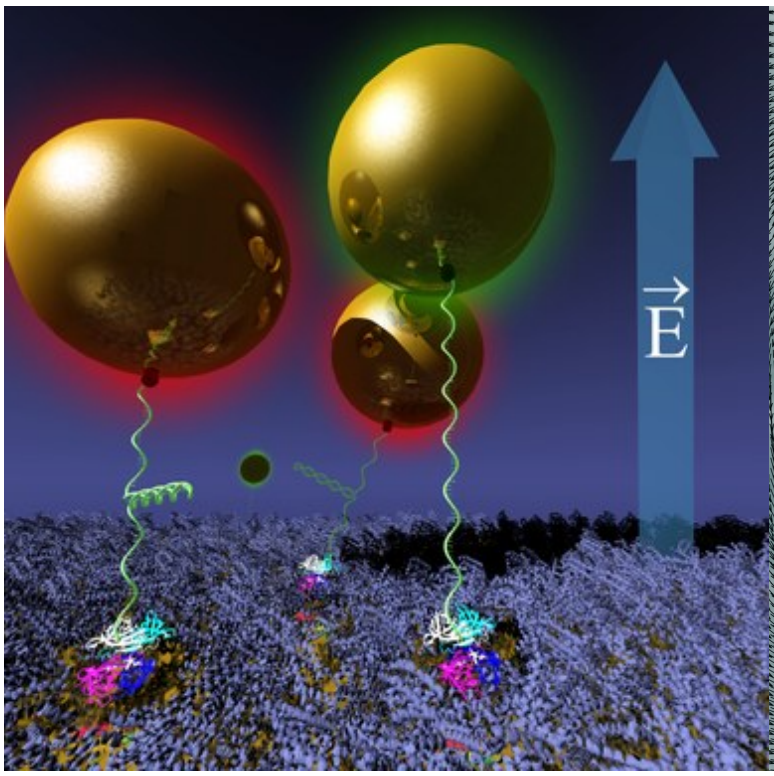
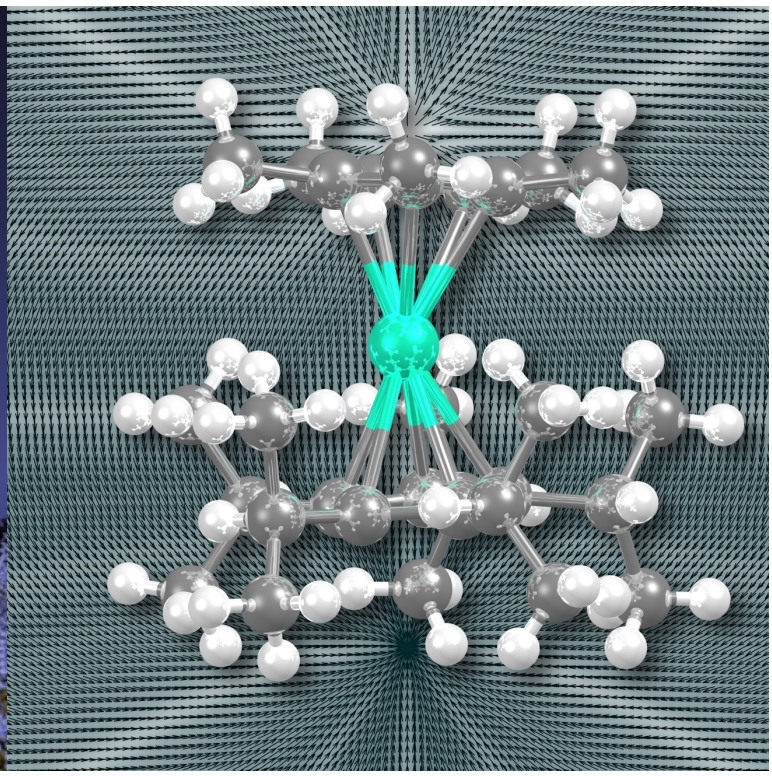




NSC

FINLAND

NANONEWS in

2018

Editorial

Heli Lehtivuori
Tero Heikkilä

Figures

Erno Merenko
Jesse Liimatainen
Ari Lehtiö
Heli Lehtivuori
Satu Lassila
Escuelas Mayores
Maija Vihinen-Ranta
Tuomas Puurtinen
Sami Kaappa
Minttu Kauppinen
Anniina Runtuvuori
Daniel Karlsson
Nisha Mammen
Jessica Rumfeldt
Camtu Suhonen
Lauri Nuuttila
Jussi Toppari
Akseli Mansikkamäki
Jarno Mikkonen

