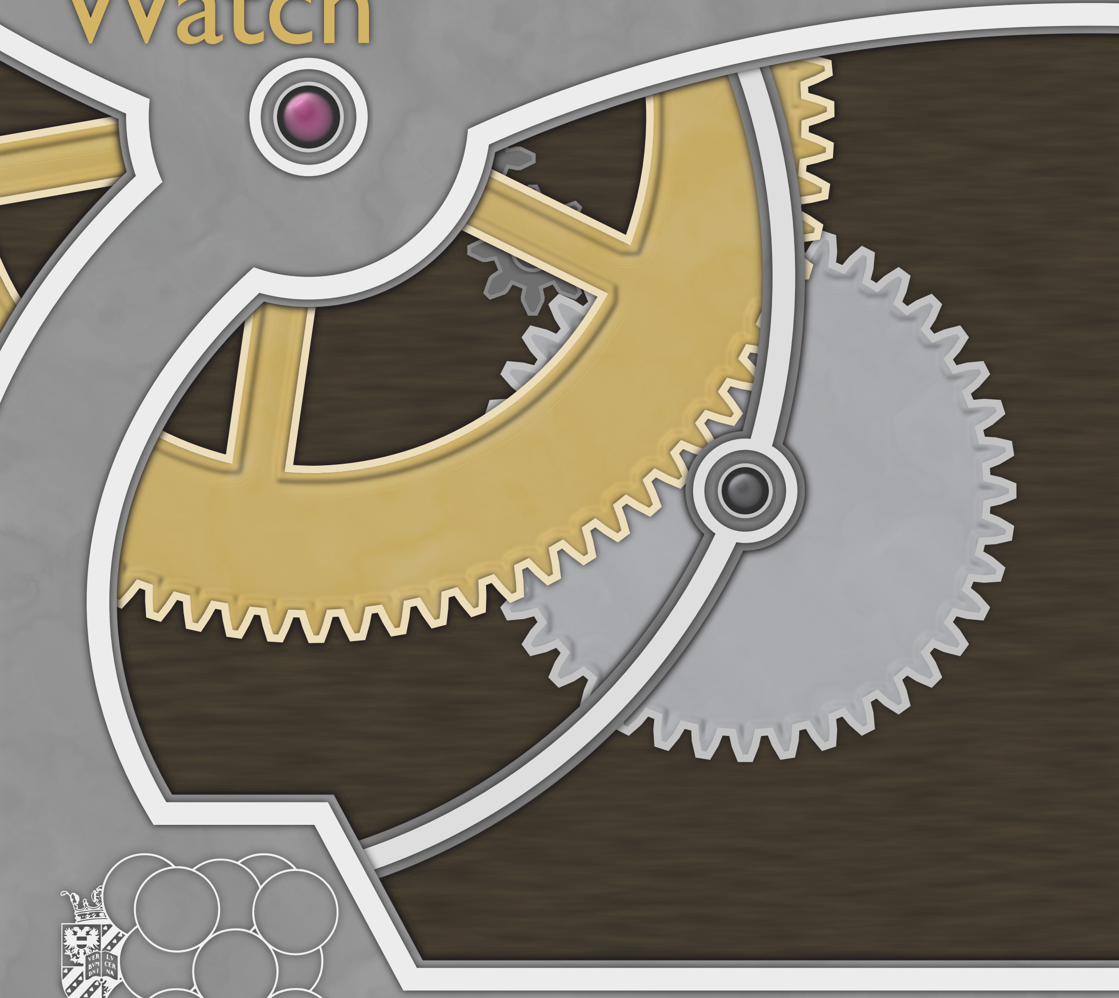
Meet the New Board
Learn more about Francken's new board

Scribent
A summary of professor de Hosson's seminar comments

Theorist
The theoretical model of a watch

Francken Vrij

Watch



23.3 Watch

Colophon

Editor in chief
Sibren Wobben

Editorial board
Emiel de Wit
Emma Giovinazzo
Laurens Kerdijk
Tabitha Minett

Senior Editor
Leon Trustram

Editorial
I have been watching my watch carefully this year and I noticed one thing: time flies when you are having fun (/many things to do). It feels like yesterday that we decided that I would become the new editor in chief of the Francken Vrij. Sadly my story ends (/starts) here, as you can read on page 11 (teaser!). This means that next year Emiel de Wit will replace me as the editor in chief of our beautiful magazine. But do not worry, I will return as the senior editor of our magazine!
All sad stories aside, the theme of this Francken Vrij is Watch. I hope you will enjoy reading it!

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Also this edition of the Francken Vrij, Bradley has again made comic for us.

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In this edition's puzzle a Franckenmember wanted to walk home but had some struggles. Could you help him figure out which places he went?

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In professor Hildner's group they use optical spectroscopy to study the photophysical and electronic properties of functional organic molecules and nanosystems. He will give some examples and tells us more about this topic.

45 Not on my Watch

Jelle Bor

This edition Jelle has writen a theorist for us. He will be talking about how we can see a clock-hand as vector.

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Nikki Arendse

For a while now Nikki lived and worked on her PhD in Copenhagen (Denmark). In this edition you can read what it is like to live in Denmark and what it is like to do a PhD there.

Chairman's Preface

By Joris Doting

Dear Franckenmembers, Some people have one of those fancy watches with the date on them; I don't. However I do know that by the time you read this, I probably won't be president of this beautiful association anymore. I will, besides making the year report with my fellow (hopefully) soon-to-be Wijze Heeren and Damesch, have to sit back and watch our successors take their turn running the association for a year (I wanted to turn the first 'n' of 'running' into an 'i', but I figured I should give them a chance). Now, watching can be as hard as anything else, judging by the many comments and bountiful advice we got from former board members throughout this year. It is also often as useful as any physical action, as we can see from the countless discoveries made by observation, not in the least in our fields of interest. I hope we can be as useful as former board members to our successors as our predecessors were to us. Now that we're talking about predecessors anyway, I might as well mention the predecessors of the word 'watch'. Turns out it comes from the old English word 'wæcce', meaning remaining awake or keeping watch. This has a lot to do with being a board member of Francken; while looking out for the interests of the association, one also occasionally has to watch out for the well-being of each member when they forget to do so themselves. Hopefully I haven't scared off any newly-in-function board members with this. Anyway, before I run out of words: Thanks to everyone for this amazing year, and best of luck to the new board!

News of the Association

By Chantal Kool

And suddenly it is the last time that I have the pleasure of writing the news of the association. Personally, the third quarter of this academic year was the busiest of the year due to the enormous amount of (amazing) activities. From borrels to Buixie, from the symposium to VrijMiBo's, it has been a turbulent period. Not only at Francken, but also in the rest of the world, including the first image of a black hole, still no Brexit, and both Formula 1 and Eurovision coming to the Netherlands next year. I hope that I have entertained you this year with my memoirs of some of our activities and that you enjoy this last one!

Casino night

With the Francken room turned into a casino, it was time to see if the odds were on our side. With games like *paardenrace*, het ad van fortuin, and everyone's personal favourite: bingo, there was plenty of opportunity to spend your coins. My memory of the end of the evening is desperately tring to spend my coins on the ad van fortuin to win crisps, but instead it resulted in me having to take more and more rietads.

Borrel lecture by QNH consulting

Personally, I think that borrel lectures embody the core of our association: high-level academic material combined with a borrel. This time we had the honour of welcoming our fellow *mooie gek*, Jakko de Jong, for a talk about his work at QNH consulting. Accompanied by Mark Boer, he explained to us how they use machine learning to improve satellite images of the earth. This of course whilst enjoying some bitterballen and beer. Classic!

Symposium "in a materialistic world"

This year's edition of the Francken symposium was all about innovations in materials science. With talks ranging from innovations in 3D printing to solar cells to non-equilibrium materials, the level of every talk was very high. Everyone, including me (as mathematician), was intrigued by their talks and the stunning location in the form of EM2 was the cherry on top.

Climbing with the Sportcie

As you may have noticed, a lot of Francken members enjoy wall climbing as their primary source of exercise. Since the Sportcie do not organise a lot of activities involving real exercise, it was about time to burn some calories. With our very own Chris van Ewijk as the instructor, we all conquered the walls of "Bjoeks", with a lot of red, sweaty faces as a result.

Welding

Our brand new committee, the Fikscie, decided that their first activity was going to be a welding workshop. On 3 separate evenings about 6 people per evening went to "de lasleraar" where they would learn the basics of TIG welding. Everyone started with a metal cube and afterwards put a personal creation on top of it. To be honest, I did not expect anything nice to come out of these evenings, but to my surprise everyone created a very impressive sculpture. Amazing activity!

Escaperoom

It is no secret that Francken members like to solve puzzles and brag about how smart they are. With this in mind, an escape room is the perfect activity for us. Everyone was separated into 3 teams, each in a different room. Of course each team wanted to get out first. The only thing I remember about the outcome is that my team wasn't in first place and that my brute-force techniques did not work that well on all the locks. Afterwards, we figured we needed healthy food to compensate for all the thinking, so we visited both KFC and McDonald's to fill our stomachs.

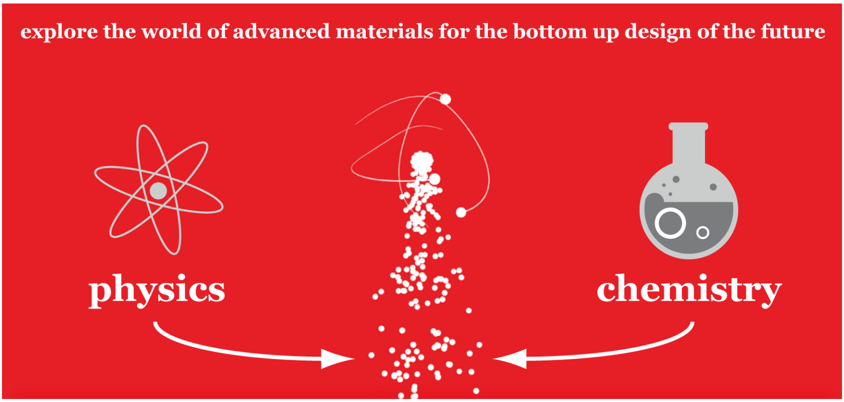
Buixie to Germany and Danmark

Since 2019 ends with a 9, it was no surprise that the Buixie went to Germany this year. Our trip to Hamburg provided us with a glimpse at some of the coolest and newest developments in physics. Not only was the research in Hamburg top-notch, but this industrial harbour city surprised us all with its beauty and hip culture. The next stop was Copenhagen, one of the few cities outside of the Netherlands where biking is one of the main forms of transport. With a visit to the Niels Bohr Institute and a lot of free time, I am sure that everyone fell in love with this city and its architecture, friendly inhabitants and modern, but relaxed atmosphere.

