

# CINSaT

Center for  
Interdisciplinary Nanostructure  
Science and Technology

Newsletter 1/2016



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Interdisciplinary Nanostructure  
Science and Technology



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*photo: Press and Public Relations Office University of Kassel, Studio Blåfield*

# Preface

Welcome to the first issue of the CINSaT Newsletter.

As an important component for the information exchange, we have decided to re-launch the newsletter and want to expand them in the future to an important dissemination forum of our centre. The newsletter is firstly addressed to our members. Therefore, internal issues, like short reports about passed meetings (e.g., in this issue is a report about the CINSaT fall meeting), future meetings, new members, etc. However, the newsletter should be in future also the premium dissemination channel of CINSaT members to highlight their scientific outcome to the university public (including students, colleagues and authorities) as well as outside the university.



Since mid of this year, a new executive board was elected by the members. The new board is briefly introduced in this issue. It is my honour to serve within CINSaT in future as head of the centre. I will try my best to improve the synergy of working together in such a centre and that all members see a significant benefit to be part of it.

Several significant changes are made in the CINSaT structure and the responsibilities. One important part is the integration of the support of the nano science program. In this issue, Thomas Fuhrman-Lieker, coordinator of the study program and member of the executive board, reports on a new student exchange program with a Finish university. More reports will follow in the next issues.

As a first scientific highlight, Kilian Singer reports on his recent discovery on "A single-atom heat engine", published in Science, which is related to a new understanding of thermodynamics beyond classical physics. We would like to see more such articles in the next issue.

Two new members could be gained, Prof. Thomas Niendorf, mechanical engineering, and Dr. André Knie, physics, who are introduced in this issue. In future, we would like to present also overview articles from older members presenting their current activities. This will give new members the chance to get background information from all members from time to time.

After extensive reading of the newsletter articles, you should relax by contemplating the "Nano art" picture, an additional section, we would like to continue in future. Please do not miss this page.

Finally, I would like to motivate all members to submit articles, either research highlights, introduction of their research field or other articles for the next issue. The editorial board is always open for new ideas, which can increase the attractiveness of this newsletter.

Enjoy the reading of the first issue.



Johann Peter Reithmaier

# General Information

## Introduction of the new CINSaT executive board

*In July 2015 the former head of the "Center for Interdisciplinary Nanostructure Science and Technology (CINSaT)" Prof. Dr. Arno Ehresmann was elected as one of the vice presidents of the University of Kassel. As a consequence, a new election of the executive board of CINSaT took place during the CINSaT spring colloquium 2016.*

Prof. Dr. Johann Peter Reithmaier as the new head of CINSaT as well as apl. Prof. Dr. Thomas Fuhrmann-Lieker, Prof. Dr. Friedrich W. Herberg and Prof. Dr. Bernd Witzigmann, representing the new executive board, were unanimously elected by the members of CINSaT. The new executive board designated structural progress, internationalization and professionalization as the key issues on the agenda of CINSaT over the next years. Therefore, the CINSaT regulations from 2013 were completely revised and, among others, the "Forschungskoordination" was established as a new instrument to initialize and promote joint research projects. The revised version of the CINSaT regulation was passed by the presidium of the University of Kassel in August 2016.

### Head of CINSaT



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**Prof. Dr. Johann Peter Reithmaier** is currently head of the department "Technische Physik" and director of the Institute of Nanostructure Technologies and Analytics (INA) at the University of Kassel since 2005. He has more than 30 years of experience in semiconductor laser physics and optoelectronic devices, over 25 years in molecular beam epitaxy and more than 20 years in nanostructuring of semiconductor materials. His current interests are focused on novel nanostructured materials and related physical properties as well as their applications in optoelectronic devices, optical communication systems and quantum technologies.