PREFACE

You are now reading the very first NSC newsletter, which we plan to publish 1-2 times a year to highlight our activities both within NSC and outside it. We include in the newsletter a general discussion about the vision for the future of the Nanoscience Center. Its aim is to provoke discussion. This is particularly relevant at the moment, because next spring we will carry out our own strategy work as a follow-up of the university strategy. To aid this, we will organize an NSC-wide event in Konnevesi after Easter (23.-24.4., please mark it in your calendar!), followed by the biennial meeting of our International Advisory Board.

Your feedback, both on NSC strategy and on the newsletter, are most welcome.

I wish you all Merry Christmas and a Happy New Year 2019!

Tero Heikkilä

Announcements

IAB meeting
24.-26.4.2019

The 29th Jyväskylä Summer School
5.-16.8.2019

European Researchers' Night
27.9.2019

Nanoscience Days 2019
8.-9.10.2019

All seminars and events in Year 2019

- **Nanoseminar**, Fridays at 13:00, YN121
- **Light and Matter seminar**, Every second Monday at 9:00, YN330
- **Nanophysics Theory seminar**, Tuesdays at 14:30
- **Multidisciplinary Life Science seminar**, Fridays at 12:00 (Lunch 11:30-), Ruusupuisto
- **NSC Explain this!** at 14:00 first Wednesday of each month, NSC coffee room
- **NSC Paper of the Year Award**, December

More information:
www.jyu.fi/science/en/nanoscience-center/current

Monthly Nanonews:
www.jyu.fi/science/en/nanoscience-center/current/nanonews

Table of Contents

New Projects at NSC

SUPERconducting ThermoElectric Detector

SUPERTED will realize the world's first **SUPER**conducting **T**hermo**E**lectric **D**etector of electromagnetic radiation. This allows the building of new ultrasensitive detectors with large pixel arrays. These detectors will not be hampered by excess heating, which is causing problems in the present-day superconducting detectors. Superconducting detectors, such as the transition edge sensor and the kinetic inductance detector, are some of the most sensitive detectors of electromagnetic radiation and they have found application in various fields ranging from astrophysical observations to security imaging and materials characterization. The present tendency is to increase the number of sensor pixels to allow for a simultaneous imaging and spectroscopy in the video rate of the measured object. However, increasing the number of pixels is hampered by the technical difficulty of fabricating and controlling the bias lines needed next to each pixel in these types of sensors, along with the heating problem associated with them. In SUPERTED -project, we will study a new type of sensor that overcomes this limitation as it is based on the thermoelectric conversion of the radiation signal to electrically measurable one. This approach is based on the newly found giant thermoelectric effect taking place in superconductor/ferromagnet heterostructures. Utilizing this effect, the sensor pixels can be self-powered by the measured radiation, and therefore extra bias lines are not needed (patent pending for the detector concept). Within the project, we aim to establish a proof of concept of this device by (i) fabricating such detector elements, and (ii) characterizing single-pixels of thermoelectric detectors for X-ray and THz imaging via approaches that are scalable to large arrays. Within the project, we also actively seek to establish technology transfer to pave the way for the possible commercial application of such sensors.

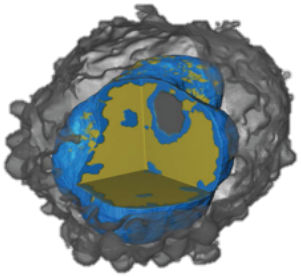
What is FET Open project?

EU FET Open supports the early-stages of science and technology research and innovation around new ideas towards future technologies. It also funds coordination and support actions for such high-risk looking ahead research to prosper in Europe.

European commission has awarded three-million euros to a research consortium SUPERTED. The consortium, lead by researchers at the University of Jyväskylä, includes research groups and a technology company from Finland, Spain, Italy and France.