Zernike Institute for Advanced Materials

You want to build the next generation of solar cells, starting from molecular building blocks? Or change the world of computing by crafting groundbreaking memory materials atom-by-atom? Maybe you want to use your talents and interests for learning how to develop materials preventing or curing disease? Then have a look at the Bachelor, Master and PhD programs related to and inspired by the Zernike Institute for Advanced Materials' research lines.

Our activities cover both **Bachelor** and **Master** levels in the field of Physics and Chemistry. It is our mission to train a new generation of researchers in cross-disciplinary approaches to research and equip them with the diverse skills required by modern science. For making our mission real, we have established programs breaking the traditional boundaries between disciplines. One example is our interdisciplinary Top Master program Nanoscience, which is rated as best Master program of the Netherlands several times by national study guides. We also offer the High Tech Systems and Materials Honours Master in collaboration with industry. In this program you can pursue real-life product development challenges in a really interdisciplinary setting. ~~Additionally to the Bachelor and~~ Master education, the Zernike Institute is training approximately 150 PhD students to become independent, high level scientists. The main component of our training is 'hands-on experience', building and developing your skillset side-by-side with the research staff of the institute.



university of groningen / faculty of science and engineering

Zernike Institute for Advanced Materials

check our video on: YouTube →

Interested to explore the interdisciplinary world of nanoscience?
Please contact us via zernike@rug.nl and we assist you in finding the next challenge for your career.

Are you interested in joining our team for a Bachelor-, Master-, or PhD-project? Check our website http://www.rug.nl/research/zernike/education/ on the different educational programs or directly approach us via zernike@rug.nl.

Meet the New Board

Eva Visser

Dear members of T.F.V. 'Professor Francken', as most of you will know by now, my name is Eva and I will be the new president of our association.

I was born and raised in Amsterdam and

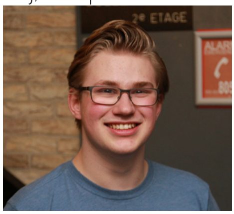
left that big city for our beautiful Groningen 6 years ago. With some intermezzi, I finished my Bachelor's in Physics 1 year ago. This year I started my Master's in Science Communication, which I hope to finish next year.

Most of you will know me as I have been around for a while and joined several committees.

My adventure at Francken started in the Sjaarscie, but in the meantime it is easier to name the committees that I haven't taken part in. A board year is therefore the only logical last step to finish my time at Francken and in Groningen. I am very happy to get this chance and we hope to make it an awesome (lustrum) year for all of you!

Sibren Wobben

For a common reader of the Francken Vrij, this picture here might seem familiar



to the one on the third page of this wonderful magazine. Please allow me to introduce myself: Hoi, my name is Sibren Wobben, however, I'm most commonly known as Fristi (a title which has no connection with my preference for beverages, but more to a *wijze heer* of our association, with whom I share a similar last name). By now I have established somewhat of a reputation of being a bit clumsy; one of my first moments of contact with Francken was not during the introduction day (as I obviously lost my group), but during the first karakterborrel of that year. During this borrel, I got dragged into the Sjaarcie after which it all spiraled downhill; I joined the **Francken Vrij** the same year; became the editor in chief, joined the Pienter-committee, the B'cie (vó!), the Sympcie in my second year, and nowadays you can find me 99% of my time playing klaverjas and drinking coffee (until four-o'clock) in the Franckenroom. Therefore, it didn't surprise many members that I can now call myself the next Secretary of T.V.F. 'Professor Francken'.

Carla Olsthoorn

Dear members of our lovely association, my name is Carla, but most of you might know me as Clara. As of this year, I have a whole year dedicated to being the treasurer of our association. As most of you know, I love spending money, however I am also quite good at managing it. Even the Buixie survived a whole year with me as their treasurer, so now I am excited to see if Francken will survive with me as their treasurer as well. Aside from having been the treasurer of Buixie, I was also the event manager the year before, as well as being a committee member of the Sjaarcie. Besides my life at Francken, I am studying astronomy. Hence, the theme of this Francken Vrij is perfectly suited for me since, as an astronomy student, you have to love WATCHing stars. Besides this, I love to go climbing several times a week. So if you can't find me at Francken, I will probably be at the climbing wall. I am looking forward to making next year an amazing year and I hope to see you all in the Francken room!

Robbert Julius

Writing a thesis is one thing, but writing a personal introduction for the Francken Vrij is another; the latter one requires some more rhetoric. If you ask me, Robbert Julius (3rd year Applied Physics), I would prefer writing the more rhetorical texts, especially the ones that require a balance between ridiculous, funny, and serious content. To introduce myself, I came up with the idea of describing some personal stuff in my bedroom. However, since I have only lived in Franckenhuisje I for less than two months, it only contains basic IKEA stuff. Instead, I will describe my bedroom in my paternal house. First of all, *'let niet op de rommel'*. The stuff in this room covers the great variety of subjects I am interested in. The books of geography (and history), the world maps, and the globe reflect my love for geography; the physics books, science magazines, and equations on my whiteboard reflect my interest in physics; the tennis stuff reflects my passion for tennis; the organized boxes and folders full of old notebooks reflect my obsession for keeping everything (organized); the Francken Maß reflects my dedication to T.F.V. 'Professor Francken'. I am happy to announce that, next year, I will be your Commissioner of Internal Relations.

Chantal Rikse

Moi eem! My name is Chantal, 23 years old (I'm at the point where hangovers start to get bad, so advice on that is appreciated), and I'm proud to say that I've been chosen to take over Leon's position as Commissioner of External Relations. I hope I can make all of you proud, as well by bringing in some money (loads of it) in the upcoming year. In the past year I've helped organizing Buixie, and I've taken some beautiful pictures of events as I also joined the Fotocie. Next to Francken I finally finished my Bachelor's in Mathematics and started my Master's in Applied Mathematics, I'm working at Swapfiets, and I'm an active member of G.S.P.V. Parafrid, the student horseback riding association of Groningen. There I helped out with promoting the association and will do so during the KEI-week this summer. I'm excited for the upcoming year and I expect all of you to show up at many company activities!

To prove to all of you that Chantal is not a "paardenmeisje", she included a picture of herself on a horse.

'Nuclear', the thirty-fifth board of T.F.V. 'Professor Francken'.

Stop and Watch: stop-watch

By prof. dr. Jeff Th. M. De Hosson

The current FranckenVrij issue is focussed on the theme 'watch' and for a microscopy person like myself the topic should be a nice breeze and a joyful piece of cake as well. Already on my D-day Symposium of March 29th I have discussed a couple of MK examples showing that electron microscopy confirms not only the widely used argument '*seeing is believing*' but goes a step further of '*gaining sight after being blind*'[1]. Important to note that during the advent of optical (light) microscopy - the time of Antoni van Leeuwenhoek and Isaac Newton- microscopy observations were rather the opposite like 'believing is seeing', since a correct interpretation of image formation was lacking behind. If you are interested in the details reference is made to Fig.1 (caption) and [1,2].

During my period in engineering physics at RuG I became particularly interested in electron microscopy observations of jerky type motions of defects in solids, i.e. motions which are not continuous and cannot described by Newton's second law of motion. Of course we are familiar with 'accidental' jerky motions, like earth quakes, avalanches, crack propagation et cetera, which I call 'jerky defect motion' because the waiting time of defects is much longer than the actual jump time.

The burning question which intrigued me over many years is whether scaling laws exist describing the transition from a jerky to a homogeneous motion and linking the characteristic length scale to the characteristic time scale in case of a fully developed jerky movement. In fact, we have shown in

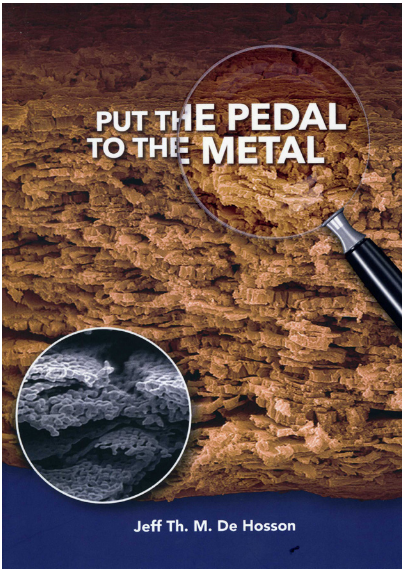


Figure 1: Cover of prof. dr. de Hosson's latest book, published on D-day: March 29th. See: http://materials-science.phys.rug.nl/index.php/scientific-publications-phd-thesis-and-awards/anniversary-publications

several publications that up to a critical force field, defect dynamics is not-continuous but jerky and that physical conditions and criteria on jerkiness can be formulated! Beyond this critical force the movement may become continuous or chaotic with higher fractality, and below the critical force field it is not-continuous and of the jerky-type.

The excitement is to formulate theoretically (and of course experimentally validate, e.g. through microscopy methodologies) this transition point in physical terms, such as correlation length scales, critical time scales, residual stress fields and gradients in stress fields, etc. A principal take-home message of my talk on March 29th was the following:

To unravel structure-property relationships in engineering materials do *not* go for *static observations* but for *in-situ* dynamic microscopy, i.e. develop a precise *stop-watch* characterized by *'start, pause, resume and reset'.*

Watch-the-shop

Over the past 42 years, unavoidably, besides research on 'jerkiness' I also got involved in governing research and in education. It turned out that here too, in addition to my own research topics, jerkiness is at stake. Near the close of my seminar in the Aula I made a couple of comments and attendees encouraged me afterwards to summarize that part in written form on paper, so here it is:

In my view, a theoretical approach (please note the word theoretical) to the question of governance of research and managing such a complex, and at the same time unique institution as a university, provides two reasonably effective ways of governing: either do *very little,* or do *very much* (please note: either/or, not and).

Very little would imply leaving the organization more or less as is, to develop a kind of spontaneous self-management: in materials science called self-organization; it is characterized by proposing choices, adaptive, decentral.

Very much would then mean developing advanced modes of control (at present very popular at Ministry, Universities, Faculties and Institutes), defined by imposing choices, determining, centralistic.

> *"Either do very little, or do a lot."*

These visions were already well accepted around the time I started (see 'Universiteiten en Hogescholen' magazines, 1977-1978). An interesting aspect about this theoretical observation is that – as I have experienced at high frequencies and large amplitudes- 'very little' and 'very much' are decomposed, like a VanderWaals gap. Graphically, the relationship between the intensity and effectiveness of governance is shaped in a theoretical world dated 2019 as shown in Fig. 2. Please note that upon decreasing the intensity from top-down the efficiency decreases using the 'do-very-much' approach, whereas the efficiency increases on the 'do-very-little' branch when the top-down involvement diminishes. The curve appears symmetric, although I am not so sure now whether we should use a logarithmic scaling or another non-linear scaling for the branch on the right!

