FRANCKEN VRIJ

year 29 issue 2

COUPLING

Coupling of Trains
Different Coupling Mechanisms

Theorist vs. Engineer
How Cilia Break Embryonic Symmetry

Science and Art
Visualizing Scientific Concepts

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Colophon

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Editorial

Coupling is everywhere. We know coupling as a phenomenon in a wide range of physical systems; we find them in the four fundamental forces, in superconductors, in quantum entanglement and more.

But coupling is found in all areas of life. For example in the Francken room. Everyday, people are playing klaverjas with their mate that they 'coupled' with. It's also found in nature. Animals couple with eachother to reproduce. Since it is mating season right now, this is the perfect moment to have a Francken Vrij themed 'coupling'. Enjoy reading!

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Chair's Preface

By Adriana van Harten

Dear members,

Love must be in the air, not just because it's February, but because the Francken Vrij seems to be choosing themes that may make you feel quite lonely; first Attraction and now Coupling?! It's like the steps of a good love story! Especially since coupling is between two oscillating bodies, making it quite the 'will they, won't they' situation. It makes me speculate about the next theme. Will this tumultuous love story end happily? Perhaps the theme will be Replication. Beautiful. The couple will officially get together and have babies! Or possibly, an ending of total devastation... Splitting? Splitting has a nice ring to it. Maybe I've guessed it correctly, though I'm sure that the Francken Vrij committee has come up with something much more creative than I. Plus, I

hope they've put more than two minutes of thought into it. I'm looking forward to seeing how this romantic drama will come to an end.

How have I been doing since the last edition? Well, Parity's lifetime has expired by more than half. Soon we'll have kandis. Ahhh scary! I feel like I've only just settled down in my board position. But everything will turn out fine, I'm sure. For now I'll just kick back, relax, and enjoy this edition of the Francken Vrij, just like you should too! So, happy reading!

News of the Association

By Gerrit Boonstra

Although not as busy as the first block of the year, this block has been quite eventful. We had a lot of activities, although it feels like we didn't because we also had the Christmas break and an exam period.

SLEF announcement

As you may know, every lustrum, SLEF organizes a foreign excursion to a destination outside of Europe. The members were of course eager to know where they would take us this year, so they showed up in big numbers to the SLEF announcement borrel. The attendees engaged in some fun games to try to find clues to the location(s!) that SLEF is going to. After this, the committee presented a fun video which revealed that we are going to Ho Chi Min, Bangkok, Kuala Lumpur, and Singapore!

Hitchhiking weekend

For the hitchhiking weekend, the Takcie worked very hard to organize a fun weekend to Antwerp. All of the teams made it there, although some needed a little help getting out of Drenthe... In the evening, we had a nice dinner together and an icecake to celebrate a birthday. On Saturday there was a treasure hunt, the winners of which were taken back by the van on Sunday. It is safe to say, it was a very successful activity!

TNO borrel lecture

On the 19th of November a representative of TNO gave us a nice talk about what it is like to work at TNO. The talk was quite interactive, and the setting was very casual. It turns out they are a very broad company, so it is definitely worth looking into if you are on the hunt for a job.

Hangover games

Borrelcie promised us quite an eventful evening with their Hangover Games borrel, and they certainly delivered! Games like twister, spijkerpoepen, and many more were played this evening.

FFL: How your spectrum is lying to you

Due to snowy weather and the partial collapse of the Feringa building (?!) the campus was very empty on the 22nd of November. A few determined souls still went to the Francken room however, to listen to Erik Woering talk about how energy spectra lie to you, and how you can correct your data to obtain more reliable results. It was a very nice talk, and although it was quite technical, it was very well explained and easy to follow.

Thrift week

Thrifting clothes is very nice. It saves you money and it is good for the climate. Last year board 'Freefall' organized the first thrift week, and the current board decided to continue this idea this year as well. Quite some clothes were brought to the room, and quite some were taken away as well. Don't worry though if your clothes did not get taken by someone: they will be donated to charity.

Transgressive behaviour workshop

On the 29th of November we, together with Sirius A, invited someone from Fairspace to give a workshop on what you can do when you see transgressive behaviour. The workshop was very nice, and we learned a lot.

Jump XL

On the 4th of December, Sportcie rented out a trampoline park for us to jump around on. It was very fun, but also a bit confrontational to see how much stamina it takes to jump on a trampoline. I was better at it when I was a kid. Some people did some crazy tricks, which led to some very cool pictures, which I recommend checking out on the website.

