PHYSICS & ASTRONOMY
NEWSLETTER

VU VRIJE UNIVERSITEIT AMSTERDAM

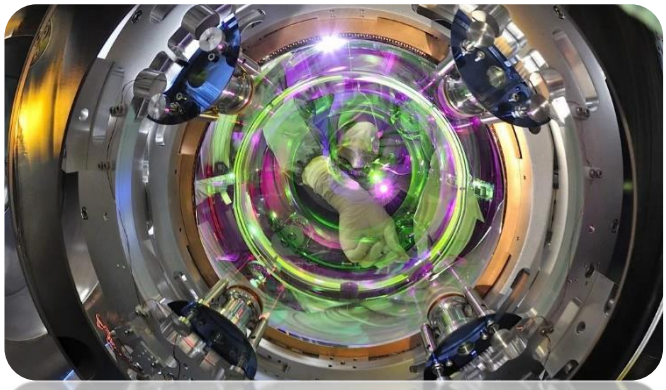
The Faculty of Science
Physics and Astronomy Department
Issue 1
4 March 2024

IN THIS ISSUE

Lets dive into it!

THE 2023 TEACHER OF THE YEAR JOHN SHEIL INTERVIEW

John Sheil, Assistant Professor at VU Amsterdam and group leader at ARCNL, has been awarded the 2023 Teacher of the Year prize in the Medische Natuurwetenschappen (MNW) bachelor programme.



GRANT & AWARDS

NWO perspectives funding for flat optics

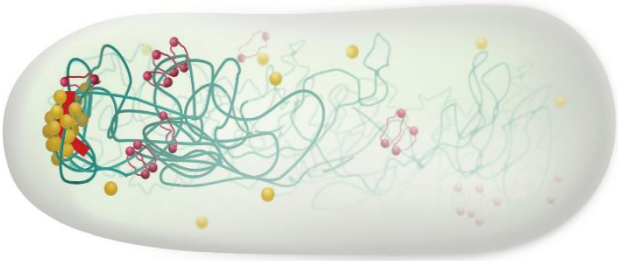
On December 13th NWO announced that one of the consortia to receive funding from the Perspectief program is the AWAVE project (Advanced Wave Engineering for Sustainable Optical Applications. VU Amsterdam assistant professor **Lyuba Amitonova**, amongst others ARCNL group leader, is one of the participating researchers. With the Perspectief program, NWO challenges researchers to establish broad, cross-disciplinary consortia with industry, civil society organizations and governments to conduct research focused on societal challenges and key technologies. **Partners:** The parties to work on the granted AWAVE project are: VU Amsterdam, Delft University of Technology (principal investigator), ARCNL, Eindhoven University of Technology, University of Twente, ASML, AAC Hyperion, Canon, Demcon, JMO, SCIL, Signify, Sumipro. The budget (including co-funding) is 3.1 million euros. Read more

NWO grant for cancer research

Dr. Imran Avci and Dr. Mahdi Mozdoor Dashtabi receive NWO grant for cancer research. They recently developed a new measurement method that is ultrasensitive and provides femtometer resolution in real-time. Read more

Prestigious Quantum Delta NL Award for our researchers

Quantum Delta NL, in collaboration with NWO, announces that 19 Honorees have been awarded €10.4 Million in grants as part of the second call of the National programme' s Actionline1 'Research & Innovation'. **Dr. Maximilian Beyer** has been awarded for his project titled 'Quantum for pressure-measuring atomic polarizabilities with molecular ions for a quantum pressure gauge (QPOL)' which aims to develop a novel method to determine the static polarizability of rare gas atoms spectroscopically. **Dr. Laura Dreissen** has been awarded for her project titled 'Silencing the Noise: entangled states in trapped ions for accurate quantum sensing and metrology' where she will use quantum entangled states in multiple Ba+ ions that are resistant to environmental noise, making them ideal for measurements with incredibly high accuracy. Read more



Physicist Chase Broedersz receives ERC Consolidator Grant

The European Research Council (ERC) awards Chase Broedersz, associate professor at Vrije Universiteit Amsterdam, a Consolidator Grant for his project "Learn4DChromosome". Chromosomes contain the genetic information to produce life and wants to understand the physical principles of functional chromosome organization in bacteria. **4D model:** The central goal of Learn4DChromosome is to develop a 4D model for the statistical folding of chromosomes and its implications for function. The development of new experimental Hi-C, chromosome, techniques has recently generated a breakthrough in measuring chromosome structure. Unlike a microscope, however, these experiments don't yield easily interpretable images, but rather a statistical metric for average pairwise interactions between chromosomal regions. Interpreting Hi-C maps at their full quantitative potential remains a major hurdle to overcome. Read more

GRANT & AWARDS

ERC STG Grant Award

With his research, **Dr. Askes** aims to challenge the traditional approach for the use of catalytic reactors in the chemical industry. These reactors are typically used to produce essential building blocks for our society, such as raw materials for plastics and fertilizers. Read more

ERC Starting Grant

Laser cooling of molecular helium. **Dr. Beyer's** research is focused on precision measurements of the simplest molecules in our universe - molecular hydrogen (H_2) and its ion (H_2^+) – to test quantum electrodynamics. Read more

Lithography light source simulation

ARCNL group leader and VU physicist John Sheil receives a Veni grant from NWO for his project "ARIES". **Dr. Sheil** will develop a unique laser-plasma simulation capability to guide the design of tomorrow's more powerful and more sustainable EUV sources for nanolithography. Read more