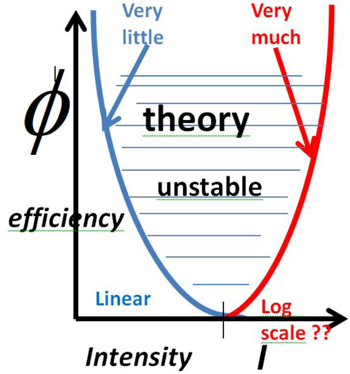


Figure 2: Theoretical representation of efficiency versus governance. The gap in between represents an unstable area of 'tie lines' like in a VanderWaals gap.

In mathematics the curve looks like a bifurcation with 2 branches (prof. Henk Broer-Bernoulli Institute knows everything about), and at the same time it also resembles binodal phase /spinodal decompositions in materials science and third it describes a wide bandgap semiconductor material: with a valence band and a conduction band (consult profs. Bart van Wees and Maria Loi).

The compelling and most pressing question remains: what must be chosen? Shall we opt for doing very much or for doing very little? Already in advance it is very clear that doing very little is an attractive choice. It costs less energy, little money, and not unimportantly also far less annoyance. Here, optimal in governance is to limit oneself to minding the store and watch the shop. So, let's go for 'do very little': self-organization and high-entropy of 'diversity' (see next section). Noteworthy: history proves that excellent centers of research (see ETH Zurich), based on the 'very little' principle, have a brilliant and flourishing existence.

Watchful eye on 'diversity'

Maybe we should organize a little questionnaire and approach important people, like the executive board and other influential council board members of our FSE faculty, what they would recommend: 'do very little' or 'do very much'? Indeed, they are all very wise people and immediately respond via the well-known 'escape route' in academia: '*very interesting, Jeff, and yes, let me think about this, and yes, I will be back to you soon over the e-mail, i.e. not immediately because I am too busy as you may understand of course* …'

As a consequence, I will handle this issue like smart Francken students operate when they search for an answer: by practicing the new verb, *to google*: I google, you google and we google! Almost instantaneously we will find the front page of the web site of the FSE, with the title "Leading in Diversity". Diversity is one of the more recent novel buzz words popping up in the Netherlands as I found out at several universities, including Groningen and Utrecht (adapted from the USA but a bit out of context).

On the front page we see a swarm of crows, all of the same size and of the same kind; indeed that seems to me a strong assumption since we have birds of many feathers in this faculty as I experienced myself over 42 years. In addition the picture shows that they fly all in the same direction, an even much stronger assumption. Maybe this is caused by an intense blizzard from the faculty Executive Board or by a rather strong breeze of fresh air from the top. As said, I am a microscopy person and so I am used to look at micrographs. Indeed I see some short and long range interactions (dashed circles in red color), i.e. all very fine, open and spacious as it

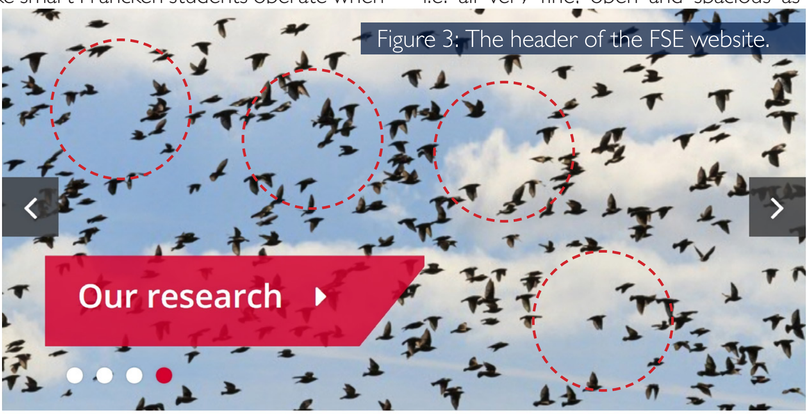


Figure 3: The header of the FSE website.

should be. Also these crows still seem to talk to each other, i.e. not sending only e-mails in endless c.c. loops around but really communicate, and that is quite important for daily lubricants in a faculty.

I judge 'diversity' is indeed an appealing term for education, it may attract students flying in all kinds of different directions: over a broad range of possibilities. Excellent picture! I love it, I love it, and I love it. But then we read: not education but diversity in *research* and my immediate Pavlov reaction is 'wait a minute....' (as Bart van Wees is usually saying during discussion meetings). This picture must refer to my start in 1977, not to the situation of research in 2019. Past is not always better but very, very different. Indeed self-organization was going on in 1977 with a high-entropy factor when each full professor was running his own business in education and research.

Another concern for Fig. 3 for 2019 is the enthusiasm of gleaming with pride of leading in diversity. Of course we wish the FSE that pleasure and it could not have happen to a nicer club (maybe) but what do we like to claim with *leading in diversity*? A fully random system with many different crow-elements, such as a solid solution in an alloy, possesses a high configurational entropy. It is very homogeneous but definitely not divers but rather the opposite. A boring and gray scientific organization is the result. In contrast, clustering of species of the same kind in a multicomponent system leads indeed to diversity, i.e. like in a spinodal decomposition. The prerequisite (thermodynamically) is that the different elements in the multicomponent 'do not like each other' (enthalpy of mixing is positive), e.g. as in an endothermic solution where composition fluctuations readily occur producing phase separation in clusters of the same kind. This is fantastic diversity but it is not what we want in a research organization either, do we?

It would be ideal to have a system based on clustering not of the same but of different kinds. This must be the most exciting and sparkling environment for doing research. So it is not a surprise that in extensive literature diversity should not be the focus but what has been called inclusiveness or inclusivity (buzz word variant of inclusiveness). Just by accident, upon writing this story for Francken Vrij a noteworthy Special Bulletin appeared in the NRC, the New-York-Times-of-the-Netherlands, about this theme (with Editor Ykje Vriesinga[3]). Interestingly I was told today, May 21st, over the e-mail that inclusivity seems to become also a leading topic at the fare-well party of prof. Elmer Sterken as vice-chancellor during the forthcoming 405th anniversary festivities of the University; amazing: my Francken Vrij contribution becomes very timely all of the sudden!

For now, I suggest changing the front page,

Figure 4: FSE 2019; Leading in inclusiveness?

so different research directions in FSE are combined. The more self-organized nodes develop based on differences, the better, see Fig. 4. The question remains whether FSE is already 'leading in inclusiveness'? Honestly speaking, I doubt that very much so.

Watch out

It is fair to say that my reason of doubting is only partially based on intrinsic factors. In fact, due to extrinsic factors *from outside*, university institutions became predominated and affected by what I call the *Hollandology & Hollanditis*. I did not find the time to 'google' the internet intensively whether this terminology was used already before by someone else or became my own unique wording.

Hollandology sounds scientific and I define it as the 'science of organizing audits', (controls, checks) and obviously Holllanditis refers to the 'disease of organizing audits'; we could alternatively call it 'aberration', which is a very familiar word for microscopy people. For your info, Hollandology & Hollanditis seem to be genetic and part of our gens. At the time of writing an immense audit is set-up of our educational programme in physics and engineering physics. In 2014, 360 pages were needed to evaluate physics/astronomy of RuG, including the report of the accreditation committee which spanned 116 pages.

My point is that in contrast to present habits in the scientific community we should really watch out and resist jumping from one fashion, or trend and hype to the next. Indeed, these days it takes a pretty strong personality not to grasp the low hanging fruits when pursuing the more principal and essential problems in engineering physics and materials science. Rather a connection of researchers, say like birds of many feathers (not like Fig. 3, the same crows flying in the same direction of course) will organize themselves automatically in nodes based on scientific passion, on content and with multi-added value of differences (Fig. 4).

Spontaneous formation of collaborating researchers is a very different story[4] than the goal of claiming as a big consortium a big subsidy which became the rule rather than the exception; see Fig. 5, real world 2019, with decreasing efficiency upon increasing intensity from top-down on a log scale since 1977.

Solving really relevant and fundamental questions takes time and many jerky steps. In fact it is rather silly to expect that these fundamental questions can be answered within a short period. The modern computers and Ipads were not invented by businessmen like Bill Gates or Steve Jobs, but by mathematicians, e.g. Alan Turing, by his inspirational thesis supervisor Alonzo Church and by John von Neumann and the many jerky steps made after that during a period over 5-8 decades[5,6].

Alan Turing's thesis[7] (1938) including his discoveries of a universal model of computing and proving his incompleteness theorem, has been reprinted in 2012 by

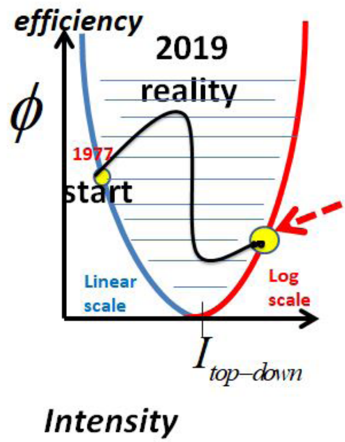


Figure 5: 'Reality of 2019' representation of efficiency versus governance intensity from the top (university/faculty/institute) for two possibilities: 'do very little' or 'do very much'. The gap in between the two branches represents an unstable area of 'tie lines' which are crossed by non-linear, far-from-equilibrium operations from 1977 (higher efficiency) to 2019 (lower efficiency). Please note the log-scale for the branch on the right.

Princeton University Press, highly recommendable. These steps were impossible without firsthand knowledge at Princeton of previous developments in the foundations of mathematics, in which Kurt Gödel and David Hilbert played a leading role, etc.

The modern computer arose from basic questions about probability and truth in mathematics[4] and the computational power was developed by many, many small steps forward. Success of science and impact to society is not a matter of one big step, but of very much of small jerky-like steps. In progress reports funding organizations ask for (at least once per quarter) 'milestones' but watch out: individual bricks is what make the wall work, and not the so-called milestones.