More information:
Tero Heikkilä, tero.heikkila@jyu.fi
Ilari Maasilta, ilari.maasilta@jyu.fi
SUPERTED project website: superted-project.eu

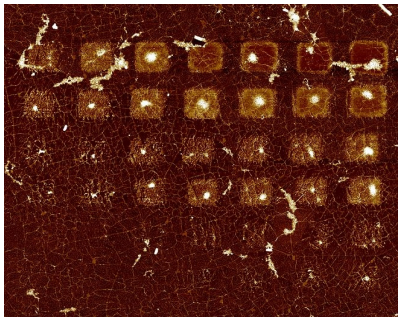
Finding a Way Out: Herpesviral Egress from the Nucleus



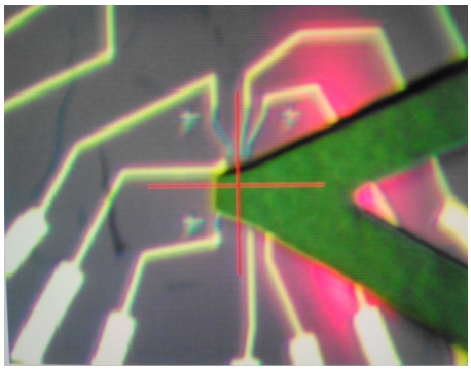
Despite the fact that herpesviruses are a significant *cause* of various human *diseases,* and increasingly used as vehicles for gene delivery and oncolytic virus therapy, the virus-induced changes in the host chromatin organization, as well as the movement of progeny viruses and viral mRNA within dense host chromatin, are understood only superficially. Our research will provide knowledge for profound comprehension of nuclear dynamics and interactions of the herpesvirus by employing an interdisciplinary approach that combines biology and biophysics with state-of-the-art techniques of imaging, advanced image analysis, and biophysical modeling. Our specific aim is to reveal the mechanisms of virus-induced chromatin modification and capsid transport in the chromatin network. The Jane and Aatos Erkko Foundation granted considerable funding, 650 000 €, for Adjunct Professor Maija Vihinen-Ranta for herpesvirus research. The funding is scheduled for three years.

More information:
Maija Vihinen-Ranta, maija.vihinen-ranta@jyu.fi
Jane and Aatos Erkko Foundation: jaes.fi/myonnetyt-avustukset/2018-2-2/

From Graphene to Nerves and Machines



The proper function of neurons within the nervous system is crucial for the good quality of life. Disturbances in this complex system cause severe limitations to our daily operations. Although the knowledge about brain function has taken significant leaps this millennium, neuronal actuators that could facilitate movement or memory in neurological diseases, promote re-growth of axons across spinal cord injuries or provide bi-directional nerve-compatible prosthetics are still closer to science fiction than clinical neuroscience. To bridge this gap, we together with the researchers of Biomeditech of Tampere University have launched an ambiguous Graphene-based Interfaces for Neuroapplications (GIN) project to develop complex and sensitive biocompatible nerve-machine interfaces based on laser-forged graphene electronics supplemented with supramolecular interface for attachment and growth of neurons and supporting cells. One of the preliminary steps in the research is to study neuronal growth, guidance and differentiation within supporting nanomaterials using induced pluripotent stem cells as a simplified model of the nervous system. Nanoscience and nanotechnology will contribute to making a breakthrough in the development of periprosthetics thereby improving the lives of people with physical disabilities.



More information:
Mika Pettersson, mika.pettersson@jyu.fi
Maija Nissinen, maija.nissinen@jyu.fi
GIN project website: www.jyu.fi/science/en/nanoscience-center/research/projects/postdoc-projects/graphene-based-interfaces-for-nerve-machines/graphene-based-interfaces-for-neuroapplications

The Academy of Finland

Academy Projects (01.09.2018 - 31.08.2022):
Lotta-Riina Sundberg (The Department of Biology and Environmental Sciences, 515 568 €): ”Molecular evolution in antagonistic interactions – linking bacterial CRISPR immunity and antagonistic coevolution in bacterial viruses”
Karoliina Honkala (The Department of Chemistry, 486 492 €): “Catalytic and electrocatalytic oxidation of biomass-derived polyols at the liquid-solid interfaces”
Kari Rissanen (The Department of Chemistry, 582 340 €): “Haloniumsupramolecular Chemistry: New Molecular Machines and Nanoreactors”
Tero Heikkilä (The Department of Physics, 532 048 €): “Hybrid nanoelectronic systems in and out of the quantum limit”
Robert van Leeuwen (The Department of Physics, 468 863 €): ” New approaches in quantum many-body theory”