Members weekend

The first members weekend of the year was surprisingly not organised in Bakkeveen, but in Hollum! The Wiecksie turned

a cozy farm into a techno bunker, where we engaged in some fun activities.

Work-life balance workshop

Since we know student life can be quite stressful, the board organized a workshop in collaboration with the Student Service Center on how to maintain a healthy work-life balance. There were some active discussions about how one may experience symptoms of stress and how to prevent stress in general.

Sjaarscie dinner

Although they have only just started studying here, the first years already organised a whole event by themselves: the Greek dinner by Sjaarscie. We had some nice tzatziki and gyros as well as an unexpected surprise from the first years: they told us the dress code was blue and white, as these are the colours on the Greek flag. What no one expected was that they adhered to this dress-code by all dressing up as smurfs! It was a very fun dinner, and I think the first years did a great job at organizing it.

FFL on earthquakes and their effects on structures

On the 13th of December, prof. Ihsan Bal gave a Francken Friday Lecture, in which he discussed the causes and effects of earthquakes from an Applied Physics perspective. Some historic earthquakes were discussed, and also how researchers monitor these. It was a very nice lecture, which was easy to follow, so I think everyone enjoyed it.

Christmas dinner by Fraccie

Once again Fraccie organised their yearly potluck Christmas dinner. Our members brought either appetizers, a main course or a dessert, and the Fraccie provided them with some nice Glühwein and Cava. One of the bottles went missing, which led to the members of the masters committee interrogating the attendees of the event, which was quite funny. The food was great, and the vibes were even better.

Dress up as a meme borrel

On the last Thursday before the Christmas break, the board organized the dress up as

a meme borrel, at Café de Brouwerij. Initially the board was afraid that all our members had gone home for the break, and that they would have to finish the beer by themselves, but luckily our members were just a bit late to the party. In the end, the beer was still finished, and we saw some really great cosplays. We got many calls by the es*calatievogel*, and did you know that Café de Brouwerij accepts mousepay? They are far ahead of their competition. I also met a guy who looked like Joost Klein, and convinced him to become a member.

Half-General Members Assembly

On the 9th of January, the board organized the H-GMA. They showed that they had learned from the I-GMA and because of this the GMA went smoothly and we were able to finish before 10! The board presented the design for the vaandel that we intend to buy, as well as the challenges for the committee competition.

Ziam Lab Tours

We organised a tour of the different labs that are part of the Zernike Institute of Advanced Materials again, to show students the labs that they might do their Bachelor research projects at. The researchers were very nice as always and it was nice to see what research is being conducted at our University. Since many of us had not been to all parts of Feringa yet, it was also a bit of a Feringa tour.

FFL nature inspired magnetic soft robotic swimmers and swarms

On the 17th of January, Ratnadeep Pramanik gave a Francken Friday Lecture about little robots that can be inserted into the human body and controlled with a magnetic field, which would have useful applications in the field of medicine. Our members had many questions, so there was a lot of active discussion after the lecture, which was very fun.

Shenanigans at the Christmas dinner

How to take your internship to the next level

Internships can be pivotal for a student's both personal and professional development, especially when it comes to fields such as high-tech research engineering. Choosing a good internship program will impact your future in the best possible way. However, making a choice can be difficult, and with so many companies and internship programs around it's easy to feel overwhelmed.

This was the case with Ben van Zon, an Applied Physics undergraduate who felt indecisive and frustrated about his internship options. After much thought, he decided to join ASML – a leader in semiconductor manufacturing technology – where his work impressed his mentors and coworkers.

But how did he do all this? In this article, Ben and his ASML mentors, Richard van Lent, Richard Engeln and Alexander Puth, reflect on his time at ASML, providing insights into the company's culture, the challenges and breakthroughs of working on complex technology, and advice for those considering a similar path.

How to get started

Ben found out about ASML through one of the multiple career events that the company organizes for students and fresh graduates. He met one of his future mentors at this event and after connecting over plasma and spectroscopy topics, they reconnected online to explore whether Ben would be a good match to the ASML intern culture. Spoiler alert: He was!

"My main goal was to deepen my knowledge and gain hands-on experience in a corporate setting. In hindsight, it turned out even better than I had imagined," Ben notes.