Recommendations

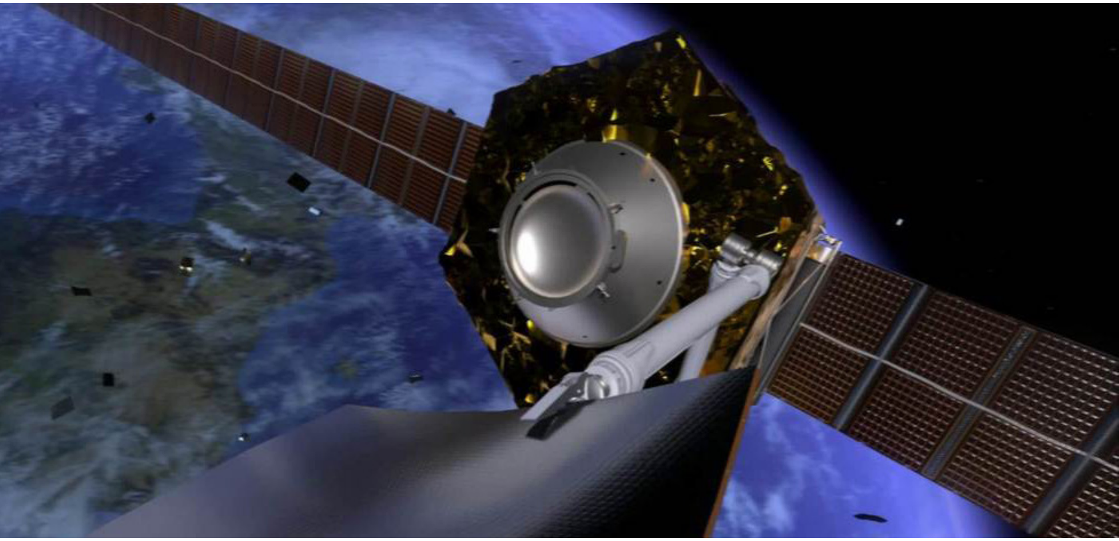
First: The best recommendation to governance of science I can think of is to finance a good breeding ground for talent (including senior researchers - e.g. like myself- who can take the time for education and guidance).

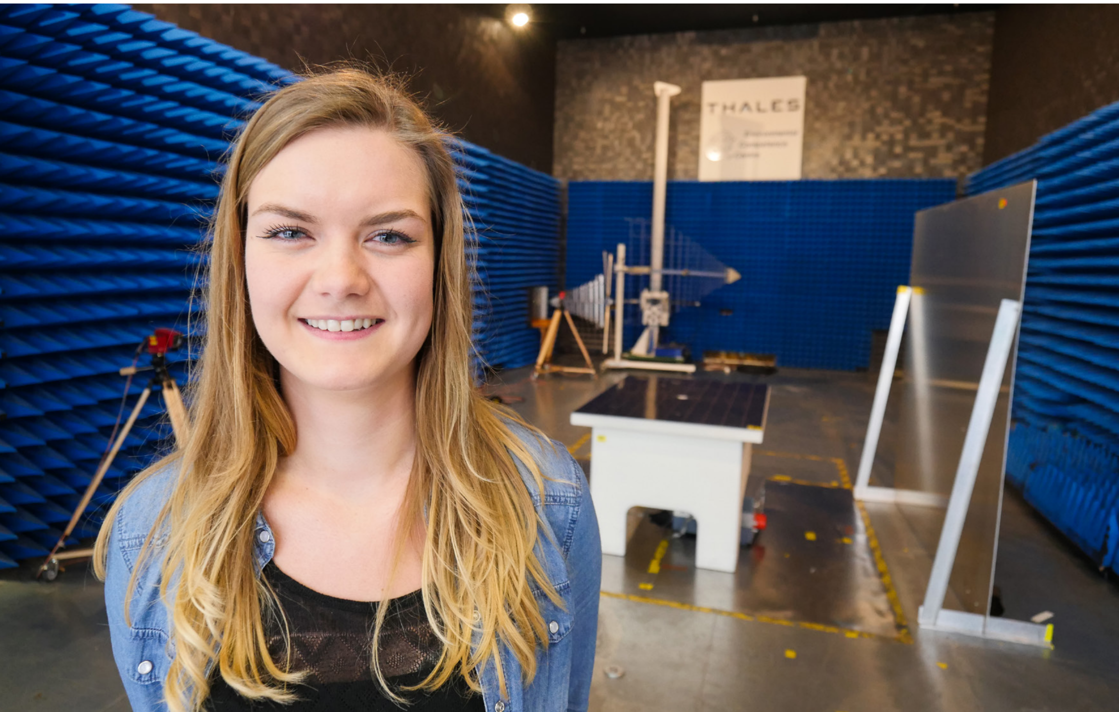
Second: *Watch out* for over-organized 'swarms of the same crows flying in the same direction' but stimulate self-organization and 'out-of-the-box' new conceptual ideas with inclusiveness, not diversity. In a university all *parameters of inclusiveness* in the end turn out to be variables and that is the intellectual fun of it.

References

1. Jeff Th.M. De Hosson, 'Gaining sight after being blind', Ultramicroscopy, 192, 37–49, 2018.
2. Jeff Th. M. De Hosson, Put the Pedal to the Metal, Groningen University Press, 2019, ISBN 978-94-034-1349-5, p.363. See: http://materials-science.phys.rug.nl/index.php/scientific-publications-phd-thesis-and-awards/anniversary-publications
3. NRC/weekend zaterdag 18 mei & zondag 19 mei 2019, verschillen omarmen is niet makkelijk,redacteur Ykje Vriesinga, E1-E16.
4. Klaas Landsman, Ethos of Science-lezing,Nijmegen,8 mei 2013.
5. Alan Turing's Systems of Logic, ed. Andrew W Appel, Princeton University press,2012.
6. George Dyson, Turing's Cathedral, Pantheon Books, New York, 2012.
7. Reprinted PhD Thesis (1938) of Alan Turing, entitled 'System of Logic Based on Ordinals', Princeton University Press, 2012.

THALES





Working at Thales Hengelo, meet our engineer Ellen!

Meet Ellen

Ellen studied applied physics at Saxion Hogeschool in Enschede. She is only working at Thales for six months now. "Before I started working here, I did my graduation assignment at Thales. During my graduation internship I worked on the thermal level, so I started working with dry air. We want the Thales systems, for example the radar, to continue to function optimally even in warm climates. After I graduated they offered me a job, so I had the opportunity to stick around."
From July 2018, Ellen started as a Thermal Engineer. "I did not continue my assignment when I started as a Thermal Engineer, but I do notice that I can apply the knowledge to my new position. My graduation also helped me to get to learn the company Thales itself. For example some basics about the internal processes and which people I can ask for help."

How did you experience your graduation internship?
"I experienced my internship as educational, interesting and enjoyable. Mainly because you can make a connection between theory and practice. I worked on my measurement set-up in the lab and compared the results with the theory. The great thing about an internship at Thales is that you get a lot of freedom to give substance to your assignment. But also get things done yourself and ask for guidance when needed."

What do you find characteristic of Thales?
"The openness of people. Everyone wants to help you where necessary and people are very friendly toward each other. Sometimes a colleague reaches out to you to ask you to join a certain meeting. Just because it might be important or useful for you in the future. Your co-workers really want to think with you. It makes you feel connected to each other as a team. You also know that you have many opportunities for growth within Thales. People are being stimulated to develop themselves as much as possible."

Can you hold your own between all those men?
"We currently have two female interns at the department. So that's nice! But normally I would indeed be the only woman. But I am not really bothered by that. I don't have the feeling that my male colleagues look different at me because of the fact that I'm a woman. I feel part of the team and they are taking me serious."

For more information about Thales and possible job openings check out:
https://www.thalesgroup.com/en/career/discover-thales

Life after Francken

By Jasper Bosch

Figure 1. The 26th board of T.F.V. 'Professor Francken'. From left to right: Hilbert, Sjoerd, Jasper, and Marten.

It's been five years since I graduated, so I suppose a short introduction might be in order. I started studying applied physics back in 2006 and had the honour of being on the board of T.F.V. 'Professor Francken' in 2010-2011 with Sjoerd, Marten, and Hilla. That was only one of the many highlights in the perpetual awesomeness that is life at Francken. But I am supposed to tell you about life after Francken. So let's move on to when I was finishing up my Master's research project.

At that time, I was pondering what I wanted to do after I graduated. For applied physics students, this usually means deciding between getting a PhD or going into industry. One thing I found out during my Master's research project was that doing cleanroom work wasn't for me. My industrial internship was up next and that seemed like a good way to find out if I would enjoy going into industry.

I ended up doing my internship at a company in Groningen called Lambert Instruments. My internship project involved thoroughly evaluating a scientific camera prototype. I worked on improving the setup, recording and analyzing images, and comparing the prototype to the product the company was selling at the time. It was gratifying to see the results improve by optimizing the prototype camera and the image processing pipeline. At the end of

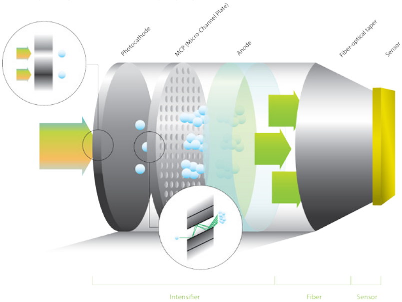


Figure 2. Schematic overview ofan image intensifier. Incoming photons (left) are converted to electrons at the photocathode. An electric field accelerates the electrons towards the micro-channel plate (MCP) where they are multiplied through secondary emission. The resulting electrons are accelerated towards the anode where a phosphor screen takes care of the conversion back to photons. These photons then go into a fiber that leads them to an image sensor.

the project it was clear to me that this was the kind of work I enjoyed doing.

Ideally, I would just stay at the company and continue developing products. Fortunately, the company agreed to hire me so for the last five years I've been a development engineer at Lambert Instruments.

The company was founded in the nineties to apply image intensifiers (the things that are in nightvision goggles) in applications like biomedical research, astronomy, and high-speed imaging. An image intensifier basically boosts the light levels so you can still see things when there is very little light. It does so in a series of steps (see Figure 2). It converts photons to electrons, multiplies those, and then converts them back to photons. This way, you can even detect single photons!

One thing you do lose in the conversion process is the wavelength information of the light. The light coming out of an image intensifier is monochrome (usually green), because of the phosphor that does the electron-to-photon conversion at the output. So in addition to increasing the light level, you also get a wavelength conversion for free! Light that normally goes undetected—like UV or the near-infrared—is turned into green light that you can detect with a camera. This opens up lots of inte-

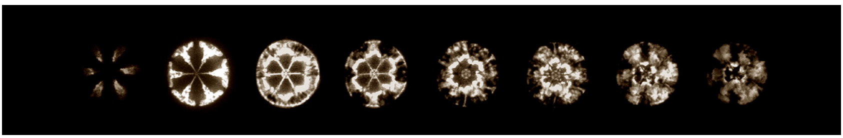


Figure 3: The steps in the combustion cycle ofa single-cylinder research engine recorded at 72000 fps.

resting applications from chemiluminescence imaging in combustion engines to in-vivo fluorescence imaging to seeing electric discharges in powerlines.

Another trick you can do with an image intensifier is modulating its sensitivity to incoming light. This lets you detect the fluorescence lifetime, which is the rate of decay of fluorescence. An application is fluorescence lifetime imaging microscopy (FLIM), which is often used in biomedical research where fluorescent proteins are used to label specific parts of neurons or cancer cells. The fluorescent proteins absorb light at a specific excitation wavelength and then emit fluorescence light at a longer wavelength. Our FLIM camera records the fluorescence light to determine the lifetime. Depending on the type of fluorescent protein, the lifetime changes proportionally to properties

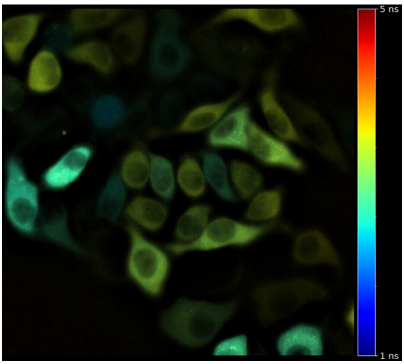


Figure 4: Fluorescence lifetime image of living cells. Fluorescence lifetime is shown as a pseudo color overlay on the image.

