies of focused fluid flow in sedimentary basins", 2013-2017. (See publication [2] above)
[2] Jørgen Trømborg received HMK Gold Medal for best PhD thesis in Science at UiO in 2016.

Curriculum Vita

Knut Martin Mørken
Professor

Department of Mathematics
Centre for Computing in Science Education
Faculty of Mathematics and Natural Sciences
University of Oslo

Date: May 19, 2017

Date and place of birth: Tønsberg, Norway, July 17, 1957.
Citizenship: Norwegian.
Civil status: Married.

Education

- Cand. mag, University of Oslo, 1979.
- Cand. real., Department of Informatics, University of Oslo, June 1984.
- Dr. Scient, Department of Informatics, University of Oslo, June 1989.

Employment

- Research Fellow, Department of Computer Science, University of Reading, England, February 1982 – July 1982.
- Research Assistant, Department of Informatics, University of Oslo, Aug. 1, 1984 – March 31, 1990.
- 1. amanuensis (Associate Professor), Department of Informatics, University of Oslo, April 1, 1990 – April 30, 1995.
- Professor, Department of Informatics, University of Oslo, May 1, 1995 – February 28, 2013.

Present positions

- Professor, Department of Mathematics, University of Oslo, March 1, 2013 – present.
- Member of the Centre of Mathematics for Applications, a centre of excellence funded by the Norwegian Research Council, March, 2003 – March, 2013.
- Project leader for a major revision of all science programmes (education programmes) at the Faculty of Mathematics and Natural Sciences (MN-Faculty), August 1, 2012 – present.
- Member of the Centre for Computing in Science Education, a national centre of excellence in education, December 1 – present.

Research interests

My research interests are in computational mathematics, particularly approximation of functions and data with a special emphasis on approximation with piecewise polynomials (spline functions) and wavelets. This includes applications in areas like for example geometric modelling, image processing, data compression, signal processing etc.

Education development

My interest in education development started when in 2000 I was asked to take responsibility for revising and teaching the traditional, introductory module in calculus by providing a variant with a more computational perspective. From the beginning, I envisaged this computational perspective to

be based on programming, not merely the use of advanced calculators. As a result of the major, national educational reform in 2003 the variants other than the computational one were terminated.

CSE. The 2003 national reform of higher education, and the forming of the centre of excellence in research in the same year, Centre of Mathematics for Applications (CMA), brought together researchers from mathematics, informatics and physics with a common vision for a coherent and aligned computational perspective on the elementary teaching of mathematics and science. This led to the formation of the project *Computing in Science Education*. This project is a typical 'bottom-up' project with a core of enthusiastic colleagues (I have acted as project leader since the project was formalised).

In 2005 the CSE vision was included in the MN-Faculty's strategic plan. Since then CSE has become well established at the MN-Faculty, particularly in the math-heavy disciplines.

Dissemination of CSE. CSE has been developed in all math-heavy subjects, and increasingly in other subjects. It has been presented in numerous talks, particularly guest lectures, but also at conferences, nationally and internationally.

In particular I have been invited to present CSE at seminars at the National University of Defence Technology in Changsha, China and leaders of this University have visited the University of Oslo.

In 2011 I worked closely with national education authorities to include CSE perspectives in the new national framework for engineering education, giving invited talks at many institutions.

The CSE-project is now continued in the Centre for Computing in Science Education (CCSE), which became a national Centre of Excellence in Education on December 1, 2016 with professor Anders Malthe-Sørenssen as director.

General education development. Since 2011 I have worked closely with the MN-Faculty's coordinator of studies, Hanne Sølna, in trying to identify the success behind CSE and bring the enthusiasm of CSE to education in general. This has resulted in a broad holistic initiative on education development in mathematics and all the sciences, *InterAct — Culture for learning*. More specifically, the aim is to obtain more coherence and synergy between related modules, make methods and perspectives from research and industry visible at the elementary level, and integrate generic competencies systematically in all modules. This is supported by an explicit awareness of the importance of the relational learning environment among students and more generally the academic culture, the relations between all staff and between staff and students. I am project leader for this work in close collaboration with the deans and the various leaders at the MN-Faculty's departments.

Highlights — Education

- Has taught modules in numerical analysis, approximation theory, signal processing and elementary calculus.
- Developed a new introductory module for first-term students in the mathematical sciences that combine calculus, numerical computation and digital representation of information, 2000 – present.
- Received the student's award for best teacher at the Faculty of Mathematics and Natural Sciences, Autumn 2003.
- Has supervised a large number of Master students in the period 1989 – present and has supervised six PhD-students.
- Project leader for *Computing in Science Education,* 2004 – 2016.
- Member of the scientific committee for the Winter meetings in eVITA, a research program in computational science governed by the Norwegian Research Council, 2007–2010.
- Leader of the board for the Bachelor programme *Mathematics, Informatics and Technology,* 2009 – present.
- Leader of a national work group that produced a guide for introducing a computational perspective at Norwegian universities and university colleges, supported by the Ministry of Education, 2010–2011.
- Leader of a national resource group Computing in Science Education, supported by the Ministry of Education via The Norwegian Association of Higher Education Institutions, 2012 – 2014.