**Apl. Prof. Dr. Thomas Fuhrmann-Lieker** is deputy head of the department "Makromolekulare Chemie und Molekulare Materialien" at the Institute of Chemistry. The research focus of his group is on chemistry and material sciences. Here, research is carried out on molecular glasses for photonics, self-organization and disorder in soft matter and hybrid systems and biological photonic crystals. Furthermore, apl. Prof. Fuhrmann-Lieker is coordinator for the bachelor program „Nanostrukturwissenschaften" and the new international master program "Nanoscience".

**Prof. Dr. Friedrich W. Herberg** - as one of the founding members of CINSaT in 2002 - is the executive director of the Institute of Biology since 2013 and head of the biochemistry department at the University of Kassel. He is also chairman and founding member of the new Promotionskolleg "Functional analysis of modifications on macromolecules". His current research activities are focused on cyclic nucleotide signaling and protein kinase structure and function with a focus on cAMP dependent protein kinase as well as the development of novel, miniaturized devices for advanced biosensing at increased sensitivity and throughput. Besides his research activities, Prof. Herberg is co-founder of the company BIAFFIN and currently scientific advisor, a nowadays leading provider of high quality bioanalytical services and contract research specialized in biomolecular interaction analysis.

**Prof. Dr. Bernd Witzigmann** is head of the department Computational Electronics and Photonics, located at the institute of electrical engineering and computer science. The research activities of his group include the development of advanced simulation techniques and the application of computational models to study and design electronic and photonic structures from the macro- to the nano-scale.

# Education

## International master program: Nanoscience

*The University of Kassel extends its range of international master programs: Starting this autumn, the faculty of mathematics and natural sciences opens the English-language master program "Nanoscience". Students will be able to apply for the new international master program in both the winter and the summer semester.*

The interdisciplinary study program comprises of four semesters in which students can acquire in-depth knowledge about colloid and supramolecular chemistry (Nanochemistry), nanoelectronics and -photonics (Nanophysics) or molecular and cell biology (Nanobiology).

"The new international master program is a key component of our internationalization strategy" says the educational dean of the department, Prof. Dr. René Matzdorf. "In the future, our students will not only receive an excellent education but will simultaneously be prepared for their work in an international "scientific community" during their studies."

The faculty of mathematics and natural sciences has more than a decade of experience in the study program nanostructure sciences. It was one of the first departments in Germany, that combined the three fundamental sciences - biology, chemistry and physics - in a nanostructure science curriculum.

"We want to introduce our students into current research topics as early as possible" explains the study program responsible apl. Prof. Dr. Thomas Fuhrmann-Lieker. "The active participation in the research groups of the "Center for Interdisciplinary Nanostructure Science and Technology (CINSaT)" is therefore an essential component of our educational profile."

Nanoscience is a new and expanding research field. There is a high global demand for alumnae and alumni in both research and industry, e.g., in materials research, biomedicine and communication technology.

### **Admission requirements for the master program „Nanoscience“**

As admission requirements, applicants should have a very good command of English (B2) together with a bachelor's degree in nanostructure sciences, which is offered at the University of Kassel as well, or a degree in related fields.

*reference: public relations department University of Kassel*

### **Further Information**

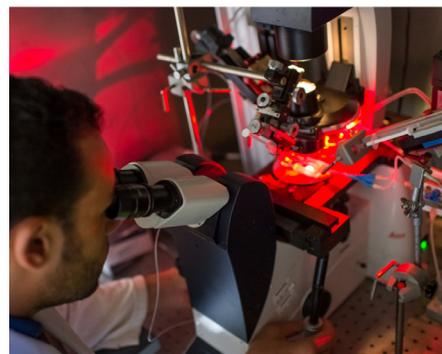
Website: <http://www.uni-kassel.de/fb10/en/study/msc/nano>

### Studying at Uni Kassel



*photo: Press and Public Relations Office  
University of Kassel, Studio Blåfield*

### Nanoscience



*photo: Press and Public Relations Office  
University of Kassel, Studio Blåfield*

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# Research Highlights

## A single-atom heat engine

*Physicists of the University of Kassel and the University of Mainz build the smallest heat engine of the world; it works with a single atom.*

The scientific journal Science reports in its current issue about a novel heat engine which works with only one single atom. The work is about experiments, which were built-up under the supervision of Prof. Dr. Kilian Singer - currently head of the department "experimental physics I" at the University of Kassel – while he was working at the Johannes Gutenberg University of Mainz (JGU) and performed in collaboration with theoretical physicists of the University of Erlangen-Nürnberg.