"Ben stood out even during our initial conversation. He was curious, driven and communicative, knowing precisely what he wanted to achieve. Although he came from a different academic background than we typically see in our interns, he quickly proved himself, exceeding even our usual standards," Engeln remarks.

A day in the life

According to Ben, his day would start with a coffee at ASML's plaza and a quick check of his emails. "After that, I'd set up the lab for measurements, which involved a lot of meticulous preparations, from stabilizing the laser's temperature to adjusting pressure levels in the measurement chamber." Around lunchtime, it's again time to take a break and enjoy some time with your colleagues. ASML's plazas are a hot spot for events, meetings and other activities, beyond being cafeterias. ASMLers also enjoy a wide range of campus benefits, from a fully equipped gym to an on-campus supermarket.

"ASML's culture is very welcoming. Its international environment means there's always an opportunity to learn from people with diverse backgrounds. I felt very comfortable, and I appreciated the collaborative, respectful atmosphere," Ben says.

The culture is focused both on boosting soft skills and technical work experience. "ASML is unique in the hands-on experience we provide. Interns here aren't just observing; they're making real contributions, notes Puth.

Ben himself admits that at first, it was intimidating to work with such advanced technology. "But my supervisors were patient, explaining every component and process,

which helped me feel confident. My motivation came from wanting to understand the complexities of extreme ultraviolet (EUV) gas plasma. The more I learned, the more curious I became, which led to many valuable discussions with my mentors."

Supported in excelling

Ben's main task was to calibrate the wave meter in ASML's Cavity Ring-Down Spectroscopy (CRDS) setup. This required precise measurements of water's absorption spectrum under different pressure conditions.

"The challenge was intense, but by carefully analyzing each measurement and observing patterns, I was able to confirm the wave meter's inherent accuracy. This task taught me the importance of patience and attention to detail in experimental work," Ben explains.

According to Engeln, Ben's work was quite demanding, but he approached it with discipline. He mapped the spatial distribution of H3+ molecules and matched his data with pre-existing experimental data.

"His findings added real value, and his internship report was appreciated by both ASML and his academic supervisors. It was above what we usually see at the bachelor's degree level," Engeln notes.

However, Ben was not alone through all this. His mentors were there every step of the way, to support him without interrupting the "discovery" process that an internship entails.

"My supervisors were always available for questions and discussions. What I appreciated most was their friendly, often humorous approach, which made even complex discussions enjoyable. Initially, I was nervous about presenting my work, especially among colleagues with Ph.Ds., but they offered practice sessions and constructive feedback, helping me improve my presentation and scientific writing skills," Ben says.

Looking ahead + internships advice

Ben says his experience at ASML helped him gain the confidence he needed to pursue a career in research, while focusing on continuous learning. "My next step is a graduation internship in Finland, where I'll study phonon tunneling phenomena at the University of Jyväskylä. After earning my bachelor's degree in applied physics, I hope to return to ASML in a more permanent role and eventually pursue a part-time master's degree."

When it comes to advice for choosing internships, he notes that the biggest lesson was not to let fear hold you back. "Even if something seems daunting or above your experience level, go for it. I almost didn't apply because I thought I lacked the right credentials. Internships are a learning experience, and with the right mindset, you can gain invaluable skills and knowledge."

"ASML values its interns and the fresh perspectives they bring. Our internships are hands-on and involve real projects. Interns here should come with curiosity and a willingness to engage deeply with their work," Puth adds.

Ben's journey at ASML shows how a motivated intern, guided by dedicated mentors, can make meaningful contributions to high-tech research. His experience underscores ASML's commitment to creating an environment that supports learning, growth and innovation. For students contemplating an internship, Ben's story is a reminder: sometimes, the biggest breakthroughs happen when you step outside your comfort zone.

Coupling biology and engineering: how cilia break embryonic symmetry

By Prof. dr. Patrick Onck and Ishu Aggarwal

Our heart, the pump that drives blood through our veins, sits slightly to the left. Our liver, the body's sophisticated waste management system, occupies the right. These organs perform critical life-sustaining functions — but have we ever paused to think why they are positioned this way? What determines that our heart is on the left and our liver on the right? This fundamental asymmetry, so essential, is not random. What if the key to understanding this process lies in the beating of tiny hair-like structures called cilia?