- Member of a Think Tank at Renate, The National Centre for Recruitment to Science and Technology. This think tank discussed how the teaching of mathematics could be tailored to different personalities, based on psychology and neuroscience, 2012 – 2013.
- Leader of a workgroup with a mandate to review the organisation of IT in education at the University of Oslo, 2014
- Member of a strategic workgroup to review how the University of Oslo can better address educational quality as a follow-up from a report from the international Strategic Advisory Board, 2015–2016.
- Member of a national work group at the Norwegian Directorate for Education and Training to write a report about the need for technology and programming in the Norwegian school system.
- Member of the organising committee for the first SIAM conference on Applied Mathematics Education to be held in Philadelphia, USA, September 30 – October 2, 2016, see www.siam.org/meetings/ed16/

Prizes for teaching and education

- Received the student's award for best teacher at the Faculty of Mathematics and Natural Sciences, Autumn 2003.
- CSE received the University of Oslo's prize for best learning environment in 2011.
- CSE received NOKUT's national price (second price) for educational quality in 2012.
- Received the Olav Thon Foundation's National Prize for Excellence in Teaching, 2017.

Administrative work

- Administrative leader of the group for Mathematical Modelling at the Department of Informatics (comprising subgroups in image and signal processing and numerical analysis), 1993 – 1998. This administrative level ceased in 1998.
- Administrative leader of the research group in Computational Mathematics at the Department of Informatics, 1998 – February 28, 2013.
- Coordinator at the Department of Informatics for a major new teaching reform for higher education, 2001–2003.
- Member of the Board of the Faculty for Mathematics and Natural Sciences, elected as one of four representatives of the scientific staff at the Faculty, 2003–2004.
- Member of the Executive Board of the Faculty for Mathematics and Natural Sciences, 2003–2004.
- Chairman of a Faculty committee with a mandate to identify teaching challenges after the teaching reform and the challenge of reallocation of scientific resources within the University, Spring 2004.
- Deputy member of the Board of the Faculty for Mathematics and Natural Sciences, 2005–2008.
- Member of the Board of the Faculty for Mathematics and Natural Sciences, elected as only representative of the scientific staff, 2013–2016.

Miscellaneous

- Co-organiser of a number of conferences, including the series International Conference on Mathematical Methods for Curves and Surfaces in 2000, 2004, 2008, 2012, 2016.
- Invited talk and seminar at the 5th International Conference on Science and Mathematics Education in Developing Countries, March 1–3, 2012. ZAMAN UNIVERSITY, Phnom Penh, Cambodia.
- Invited to give a two-day seminar on how to develop a computational perspective on mathematics and science teaching at the National University of Defence Technology in Changsha, China, May 2014.
- Invited to an international workshop at Breckenridge, Colorado in August 2014 to prepare a report on development of research and education in Computational Science and Engineering, organised by SIAM.

Some publications

T. Lyche and K. Mørken, A data reduction strategy for splines with applications to the approximation of functions and data, IMA J. of Num. Anal. **8** (1988), 185–208.

K. Mørken, Contributions to the theory and application of splines, dissertation for the degree of dr. Scient., Dept. of Informatics, University of Oslo, 1989.

T. Dokken, M. Dæhlen, T. Lyche, and K. Mørken, Good approximation of circles by curvature continuous Bezier curves, CAGD **7** (1990), 33–41.

K. Mørken, Some identities for products and degree raising of splines, Constructive Approximation **7** (1991), 195–208.

T. Lyche and K. Mørken, Spline Wavelets on Arbitrary Knots, in *Numerical Methods in Approximation Theory*, Vol. 9, D. Braess and L. L. Schumaker (eds.), Birkhäuser, Basel, 1992, pp. 177–194.

K. Mørken, On total positivity of the discrete spline collocation matrix, Journal of Approximation Theory **84** (1996), 247–264.

K. Mørken and K. Scherer, A general framework for high accuracy parametric interpolation, Mathematics of Computation **66** (1997), 237–260.

T. Lyche and K. Mørken, The sensitivity of a spline function to perturbations of the knots, BIT **39** (1999), 305–322.

M. Dæhlen, T. Lyche, K. Mørken, R. Schneider and H. P. Seidel, Multiresolution analysis over triangles based on quadratic Hermite interpolation, Journal of Comp. and Appl. Math. **119** (2000), 97–114.

B.-G. Lee, T. Lyche, and K. Mørken, Some examples of quasi-interpolants constructed from local spline projectors, in *Mathematical Methods in CAGD: Oslo 2000*, T. Lyche and L. L. Schumaker (eds.), Vanderbilt University Press, Nashville, TN., 2001, pp. 243–252.

K. Mørken, On geometric interpolation of parametric surfaces, CAGD **22** (2005), pp. 838-848.

N. Foldnes, K. Mørken and A. I. Vistnes, A new world: The computer, computations and teaching of science (in Norwegian), Uniped (2005), a journal on University pedagogy.

K. Mørken and M. Reimers, An unconditionally convergent method for computing zeros of splines and polynomials, Mathematics of Computation, 2007, Volume **76**, pp. 845–865

S. O. Larsen, K. Mørken and E. Samset, Segmentation of the frozen region in MR images during cryo ablation in the liver, International Journal of Computer Assisted Radiology and Surgery 2007, **2**. Suppl. 1, pp. 479-479.

M. Hjorth-Jensen, K. Mørken, A. Myhre, and H. Sølna. Computers in Science Education: A new way to teach science? In *Ripples: Five years of flexible learning at the University of Oslo,* Susanne Kjekshus Koch (Ed.). Published by University of Oslo, 2008.

T. Lyche, K. Mørken and F. Pelosi, Stable, linear spline wavelets on nonuniform knots with vanishing moments, CAGD **26** (2009), pp. 203–216.