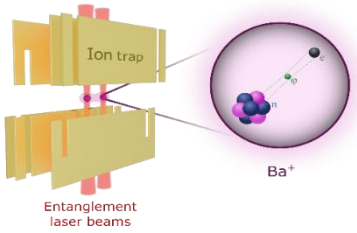
Gold Medal award

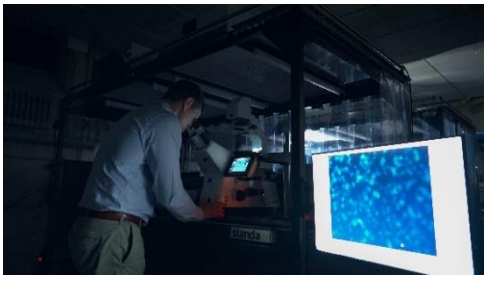
Prof. Dr. Roberta Croce has been honored with the Gold Medal award for Excellence in Photobiology. The award is presented during the biennial congress of the European Society of Photobiology to eminent scientists recognized globally for their exceptional contributions to the field of Photobiology and to the ESP activities. Read more

Laura Dreissen develops quantum sensor for dark matter with Veni grant

What is the origin and composition of dark matter? Although 85% of all the matter in our universe consists of dark matter, we still know very little about it. Physicist **Dr. Laura Dreissen** therefore plans to use her Veni grant to search for signs of this mysterious and remarkable phenomenon.

Read more





NWO funding for Andrea Baldi to study valuable metal nanoparticles features

For his research proposal titled: Selective CO2 photoreduction on plasmonic nanoparticles, VU Amsterdam physicist **Dr. Andrea Baldi**, is awarded a NWO Open Competition Domain Science grant. The funding will be used to study how metal nanoparticles under illumination can drive CO2 towards specific desired products. The chemical industry relies heavily on carbon-based building blocks such as CO, methanol and other organic reduction of atmospheric CO2, an attractive approach to lower our dependency on fossil fuels and reduce global warming. Baldi and fellow researchers from Vrije Universiteit Amsterdam will collaborate with scientists at the University of Twente and will make use of both these characteristics. They will use advanced microscopy and spectroscopy techniques to control chemistry both in space, using single nanoparticles, and in time, with ultrafast spectroscopy. Read more

GRANT & AWARDS

Vidi & NWO Open Competition Fund

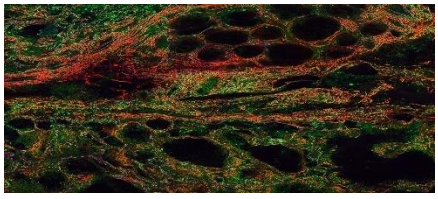
Peter Kraus, VU physicist and ARCNL group leader, has received the Vidi grant for his research HIMALAYA, which focuses on super-resolution for ''dancing electrons.'' The researcher also received funding from the NWO Open Competition for a project called "Ultrafast X-ray access to strongly correlated designer materials" (UltraX).
Read more

Grant for improvements Virgo detector

VU physicist Andreas Freise has received funding from the Dutch Research Council (NWO) Scientific Research Infrastructure programme to further improvements to the Advanced Virgo detector for gravitational waves in Pisa. Freise leads the Virgo innovation project at Nikhef. NWO has awarded 2.7 million euros to the project.
Read more

ERC Consolidator Grant

VU Physicist and ARCNL group leader, O. Versolato has received a Consolidator Grant from the ERC of two million euro. The grant allows him to investigate the ideas put forward in the research proposal 'Next-Generation Light Source: Driving plasmas to power tomorrow's nanolithography'.
Read more

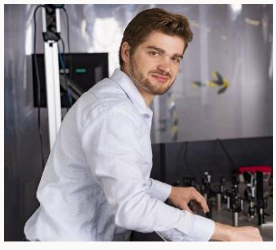


Million grant for early detection and treatment of lung cancer

Can you simply take a biopsy from a lung tumor via the trachea, and then treat that tumor locally in the same procedure? According to the IMAGIO research team, including VU professor of Biophotonics & Medical Imaging Marloes Groot, this is getting closer. Additional and new technology is being developed that allows a doctor to find lung cancer earlier, results in better identifying and treat the cancer more vigorously. The research is part of the IMAGIO project, which also investigates liver cancer and soft tissue tumors. A grant of 24 million euros has been awarded to the project by Innovative Health Initiative. The research ensures that major changes can take place. For example, the routine analysis of a biopsy in the Pathology department now takes about three days. However, with the development of a laser microscope, the biopsy can be analyzed in 3D directly in the operating room. When cancer is found, treatment can be started immediately.
Read more

L'Oréal UNESCO For Women in Science fellowship

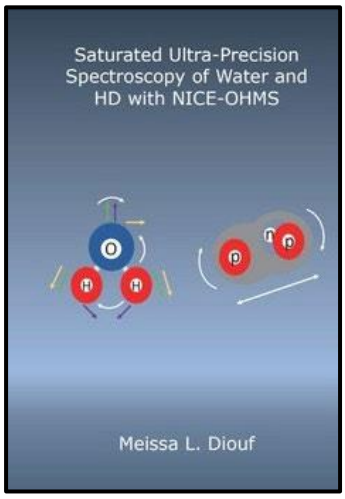
Biophysicist Volha Chukhutsina has received a research grant of 30,000 euros. On April 18, the L'Oréal UNESCO For Women in Science Fellowships and Rising Talent Awards were presented for the 11th time in the field of Life Sciences and STEM disciplines. VU biophysicist V. Chukhutsina received one of the research grants.
Read more