Academy Research Fellow (01.09.2018 - 31.08.2023):
Jani Moilanen (The Department of Chemistry, 438 874 €): “Bridging Solutions for Increasing Blocking Temperature in Molecular Nanomagnets”

Academy Postdoctoral Researchers (01.09.2018 - 31.08.2021):
Toni Metsänen (The Department of Chemistry, 246 585 €): ” Synthetic Ketoreductase Mimics”
Petra Vasko (The Department of Chemistry, 256 245 €): ” Low-valent Main Group/Transition Metal Hetero-bimetallic complexes for Small Molecule Activation and Catalysis”

Research Collaboration with BINA and Alumni Stories

Development of Nanoprobes Facilitating Sensitive Fluorescent Measurements in Cellular Vesicles

Varpu Marjomäki (NSC), Jussi Toppari (NSC), Rachela Popovtzer (BINA), and Dror Fixler (BINA)

Project Description: Intercalating dyes have commonly been used to detect DNA/RNA within a solution since their fluorescence is efficiently quenched before they connect to the DNA or RNA helix. Connection to helix makes them more rigid, which prevents the quenching and thus enables the fluorescence. These same dyes could be utilized inside a living cell also to detect nucleic acids within a vesicle, cytoplasm or inside nucleus. Recently, there has appeared a strong need to detect nucleic acids inside endocytic vesicles only. For that purposes, one needs to prevent the intercalating dyes to enter other parts of the cell, e.g. the nucleus and cytoplasm containing massive amounts of DNA and RNA, respectively. Another major obstacle in utilizing these dyes have been their low level of fluorescence. To tackle both of these obstacles simultaneously and thus enable sensitive detection of nucleic acids solely in cellular vesicles, we are developing new nanoprobes based on intercalating dyes and nanoparticles.

Examining Nuclear Dynamics of mRNA during Viral Infection

Maija Vihinen-Ranta (NSC) and Yaron Shav-Tal (BINA)

Project Description: The intra-nuclear movement of messenger RNA (mRNA) is a critical step both for the cellular and viral life cycles. The understanding of mRNA dynamics in cells is essential for basic research, and for the development of oncolytic virus therapy and novel antivirals that aim to block the nuclear steps of viral life cycle. We are focusing on initiating a collaboration between NSC and BINA in order to set up means by which to study the nuclear dynamics of mRNA in the absence and presence ofherpesvirus infection.

Read more about BINA collaboration:
www.jyu.fi/science/en/nanoscience-center/research/projects/bina-nsc

Be positive, be happy!

Camtu Suhonen graduated from Nanoscience, Physics as a Major in 2011 and her study life in Finland was excellent. She loved the way the Finnish organize classes, the learning methods, modern materials, and classroom design.

Read more about her advices to students:
www.jyu.fi/science/fi/yhteistyo/alumniyhteistyo/alumnitarinat/be-positive-be-happy

A multidisciplinary job from recruitment exhibition

Lauri Nuuttila graduated from Nanoscience, Physics as a Major in 2017 and he found his job at Gasmet Technologies Oy. The best thing about his new job is the opportunities for creativity and good colleagues.

Read more about his career path:
www.jyu.fi/science/fi/yhteistyo/alumniyhteistyo/alumnitarinat/monitieteinen-tyopaikka-rekrytointimessuilta

Practical work deepens the understanding of the field

Olli Herranen, who graduated from Nanosciences, is currently working as an expert in Millog Oy. He shares his career and advises for current and future students to employ the private sector.

Read more about this career path: www.jyu.fi/science/fi/yhteistyo/alumniyhteistyo/alumnitarinat/kaytannon-tyossa-ymmarrys-alasta-syvenee

Role of the Nanoscience Center for its researchers

"... I worry about NSC renewal. Ideally one of our most promising themes would change in 3-5 years. ..."