Since the industrial revolution, heat engines play a decisive role in our society. They transform thermal energy into mechanical work, as for example in vehicles, and have become an indispensable part of our everyday life. At the same time, miniaturization continuously leads to smaller technical devices.

The team of scientists led by Kilian Singer use a so called Paul trap to store a single, electrically charged calcium atom. This atom can be heated by electrical noise and cooled via laser irradiation. Therefore, the atom runs through a thermodynamic cycle, which is comparable to the processes running in the cylinder of a classical engine. The generated power is transferred into an oscillation of the atom. Consequently, the atom simultaneously plays the role of both the motor and the energy storage.

The physicists were able to characterize the thermodynamic behavior in a detailed series of measurements. As the scientists show in their publication, the single atom engine delivers a power of  $10^{-22}$  Watts and has an efficiency of 0.3 percent. By scaling the power of the single atom machine to its small mass, its power becomes comparable to that of a car engine. "We can use the engine as a single atom fridge by reversing the cycle process and were therefore able to cool coupled nanosystems" says Johannes Roßnagel, the lead author of the study.

The most important issue of this research is that the realization of such a nano engine gives insights into the thermodynamics of single particles, which is a hot topic in current research. Plans for the future envisage to further decrease the working temperature of the engine and to investigate thermodynamic quantum effects. Theoretical studies proposed that the power of a heat engine can be increased via its coupling to a quantum bath. This provides opportunities to go beyond the paradigms of classical thermodynamics and develop novel types of engines.

The project was funded by the Deutsche Forschungsgemeinschaft in the scope of the project "Einzelionenwärmekraftmaschine" and by the Volkswagenstiftung within the project "Atomarer Nanoassembler".

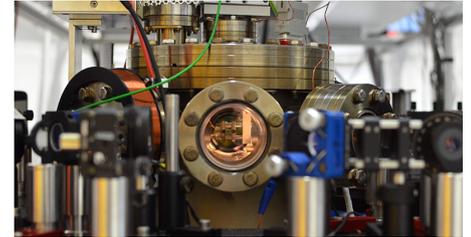


photo: AG Quantum, JGU Mainz



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<http://science.sciencemag.org/content/352/6283/325>

# New Members

**Professor Dr.-Ing. Thomas Niendorf** is the head of the Metallic Materials group at the Institute for Materials Engineering and joined the University of Kassel in October 2015. He obtained his PhD at the University of Paderborn in 2010. His PhD thesis reported on fatigue properties of ultrafine grained and nanocrystalline metallic alloys. From 2010 to 2014 he was group leader Fatigue at the Materials Science group in Paderborn.



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In 2014 Prof. Niendorf moved to TU Bergakademie Freiberg to lead an Emmy Noether-research group at the Institute for Materials Engineering. Research activities focused on fatigue issues in additively manufactured, i.e. 3D-printed, alloys. His main interests are in processing-microstructure-property-damage relationships in metallic alloys. He established two new topics in the Metallic Materials group: additive manufacturing and shape memory alloys. Furthermore, he will continue the well-established topics residual stress-analyses, surface treatments, cyclic deformation, microstructure analyses, corrosion, etc.

In 2016 Prof. Niendorf joined CINSaT in order to bridge length-scales, i.e. the gap between natural sciences and materials respective mechanical engineering. Integration of effects showing huge potential on the nanoscale into macroscale products using robust processing techniques is vision of his activities. 3D-printing will be one anchor for addressing current issues. Other activities will focus on effects of nanoscale surface features on meso- and macroscale properties as well as magnetic properties of alloys including tailored local features. Thereby, Prof. Niendorf will actively contribute to the CINSaT main topic Nanostructures in natural sciences, engineering sciences and the arts.