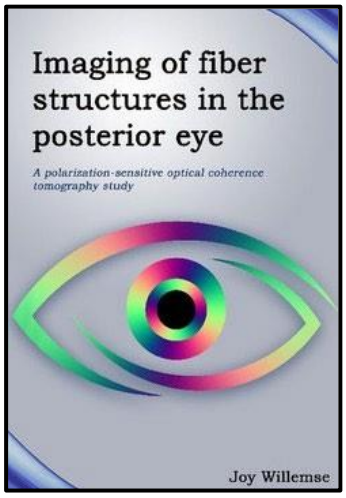
NWO grant for visualizing structures in computer chips

VU physicist and ARCNL group leader Peter Kraus has received funding from the Dutch Research Council (NWO) Open Technology Programme for the project 'Integrated nanophotonic and extreme-ultraviolet access to semiconductor metrology'. NWO has awarded 1 million euros to the NANOXUV project. Read more

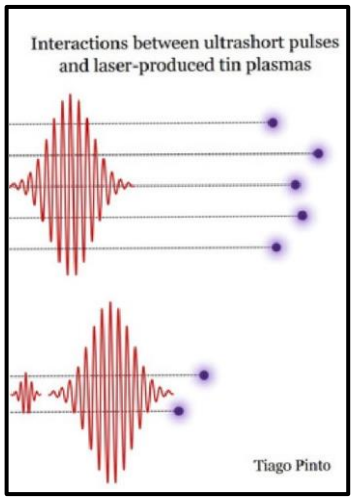
Recent PhD Theses



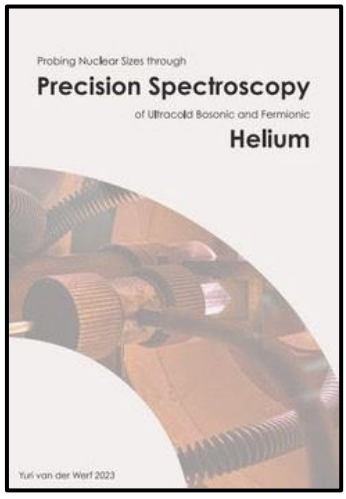
M.L. Diouf
6 December 2023



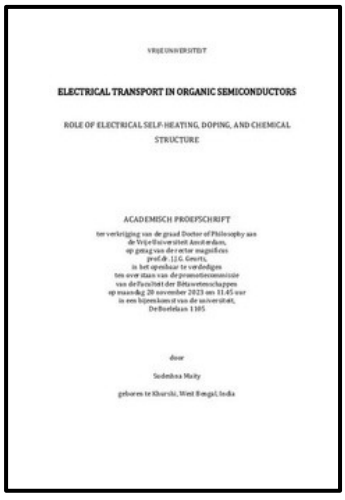
J. Willemse
29 November 2023



T. Pinheiro de Faria Pinto
27 November 2023

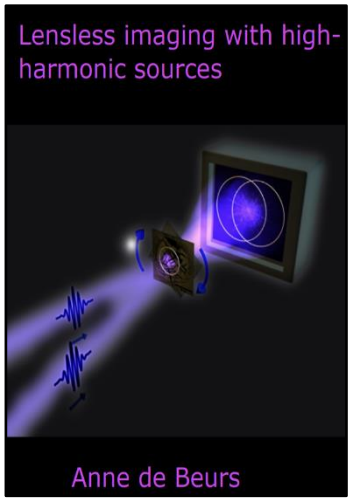


Y. van der Werf
24 November 2023

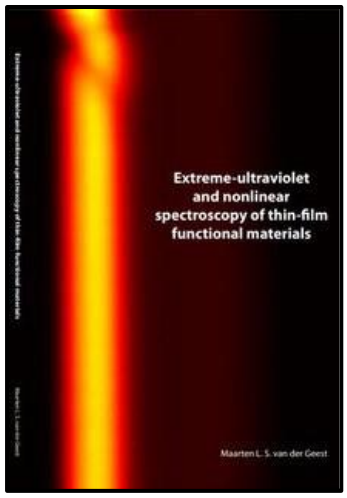


S. Maity
20 November 2023

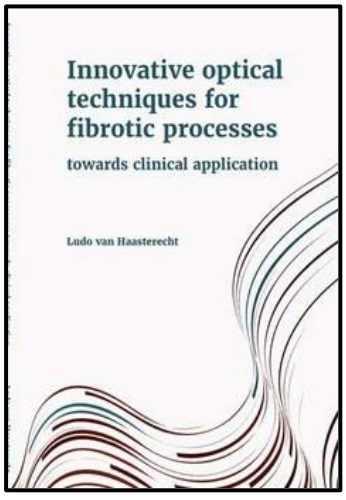