Cilia are found on nearly every cell in the human body and in many other living species. Cilia come in two types: (a) active (motile) cilia, capable of moving on their own and functioning as actuators, and (b) passive (immotile) cilia, incapable of independent movement and function as sensors. Both types of cilia perform essential tasks that keep us alive and healthy. For instance, active cilia in the lungs clear mucus and debris, while in the fallopian tubes, they guide eggs toward the uterus. Passive cilia in the inner ear detect sound waves, essential for hearing and maintaining balance. Beyond humans, cilia enable microscopic organisms like paramecia to swim and assist starfish larvae in navigating their environment. Yet, their most captivating role unfolds within the developing embryo, i.e., at the earliest stages of life, when our body determines its asymmetry — the placement of the heart, liver, and other organs. This breaking of symmetry occurs within the embryonic node, a microscopic, fluid-filled cavity where active cilia beat in unison and generate a fluid flow that leads to biological

signaling, establishing the blueprint for left and right in the body.

In mice, the embryonic node measures about 150 μm (see Fig. 1(a))—roughly the thickness of a human hair—and its decisive activity occurs within the first few days of embryonic development. For years, the mechanics of this process remained unclear. How does the flow generated by cilia translate into signals that determine the placement of organs? Previous research proposed two hypotheses: (i) mechanosensing: Passive cilia in the embryonic node deflect due to the flow field generated by active cilia, and (ii) chemosensing: Morphogens, signaling molecules, are localized by the flow field to create a concentration gradient. However, the biological community continues to debate which mechanisms occur in reality.

Coupling biology and engineering

To address this question and understand the physics of this complex system, we developed a bio-inspired engineering approach by coupling fluid, solid, magnetostatics, and microfabrication techniques. In collaboration with the Den Toonder group at the Eindhoven University of Technology, we fabricated an artificial embryonic node (4.6x scaled-up version of mice embryo)—a cylindrical cavity lined with 156 polymer-based super-paramagnetic cilia placed randomly (see Fig. 1(d)). Each cilium, 23 μm in length and 2 μm in diameter, was driven by a complex magnetic field that replicates the tilted conical motion of the biological cilia (see Fig. 1(b & c)). Immersed in a viscous fluid, these cilia generate directional flow that resembles those observed in real embryonic nodes.

Using finite element method (FEM) simulations, we modeled the coupling between cilia and embryonic fluid and revealed how active cilia generate fluid flow, either triggering mechanosensing or chemosensing. The flow exhibited a distinctive rotational pattern in the vertical plane (xz-plane; Fig. 1(f)): near the node's base, the flow streamlines move leftward, while near the top, they move rightward. At the location of passive cilia (60 μm above the base; marked by the dotted line), the flow goes from left to right when seen in the xy-view (Fig. 1(e)). Experiments conducted by our collaborators at TU Eindhoven confirmed this flow pattern. This specific nature of the flow field resulted in asymmetric deflection of passive cilia: on the left side, passive cilia are deflected downward, while on the right, they are deflected upward (see Fig. 1(g)). Notably, passive cilia on the left deflected more than those on the right (shown by dashed lines in Fig. 1(g)). Consequently, this differential sensing by the passive cilia on the two sides of the node breaks the left-right symmetry. These observations aligned with studies on mouse embryos [1], demonstrating how passive cilia detect and transmit signals to establish left-right asymmetry.