## Further Information

Website: <https://www.uni-kassel.de/maschinenbau/institute.html>



*Group Metallic Materials*

Time-resolved chiral dynamics and tailored artificial nanostructures – **Dr. André Knie** is the newest associated member of CINSaT. In his research he uses spectroscopic methods developed in the atom and molecular physics, namely photoelectron spectroscopy and fluorescence spectroscopy combined with the most advanced photon sources, synchrotron radiation of storage rings and free-electron-laser facilities. Those methods are then applied to chiral gaseous samples, artificial molecules, and solvated samples in liquid environment.

In a recent study he and his coworkers observed fluorescence cascades evoked by resonant interatomic coulombic decay of inner-valence excited neon clusters. Here, resonant interatomic coulombic decay (RICD) in inner-valence excited neon clusters was observed by a combination of vacuum-ultraviolet (VUV) and UV/visible fluorescence spectroscopy. These ultrafast interatomic electronic processes efficiently quench radiation emission from inner-valence excited clusters. After RICD took place, outer-valence excited clusters relax further by emission of fluorescence. The direct correspondence of the structures observed in the VUV and UV/visible fluorescence signals implies that the final states of the spectator RICD decay by a cascade of radiative decays: First, by the Rydberg-to-Rydberg transitions in the UV/visible spectral range, and then, by the Rydberg-to-valence transition in the VUV range. This study demonstrated a possibility of detecting interatomic electronic processes by UV/visible fluorescence spectroscopy.



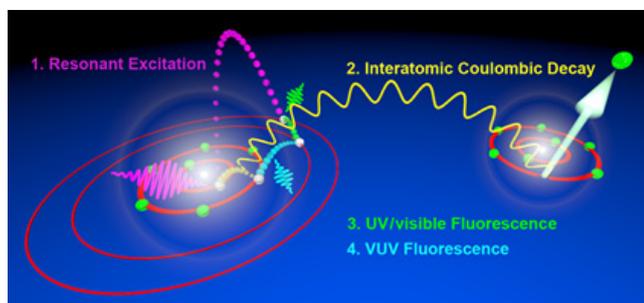
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*Hans et al., Chemical Physics (2016), in press*

In a more fundamental study from this year Dr. Knie used angle-resolved Auger spectroscopy as a sensitive access to vibronic coupling. Here, he showed that in the angle-averaged excitation and decay spectra of molecules, vibronic coupling may induce the usually weak dipole-forbidden transitions by the excitation intensity borrowing mechanism. In this complementary theoretical and experimental study of the resonant Auger decay of core-to-Rydberg excited  $\text{CH}_4$  and Ne Dr. Knie demonstrates that vibronic coupling plays a decisive role in the formation of the angle resolved spectra by additionally involving the decay rate borrowing mechanism. Thereby, he proposed that the angle-resolved Auger spectroscopy can in general provide very insightful information on the strength of the vibronic coupling

## Further Information

Website: <http://www.uni-kassel.de/fb10/institute/physik/>

# Latest Reports

## Autumn colloquium

On Wednesday, the 19th of October 2016, it was that time again: CINSaT opened its gates to its annual autumn colloquium at the location "Heinrich-Plett-Straße" of the University of Kassel. A broad spectrum of topics in the field of interdisciplinary nanostructure science was presented to the audience, featuring exciting talks about current research issues in biology, chemistry, physics and engineering. In addition, the colloquium provided a unique opportunity to get insight into the research activities at the new partner University in Jyväskylä (Finland) within the scope of the recently established Erasmus program in the nanostructure sciences course.

The colloquium started with a warm welcome speech of the new CINSaT - speaker Prof. Dr. Johann Peter Reithmaier - who also provided a short personal introduction. Again, numerous professors, PhD students as well as bachelor and master students from different disciplines were present in the audience. The opening speech was followed by three scientific talks related to nanotechnology, given by the invited speakers.