D. Hemminga
20 November 2023



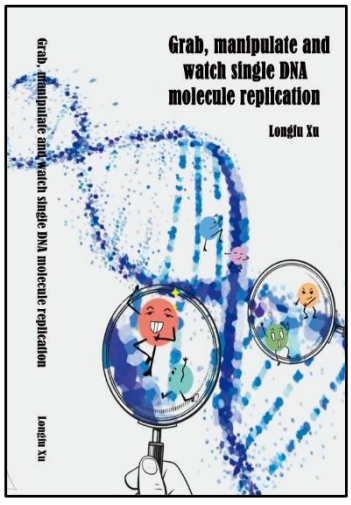
A.C.C. Beurs
16 November 2023



M.L.S. van der Geest
15 November 2023



L. van Haasterecht
13 November 2023



L. Xu
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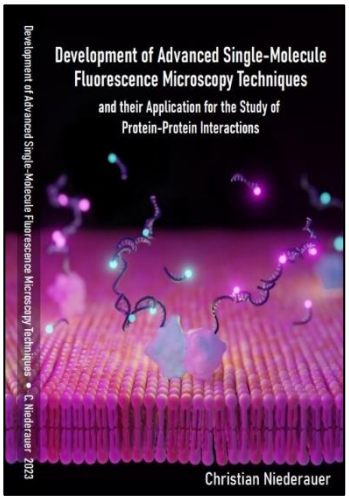
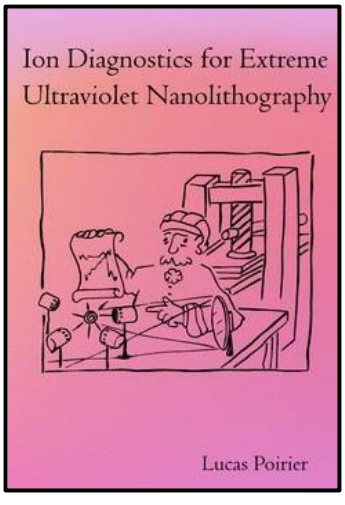
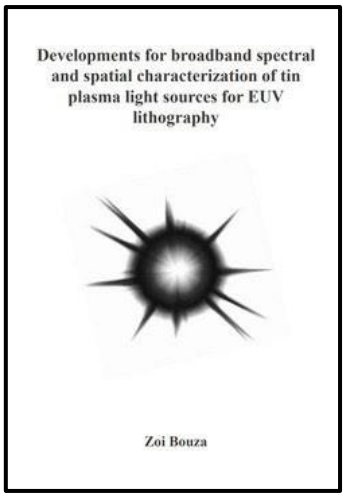


C. Niederauer
19 October 2023



L.R. Poirier
6 October 2023

Recent PhD Theses



Z. Bouza
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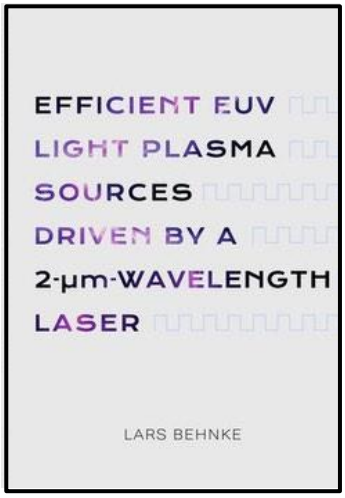
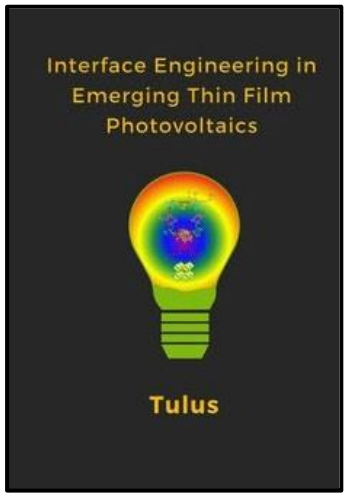


L.P. Behnke
2 October 2023



Tulus
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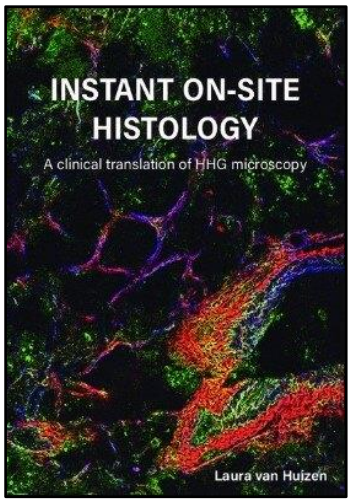
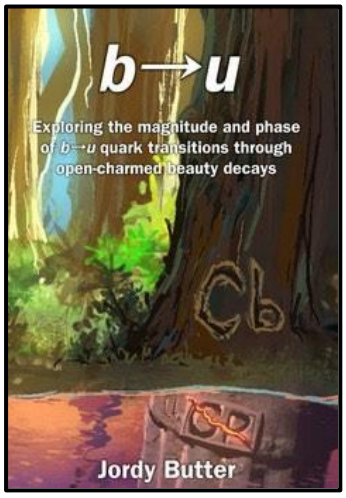
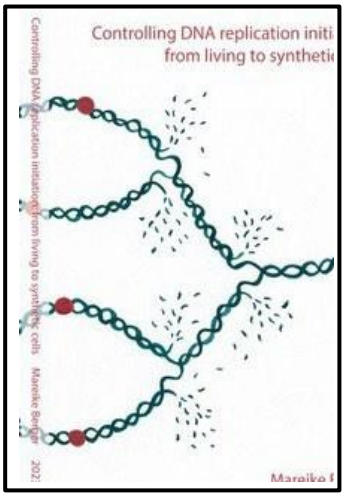