K. Mørken, M. Reimers and C. Schulz, Computing intersections of planar spline curves using knot insertion, CAGD **26 (**2009**)**, pp. 351–366.

X. C. Tai, K. Mørken, M. Lysaker, K. A. Lie, Scale Space and Variational Methods for Computer Vision, *Proceedings of the Second International Conference*, Voss, Norway, June 1–5, 2009, Lecture Notes in Computer Science, Vol. 5567, Springer Verlag, (2009).

K. Mørken, I. Simonsen, A. Malthe-Sørensen, H. Hammer, T. B. Løyning, J. E. Vatne, E. Nøst, L. O. Dahl, N. Sasaki, T. Skramstad, *Computing in Science Education. A guide for universities and colleges in Norway*. The Faculty of Mathematics and Natural Sciences, University of Oslo, 2011.

E. L. Melvær, K. Mørken, E. Samset, A motion constrained cross-wire phantom for tracked 2D ultrasound calibration. International Journal of Computer Assisted Radiology and Surgery, **7** (4) (2012), pp. 611-620.

M. Floater, T. Lyche, M.-L. Mazure, K. Mørken, L.L. Schumaker (eds), *Mathematical Methods for Curves and Surfaces, Proceedings of the Eigtht International Conference*, Oslo, Norway, June 28–July 3, 2012, Lecture Notes in Computer Science, Vol. 8177, Springer Verlag, 2014.

K. Mørken, H. Sølna, I. D. Villanger (2015), Hvordan skaper vi gode betingelser for læring? (in Norwegian. English title: How do we create good conditions for learning?). UNIPED, ISSN 1893-8981, **38** (4), pp. 264- 273.

A. Malthe-Sørenssen, M. Hjorth-Jensen, H. P. Langtangen, K. Mørken (2015), Integrasjon av beregninger i fysikkundervisningen, (in Norwegian. English title: Integrating Computation in the Teaching of Physics, English translation: http://hplgit.github.io/cse-physics/doc/pub/uniped15.html) UNIPED, ISSN 1893-8981, **38** (4), pp. 303- 310.

UiO : Department of Physics
Prof. Jøran Moen, Head of Department

To whom it may concern

Date: 23 May 2017

INTPART : Computing in Science Education (CSE):

Computing forms now an integrated and central part of essentially all aspects of modern science and engineering, from basic research to industrial and societal applications. This is particularly true in physics, where many important recent advances in our understanding of the physical world have been driven by large-scale computational modeling and data analysis - for example, the 2012 discovery of the Higgs boson, the 2013 Nobel Prize in chemistry for computational modeling of molecules (received by biophysicists), and the 2016 discovery of gravitational waves. It has become clear that a large fraction of theoretical and experimental physicists require a high level of computational sophistication to competently pursue many aspects of their work a trend that is likely to grow with time as computers increase in power and experimental data sets grow exponentially. These observations are applicable to essentially all disciplines in the Sciences.

Beyond its increasing centrality in research, the use of computational modeling in the classroom setting provides students with insights that can go well beyond those resulting from pencil-and-paper manipulation of equations. In particular, the ability to closely examine the behavior of systems that are too complex to be easily analytically tractable, or that have no analytic solutions (i.e., many systems of practical interest), helps to develop intuition that is unavailable to many students from analytic calculation.

In this connection, the present proposal is very timely and unites the strengths of research and educational activities that are seen as strategic for both universities. Through workshops, new learning material, courses for university teachers, exchange of faculty and students at all levels, the establishment of this network has the potential to add significant new insights and experiences on how computing can be integrated in a seamless way in our basic science education. The outcome of the various research and educational projects are expected to be of great importance and transferable to universities worldwide. The outcome of this project is of strategic importance for both partners. It prepares the ground for the integration of computing in education and thereby how to design our education for the future. The Department of Physics at the University of Oslo endorses and supports thus fully the present partnership proposal on Computing in Science Education.

Sincerely yours,

Jøran Moen
Head of Department

Postal address: P.O box 1048 Blindern, 0316 OSLO, Norway
E-mail: jmoen@fys.uio.no
www.mn.uio.no/fysikk/english

Name: Cathrine Wahlstrøm Tellefsen
Born: April 16, 1967
Position: Head of science teacher education and leader of competence center in STEM education, Faculty of Mathematics and Natural sciences, University of Oslo.

Summary
Cathrine Wahlstrøm Tellefsen has extensive experience from teaching physics and developing physics textbooks for high school and university. She is responsible for teacher education at the Faculty of Mathematics and Natural Sciences at the University of Oslo and is the leader of a competence center in STEM education at the same faculty.

She is a prize-winning university teacher who is highly praised by her students. She has been an active proponent of student-active teaching approaches and has initiated and developed the teaching assistant seminar series - a compulsory pedagogical seminar for student teachers at the Faculty.

Tellefsen is a prize-winning author of textbooks in physics and natural sciences and has long experience in the challenges facing students coming from high school to the university system.

Professional experience

2017-	Leader of Competence center in STEM education at Faculty for Mathematics and Natural Sciences, UiO
2014-	Responsible for teacher education at Faculty for Mathematics and Natural Sciences, UiO
2010-	University lecturer in Physics education research section, Department of Physics, UiO
2005 -	Author of text books in physics and natural science for use in Norwegian upper secondary school. Aschehoug Publishing House.
1999-2014	Teacher in physics and mathematics at Asker and Valler videregående skole (upper secondary school).
1993-1999	Scientist at Department for Global Pollution Issues, Norwegian Institute for Air Research.