The first part of the lecture series was opened by Prof. Dr. Dario Anselmetti, who is holding the chair for experimental biophysics and applied nanosciences at the University of Bielefeld since July 2000, with the topic: "Single-Molecule Biophysics: From Catch bond Interaction to Nanopore Translocation". The talk was followed by an exciting discussion and afterwards the participants had the chance to hold one-on-one conversations during the coffee break.

In the second part of the session, Prof. Dr. Mika Pettersson from the University of Jyväskylä first presented his current research results related to the topic "Optical patterning of graphene by two-photon oxidation". The application-oriented talk about the purposeful modification of the physical properties of graphene was followed by a fascinating talk of Prof. Dr. Janne Ihalainen concerning "The functional mechanism of phytochromes, the eyes of bacteria and plants", who is also a professor at the University of Jyväskylä. Thus, both invited speakers, for the first time, gave an overview about the research activities of the partner university in Jyväskylä in the context of the recently founded Erasmus program.



*Prof. Dr. J. P. Reithmaier*



*Guest speakers (from left to right): Prof. Dr. Dario Anselmetti (University of Bielefeld), Prof. Dr. Janne Ihalainen (University of Jyväskylä), Prof. Dr. Mika Pettersson (University of Jyväskylä)*

After the plenary talks, the event was again completed by a poster session, where the physical well-being of the participants was ensured by the catering of the Studentenwerk of the University of Kassel. During the poster session, the participants had the opportunity to hold scientific discussions and informational exchanges about current research projects within CINSaT.

Finally, the prizes for the best three contributions were awarded by this year's poster jury, consisting of the CINSaT members Prof. Dr. Martin E. Garcia, Prof. Dr. Cyril Popov and Prof. Dr. Bernd Witzigmann (1<sup>st</sup> place: tablet, 2<sup>nd</sup> place: external hard disc, 3<sup>rd</sup> place: Wireless presenter). Before the prizes were awarded, the jury explicitly pointed out the high quality of the poster contributions, which continuously improved over the past years. Besides, with 46 poster contributions, CINSaT achieved a new record of participants. This year, the first prize was given to the poster "New Porous Uranium Scavengers" by Dana Bloß and Eireen Käkel. Thereby, two authors of one poster were for the first time awarded for their outstanding contribution. The second and third prize were given to Marlene Adrian with her poster entitled "Transmission Electron Diffraction on a really free standing heterostructure and analysis of the resulting Moiré pattern" and Harmen Hawer for his presentation about "Cooperation of tRNA and diphthamide modifications in mRNA translation?"; respectively.



*Members of the audience listening to the scientific talks*



*Members of the poster jury, award winners and CINSaT speaker (f.l.t.r.): Prof. Dr. Bernd Witzigmann, Dana Bloß and Eireen Käkel (1<sup>st</sup> place), Marlene Adrian (2<sup>nd</sup> place), Harmen Hawer (3<sup>rd</sup> place), Prof. Dr. Martin E. Garcia, Prof. Dr. Cyril Popov, Prof. Dr. Johann Peter Reithmaier*

# Announcements

## Spring colloquium 2017

CINsaT cordially invites all members and their staff to take part of the internal spring colloquium, taking place from **Wednesday, the 15<sup>th</sup> to Thursday, the 16<sup>th</sup> of February 2017** in the Ahorn Berghotel in Friedrichroda. All participants (except the members) have to submit a poster contribution during the registration (talks will be requested in individual cases until the end of January 2017).

For registration, please send an E-Mail to Dr. Dennis Holzinger including the following information:

- Name of the participants
- Preliminary title of the poster contribution(s)
- Information, if you stay over night

The **deadline for registration is Wednesday, December 21<sup>st</sup>, 2016**. The preliminary schedule will be delivered after the registration deadline has expired. We expect the colloquium to start at 9:00 a.m. (15.02.2017) and end at 4:00 p.m. (16.02.2017).

*Note that all participants have to arrange for their own travel, which is not funded by CINsaT.*

We are pleased to welcome you to the colloquium and look forward for your interesting contribution!