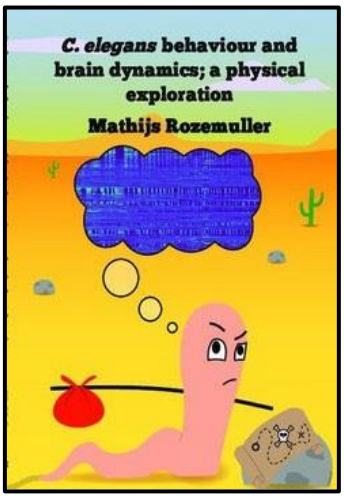
L. van Huizen
6 September 2023



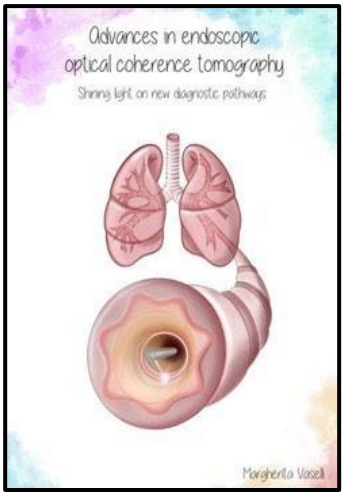
J. Butter
13 Jun 2023



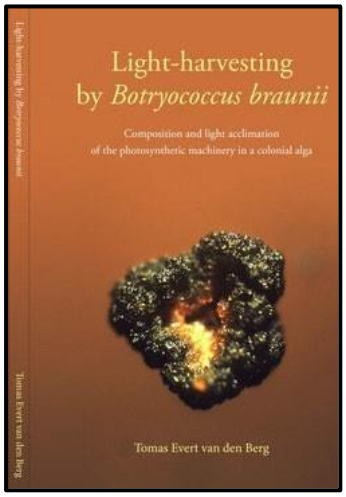
M. Berger
3 May 2023



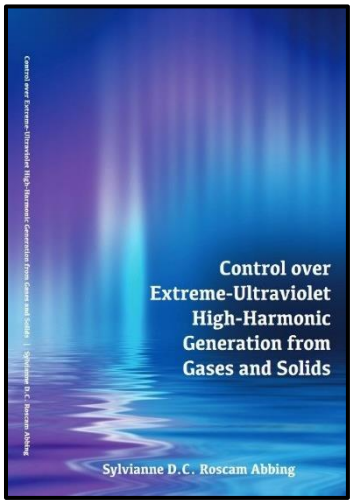
M. Rozemuller
26 April 2023



M. Vaselli
19 April 2023



T. van den Berg
30 March 2023



S.D.C.R. Abbing
27 March 2023

Interview

The teacher of the year 2023

John Sheil

Give us a brief information on your background and your research plan

I'm originally from Dublin (Ireland) and completed both my undergraduate bachelor's degree and PhD (in atomic physics and spectroscopy) at University College Dublin. It was actually after a talk I gave in Dublin that I was approached by my future colleague Dr. Oscar Versolato, who very much 'enticed' me to apply for a job at a new research Center in Amsterdam, the Advanced Research Center for Nanolithography. In essence, they wanted someone who would study, using theory and modeling, what would happen when a high-intensity laser pulse hits a tin droplet and form a hot, intensely radiating plasma (ionized gas). Why? Well, it so happens that the light radiated from such plasmas is nowadays used to make computer chips! I spent 2.5 very happy years as postdoctoral researcher in the group, and ultimately applied for a tenure track assistant professor position at VU Amsterdam and group leader at ARCNL to build a group focused on modeling these complex environments. And here we are!!

As you are the teacher of the year; what is your secret and how is working at VU and ARCNL?

The teacher of the year was obviously a big honor, especially given that I'm quite new to this game!
I teach the first physics course ('Classical Mechanics') in the Bachelor Medische Natuurwetenschappen programme, a rather a broad study covering physics, chemistry, biology, math, and medical science. My secret? I probably have 3. Enthusiasm and passion for the subject is probably the most important, and students very much recognize a teacher who works hard to maximize the learning experience for students. Second, it is important to motivate WHY the topic of the lecture/course is relevant for the programme. For example, I recently discussed (briefly) the physics of photon and proton beam therapy in one of my lectures. Finally – use the blackboard! Perhaps I'm old fashioned, but I think students follow the material best when you work through examples/concepts on the board. It really allows students to 'think along with you'.

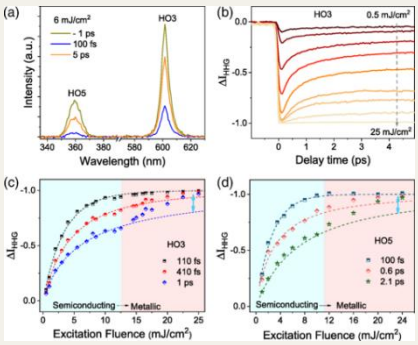
Working at VU Amsterdam and ARCNL is very rewarding and also very fun! I very much enjoy the teaching I do at VU Amsterdam and also interacting with the PIs. Although we work in quite different fields, I have learned a lot through our discussions. For instance, I now include videos of my colleague Dr. Chase Broederz's research on cell dynamics in my Classical mechanics course, which the students think is fascinating. These kind of interactions makes me happy here at VU Amsterdam and ARCNL. People at both institutions are very nice, friendly, open, and willing to help each other.

Lastly, a personal questions what is your hobbies and give us some facts about you:

I love writing music. I was in a band for 14 years before moving to the Netherlands, and we played at music festivals in Dublin and abroad, which was super fun. I still write and release music would you believe! I also read a lot about the history of physics, and more recently have got interested in drawing (although I'm very much a beginner!) Some funny facts: I have a fear of heights and dolphins! That's me!