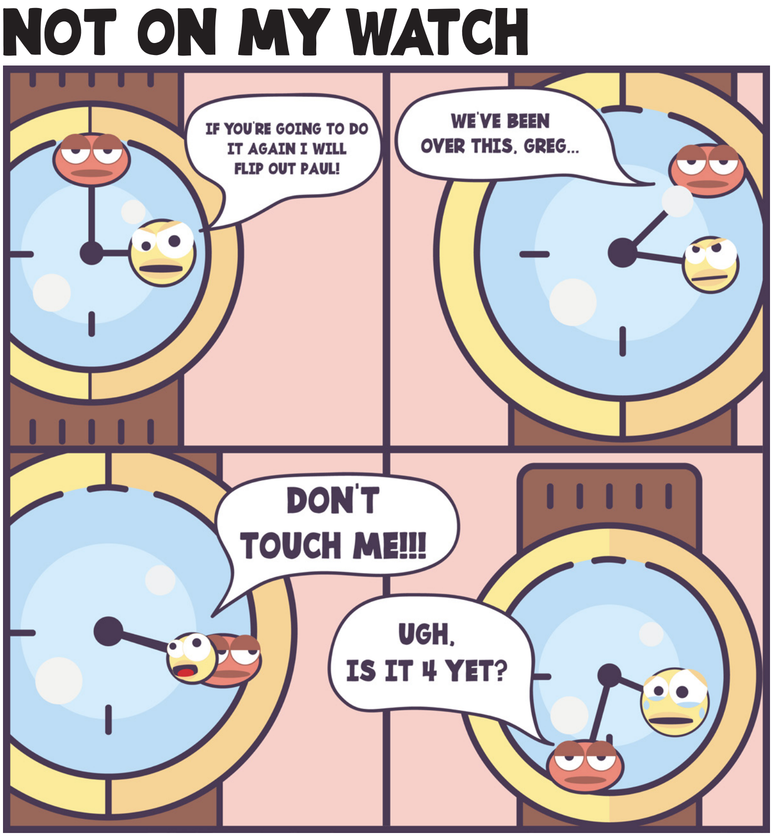
of the protein's environment, like the pH, oxygen level, or calcium concentration. This is an incredibly useful tool in biomedical research because it lets researchers study living cells in their natural environment.

It's my job to keep on improving our existing products and to develop products that enable new applications. This involves a lot of teamwork with my colleagues who design the electronics and develop the software. It also requires building test set-ups, recording images, and analyzing the data to figure out where we can make improvements. This is where my applied physics background in optics, applied signal processing, and electronics comes in handy.

We're a small company with just ten employees and sometimes a couple of interns. Personally, I like working in a small team because I can work on my own ideas and shape the way a product works. It's especially rewarding when I get to help a customer image something they've never been able to see before. Most of our customers are researchers at universities or R&D departments of companies all around the world. They are doing cutting-edge research and that challenges us to keep improving our products to make new applications possible.

Comic

By Bradley Spronk



Watching molecules one at a time

Optical spectroscopy of functional organic materials

By prof. dr. R.M. Hildner

Optical spectroscopy is broadly defined as the study of wavelength-dependent interactions of visible electromagnetic radiation with matter. It is a powerful technique that allows us to learn about and characterise the optical and electronic properties of different systems, e.g. of atoms, of molecules as well as of more complex organic and inorganic (nano-)structures. Spectroscopic data tell us which wavelengths of incident light are absorbed, scattered, transmitted or reflected by matter. But not only static properties can be studied, also dynamic processes can be unveiled that occur on time scales as fast as a few femtoseconds. One intriguing example is the resolution of light-driven processes in photosynthesis, i.e., absorption of sunlight by organic molecules and subsequent femto- to picosecond energy transport within the photosynthetic machinery. Another active field of research is the characterisation of electronic properties of functional materials, that are exploited in optoelectronic devices, such as solar cells, sensors, and field-effect transistors.

Although the ancient Greeks and Romans already exploited wavelength-dependent scattering/absorption of light by noble metal particles to create colourful artwork, e.g. the famous Lycurgus cup, one of the earliest systematic spectroscopic experiments was performed by Isaac Newton around 1670. Newton used a prism to disperse 'white' sunlight into its colours[1]. More than 100 years afterwards, William Hyde Wollaston (1802) and Joseph von Fraunhofer (1814) independently discovered dark lines in the solar spectrum. Later it was rea-

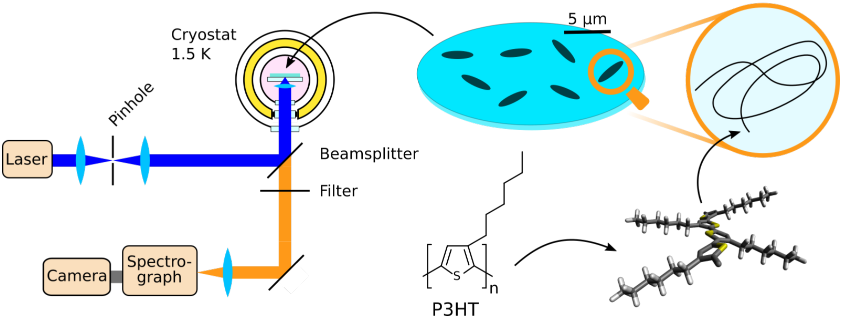


Figure 1: Confocal microscope with cryostat used for low-temperature spectroscopy on single molecules (L: lens). Our samples contain highly diluted, spatially isolated molecules, here for example the conjugated polymer poly(3-hexylthiophene), P3HT, which is used as active material in organic solar cells.

lised that these lines are caused by absorption of light by different chemical elements in the sun's photosphere and the earth's atmosphere. This observation of discrete absorption lines ultimately led to the development of quantum mechanics, which now provides a solid theoretical framework to describe all spectroscopic observations on atoms, molecules and highly complex material systems.

In our group, we apply optical spectroscopy to study the photophysical and electronic properties of functional organic molecules and nanosystems[2,3] that are applied in a variety of optoelectronic devices like organic solar cells, transistors and light-emitting diodes. The aim of our work is to understand how the chemical and conformational ("geometric") structure of organic molecules influences their optical properties, e.g. their emission colour. In devices, these molecules are densely packed into assemblies or thin films. This often leads to conformational changes as well as electronic interactions between molecules, which results in significantly different optical and electronic properties. Thus, an important goal of our work is to understand how the molecules' properties change upon packing. In other words, we want to understand how (electronic) function is related to (molecular) structure, which ultimately should help to devise routes for the improvement of device performance.

A specific research topic in our group is spectroscopy of individual nano-objects all the way down to the scale of single molecules. To address individual objects we combine spectroscopic techniques with optical confocal microscopy (Fig. 1) for two reasons: (i) Microscopy allows us to focus the excitation source, typically a laser, to the optical diffraction limit; and (ii) only light emitted from molecules within this diffraction-limited focal volume is detected. In this way, we limit the sample volume, that we can observe, to about 1 μm^3 or 1 femtolitre. However, in e.g. a thin film, such a tiny volume still contains about 10^{10} molecules. In a second step, we therefore have to dilute the molecules to be investigated to nano-molar concentrations in solution. Upon deposition on a substrate by spin-coating we will then find only one molecule every few micrometres (Fig. 1). To give an idea about such dilutions: this corresponds to one litre of water compared to the entire volume of the Paterwoldsemeer.

As a recent example from our group, in which we use single-molecule spectroscopy, in the following I will present our work on poly(3-hexylthiophenes), P3HT, see Figure 1. This molecule is a prototypical conjugated polymer used as active material in e.g. organic solar cells[4]. Conjugated polymers are long chains of covalently bound repeating units, here thiophene with its 5-membered sulphur containing ring. The hexyl side group attached to the thiophene unit provides solubility and allows dilution of this polymer in organic solvents. Since conjugated polymer chains are semi-rigid, they usually form a coiled structure, like cooked spaghetti, by bending of the thiophene-backbone or by varying torsional angles between repeating units (Fig. 1). This so called conformational disorder makes it very difficult to understand the electronic properties of conjugated polymers on a molecular-scale. Here, single-molecule techniques have clear advantages: Instead of looking at an entire bowl of spaghetti, which will tell us only about the properties of an "average spaghetti", we pick out a single spaghetti to study its specific properties. We can then compare these to the properties of other spaghetti with different shapes to understand how geometry determines electronic properties.

Generally, the optical properties of conjugated polymers are determined by their delocalised π-electron system along the backbone. Due to conformational disorder, however, the delocalisation is limited to short segments of about 5 – 10 repeating units, which are often referred to as chromophores. Absorption and emission of light induces transitions between the electronic ground and excited state of a chromophore, i.e. the chromophores determine the optical and electronic properties of conjugated polymers. Due to the large conformational disorder even along a single conjugated polymer chain, each chromophore on a chain possesses a distinct spatial extent. In analogy to a particle-in-a-box model, a more extended delocalisation results in a smaller transition energy between the ground and excited state of a chromophore, and vice versa less delocalisation results in larger transition energies.

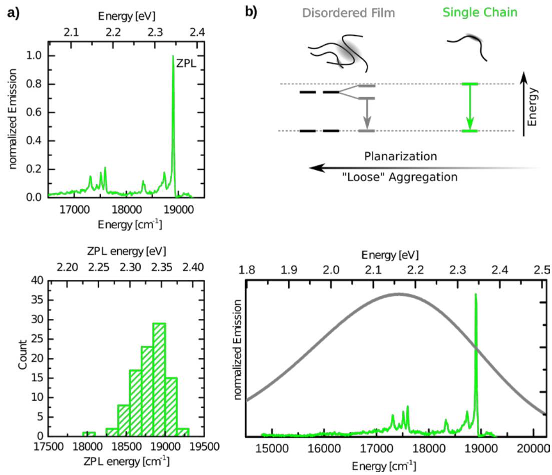


Figure 2: a) Emission spectrum of a single P3HT chain at 1.5 K (top) and the distribution of energies of the zero-phonon lines (ZPL, bottom) from 100 different chains. b) Emission spectrum of a single P3HT chain (green) compared to that of a disordered P3HT films (grey). Adapted from[5]*.*

Fig. 2a (top) shows an example of an emission spectrum of an individual P3HT chain at low temperatures (1.5 K). Here, we specifically looked at a short chain comprising only 16 thiophene-units, which carries only a single chromophore. The sharp peak around 2.35 eV (corresponding to a wavelength of 530 nm) results from the purely electronic transition from the electronically excited state to the ground state of this chromophore on the chain – the so called zero-phonon line. The less intense peaks towards lower energies reflect transitions into vibrational levels (e.g. due to carbon-bond stretch modes) of the electronic ground state. Fig. 2a (bottom) depicts the distribution of the spectral positions of the zero-phonon lines measured from about 100 different single P3HT chains. This distribution demonstrates that the zero-phonon line of each chain is at a different spectral position, or in other words, the energy difference between the electronic excited state and ground state varies from chain to chain. This variation is a direct consequence of conformational disorder from chain to chain: each chain possesses a specific backbone bending and distribution of torsional angles between repeating units. In turn, this disorder determines the delocalisation of the π-electron system (the length of the chromophore) and thus the precise transition energy observed in each spectrum.