Education

1999	PPU – Practical Science Education to become a physics and mathematics teacher in upper secondary school, University of Oslo
1992	MSc (Cand. Scient.), Astrophysics, Institute of Theoretical Astrophysics, University of Oslo

Selected educational awards and prizes

2011	William Nygaards legat, Aschehoug publishing company.
2011	The Norwegian Physical Society prize for excellent teaching.
2012	University of Oslo Excellence in Teaching Award.

Teaching experience

2010-	Popular science lectures and outreach aimed at visiting pupils/students at the University of Oslo. Guest lectures at upper secondary schools. Lectures on science teaching and learning for University employees.
2010-2012	Lecturer for FYS1000 – the largest physics course at University of Oslo. (10 credit points)
2010-1012	With colleagues: Develop and implement an in-service continued education package in science for secondary teachers (30 credit points)
1999-2014	Teacher in physics and mathematics at Asker and Valler videregående skole (upper secondary school).

Administrative experience, membership in academic and professional committees, etc

2017– Leader of Competence center in STEM education at Faculty for Mathematics and Natural Sciences, UiO

2014 – Leader of the teacher education at the Faculty of Mathematics and Natural Sciences, University of Oslo.

2013–2017 Member of the steering committee for educational resources at The Norwegian Non-fiction Writers And Translators Association (NFF) .

2008– Member of the steering committee of the Norwegian Physics Teacher Association.

1990-1991 Leader of the Student association for physics.

1990-1991 Leader of the Student association for astrophysics.

Selected articles in peer-reviewed journals:

[1] Henriksen, E. K., Bungum, B, Angell, C., Tellefsen, C. W., Frågåt, T. & Bøe, M. V. (2014). Relativity, quantum physics and philosophy in the upper secondary curriculum: Challenges, opportunities and proposed approaches. *Physics Education. 49(6), 678* .

[2] Van Roozendael, M.; Peeters, P.; Roscoe, H. K.; De Backer, H.; Jones, A. E.; Bartlett, L.; Vaughan, G. et al. (1998). Validation of GroundBased Visible Measurements of Total Ozone by Comparison with Dobson and Brewer Spectrophotometers. *Journal of Atmospheric Chemistry.* ISSN 0167-7764. 29, s 55- 83

[3] Høiskar, Britt Ann Kåstad; Dahlback, Arne; Tellefsen, Cathrine Wahlstrøm & Braathen, Geir O. (1997). Retrival of total ozone retrieved from the ultraviolet region of spectra recorded with an ultraviolet-visible spectrometer. *Applied Optics.* ISSN 0003-6935. 36, s 7984- 7991

[4] Tellefsen, Cathrine Wahlstrøm & Carlsson, Mats (1994). The Formation of the Solar He II 1640.4 Å Emission Line. *The Astrophysical Journal.* ISSN 0004-637X. 443(1), s 417- 428

Selected books and book chapters

[1] Brandt, Hushovd, Tellefsen (2013) Naturfag for yrkesfag, text book in natural science, Aschehoug.

[2] Callin, Pålsgård, Stadsnes, Tellefsen (2012) ERGO Fysikk 2, revised text book in physics, Aschehoug.

[3] Callin, Pålsgård, Stadsnes, Tellefsen (2012) ERGO Fysikk 1, revised text book in physics, Aschehoug.

[4] Brandt, Hushovd, Tellefsen (2011) Naturfag 5, revised text book in natural science, Aschehoug.

[5] Angell, C., Bungum, B., Henriksen, EK , Kolstø, SD, Persson, J. and Renstrøm, R. (2011). *Fysikkdidaktikk [Physics Education]*. Kristiansand: Høyskoleforlaget / Norwegian Academic Press. Coauthor on the chapters "Teaching through ICT" and "To teach astrophysics"

[6] Callin, Pålsgård, Stadsnes, Tellefsen (2008) ERGO Fysikk 2, text book in physics, Aschehoug.

[7] Callin, Pålsgård, Stadsnes, Tellefsen (2007) ERGO Fysikk 1, text book in physics, Aschehoug.

Brandt, Fonstad, Hushovd, Tellefsen (2006) Naturfag 5, text book in natural science, Aschehoug.

Other publications relevant to the project

[1] Bungum, B., Henriksen, E. K., Angell, C., Tellefsen, C. W., & Bøe, M. V. (submitted). ReleQuant - Improving teaching and learning in quantum physics through educational design research. Submitted to *Proceedings for the NFSUN conference* (Nordisk forskersymposium om undervisning i naturvitenskap), Helsinki 2014.

Biographical Sketch

Vashti Sawtelle
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A. PROFESSIONAL PREPARATION

College/University	Location	Major	Degree & Year
Grinnell College	Grinnell, IA	Physics	B.A, 2006
Florida International University	Miami, FL	Physics	Ph.D., 2011
University of Maryland	College Park, MD	Physics	Postdoc. Pos. 2011-14

B. ACADEMIC/PROFESSIONAL APPOINTMENTS

Aug 2014 – Present **Asst. Professor**, Lyman Briggs Coll. & Dept. of Phys. Mich. St. University
Aug. 2011 – Aug 2014 **Research Associate,** Dept. of Physics, University of Maryland, College Park
Aug. 2007 – Dec. 2011 **Research Assistant**, Dept. of Physics, Florida International University
Aug. 2008 – April 2010 **Graduate Teaching Assistant**, Dept. of Physics, Florida International University
May 2006 – Aug. 2007 **Researcher,** Battelle Memorial Institute, Columbus, OH