Highlighted Papers

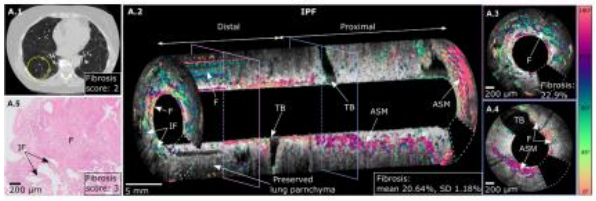
Ultrafast switching with light in correlated materials



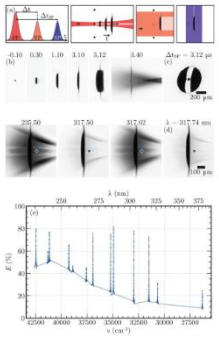
Materials that refuse to fit into theory are often the most fascinating. They challenge researchers to try harder to understand their peculiar behavior, especially when their properties are promising for technological applications. Researchers in the High Harmonic Generation & EUV Science group of Peter Kraus at ARCNL have recently unraveled some of the mysteries of a so-called correlated material and found a way to manipulate its resistivity with light. This paves the way for opto-electronic ultrafast switching in future microelectronics. The study was recently published in Physical Review Letters. Read more

New optical technique for determining fibrotic tissue in lungs

An interdisciplinary research team has developed a new optical technique for determining fibrotic tissue in the lungs of interstitial lung disease patients. This groundbreaking study demonstrates that this new technique has potential to



outperform fibrosis detection and quantification in the lung as compared to high resolution Computed Tomography. The team was led by VU Amsterdam physicist **Prof. Dr. Johannes de Boer** and Amsterdam UMC lung specialists Dr. Peter Bonta and Prof. dr. Jouke Annema. The study was recently published on BMJ open Respiratory Research and presented at the European Respiratory Society conference in Milan.

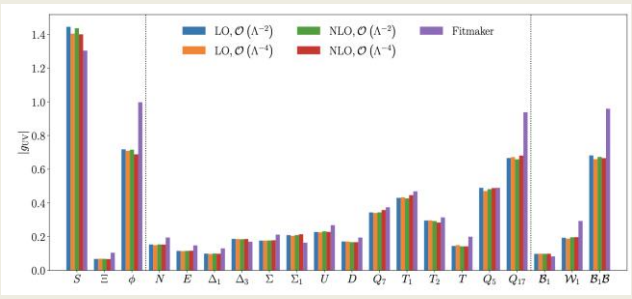


High-resolution spectroscopic imaging of atoms and nanoparticles in thin film vaporization

We introduce a spectroscopic absorption imaging method in the UV regime (225–400 nm) to study tin vapor created by irradiating a thin film with a low intensity 108 W cm−2 nanosecond laser pulse, a case inspired by current developments around “advanced target shaping” in industrial laser-produced plasma sources for extreme ultraviolet light. The 4-ns-time-resolved, 10-µm-spatial-resolution images contain a 10-cm−1-resolution spectrum of the vapor in each pixel 100 ns after the vaporization. The images allow us to reveal a homogeneous temperature profile throughout the vapor of around 3000 K. We obtain a density map of the atoms (with a peak density of 5 × 1018 cm−3) and nanoparticles (1012 cm−3 for the best fitting 20 nm radius case), which both are shown to be present in the vapor. For each free atom, approximately three appear to be clustered in nanoparticles, and this composition is invariant over space and density. The density and temperature maps of the free atoms are combined to estimate the electron density (peaking at 1013 cm−3) in the vapor. Read more

The automation of SMEFT-assisted constraints on UV-complete models

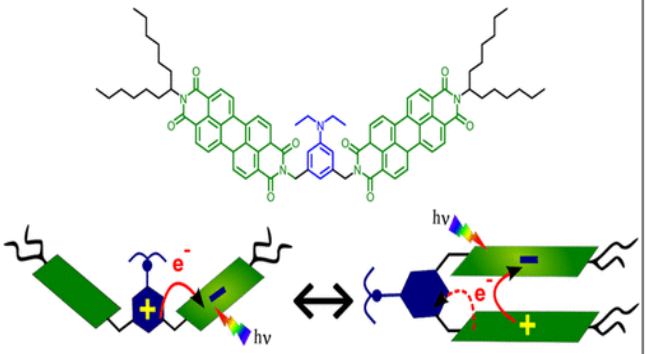
By deploying the Standard Model Effective Field Theory (SMEFT) as a bridge between UV-complete models and data, the authors present an automated framework that can indirectly constrain a wealth of New Physics particles and interactions from their matching to the SMEFT. This paper realizes one of the main objectives of the EFT program in particle physics: deploying the SMEFT to bypass the need of directly comparing the predictions of heavy UV models with experimental data. Read more