After one year's experience as the NSC scientific director I try to state my view of what NSC is and what it perhaps should be. I do this with three different viewpoints: (i) NSC is a research center where the only thing common with all groups is the research interest on nanoscale phenomena, and NSC mostly makes this research possible through infrastructure and office space. (ii) NSC as a center supports activities for which departments are not the best source of support. In this case, the focus is on interdisciplinary projects and planned common use of infrastructure. (iii) NSC could actively engage to finding the best research areas and mostly support those. In my decisions as a scientific director, I have to use all these viewpoints, although (iii) has unfortunately not been used much. In the past, point (ii) has also been understood so that there would be some common theme unifying us all. I do not personally believe in the feasibility of such an approach. Rather, I believe that we should find a few (3-5) most promising thematic areas and support those, and simultaneously maintain another 3-5 other - "future" - areas to support diversity. The near future center of excellence and other types of network applications should be founded around those most promising areas, also looking for partners outside NSC both nationally and internationally. At the same time, we will have to look into the future - say, 10 years from now - and support young groups to develop their activities. This latter type of support would not be financial, as those groups should get the financial support from outside funding sources, but we should support them in getting that funding, and for example participating in visions about future infrastructure. I worry about NSC renewal. Ideally one of our most promising themes would change in 3-5 years. How to do this in an environment where the only way to change is via retirements or when someone is recruited elsewhere? When I visited Israel, I learned that one can make future visions based on present resources (which are always inadequate) or the possible future resources. Can we find a vision that helps our strongest teams to become even stronger while taking care that there is chance of changing those themes from time to time?

Tero Heikkilä, Scientific Director of NSC

Head of Departments and Dean replies to Scientific Director of NSC

"... it is not surprising that one can indeed find quite differing views on the important question of "what NSC is and what it perhaps should be"..."

Tero Heikkilä, as the scientific director of NSC, has obviously pondered carefully the role and the inherent characteristics of NSC as an interdisciplinary research entity acting at the interfaces of three quite different departments, hosting a number of research groups that work within a wide spectrum of research topics, and using a variety of methods and facilities. Given this rather challenging *modus operandi* of NSC - deliberately selected at the time of its foundation, I believe - it is not surprising that one can indeed find quite differing views on the important question of "*what NSC is and what it perhaps should be*". Looking at the items (i-iii) in the beginning of Tero's article, I cannot help thinking he has selected a provocative approach to this question using negation, *i.e.* actually giving a list of views on what *NSC is not and what it never should be*! With this idea, and supported by the rest of Tero's article, I repeat the same list of views - negated again in a purpose to grasp his actual views: (i) NSC is a research center bringing together research groups and individual researchers to jointly work on interesting and important nanoscale phenomena. NSC works to make such research possible through up-to-date infrastructure and by providing an inspiring working environment and community; (ii) NSC as a center enjoys full support of the three departments among which it operates. It brings together their common research interests focusing on interdisciplinary projects effectively utilizing their common infrastructure; (iii) NSC acts towards finding a productive balance between identifying and supporting research areas with most impact on the one hand, and nurturing new ideas and freedom of academic research on the other.

Markku Kataja, Head of the Department of Physics

"… We should not look back but rather ahead. Science is developing with perhaps pace than ever…"

Tero's viewpoint is very understandable as he, as a newly appointed scientific director, worries about how NSC could be even more successful in future than what it is now. I think that we all agree that NSC has been a right move at the faculty. This can be judged simply by looking at the scientific output that the center has produced over the years. However, we should not look back but rather ahead. Science is developing with perhaps faster pace than ever meaning that in order to stay at the forefront, one has to be ready to make fast moves and to enter new scientific areas. I think that the strength of NSC is the freedom that the groups have in deciding what they do. But I agree that we could be stronger if we had a way to support and steer renewal. It looks like once more NSC has to develop an innovative way of operation. Somehow, I have a feeling that we will see that happening.

Mika Pettersson, Head of the Department of Chemistry

"… One way to do this is to first identify the grand challenges, scientific and societal, that the research in this particular field should to address, then define the unit's own niche within these grand challenges and formulate strategic aims for the next 5-10 years. …"