**When: February,  
15th - 16th, 2017**

**Where: Ahorn Berghotel Friedrichroda  
Zum Panoramablick 1, 99894 Friedrichroda**

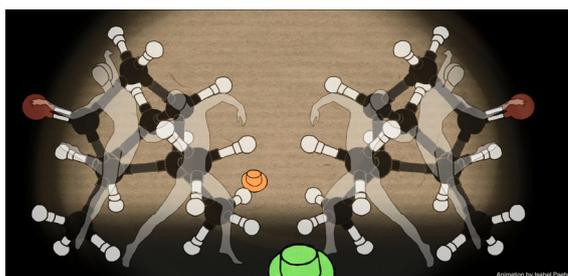
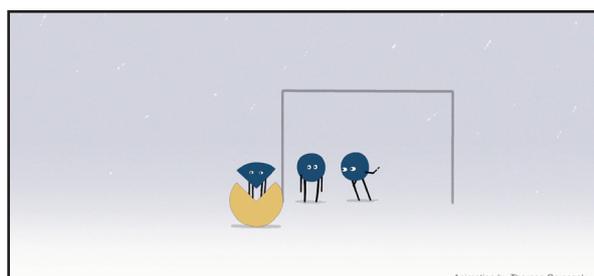


*Audience listening to the talks and excited discussions during the poster session at the CINsaT spring colloquium 2016.*

# Image film

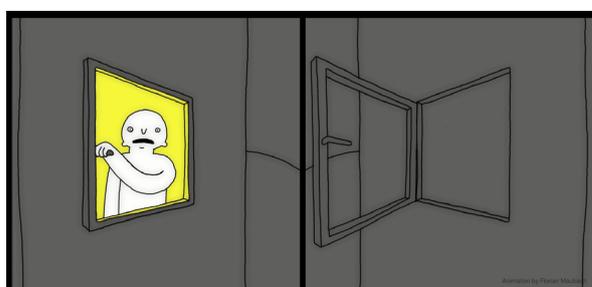
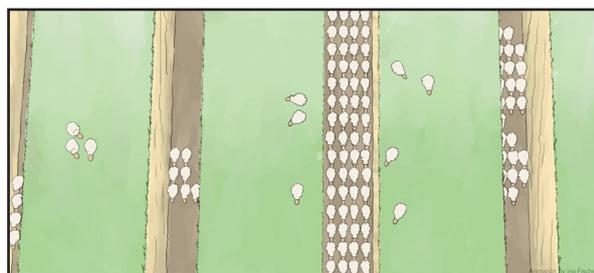
Recently, the first image film of CINSaT, which has been produced in collaboration with Studio Blåfield and the Trickfilmklasse of the art academy Kassel, was finally released. In this film, selected examples of the broad spectrum of interdisciplinary research activities taking place in CINSaT were chosen to be presented for a public audience in an artistic manner. As a result, a fruitful collaboration between the artists of the Trickfilmklasse and the scientific staff of the CINSaT members was established and both sides benefited from it. For the future, CINSaT intends to create more similar films to introduce interested people to its ongoing projects and activities.

*Selective particle transport, medical diagnosis*



*Chiral recognition, distinguishable medical effects*

*Molecular self assembly, LCD screens*



*Quantum entanglement, secure telecommunications*

The film can be found at:

<https://www.uni-kassel.de/cinsat/de/ueber-cinsat/imagefilm.html>

# Nano arts

In this section, artistically appealing images from the CINSaT groups will be presented. If you obtained any kind of visually appealing and fascinating data during your experiments with focus on micro- and nanometer length scales, you are cordially invited to submit your contribution to the editors.

In this edition: Self-assembled crystals of Tetra-PPC, a functional material for organic optoelectronics.



*photo: Julia Heupel, Macromolecular Chemistry and Molecular Materials, 800  $\mu\text{m}$  x 600  $\mu\text{m}$*



*photo: Campus Heinrich-Plett-Straße, Press and Public Relations Office University of Kassel, Studio Blåfield*

## Imprint

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