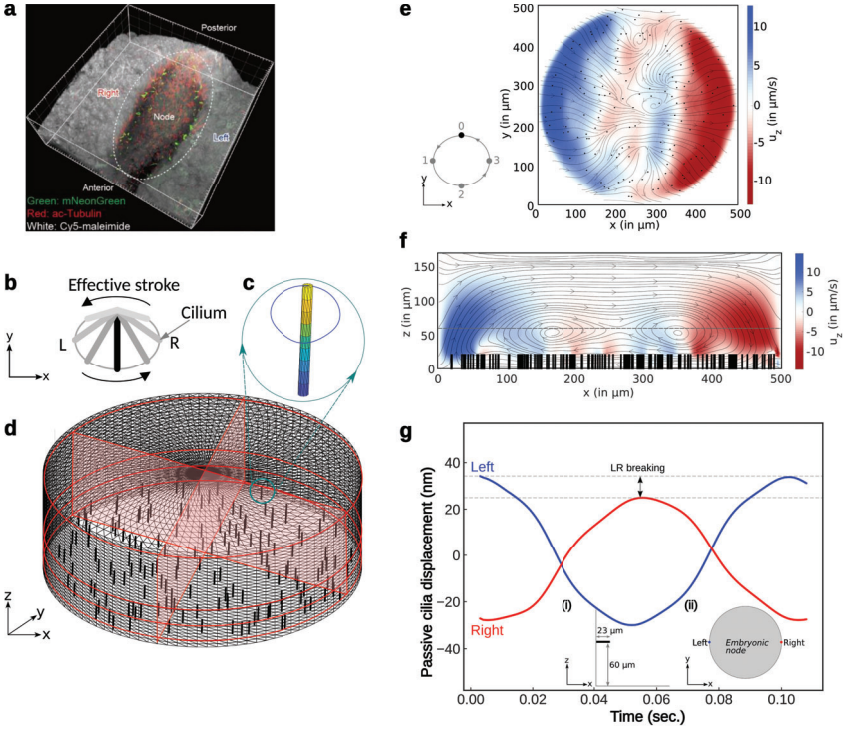

Figure 1: ***Breaking of symmetry via mechanosensing.*** ***(a)*** *Super-resolution 3D view of a mouse embryo (adapted from [1]). Active cilia are highlighted in red, while passive cilia are shown in green. Schematics of active cilia motion:* ***(b)*** *Top view of the tilted conical motion observed in the xy-plane and* ***(c)*** *3D view showing the cilium's trajectory (blue path).* ***(d)*** *Meshed model of the artificial embryonic node, featuring 156 active cilia within a cylindrical cavity (width/height ratio = 3). Flow observation in the xy, xz, and yz-planes are marked in red at their respective positions.* ***(e & f)*** *Flow velocity component (uz) in the artificial embryonic node at z=60 µm (location of passive cilia):* ***(e)*** *in the xy-plane and* ***(f)*** *in the xz-plane at the onset of the effective stroke of the active cilia motion. The dashed line indicates the position of passive cilia.* ***(g)*** *Tip displacement of the passive cilia (length of 23 µm and diameter of 200 nm) positioned on the node periphery at ~60 µm from the node base, as shown in the inset* ***(i)*** *over a beating cycle of the active ciliary motion. The blue line represents the left-side cilium, while the red line corresponds to the right-side cilium. The gap between the dashed lines highlights the difference in passive cilia deflection magnitude. Insets:* ***(i)*** *Schematic showing the position and size of the passive cilia in the xz-view;* ***(ii)*** *Top-down (xy-view) schematic of passive cilia location, indicating left and right cilia positions.*

We also investigated the chemosensing hypothesis by observing how particles, mimicking biological morphogens, move through the flow field in the artificial node. The results showed an asymmetric particle deposition, with more particles accumulating on the left side of the node (see Fig. 2(a)) at the beginning of the flow (see Fig. 2(c)) while more accumulation on the right side of the node over time (see Fig. 2(d)). This differential deposition of the particles could act as another signaling mechanism for the left-right determination. In conclusion, these findings reinforce the importance of cilia-generated flow in determining left-right asymmetry, which can be either the result of mechanosensing or chemosensing.

Beyond biology: broader implications

Our artificial cilia system offers a platform for designing microfluidic devices capable of precise flow manipulation and mixing. Understanding how cilia generate and sense flows could inspire innovations in designing organ-on-a-chip devices, advanced sensors, and industrial flow systems. For example, the embryonic node could inspire sophisticated sensors that use flow patterns to activate or de-activate critical medical or industrial devices. This work bridges biology and engineering to study one of life's most fundamental processes and highlights the elegance of nature's design: exemplifying how small variations at the micrometer length scale can have such profound implications.

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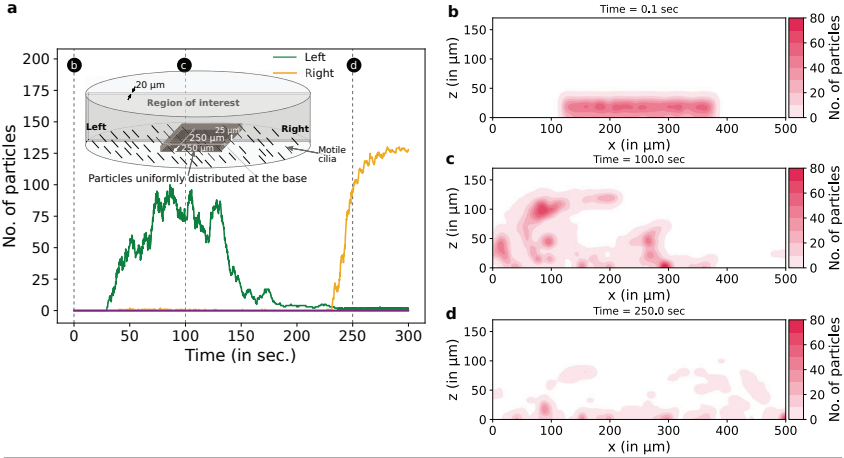