Strategy of any research unit has to tackle at least two, often conflicting objectives. The first objective is to identify strengths of the unit and make sure that these strong ideas, research groups or irreplaceable infrastructures are maintained and supported. Second, and perhaps even more challenging objective is to foresee the future and nurture renewal so that the unit will also in future have strong research ideas and research groups studying them with modern research facilities. Tero's three viewpoints serve tackling these challenges in different ways and Tero poses the question of which approach to adopt. Perhaps the solution is not focusing on only one of them but using them in concert. This would require, in my opinion, first building a strategy that is based on dynamic vision where the research is heading in 5-10 years perspective; it is too demanding to try to see the more distant future. One way to do this is to first identify the grand challenges, scientific or societal, that the research in this particular field should to address, then define the unit's own niche within these grand challenges and formulate strategic aims for the next 5-10 years. Because the society changes and science advances rapidly, this process has to be dynamic and reiterated frequently enough. Within this dynamic framework, NSC can potentially make the best use of all three approaches Tero elaborated. NSC can provide a platform and physical premises for research at nanoscale, which does not exclude anybody from common activities. Emphasis on interdisciplinarity ideally will bring in new ways of thinking and doing, and support interdisciplinary projects and acquiring common infrastructures. Yet NSC would have identified the strongest research areas for the near future, and clearly defined strategic aims to make sure that the resources are allocated in an efficient way. The dynamic nature of the strategy and openness of the unit ensures renewal.

Mikko Mönkkönen, Dean of Faculty of Mathematics and Science

1. What's your name, your group leader, and your core field at NSC?
2. What is your project and how often do you visit at NSC building?
3. Why do you want to be part of NSC?
4. What is your major scientific finding in Year 2018?
5. What should researchers at NSC do together in Year 2019?

1. My name is Tuomas Puurtinen. I work in theory and simulations of thermal properties of nanostructures in Prof. Maasilta's group.
2. I come to Nanoscience Center every day, access my computer and remote clusters, where all the hard calculation is done, and try to analyze and interprete the results.
3 I want to be part of NSC, because under the same roof there's so much theoretical and experimental knowledge and skills, crucial to my work.
4. I found that there's real prospect in using phononic crystals in the next generation low temperature detectors, and that this field should be pushed forward in collaboration with scientists and application specialists.
5. Researchers at NSC should brainstorm on the research ideas for new in-house collaboration. We really should think how our 'nanoscience' could be used in applications.

1. My name is Sami Kaappa and I'm 4th year PhD student. I work in Hannu Häkkinen's group and my field is DFT-level computational research of ligand-protected metal nanoclusters.
2. My study considers characterization of nanoclusters in terms of structural, electronic and optical properties using GPAW code that implements density functional theory with high parallelizability. I work in NSC daily.
3. NSC is a house with wide range of scientific skills around all fields of hard sciences. Very inspiring environment to work in.
4. My first-priority work in 2018 was to resolve the symmetry representations of Kohn-Sham wave functions of nanoclusters using the traditional formulation of group theory in chemistry. In another project, we achieved the highest resolution so far in STM imaging a nanocluster. In the report, we show how to implement simple image recognition techniques to resolve the orientation of a single cluster in an STM image.
5. I would say the first thing would be to know what other people and groups are doing in the house. As a PhD student, I would like to have common activities with other PhD students from the house, since its always easier to talk freely with peers than with more experienced colleagues. As has been seen, there should be a particular person to organize that kind of occasions since the students (seemingly) have no time or nerves to organize that themselves.

1. My name is Jessica Rumfeldt. I work in protein biochemistry in Prof. Janne Ihalainen group.
2. Functional mechanism of phytochromes. I am in NSC at least once a week sometimes more.
3. I use the FTIR and UV-Vis spectrometers
4. A tyrosine implicated in optimizing phytochrome photochemistry shows evidence for deprotonation at a relatively low pH, starting around pH 8.
5. Have a short demonstration (in the lab) of how some experiments are carried out.

1. Anniina Runtuvuori from Lotta-Riina Sundberg group. I am a cell and molecular biologist.
2. I am working in BONUS Flavophage project. I am studying Flavobacterium columnare bacteriophages and on NSC I am using helium ion microscope for that. I am visiting in NSC 1-10 times per month. Depending my work schedule.
3. In NSC I can have support from other workers and precise knowledge about nanoscale particles and how to study those.
4. My major scientific finding was to learn to use the HIM and learn to think the samples differently, "out of the box".
5. NSC people could have some grill, Easter or mulled wine parties in year 2019. It would be also nice to have some Friday afternoon seminars, where for example PhD students can present their research and audience have some food, beer, and wine.

1. My name is Daniel Karlsson, and my group leader is Robert van Leeuwen. My core field is theoretical many-body physics.
2. My project is about the physics of strong interaction between light and materials. My office is at the NSC building, so I am there every work day.
3. NSC is a nice and multidisciplinary work place. I have learned a lot during my time here.
4. We managed to find a solution to a theoretical problem in many-body perturbation theory, that has the possibility of speeding up materials calculations.
5. Perhaps more open discussions, which have been useful.