We then went on and compared our single-molecule data with the spectrum measured from a disordered P3HT film, see fig. 2b (bottom, grey line). The first striking observation is the lack of fine-structure in the film spectrum, which appears broad and rather smooth. Moreover, we expected the sum over all single molecule spectra to resemble the film spectrum. Surprisingly, this is not what we found: Especially around a photon energy of 2.1 eV we never detected emission from single chains, but a very strong emission signal from the film. Based on concentration dependent measurements, we were finally able to explain this discrepancy by a combination of two effects: (i) At higher concentrations and especially in films, thiophene chains "feel" each other, and chain-chain contacts form by van-der-Waals interactions between the aromatic backbones (fig. 2b, top). This effect induces a planarization of the chains, i.e., reduces the inter-ring torsional angles. More planar chains possess a more delocalised π-electron system, which reduces the transition energy between ground and excited state; (ii) The chain-chain contacts induce electronic interaction between chains and give rise to a splitting of the excited state energy levels. Hence, the electronic excited state is further shifted to lower energies. In fact, these chain-chain contacts or "loose aggregates" dominate the ensemble emission for P3HT both in disordered films and in solutions. Since in disordered films many different realisations of chain-chain contacts exist, each with different interaction and degree of planarization, the precise energy shift varies from loose aggregate to loose aggregate. The spectrum of a disordered film appears therefore broad and unstructured. These data provide a clear picture of how optical and electronic properties change from an isolated, single chain to a densely packed film, which helps us to better understand processes in devices based on conjugated polymers.

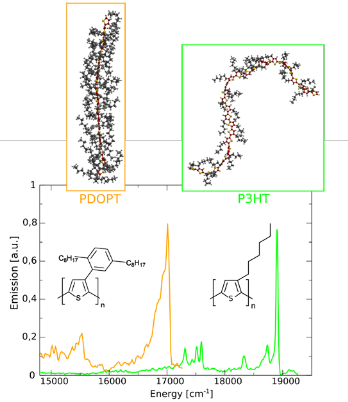


Figure 3: Comparison of single chain emission spectra of the thiophene-derivatives PDOPT (orange) and P3HT (green) together with calculated chain conformations. Adapted from[6].

In the next step, we investigated whether the flexible side chains, appended to the thiophene backbone, influence the optical properties. The standard notion was that side chains only provide solubility, but do not influence the photophysics. We therefore compared a polythiophene-derivative PDOPT, which possesses very bulky dioctylphenyl side groups (compared to the short hexyl groups of P3HT). We found that the general shape of low-temperature single-chain spectra of PDOPT is very similar to those of P3HT (fig. 3). Both spectra feature a pronounced, sharp zero-phonon line at high energies and several weak vibrational lines at lower energies. However, despite chemically identical backbones, we find that the zero-phonon lines of PDOPT are shifted to lower energies by more than 270 meV (or 2000 cm^{-1}). This energy shift is surprisingly large and corresponds to about 10% of the total transition energy. To understand the origin of this shift, we worked together with cooperation partners, who performed quantum-chemical simulations. Based on these calculations, we were able to attribute the shift of PDOPT spectra to non-covalent interactions between the bulky side groups and the conjugated PDOPT backbone: The side groups "embrace" the backbone, forming structures resembling barber's pole stripes (fig. 3, top). This planarises and stretches the PDOPT backbone, compared to the more curved P3HT backbone. Overall, this geometry change of the backbone, induced by the side chains, decreases the transition energy of PDOPT.

The spectral shift from P3HT to PDOPT corresponds to about 70 nm if translated into a wavelength difference. While P3HT has its zero-phonon lines at about 530 nm, i.e., in the green spectral region, those of PDOPT appear at 600 nm, i.e., the colour of the PDOPT emission is orange. Intriguingly, this colour change was achieved only by changing the side groups. This so-called side-chain engineering clearly helped us to understand the relationship between chain conformation and optical properties, and may also provide a new route for the colour-tuning of organic displays.

Although polythiophenes are known since more than 20 years, optical single-molecule spectroscopy of this class of conjugated polymers was full of surprising results. In future work, we will focus on the so-called second generation of conjugated polymers that are used in high-performance solar cells with more than 17% power conversion efficiency[7]. These polymers possess a much more complex chemical structure compared to thiophenes and we therefore expect that they will further surprise us.

References

1. I. Newton, Opticks, 1704.

2. R. Hildner, A. Koehler, P. Mueller-Buschbaum, F. Panzer, M. Thelakkat, Adv. Energy Mater. 17, 1700314, 2017.

3. T. Brixner, R. Hildner, J. Koehler, C. Lambert, F. Wuerthner, Adv. Energy Mater. 17, 1700236, 2017.

4. E. H. Jung, N. J. Jeon, E. Y. Park, C. S. Moon, T. J. Shin, T.-Y. Yang, J. H. Noh, J. Seo, Nature 567, 511, 2019.

5. D. Raithel, S. Baderschneider, T. B. de Queiroz, R. Lohwasser, J. Koehler, M. Thelakkat, S. Kuemmel, R. Hildner, Macromolecules 49, 9553 – 9560, 2016.

6. D. Raithel, L. Simine, S. Pickel, K. Schoetz, F. Panzer, S. Baderschneider, D. Schiefer, R. Lohwasser, J. Koehler, M. Thelakkat, M. Sommer, P. J. Rossky, R. Hildner, Proc. Natl. Acad. Sci. U.S.A. 115, 2699 – 2704, 2018.

7. L. Meng, Y. Zhang, X. Wan, C. Li, X. Zhang, Y. Wang, X. Ke, Z. Xiao, L. Ding, R. Xia, H.-L. Yip, Y. Cao, Y. Chen, Science 361, 1094 – 1098, 2018.

Francken Abroad

By Nikki Arendse

While suffering my quarter-life crisis (something that you will definitely experience while writing your Master's thesis and contemplating future career choices), the opportunity presented itself for me to go to Copenhagen to do a PhD in Cosmology. People often say that the Danes are the happiest people in the world, so it seemed like a good country to spend the next three years of my life. I would be going to the DARK institute for Cosmology, which is part of the Niels Bohr Institute in Copenhagen.

The timing of my arrival turned out to be quite fortunate; it was mid December, so everything in the city was decorated in the Christmas spirit, with quaint Christmas markets found on any corner of the street, selling Glugg: the Danish version of gluhwein. My first day at work also marked the first day that the DARK-employees were let into their new office building, so there was more a feeling of chaos than of productivity. For one, the coffee machines were not set up yet, so you can imagine the kind of effect this had on people. I also arrived a few days before the annual Christmas lunch, which was of course the responsibility of the new PhD students to arrange. Therefore, I spent the majority of my time carrying chairs from one room to another, or asking people to finally send in their baby photos for the pub quiz. I soon discovered that the term 'Christmas lunch' was a bit of a misnomer; it was actually a dinner party with a lot of free alcohol that continued until the early hours of the next morning. According to Danish tradition, we played "Pakkeleg", which is their version of

Figure 1: The DARK group of the University of Copenhagen

the 'Sinterklaas present game', where you have to throw a die in order to collect as many presents as you can. People got terrifyingly competitive in this game, trying to throw as quickly as they could to snatch presents away from the other tables who were playing the game. Presents that, without a doubt, would land straight in the bin once they were taken home.

After the madness of the Christmas holidays, I could get settled down and actually start working. One interesting thing about the new office was that it was an open office, with some separate smaller rooms that can be used for group discussions. This means that it's completely transparent when everyone shows up for work and goes home. I soon discovered that also here, astronomers are not morning people. My supervisor usually comes in around 11:00, and he's not the latest. In the beginning I felt a bit watched, but I'm understanding more and more that people here care about results, and not about when you make them. Another thing that surprised me when I joined DARK was the male/female balance. The use of the word 'balance' is very applicable here, because actually half of the employees seem to consist of women! Sometimes I find myself looking around at the lunch table and noticing that I'm only surrounded by women. A very new experience. Unfortunately this does not hold up for the rest of the NBI institute, or even for our sister-astronomy institute DAWN. It seems to be something specific to the policies at the DARK-side.

My supervisor is extremely kind, enthusiastic, and relaxed, so I've been very lucky to have him. Together we work on cosmography, which is an area of cosmology that aims to describe the universe without assuming any cosmological model. One of the questions that we're trying to shed some light on is the discrepancy in the Hubble constant. This constant describes how fast galaxies are receding away from us, and therefore gives us the expansion rate of the Universe. There are two different methods that are used to measure this constant; the first one uses the Cosmic Microwave Background radiation (CMB), which is the oldest light we can see, and the other method uses local measurements. Before, these two methods seemed to be in agreement with each other, but now that we're able to do cosmology with ever growing precision, it turns out that the CMB measurement gives us a value of H0 = 67 km/s/Mpc and the local measurements give H0 = 73 km/s/Mpc. This disagreement is currently one of the biggest mysteries in cosmology, and it can point to the need of a new cosmological standard model. The CMB method relies on our current best model, Lambda-CDM; so any flaw in this model can lead to a slightly different outcome of the Hubble constant. In my research I aim to conduct another measurement of the Hubble constant, one that does not rely on any cosmological model, but only on observational data. For the project I use different cosmological probes, such as supernovae and Baryon Acoustic Oscillations (BAO), and everything is calibrated with 4 gravitationally lensed quasars. What I need from these probes is a redshift and a distance, and then I construct a polynomial function to fit as accurately as possible through the data points. Working on this project has already taught me a lot more about cosmology, mathematics, and computational methods. As PhD students, we are also obliged to obtain 30 ECTs from courses at the University of Copenhagen. This can be done by following astronomy courses, or any other courses that seem relevant to you or your supervisor. It's a nice way to brush up on some skills, while meeting other students and getting some invitations to go to house parties (because alcohol in bars is expensive here!). It's incredible how big of a difference it can make in your motivation when you're actually paid to follow a course, instead of paying for it yourself.