Figure 2: ***Breaking of symmetry via chemosensing. (a)*** *Time evolution of the number of particles at the left and right of the node due to the flow generated within the artificial node. The green line corresponds to the number of particles at the left side, while the yellow corresponds to the right side. The inset shows a schematic illustrating the initial position of particles and the region of interest used for particle tracking.* ***(b-d)*** *Contour plots showing particle distribution at different time points corresponding to the markers in (a): 0.1 s, 100 s, and 250 s. The color map represents the number of particles.*

Locked in: Train couplers

By Zoltán Hermann

As STEM students, we think we can safely assume that most of us had some kind of obsession as a child. For some it was cars, dinosaurs, or whatever, but for many it must have been trains and perhaps it still is. Locomotives, whether steam-powered, electric or diesel are all fascinating. How steam is converted into movement, or how the overhead lines are designed so that they are always under tension to reliably transfer energy to the motors. But have you ever thought about the crucial part that makes it possible to link over hundreds of cars, totalling kilometers long?

Throughout Europe in the 19th century mostly buffer-and-chain couplings were used between passenger trains. As the name suggests these consisted of two side buffers to absorb shocks, and a central link-and-hook. This was a manual system that required a person to stand between the cars and link them by hand. Not suprisingly, this is extremely dangerous and resulted in thousands of injuries or even deaths. While this system still remains in European freight trains, in passenger trains a shift towards automatic couplers started at the end of the century. In the USA fast progress was made as Eli H. Janney patented the Janney coupler in 1873, which is still used to this day. Later on in Europe Karl Scharfenberg invented his coupler that slowy became the standard. [1, 4]

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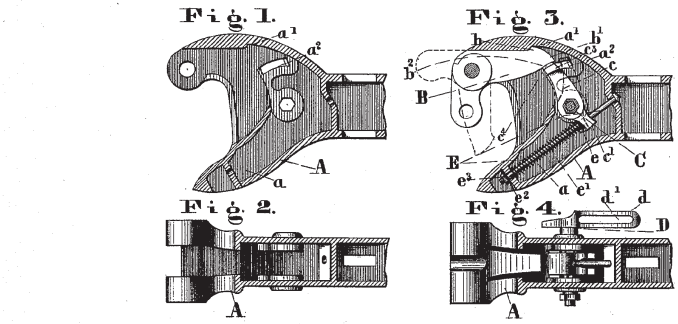

Figure 1: Original image in patent of the Janney coupler [9]

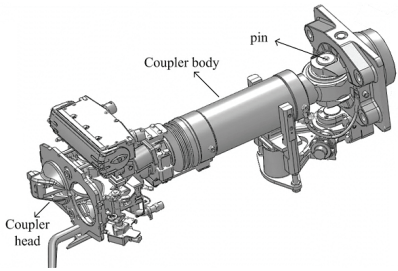

Figure 2: Typical structure of a modern Scharfenberg coupler. [2]

The Janney coupler, also known as the knuckle coupler seen in figure [1], is mostly used across America in freight trains. The rotating knucle locks in place when the cars come together, but this is not fully automatic. The brake hoses and electrical connections still have to be made by hand. It is incredibly strong while still allowing some movement, therefore making it possible to have hundred of cars together. It's not too practical for operational speed, but freight trains aren't disconnected too often. [1, 4]

The Scharfenberg coupler on the other hand, is the standard in passenger trains across Europe. The coupling head is fitted with a cone and a funnel, which join together. The centering cone guides the connection, and inside each coupler there is a rotating lock that secures it. Compared to the Janney coupler it handles all connections, like electric, and pneumatic automatically. This makes it much faster, and safer by ommiting human interaction. Only buttons have to be pressed by the driver. [6]