1. I am Nisha Mammen, I work with Prof. Hannu Häkkinen and Prof. Karoliina Honkala and my core field is computational nanoscience.

2. I work at the NSC building. My project deals with investigating the catalytic activity of ligand-protected nanoclusters. This is a puzzle and a really interesting one, since one naively thinks that protecting nanoclusters with ligands would render them highly stable and inactive for any chemical reaction. Some recent experiments have, however, surprisingly shown that certain combinations of ligand and metal nanoclusters can exhibit excellent catalytic activity for certain reactions.
3. I am here because I get to work with two leading experts in the fields of ligand-protected nanoclustersand computational catalysis. The people and environment at NSC also seem very nice and I am happy to be a part of it.
4. We recently proposed a simple yet quantitative way to interpret XANES spectra of metal nanoclusters using theoretically computed charges on the atoms, so as to yield oxidation states for nanoclusters. This was work done in my earlier research group in Bangalore, India.
5. Go away together for a one day/weekend trip? This would strengthen bonds and interactions between researchers.

1. My name is Minttu Kauppinen, and my group leader is Karoliina Honkala. My core field at NSC is computational catalysis.
2. My project is about modeling industrially relevant reactions such as water-gas shift and hydrodeoxygenation on transition metal and oxide surfaces and at the metal-oxide interface using density functional theory and microkinetic modeling. My work station is in the NSC building, so I am here during most of my work hours.
3.NSC is a great environment to work in, and there are plenty of opportunities to meet other researchers from different disciplines. Here I get to be a part of an excellent research group. Coming here meant returning to my home town of Jyväskylä, which is a nice bonus.
4. I have studied the mechanism of the water-gas shift reaction on zirconia supported rhodium using DFT and microkinetic modeling, and found the metal-oxide interface to be the most active domain of the catalyst, while the rhodium metal facets are rather inactive and covered in CO, and the zirconia accumulates spectator speciesformate.
5. We should have more after work get-togethers.

Research Outreach and Highlights

University of Jyväskylä's Laser laboratory of the Nanoscience Center (Laserlab-NSC) became a full member of Laserlab-Europe in the general assembly of the consortium at Salamanca, Spain on the 31th October 2018. Closer working with best European laser laboratories opens doors to creating new international research networks to Laserlab-NSC. **Read more:** www.laserlab-europe.eu

The Photonics Finland annual event OPD2018 on 28th – 30th May 2018 was organized at the University of Jyväskylä by researchers from Laserlab-NSC. The meeting presented the latest developments in academic optics and photonics research as well as on progresses made by photonics companies.

Read more: www.photonics.fi/fi/event/opd2018-optics-photonics-days-2018/

Nanoscience centers of the University of Jyväskylä and the Bar-Ilan University of Israel signed a collaboration agreement to start research and education collaboration on the 7th August 2018.
Read more: www.jyu.fi/science/en/nanoscience-center/research/projects/bina-nsc

A European-wide science event, the Researchers' night, makes the science familiar to the general public. On 28th September 2018 1800 visitors could explore nanoscience through researchers' meetings,

science shows, and laboratory visits for free at NSC.
Read more: www.tutkijoidenyo.fi/en

The Nanoscience Days (*chair* Varpu Marjomäki) were held during 9th - 10th October, 2018. The conference is a traditional event organized more than ten years by NSC. The topics present a balanced overview of emerging trends and perspectives in the field of nanoscience.
Read more: www.jyu.fi/science/en/nanoscience-center/nanoscience-days

Academy Professor Hannu Häkkinen from NSC has been named as one of the most-cited researchers in the world in 2018 by by Clarivate Analytics in its annual "Highly Cited Researchers 2018" list.