Highlighted Papers

Competitive Charge Separation Pathways in a Flexible Molecular Folda-Dime

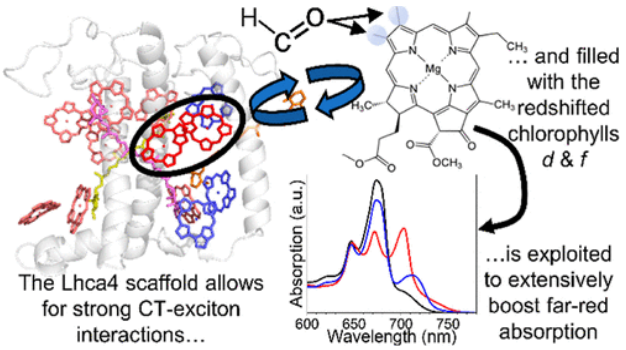
We report the photophysical properties of a molecular folda-dimer system PDI-AnEt2-PDI, where the electron-donating N,N-diethylaniline (AnEt2) moiety bridges two electron-accepting perylene diimide (PDI) chromophores. The conformationally flexible PDI-AnEt2-PDI adopts either an open (two PDIs far apart) or folded (two PDIs within π-stacking distance) conformation, depending on the solvent environment. We characterized the photoinduced charge separation dynamics of both open and folded forms in solvents of varying polarity. The open form undergoes charge separation to give PDI•–-AnEt2•+-PDI (Bridge electron transfer) independent of solvent polarity. The folded form exhibits two charge separation photoproducts, yielding both PDI•–-AnEt2•+-PDI and PDI•–-AnEt2-PDI•+, the latter of which is formed via symmetry-breaking charge separation (SBCS) between the two π-stacked PDI chromophores. Our results further indicate that the conformational flexibility of the folda-dimer leads to unexpected excimer formation



in some open form conditions. In contrast, no excimer formation is observed in the folded form, indicating that this geometry preferentially yields the SBCS instead. Our results provide insight into how conformationally flexible folda-dimer systems can be designed and built to tune competitive photophysical pathways. Read more

Coloring Outside the Lines: Exploiting Pigment–Protein Synergy for Far-Red Absorption in Plant Light-Harvesting Complexes

Plants are designed to utilize visible light for

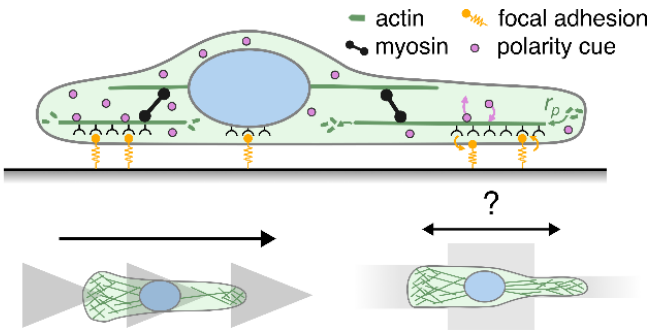


photosynthesis. Expanding this light absorption toward the farred could boost growth in low-light conditions and potentially increase crop productivity in dense canopies. A promising strategy is broadening the absorption of antenna complexes to the far-red. In this study, we investigated the capacity of the photosystem I antenna protein Lhca4 to incorporate far-red absorbing chlorophylls d and f and optimize their spectra. We demonstrate that these pigments can successfully bind to Lhca4, with the protein environment further red-shifting the chlorophyll d absorption, markedly extending the absorption range of this complex above 750 nm. Notably, chlorophyll d substitutes the canonical chlorophyll a red-forms, resulting in the most red-shifted emission observed in a plant light-harvesting complex. Using ultrafast spectroscopy, we show that the introduction of these novel chlorophylls does not interfere with the excited state decay or the energy equilibration processes within the complex. The results demonstrate the feasibility of engineering plant antennae to absorb deeper into the far-red region while preserving their functional and structural integrity, paving the way for innovative strategies to enhance photosynthesis. Read more

Highlighted Papers

Geometry sensitive protrusion growth directs confined cell migration

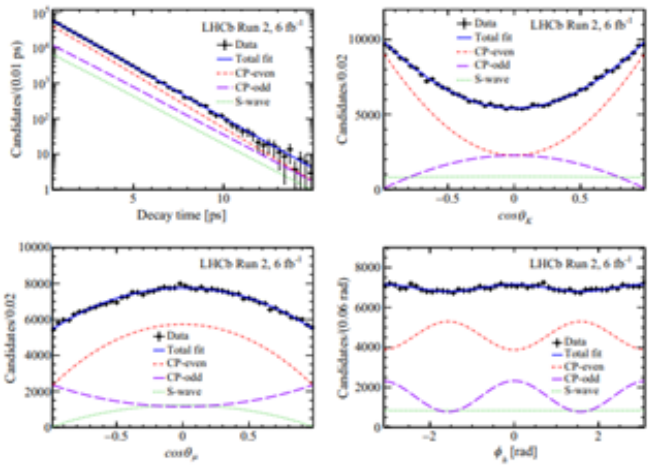
The migratory dynamics of cells can be influenced by the complex micro-environment through which they move. It remains unclear how the motility machinery of confined cells responds and adapts to their micro-environment. Here, we propose a biophysical mechanism for a geometry-dependent coupling between cellular protrusions and the nucleus that leads to directed migration. We apply our model to geometry-guided cell migration to obtain insights into the origin of directed migration on asymmetric adhesive micro-patterns and the polarization enhancement of cells observed under strong confinement. Remarkably, for cells that can choose between channels of different size, our model predicts an intricate dependence for cellular decision making as a function of the two channel widths, which we confirm experimentally.