I always imagined that doing a PhD had two sides: the glamorous side of attending many conferences and being able to travel a lot, and then the slightly depressing side of a lot of stress and hard work. I must say I've already experienced both of them. My first conference that I went on was the Annual Danish Astronomy meeting, where all

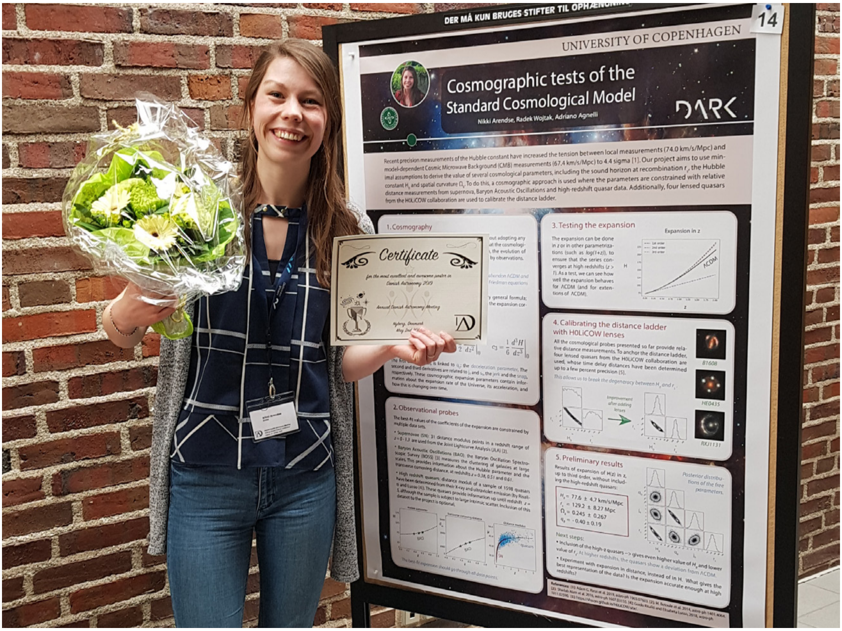


Figure 2: Nikki's first conference at the anual Danish Astronomy meeting where she presented her first scientific poster!

astronomers from Denmark could come together to give talks and present posters about their research. It was held in the picturesque small town of Nyborg, on the other side of the bridge to Fyn. This conference turned out to be an amazing experience for me; firstly because our hotel room had a view on the beautiful Storebælt bridge, and because they overloaded us with luxurious food (we had desserts 3 times a day!). But also because I made my very first scientific poster, and actually managed to win the poster prize! The prize consisted of more chocolate. I've already planned my next conference as well: a 'cosmology mountain workshop', which is basically an excuse to go hiking in the mountains (while talking about cosmology) and to make your work pay for it.

But of course this job can be exhausting as well. Right now we're working under quite some time pressure to wrap up my first paper, because other groups are starting to publish worryingly similar results. Ideally, I would like to have a lot more time to polish everything and to run more tests, but that is a luxury we can't afford. I'm starting to understand why some of the papers I read are so messy.

When I'm not stressing about papers, I often go bouldering, follow Danish lessons, and enjoy the exploration of this new and vibrant city I live in. I've completely fallen in love with Copenhagen, with its beautiful towers, spacious parks, and diverse neighbourhoods. I don't miss home yet because Denmark seems similar enough to the Netherlands in many aspects. Cycling is also the main means of transport, the weather is just as abominable as back home, the people's mentality is similar (they're not as socially awkward as the Swedes, according to the Danes), and most importantly: they also like salty liquorice! Here in Denmark they go a bit further and they're not afraid to experiment with liquorice and mix it with everything; I've had liquorice ice-cream, liquorice chocolate, and liquorice-raspberry snaps. I can recommend all of them. The language is also very similar, although their pronunciation is so messed up that you usually don't notice that. When I was in Sweden, I almost found it easier to understand them because they have similar words but then pronounce them in a normal way. What I've seem from the student life also reminds me of home. I've been to some house parties where they also played beer pong, dressed up, and danced to hit songs from the noughties. Also like us, the Danes don't have any particularly nice diner dishes to be proud of, but they do have very good sweet pastries.

Of course there are also differences. Although people also cycle a lot here, they seem to be much more structured about it. About half of the people actually wear


The beautiful city Copenhagen

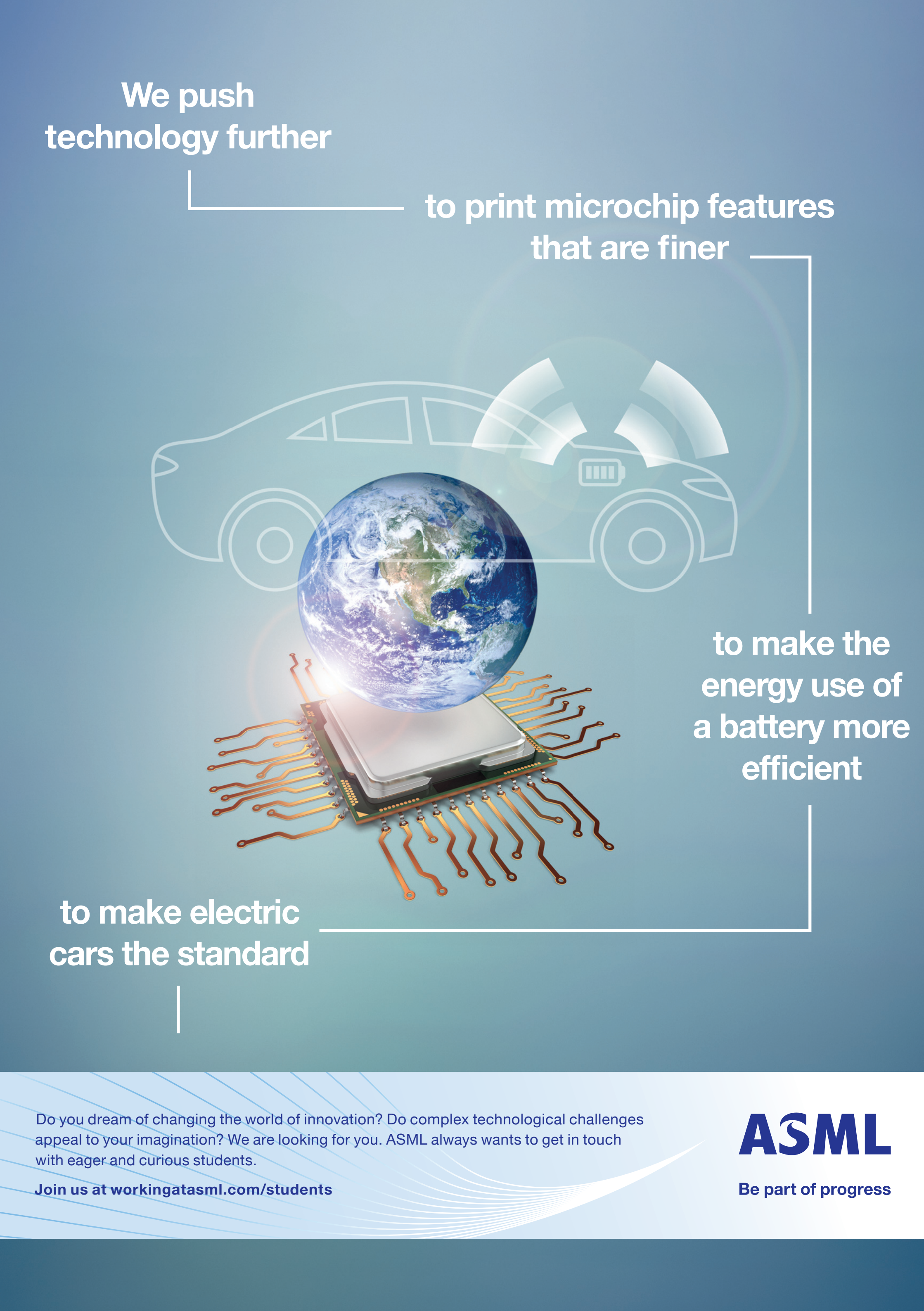
helmets on the bike (so not just the lycra-clad cycling enthusiasts) and they follow the rules very strictly. They've also invented an additional sign: hold up your left hand to indicate that you're going to stop, which might save us a few traffic accidents if we tried to implement that one in Groningen. And I'd already mentioned it before: beers are expensive here. Let me rephrase that: everything is expensive here. It's very normal to pay around 9 euros for a beer in a bar, and one ride in the rollercoaster in Tivoli (the amusement park in the middle of the city centre) costs 12 euros. Luckily they have another currency and a not so convenient conversion rate (divide by 7), so it's also easy to forget about these prices. Danes like to solve this issue by buying cheap beers in the supermarket and drinking them on the streets, in parks, or on bridges. Another favourite hang-out spot for many Danes is the cemetery. They are not so much treated as sad places meant for grieving, but more as additional parks.

Figure 3: A small delecation of Franckenmembers that visited Nikki during the Buixie

When the Buixie was here, we went on a little quest to find Niels Bohr's grave, which we found together with two students sitting on the family grave and drinking some beers.

So are you suffering from your own quarter life crisis? I can highly recommend it to join the Francken delegation CPH! Right now we're only one woman strong, but I've heard that two other Francken members are on their way to join the life in this wonderful city, so maybe we can set up our own Brouwcie soon! It is really an amazing place to live, and I can't wait for summer to come and to finally leave my rain jacket at home.