C. PRODUCTS

5 Publications Most Closely Related to Proposal

1. **Sawtelle, V.,** Brewe, E., & Kramer, L. H. (2012a). Exploring the relationship between self-efficacy and retention in introductory physics. *Journal of Research in Science Teaching*, *49*(9), 1096–1121. doi:10.1002/tea.21050
2. **Sawtelle, V**., Brewe, E., Goertzen, R., & Kramer, L. (2012). Identifying events that impact self-efficacy in physics learning. *Physical Review Special Topics - Physics Education Research*, *8*(2), 020111. doi:10.1103/PhysRevSTPER.8.020111
3. **Sawtelle, V.**, & Turpen, C., (2016) Leveraging a Relationship with Biology to Expand a Relationship with Physics, *Physical Review Physics Education Research*, *12*(1), 010136. doi:10.1103/PhysRevPhysEducRes.12.010136.
4. Brewe, E., **Sawtelle**, V., Kramer, L. H., O'brien, G. E., Rodriguez, I., & Pamelá, P. (2010). Toward equity through participation in Modeling Instruction in introductory university physics. *Physical Review Special Topics - Physics Education Research*, *6*(1), 010106. doi:10.1103/PhysRevSTPER.6.010106
5. Little, A., **Sawtelle, V**., Humphrey, B., (in review). Mindset in context: Developing new methodologies to study mindset in interview data, Proceedings of the 2016 Physics Education Research Context, Sacramento, CA (in review).

Other Significant Publications

1. Gouvea, J. S., **Sawtelle, V**., Geller, B. D., & Turpen, C. (2013). A Framework for Analyzing Interdisciplinary Tasks: Implications for Student Learning and Curricular Design. *CBE-Life Sciences Education*, 12(2), 187–205. doi:10.1187/cbe.12-08-0135
2. Rodriguez, I., Brewe, E., **Sawtelle**, V., Kramer, L.H., "The Impact of Equity Models and Statistical Measures on Interpretations of Educational Reform," Phys. Rev. Special Topics – PER, 8, 020103 (2012).

3. Brewe, E., Kramer, L., & **Sawtelle**, V. (2012). Investigating student communities with network analysis of interactions in a physics learning center. *Physical Review Special Topics - Physics Education Research*, *8*(1). doi:10.1103/PhysRevSTPER.8.010101
4. Dreyfus, B. W., Geller, B. D., Meltzer, D. E., & **Sawtelle**, V. (2015). Resource Letter TTSM-1: Teaching Thermodynamics and Statistical Mechanics in Introductory Physics, Chemistry, and Biology. *American Journal of Physics*, *83*(1), 5–21. doi:10.1119/1.4891673
5. Geller, B. D., Dreyfus, B. W., **Sawtelle, V.**, Svoboda, J., Turpen, C., & Redish, E. F. (2013). Students' reasoning about interdisciplinarity. In P. V. Engelhardt, A. D. Churukian, & N. S. Rebello (Eds.), (Vol. 1513, pp. 146–149). Presented at the 2012 PER Conference, AIP. doi:10.1063/1.4789673

D. SYNERGISTIC ACTIVITIES

1. **I am actively designing a course on Introductory Physics for Life Science (IPLS) majors at Michigan State University**. The curriculum for this course explicitly builds bridges between biology, physics, and chemistry in ways that preserve the authenticity of the individual disciplines. The design of the course also focuses on developing students' scientific reasoning skills including (1) making and justifying modeling decisions and (2) making implicit disciplinary assumptions visible. The interdisciplinary curriculum is also facilitates the development of sophisticated epistemologies including encouraging students to (1) seek connections across the scientific disciplines and (2) reconcile apparent contradictions in the sciences.
2. **I serve on the American Physical Society's Committee on Education and as the chair of the committee on Research in Physics Education for the American Association of Physics Teachers.** The APS COE committee is responsible for providing reports and advice to the president and council of the American Physical Society on physics education. As a member of the graduate education sub-committee, I review Bridge Partnership grants and serve on the steering committee of the upcoming graduate education conference. As the chair of the AAPT- RiPE committee, I facilitate the sessions and workshops presented
3. **I supervise independent research for undergraduate students**. The honors program at Michigan State University is designed to provide opportunities for students to engage in experiences center on research. As part of this program I have am mentoring undergraduate biology and physics majors in exploring the biological authenticity of curricular tasks designed for the new course on Introductory Physics for the Life Science Majors.
4. **I am serving as a co-editor on a focused collection on Gender in Physics for the journal Physical Review Special Topics – Physics Education Research.** As a co-editor for the focused collection I drafted and distributed a call for the focused collection, I serve as a moderator to evaluate the relevance of proposed articles, and I invite researchers to contribute to the collection. The invitation to serve as co-editor for a focused collection in Physical Review Special Topics – Physics Education Research, indicates the community has recognized my contribution to the research on equity and gender in physics.
5. **I am PI on a project developing an interdisciplinary diagnostic tool for student understanding**. A project is underway at Michigan State University to develop a diagnostic survey tool that can be administered in introductory physics, biology, and chemistry classes to examine the content and practice connections students make across these disciplines. As PI of this project I supervise the data collection and analysis across multiple disciplines as we move through the iterative cycle of developing an instrument.