The BSI coupler is another system used in the Netherlands, but mainly on less intensive applications like light rail, and metros. It

looks similar to the Scharfenberg coupler with two diagonally arranged cones and two symmetrically arranges grooves that connect. It's smaller and designed to resist less force, but remaining fully automated. This way it's standard in systems that require frequent coupling and decoupling. [7, 5]

Couplers do more than just connect train cars: they have to handle massive forces while keeping the ride smooth. So one of the biggest differences between freight and passenger train couplers comes down to load and stress distributions. In freight trains, couplers need to withstand huge tensile forces as the locomotives pull long chains of cars. The Janney coupler is better designed to handle this. In the Scharfenberg coupler passenger comfort is prioritized over raw strength, since they include energy absorbing elements, like hydraulic dampers and rubber buffers. This results in smoother acceleration and braking, but also limits on how much they can handle.

A train in motion is more than just a simple linear system. It's a chain of coupled oscillators, where each car moves differently throughout speed changes, and differing track conditions. This means tensile forces, compressive forces, and lateral forces have to be differently accounted for in every connection point. Early coupler designs were tested by trial and error, in real train yards, applied on real trains. This obviously required meticulous planning and a lot of time. Today couplers are designed and tested using dynamic simulations to predict behaviour across all conditions that they could encounter.

Overall, couplers may not be the flashiest part of a train, but they are a key component. Whether it is after receiving a package - which travelled through the intricate train system - or while travelling, never forget that it is all possible thanks to couplers. [2, 3]

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From Physics to Philosophy: Quantum Mechanics and Aristotle

By Annabelle van Berlo

After 3 years of hard work on Astronomy, I recently decided to drop my first Bachelor's and continue with studying Philosophy. This has been a hard choice to make as 105 ECTs is not something you leave behind easily. So when I had to write my first essay for Philosophy about Aristotle's ideas about actuality and potentiality I had a very strong interest in combining it with quantum mechanics. I really enjoyed writing it and thus I was talking to Tania about my paper. The idea came up to write a piece about it for the Francken Vrij, so in this piece, you can learn more about Aristotle, teleology and how this relates to quantum mechanics. Who knows, you might even get interested in studying Philosophy yourself!

I will assume you have all heard about the ancient Greek philosopher Aristotle before. He was a very significant figure in shaping the general notions of physics until modern science emerged. The aspect I want to focus on now is his distinction between actuality and potentiality. Actuality refers to the things that currently are, for example, that you are reading this text right now is an actuality, just like how you are probably sitting down. Potentiality, on the other hand, is the things that could possibly be, you could also be walking while reading the Francken Vrij or burning it (in case you think my piece is absolute nonsense). Aristotle argued that actuality is prior to potentiality. This means that for something to be potential, there has to be actuality first.[1] For example, if you want to have the potential to build a house, first you have to build one so that you can learn how to do it in the future. From this distinction and order between

actuality and potentiality follows a teleological worldview. Teleology is a theory that states that everything moves towards an end, like a caterpillar moves towards its end which is becoming a butterfly.

You might have noticed that although teleology was a very prominent philosophy for close to 2 millennials, we do not use it anymore when conducting research or developing theories. A more likely course to follow is to observe the facts and try to find a theory that fits the data you have gathered. Instead of moving from the top down, you move from the bottom up. Naturally, at some point this idea changed around, meaning some scientists tried to combine new discoveries with Aristotelian philosophy, even in quantum mechanics. Even though it seems clear that these cannot be combined because quantum mechanics is inevitably tied with uncertainty. And because of this uncertainty, how could you ever argue that something is moving toward a goal or an end if this end is not yet established?

Still, people tried to combine these theories. One of them was Heisenberg himself, he compared the wave function to potentiality and the measuring of a particle to the transition from potentiality to actuality.[2] Another physicist and philosopher, David Bohm, also tried uniting the theories, but he focused more on the wave-particle duality. He mentioned that an electron with a broad wave packet and definite wavelength could potentially become more like a particle when we measure its position, much like Heisenberg's comparison.[3] And yet another philosopher, Gregg Jaeger, tried to restore Aristotle's ideas by replacing the goal, not by the precise velocity of the electron but rather by the measurement and determination of it. With this he tried altering the general understanding of teleology altogether.[4]

Now, I quit studying Astronomy for a reason, and that reason is indeed quantum. So if you are interested in this topic I advise you to read Boris Kožnjak's paper on this topic.[5] Of course, I do not have the right answer to this question of a bottom-up or top-down established universe, if I did, do you think it would still be considered Philosophy? What I would like you to take away from this piece is that there are always different ways of approaching the world and your research. So stay critical about the patterns and views that are already established and you might find that doing some philosophy will be an inspiring addition to your life!