As Denmark is not that far away, many members visited as you can see on this page.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Puzzle

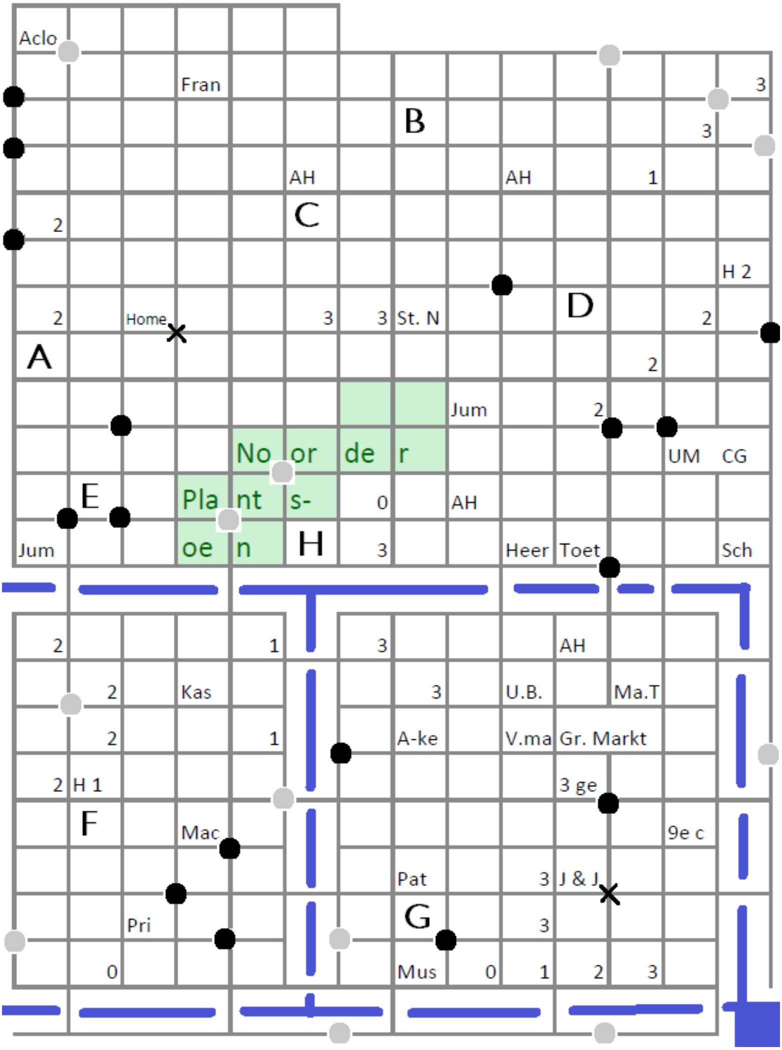
By Arjen Kramer

In this puzzle, you'll be retracing the route of a Franckenmember who had some trouble finding his way back home after a good Karakterborrel in the Jut & Jul. Luckily, he regularly checked his watch at street corners and noted down at what location he was. He was walking at a remarkably convenient pace of 1 street segment per minute. Also, some people were watching him, giving us some more information about his route. We've denoted with a number in a square the exact number of streets he was seen walking along adjacent to that square. On intersections with a black dot, he was seen taking a turn, while grey dots mean he went straight ahead. His complete route, from home, to 'Professor Francken', to the Jut & Jul, and finally back home just so happens to make a non-intersecting closed loop. The first puzzler to tell us which of the squares marked A through H are inside this loop will win the prize!

The following list of locations with corrisoinding timestamps was eventually made:

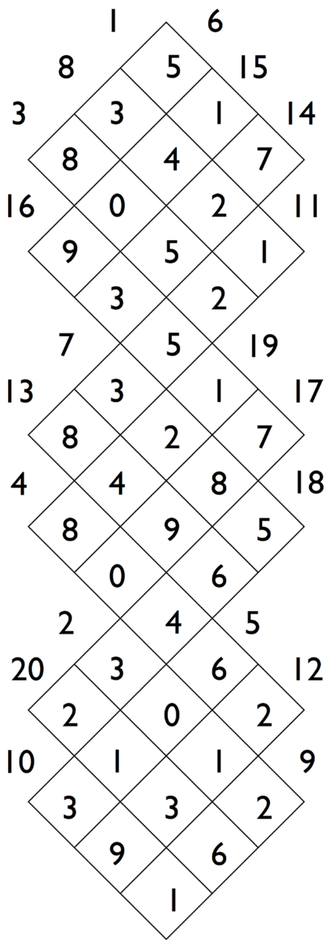
Jut&Jul: 2:00
9e Cirkel: 2:03
Martini Tower: 2:06
9e Cirkel: 2:12
Jut&Jul: not readable
Pathé: 2:33
Museum: 2:36
Primark: 2:51 & 2:53
Bridge: not readable
McDonalds: 3:04
Het Kasteel: 3:06
Franckenhuisje 1: 3:13 & 3:18
Jumbo: 3:25
ACLO: 3:43
Franckenhuisje 2: 4:05 & 4:06 & 4:07 & 4:08
Station North: 4:14
Noorderplantsoen: from 4:16 until 4:20
Jumbo: 4:22
UMCG: 4:33 & 4:45
Stads Schouwburg: 4:46 & 4:48
Albert Heijn: 4:52
Martini Tower: 4:53
University Library (UB): 4:55
Vismarkt & 3 Gezusters: 4:56
A-kerk: 4:59 & 5:07
Albert Heijn: 5:10
Heerenhuis & de Toeter: 5:14 & 5:17
Noorderplantsoen: from 5:23 until 5:29
Station North: 5:30
Albert Heijn: 5:42 & 5:48 & 5:55 & 5:57
'Professor Francken': 6:02
Back of Home: 6:09
Real Home: 6:22!

The map of Groningen our member used in his journey:



Also the solutions to last editions puzzle:

1	1	5	7		
2	3	0	1	2	
3	2	5	8	0	
4	0	2	4	6	8
5	0	1	3	6	
6	5	3	8		
7	2	3	5	8	
8	1	2	3	4	
9	1	2	6		
10	1	3	9		
11	1	2	3	5	8
12	2	3	1	9	
13	4	6	8	9	
14	2	3	5	7	
15	0	1	4	9	
16	1	3	5	7	9
17	0	7	8	9	
18	2	3	4	5	6
19	1	2	4	8	
20	1	2	3	6	



Not on my Watch

By Jelle Bor

Some people love to wear a watch around their wrist, which is nowadays as more of an accessory than for practical purposes, while others do not. Whatever the taste of an individual, time is important for all of us, as decent Francken members often wonder if it is already four o'clock to know if they are allowed to get a cold refreshing beer from the fridge. In this article, I would like to take you on a geometrical detour of a classical mechanical watch, so not, as you might have expected, about '*de theoreet*' of Rolexes travelling with the speed of light flying through an Einsten-Rosen wormhole (yes that thing in sci-fi movies).

Figure 1: Advertisement of the Rolex Cosmograph Daytona - the fastest expensive watch on the market right now.

As in many physical situations, it is convenient for a theoretical physicist to simplify things to set the stage. Consider, therefore, a surface which contains a point in the middle and twelve numbers around it in a circle (with constant angles between the numbers), so that this represents a watch. In our set-up we consider only one clock-hand which makes it possible to read what hour it is. Note that 12:30 cannot be read; for example, it will we be seen as 12:00, meaning that we would have to wait till 13:00 to know if we could have had our lunch-break half an hour ago. Very unfortunate, but the life of a theoretical physicist isn't easy sometimes. Our clock-hand points to one of the numbers and is therefore most logically considered as a vector in mathematical language.

A vector has two properties, namely a length and a direction. We consider the length of the vector to be constant of course; it would be rather strange to see a clock whose clock-hand's length is changing when time evolves. Interesting though, if one thinks about it; one could make a fully working watch with one clock-hand which moves sinusoidally between the numbers to show the time in between the hours and no second clock-hand is needed, any designers who read this? Nevertheless, we need to talk about the direction of our clock-hand vector since it is changing when we move to any next hour. Consequently, we don't have the same vector anymore since our direction is changed, but we still have the same clock-hand, hence we have a problem.

Well, at this point there will be probably people reading this and thinking, "What the **** are you talking about, this is not how the world works." I do not disagree, because one could just multiply the vector with a phase to change the direction of the vector every time step and solve the problem. Nevertheless, a theoretical physicists likes to solve little puzzles, so I will just go on with my story and pretend the latter is not an option.

For the first step, to solve the problem, we have to thank our fellow mathematicians who, a long time ago, came up with the idea that any at surface can be projected on a sphere in many different ways. I will probably disappoint the mathematicians here, but this text should still be readable for normal people. To still satisfy them here is a buzz-sentence; I consider a projection on a 2-sphere as a subset of Euclidean space. Let us consider the easiest of these mappings, namely the orthographic projection, which equivalently set the numbers of our watch on the `equator' and the clock-hand on the `north-pole'.

Now here comes the trick. We can use Christoel symbols (by using the metric) to parallel transport any vector on any surface (a mathematical connection). These same

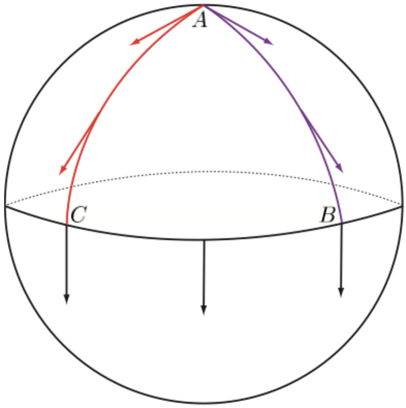
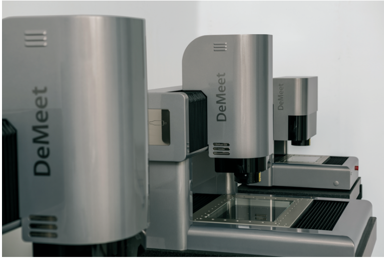
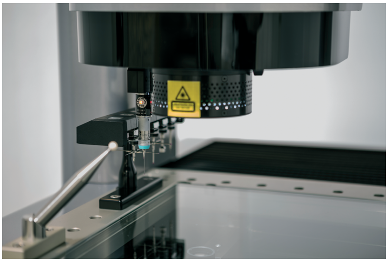


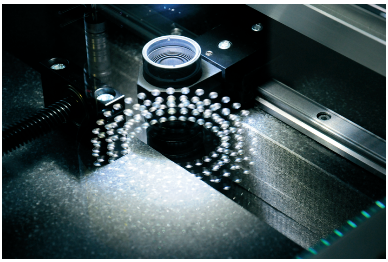
Figure 2: Parallel transport of a vector on a sphere.

symbols are of great importance in general relativity, the Einstein's famous theory. Parallel transporting in a space could be seen as putting a pencil on your desk and moving the pencil on the desk by not changing its direction or to where it points, hence the length and direction stay the same and only the (x,y)-coordinate of the back-end (maybe an eraser) of your pencil will change. Doing a similar thing on the surface of our sphere we can transport our clock-hand vector in a way that the direction does not change (and length) and we will be able to point to the next hour! In Figure 2, the following can be considered: at point A it is 3 o'clock, we transport our vector to the `equator' (to point B), move a long the `equator' (to point C), go up again to the `north-pole', and the clock-hand points now to 6 o'clock (we are back at point A). Projecting this to a point at the surface, we get our watch back and we solved our problem of our changing clock-hand vector.

Some physical quantities are difficult to grasp for a lot people, especially time, which is a constantly occurring phenomenon and important in many different ways. Sometimes this can lead to awfully long discussions, but luckily this is mostly time limited in the physics community, which means, in my opinion, we agree with each other (hopefully). Einstein was very successful in using time by describing gravity in the theory of general relativity as the bending of space-time. Note that in this article I gave you a hint of one of the concepts that come into play by understanding this theory, namely the transporting of vectors; in general relativity over geodesics (the shortest path in curved space-time). However, general relativity gave, and is still giving, many people a headache, especially if one wants to combine this with quantum field theory, which describes the standard model of elementary particles; one comes into really big problems which are not yet solved. This brings me on questions such as: do we have to change ideas that are so successful, such as how we use time? Not (yet) on my watch, but this will maybe change in our life-times.







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