MICHIGAN STATE
UNIVERSITY

May 23rd 2017

Professor Morten Hjorth-Jensen
FV308, Department of Physics
The Faculty of Mathematics and Natural Sciences
University of Oslo, Norway

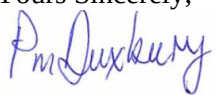
Dear Morten,

Computing is now an integral and central part of essentially all aspects of modern science and engineering, from basic research to industrial and societal applications. This is particularly true in physics, where many important recent advances in our understanding of the physical world have been driven by large-scale computational modeling and data analysis - for example, the 2012 discovery of the Higgs boson, the 2013 Nobel Prize in chemistry for computational modeling of molecules (received by biophysicists), and the 2016 discovery of gravitational waves. It has become clear that a large fraction of theoretical and experimental physicists require a high level of computational sophistication to competently pursue many aspects of their work; a trend that is likely to grow with time as computers increase in power and experimental data sets grow exponentially. These observations are applicable to essentially all disciplines in the Sciences; and to careers ranging from the industrial sector to government laboratories and academia.

Beyond its increasing centrality in research, the use of computational modeling in the classroom setting provides students with insights that can go well beyond those resulting from pencil-and-paper manipulation of equations. In particular, the ability to closely examine the behavior of systems that are too complex to be easily solved analytically , or that have no analytic solutions (i.e., many systems of practical interest), helps to develop intuition that is unavailable to many students from analytic calculations alone. In this connection, the present proposal is very timely and unites the strengths of research and educational activities that are seen as strategic for both universities. Through workshops, new learning material, courses for university teachers, exchange of faculty and students at all levels, the establishment of this network has the potential to add significant new insights and experiences on how computing can be integrated in a seamless way in our basic science education.

The outcomes of the various research and educational projects are expected to be of great importance and transferable to universities worldwide; and the project is of strategic importance for both partners. It prepares the ground for the integration of computing throughout the university curriculum and the design of our education programs for the future. The Department of Physics and Astronomy at Michigan State University thus enthusiastically endorses and supports this partnership proposal on Computing in Science Education.

Yours Sincerely,



Phillip M. Duxbury

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BRIAN W. O'SHEA

Professional preparation

University of Illinois, Urbana-Champaign, IL, Engineering Physics (cum laude), B.S., 2000,

University of Illinois, Urbana-Champaign, IL, Physics, M.S., 2001,

University of Illinois, Urbana-Champaign, IL, Physics, PhD, 2005,

Los Alamos National Laboratory, Los Alamos, NM, Theoretical Astrophysics (postdoctoral education; 2005 – 2008)

Appointments

2008-present: Assistant and Associate Professor, Department of Computational Mathematics, Science and Engineering; Department of Physics and Astronomy; and National Superconducting Cyclotron Laboratory, Michigan State University

2005-2008: Director's Postdoctoral Fellow, Theoretical Astrophysics Group, Los Alamos Nat. Lab.

2005: Graduate Research Assistant, Theoretical Astrophysics Group, Los Alamos Nat. Lab.

2002-2005: Graduate Research Assistant, Lab. for Computational Astrophysics, UC San Diego

Related products and synergistic activities

5 closely related products

1. Egan, H., O'Shea, B.W., Hallman, E., Burns, J., Xu, H., Collins, D., Li, H. & Norman, M.L. "Length Scales and Turbulent Properties of Magnetic Fields in Simulated Galaxy Clusters," 2016, ApJ, submitted (arXiv:1601.05083)

2. O'Shea, B.W., Wise, J.H., Xu, H., & Norman, M.L., "Probing the Ultraviolet Luminosity Function of the Earliest Galaxies with the Renaissance Simulations," 2015, ApJL, 805, 12

3. Bryan, G. L., Norman, M. L., O'Shea, B. W., et al. "ENZO: An Adaptive Mesh Refinement Code for Astrophysics," 2014, Ap. J. S., 211, 19

4. Skillman, S.W., Xu, H., Hallman, E.J., O'Shea, B.W., Burns, J.O., Li, H., Collins, D.C., & Norman, M.L., "Cosmological MHD Simulations of Galaxy Cluster Radio Relics: Insights and Warnings for Observations," 2013, Ap. J., 765, 21

5. Skillman, S.W., Hallman, E.J., O'Shea, B.W., Burns, J.O., Smith, B.D., Turk, M.J., 2011. "Galaxy Cluster Radio Relics in Adaptive Mesh Refinement Cosmological Simulations: Relic Properties and Scaling Relationships," Ap. J., 735, 96

5 other significant products

1. Gomez, F.A., Coleman-Smith, C. E., O'Shea, B. W., Tumlinson, J., & Wolpert, R. L. "Dissecting Galaxy Formation Models with Sensitivity Analysis - a New Approach to Constrain the Milky Way Formation History," 2014, Ap. J., 787, 20

2. Meece, G. R., Smith, B. D., & O'Shea, B. W. "Fragmentation in Dusty Low-metallicity Star-forming Halos," 2014, Ap. J., 783, 75

3. Skory. S., Hallman, E., Burns, J.O., Skillman, S.W., O'Shea, B.W. & Smith, B.D. 2013 "On the Road to More Realistic Galaxy Cluster Simulations: The Effects of Radiative Cooling and Thermal Feedback Prescriptions on the Observational Properties of Simulated Galaxy Clusters," ApJ, 763, 38

4. Turk, M.J., Abel, T., & O'Shea, B.W. 2009, "The Formation of Population III Binaries from Cosmological Initial Conditions," Science, Vol. 395, Issue 5940, pp.601-606

5. O'Shea, B.W. & Norman, M.L. 2007, "Population III Star Formation in a Lambda CDM Universe, I: Effect of Environment on Protostellar Accretion Rates," ApJ, 654, 66–92

Synergistic activities

1. Co-developer of the Enzo AMR cosmology code, organizer of multiple public code releases, and co-organizer of several Enzo User and Developer Workshops. Enzo is an NSF PRAC project, funded by three separate awards (I am the PI on two).