Read more: www.jyu.fi/en/current/archive/2018/11/academy-professor-hannu-hakkinen-achieves-the-201chighly-cited-researcher201d-status-in-2018

Highlights at NSC in 2018*

- J. Nevalaita and P. Koskinen, *"An Atlas of two-dimensional elemental metals"*, *Phys Rev B* **97**, 035411 (2018)
- B. Shen, V. Linko, K. Tapio, S. Pikker, T. Lemma, A. Gopinath, K. V. Gothelf, M. A. Kostiainen, and J. J. Toppari, "*Plasmonic nanostructures through DNA-assisted lithography*" *Science Adv* **4**, 8978 (2018)
- L. Pyöriä, M. Toppinen, E. Mäntylä, L. Hedman, L. M. Aaltonen, M. Vihinen-Ranta, T. Ilmarinen, M. Söderlund-Venermo, K. Hedman, and M. Perdomo, "*Extinct type of human parvovirus B19 persists in tonsillar B cells*" *Nature Comm* **4**, 14930 (2018)
- G. Deng, S. Malola, J. Yan, J. Han, P. Yuan, C. Zhao, X. Yuan, S. Lin, Z. Tang, B. K. Teo, H. Häkkinen, N. Zheng, "*From Symmetry Breaking to Unraveling the Origin of the Chirality of Ligated $Au_{13}Cu_2$ Nanoclusters*" *Angew Chem* **57**, 13, 3421 (2018)
- C. F. Ockeloen-Korppi, E. Damskägg, J. M. Pirkkalainen, M. Asjad, A. A. Clerk, F. Massel, M. J. Woolley, and M. A. Sillanpää, "*Stabilized entanglement of massive mechanical oscillators*", *Nature* **556**, 478 (2018)
- J. Hicks, P. Vasko, J. M. Goicoechea, and S. Aldridge, "*Synthesis, structure and reaction chemistry of a nucleophilic aluminyl anion*", *Nature* **557**, 92 (2018)
- Q. Zhou, S. Kaappa, S. Malola, H. Lu, D. Guan, Y. Li, H. Wang, Z. Xie, Z. Ma, H. Häkkinen, N. Zheng. X. Yang, and L. Zheng, "*Real-space imaging with pattern recognition of a ligand-protected Ag374 nanocluster at sub-molecular resolution*" *Nature Comm* **9**, 2948 (2018)
- H. J. Green, A. G. M. Griffiths, J. Ylänne, and N. H. Brown, "*Novel functions for integrin-associated proteins revealed by analysis of myofibril attachment in Drosophila*", *eLife* **7**, e35783 (2018)
- J. Yan, S. Malola, C. Hu, J. Peng, B. Dittrich, B.K. Teo, H. Häkkinen, L. Zheng, and N. Zheng, "*Co-crystallization of atomically precise metal nanoparticles driven by magic atomic and electronic shells*", *Nature Comm* (2018)
- K. Tapio, D. Shaoa, S. Auer, J. Tuppurainen, M. Ahlskog, V. P. Hytönen, and J. J. Toppari, "*DNA-nanoparticle actuator enabling optical monitoring of nanoscale movements induced by electric field*", *Nanoscale* **10**, 19297 (2018)
- F.-S. Guo, B. M. Day, Y.-C. Chen, M.-L. Tong, A. Mansikkamäki, and R. A. Layfield. "*Magnetic hysteresis up to 80 K in a dysprosium metallocene single-molecule magnet*" *Science*, (2018)
- F. S. Bergeret, M. Silaev, P. Virtanen, and T. T. Heikkilä, "*Colloquium: Nonequilibrium effects in superconductors with a spin-splitting field*", *Rev. Mod. Phys.* **90**, 041001 (2018)
- L. de Knoop, M. J. Kuisma, J. Löfgren, K. Lodewijks, M. Thuvander, P. Erhart, A. Dmitriev, and E. Olsson, "*Electric-field-controlled reversible order-disorder switching of a metal tip surface*", *Phys. Rev. Materials* **2**, 085006 (2018)
- M. M. Kauppinen, M. M. Melander, A. S. Bazhenov, and K. Honkala, "*Unraveling the Role of the Rh-ZrO2 Interface in the Water-Gas-Shift Reaction via a First-Principles Microkinetic Study*", *ACS Catal.* **8**, (2018)

29
Group leaders*

141
Researchers*

140
Peer-reviewed publications**

Top 5	Author (No. of Publ.)
1.	Kari Rissanen (38)
2.	Hannu Häkkinen (11)
3.	Mihail A. Silaev (10)
4.	Tero T. Heikkilä (7)
	Heikki Tuononen (7)
5.	Akseli Mansikkamäki (6)

*Data taken from NSC websites at 13.12.2018.
**Data taken from Scopus at 13.12.2018, keywords: Nanosci* and Univ* Jyvaskyla.