Read more

Improved Measurement of CP Violation Parameters in B0s→J/ψK+K− Decays in the Vicinity of the φ(1020) Resonance

A new “world’s best measurement” by the LHCb Collaboration, with a strong contribution from the VU/Nikhef colleague V. Lukashenko (PhD candidate) and her supervisors Prof. G.Raven and Dr. W. Hulsbergen, is presented in Ref. [1]. The LHCb experiment, at CERN, uses data from proton-proton collisions at very high energies to explore the conditions created right after the Big Bang, that led to a massive the prevalence of matter (and almost complete disappearance of anti-matter) in the universe. Within the Standard Model of particle physics, differences between matter and antimatter are related to violation of the Charge-Parity (CP) symmetry. The comparison between CP-symmetry measurements and theory predictions sheds light into the mechanisms involved in the creation and disappearance of matter and antimatter. B mesons are particles of special interest for the LHCb experiment, since after being produced in proton-proton collisions, they can oscillate into their own anti-particles before disintegrating within the detector. The disintegration of B0 s mesons into J/ψK+K− is a particularly sensitive process, as it provides access to the CP-violating phase ϕs. Standard model predictions for the ϕs phase can be accurately calculated from other measurements, and the value is predicted to be close to zero, ϕs = −0.037 rad. Any deviation, even small, from this prediction, could be indicative of how the large imbalance of matter took place at the early universe. The LHCb Collaboration, led by its Nikhef/VU team, has recently completed the most accurate measurement of ϕs to this date. The measurement yields ϕs = −0.039 ± 0.022 ± 0.006, in agreement with the standard model prediction within the current precision. The result represents an important step forward in accuracy, and establishes several novel methods to analyze the even larger data samples that will be collected at CERN in the near future.



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News & Announcements

Dr. Sven Askes joins the Physics and Astronomy

Askes is an assistant professor at the Vrije Universiteit Amsterdam since September 2023. He is hired in the context of the VU/UT collaboration on the Mechanical Engineering BSc program.
Read more

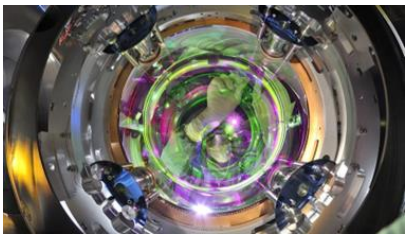
Dr. Joris van Heijningen joins the Physics and Astronomy

Van Heijningen is an assistant professor at the Vrije Universiteit Amsterdam since November 2023. Dr. van Heijningen is hired in the context of the VU/UT collaboration on the Mechanical Engineering BSc program. Read more

Dr. Loreta Muscarella joins the Physics and Astronomy

Muscarella joins the Physics Department as Assistant Professor in the section of PhotoConversion Materials.
Read more

Back to the Big Bang with the Einstein Telescope



Dive into the universe's deepest secrets with **Prof. Dr. Andreas Freise**, the visionary behind the Einstein Telescope, as Freise takes us on an exhilarating journey to uncover the mysteries of gravitational waves and explore the cosmos like never before. Read more to discover how this monumental project could change our understanding of the universe.

Mara Senghi Soares new program leader LHCb experiment at Nikhef

Assoc. Prof. Mara Senghi Soares has been appointed as the national program leader for the Large Hadron Collider beauty (LHCb) experiment at Nikhef, starting from November 1st. This experiment is one of the four major international experiments at the Large Hadron Collider (LHC) accelerator in Geneva. The experiment is specialized and leading in measuring differences between antimatter and matter. Read more

Prestigious‘ ASML Corporate Fellow’ for Arie den Boef

At ASML’s Technology conference, ARCNL group leader and VU **Prof. Arie den Boef** has been awarded with the title of ASML Corporate Fellow. Only one other person currently working for ASML holds this title, which shows the great appreciation of his work for the company ASML. Arie den Boef is professor of Metrology and Nanolithography at Vrije Universiteit Amsterdam, works at ASML and ARCNL and closely collaborates on Digital Holographic imaging with the VU Physics department. Read more

Karin Colvin started her role as Assistant Department Manager on 1st February 2024.

Karin Colvin's responsibilities will amongst others encompass the oversight of the department's research portfolio. She will undertake reviews of all projects, subsequently providing stakeholders with comprehensive financial updates. This initiative aims to ensure clarity regarding financial standings, thereby allowing researchers to concentrate more intently on their academic pursuits.

Science ART

Jamming with plants Lowlands Science lab

Thanks to biophysicist and art science researcher **Raoul Frese** and artist-researchers Christiaan Zwanikken and Marc Marc, you can experience what it is like to literally be connected to plants in the Lowlands Science Lab. The scientists are investigating the operation of electrical processes in plants and possible applications thereof. To provide insight into these processes, a huge electronic installation has been developed that converts the plant's signals into sound. Read more

Exciting Innovation at the Intersection of Nature and Technology!

Thrilled to share the ground-breaking project "Smart Hybrid Forms: A plant becomes a machine becomes a plant" led by **Dr. Raoul Frese** - Vrije Universiteit Amsterdam, at our department and co-applicant Gerrit Rietveld Academy, with partners Waag Society, V2_the lab for unstable media, and Zone2Source. In collaboration with Špela Petrič, a visionary new media artist with a scientific background, the project introduces PL'AI - a plant-centered robot that seamlessly merges nature and technology. This interdisciplinary endeavor involves experts from computer and cognitive science, biology, engineering, design, art, and philosophy. It challenges our perception of plants and machines, offering a fresh perspective on the coexistence of living beings and technology. Read more

VU PHYSICS & ASTRONOMY COLLOQUIUM
14 March 2024

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