2. Co-founder of MSU's Department of Computational Mathematics, Science and Engineering; director of both undergraduate and graduate programs and developer of introductory computational modeling and data analysis courses.

3. Active collaboration with the National Center for Supercomputing Applications scientific visualization group (led by Donna Cox) to do scientific visualizations for PBS, Discovery Channel, and planetarium shows.

4. PI of two sequential NSF PRAC grants with a total of 200 million core-hours on the Blue Waters supercomputer.

5. Head of effort to create a calculus-based introductory physics sequence, targeted toward life science majors, that utilizes current reseach on active learning and effective teaching techniques.

Vitae for Hjorth-Jensen, Morten

Professional preparation, education and personal data:

- Role in proposal: Project Manager
- Last name, first name: Hjorth-Jensen, Morten
- Professor of Physics at Michigan State University, USA and the University of Oslo, Norway
- Norwegian citizen, born in Haugesund, July 29, 1961
- Norwegian University of Science and Technology, Trondheim, Norway, Siv.Ing. in Theoretical Physics (Master of Science equivalent), 1988
- University of Oslo, Norway, Ph.D in Theoretical Nuclear Physics, 1993
- ECT*, Trento, Italy, Postdoctoral Researcher in Theoretical Nuclear Physics, 1994-1996
- Nordita, Copenhagen, Denmark, Postdoctoral Researcher in Theoretical Nuclear Physics, 1996-1998

Appointments:

Position	Institution	Dates
Associate Professor of Physics	University of Oslo	1999-2001
Professor of Physics	University of Oslo	2001-present
Adjunct Professor of Physics	Michigan State University	2003-2011
Professor of Physics	Michigan State University	2012-present

Brief research overview

I am a theoretical physicist with a strong interest in computational physics and many-body theory in general, and the nuclear many-body problem and nuclear structure problems in particular. This means that I study various methods for solving either Schrdinger's equation or Dirac's equation for many interacting particles, spanning from algorithmic aspects to the mathematical properties of such methods. The latter also leads to a strong interest in computational physics as well as computational aspects of quantum mechanical methods.

Awards:

1. University of Oslo award for excellence in teaching, 2000
2. Fellow of the American Physical Society, 2007
3. Oak Ridge National Laboratory excellence in research award, 2008
4. Outstanding referee award of the American Physical Society, 2008
5. University of Oslo award for excellence in teaching for the **Computing in Science Education** project, 2011
6. NOKUT (Norwegian entity of quality assessment in higher education) award for excellence in teaching for the **Computing in Science Education** project, 2012
7. Elected member of the Norwegian Academy of Sciences and Letters, 2013

8. Elected member of the Royal Norwegian Society of Sciences and Letters, 2015
9. University of Oslo award for excellence in teaching for developing the Computational Physics group, 2015
10. Favorite graduate teacher at the Department of Physics and Astronomy at Michigan State University, 2016

Citation metrics, highly cited articles, and additional research highlights:

Full Vitae can be downloaded from `http://mhjgit.github.io/info/doc/pub/cv/html/cv.html`.

1. Google scholar h-index=50, 8996 citations (May 2017)
2. **Realistic effective interactions for nuclear systems**, M Hjorth-Jensen, TTS Kuo, E Osnes, Physics Reports 261, 125-270 (1995), cited 725 times (Google Scholar)
3. **Phases of dense matter in neutron stars**, H Heiselberg, M Hjorth-Jensen, Physics Reports 328, 237-327 (2000), cited 403 times (Google Scholar)
4. **Pairing in nuclear systems: from neutron stars to finite nuclei**, DJ Dean, M Hjorth-Jensen, Reviews of Modern Physics 75, 607 (2003), cited 355 times (Google Scholar)
5. A total of 144 peer reviewed articles and three books published and/or in press in 2017, and three books in preparation.
6. Supervised and co-supervised 65 graduate students (53 Master of Science and 12 PhD students) and six post-doctoral fellows.
7. Authored and co-authored 22 Physical Review Letters articles, 15 Rapid communications in Physical Review C, seven Physics Letters B articles, one Astrophysical Journal Letters article and one Nature Physics article
8. Written one Physics viewpoint and been highlighted in one other.
9. Taught and developed several courses in Computational Physics and many-body physics, courses in nuclears structure and quantum physics and mechanics and statistical mechanics.
10. More than two hundred invited talks, seminars, colloquia and lectures given worldwide.
11. Organized more than 30 conferences, workshops and schools and advanced courses.
12. Presently supervising 12 Master of Science students (University of Oslo) and four PhD students (Michigan State University)
13. Principal investigator of the center of excellence *Center of Mathematics for Applications*, UiO, 2003-2013
14. Principal investigator of the center of excellence in education *Center for Computing in Science Education*, UiO, 2016-present

Selected publications: books and refereed scientific articles

Books:

1. M. Hjorth-Jensen, Maria Paola Lombardo, and Ubirajara Van Kolck (editors), *Computational Nuclear Physics-Bridging the scales, from quarks to neutron stars*, Lectures Notes in Physics **936**, 2017.
2. Morten Hjorth-Jensen, *Computational Physics, an introduction*, IOP, in press, 2017.
3. Morten Hjorth-Jensen, *Computational Physics, an advanced course*, to be published by IOP in 2017.
4. Marcos Daniel Caballero and Morten Hjorth-Jensen, *How to introduce computing physics courses*, in preparation for Springer University Texts in Physics, to be published in 2018.
5. Marcos Daniel Caballero and Morten Hjorth-Jensen, *Quantum Physics with a Computational Perspective*, in preparation for Springer University Texts in Physics, to be published in 2019.
6. Morten Hjorth-Jensen, *Nuclear many-body physics, a computational perspective*, in preparation for Taylor Francis.

Five recent publications in journals with a referee system:

1. G. Hagen, A. Ekström, C. Forssén, G. R. Jansen, W. Nazarewicz, T. Papenbrock, K. A. Wendt, S. Bacca, N. Barnea, B. Carlsson, C. Drischler, K. Hebeler, M. Hjorth-Jensen, M. Miorelli, G. Orlandini, A. Schwenk, and J. Simonis, *Charge, neutron, and weak size of the atomic nucleus*, Nature Physics **12**, 186 (2016).
2. A. Ekström, G. R. Jansen, K. A. Wendt, G. Hagen, T. Papenbrock, B. D. Carlsson, C. Forssén, M. Hjorth-Jensen, P. Navratil, W. Nazarewicz,*Accurate nuclear radii and binding energies from a chiral interaction*, Physical Review C **91**, 051301(R) (2015).
3. G. Hagen, T. Papenbrock, A. Ekstrom, G. Baardsen, S. Gandolfi, K. A. Wendt, M. Hjorth-Jensen, and C. Horowitz, *Coupled-cluster calculations of nucleonic matter*, Physical Review C **89**, 014319 (2014).
4. T. Papenbrock, G. Hagen, M. Hjorth-Jensen, and D. J. Dean, *Coupled-cluster computations of atomic nuclei*, Reports on Progress in Physics **77**, 096302 (2014).
5. A. Ekström, G. Baardsen, C. Forssén, G. Hagen, M. Hjorth-Jensen, G. Jansen, R. Machleidt, W. Nazarewicz, T. Papenbrock, J. Sarich, and S. Wild, *Optimized Chiral Nucleon-Nucleon Interaction at Next-to-Next-to-Leading Order*, Physical Review Letters **110**, 192502 (2013).

Service throughout the years

Editorial boards and committees.

- Member of the Physics Advisory Comittee at the National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, USA, 2003-2008
- Member of the Canadian research council's evaluation board on subatomic physics 2012-2015.
- Member of the Swedish research council's evaluation board on subatomic physics 2007-2008.
- Editorial Board member of Physical Review C (2014-2016)
- Editorial Board member of European Physical Journal A (2010-present)
- Editorial Board member of European Physical Journal Special Topics (2010-2016)

- Editorial Board member of Springer's Lecture Notes in Physics (2010-present)
- Editorial Board member of Springer's Undergraduate Lecture Notes in Physics (2014-present)
- Editorial Board member of Springer's UniTexts in Physics (2016-present)
- Editorial Board member of Springer's Undergraduate Texts in Physics (2016-present)
- Editorial board member of Computers in Science and Discovery journal, a journal by IOP, UK (2008-2014)
- Steering Committee member of the FRIB theory alliance at Michigan State University (2013-2016)
- Initiated and led the Nuclear Talent initiative from 2010 till 2015, now member of the Steering committee
- Member of the Board of Usit at UiO (Center for information technology at the University of Oslo), 2002-2004
- Project leader for High-performance computing courses at UiO, 2000-2003
- Board member of the Bachelor program Mathematics, Information theory and Technology at the University of Oslo, 2002-2008
- Leader of the Bachelor program Physics, Astronomy and Meteorology at the University of Oslo, 2002-2011
- Together with colleagues from the Department of Physics, Department of Mathematics and Department of Informatics at the University of Oslo, we started the Computers in Science Education project in 2004. This project, which we conceived back in 2003, has changed totally changed the way Science is taught.
- Member of the OECD working group on nuclear physics 2006-2008
- January 2009-December 2011, leader of the Nuclear Physics group at the University of Oslo
- Initiated and chair the newly established Master of Science program in Computational Science, University of Oslo, a new crossdisciplinary educational initiative with partners in physics, chemistry, biology, geoscience, computer science, mathematics, statistics, and material science.

I am also the referee for more than 20 Scientific journals, spanning from Mathematical Physics to particle physics. In addition I have evaluated and evaluate research applications from 17 National Research Councils. I am also a member of more than ten International Advisory committees for various conferences.

UiO : University of Oslo
Center for Computing in Science Education
Director, Professor Anders Malthe-Sørenssen

Norges Forskningsråd

Date: 24 May 2017

Letter of Support for the INTPART proposal "International partnership for Computing in Science Education"

The INTPART proposal "International partnership for Computing in Science Education" is an important part of the core activities within our Center for Computing in Science Education, a Center for Excellence in Education at the University of Oslo.
The activities in the project are closely coordinated with our research and education strategy and will provide essential support for our core projects. The development of a partnership on research and education with Michigan State University will provide the center with world-leading expertise in physics education research directed towards the integration of computing in science education and will be an important factor for us to build an internationally leading research activity in the field of educational research.

We support the project as described in the project proposal and the associated budget, and will provide funding as described in the budget.

Yours sincerely,

Anders Malthe-Sørenssen
Director, Center for Computing in Science Education, University of Oslo

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