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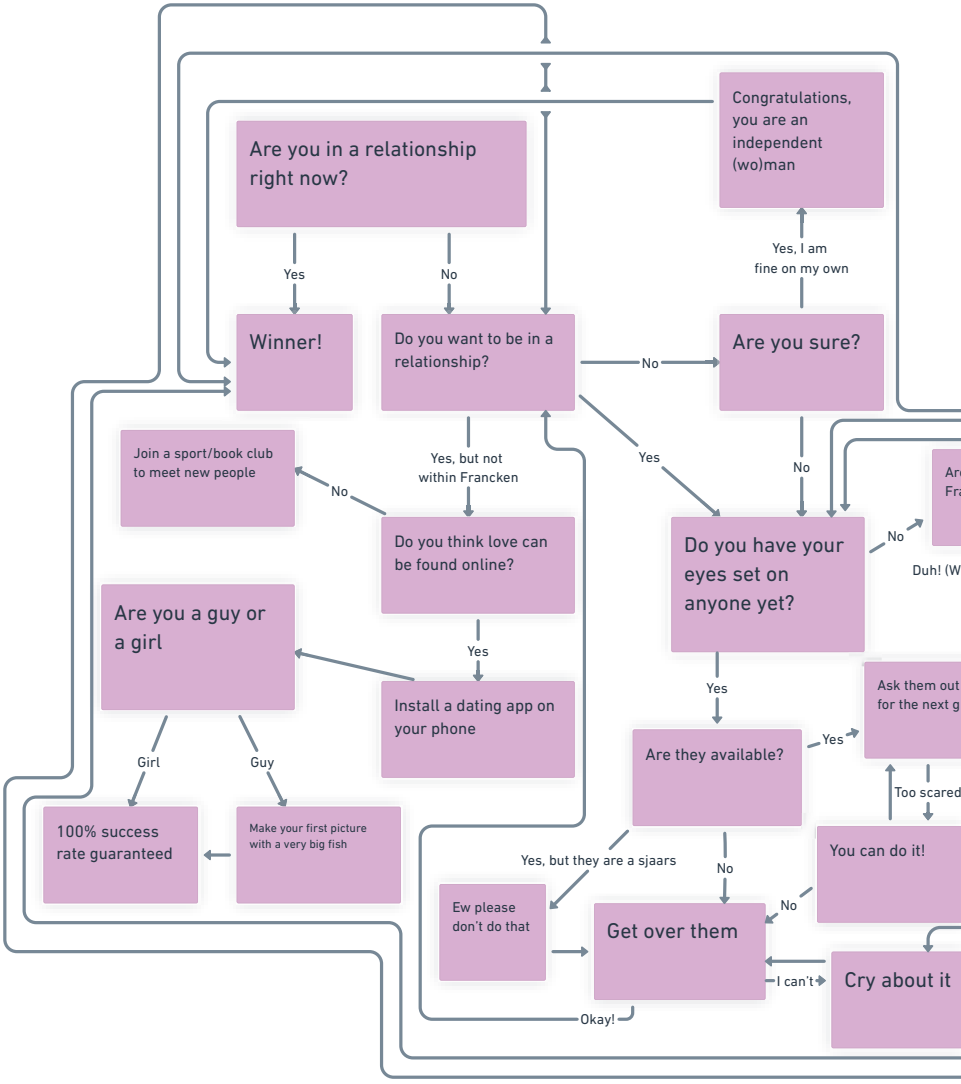
1. Aristotle, Metaphysics, 1045b-1050b
2. Heisenberg, W. (1958). Physics and philosophy: The revolution in modern science. Harper & Brothers Publishers
3. Bohm, D. (1951). Quantum Theory. Dover Publications.
4. Jaeger, G. (2017). Philosophical Transactions of the Royal Society. https://doi.org/10.1098/rsta.2016.0390
5. Kožnjak, B. (2020). Aristotle and actuality, Spontaneous Events and Final Causes. Springer Nature B.V. https://www.jstor.org/stable/45378815

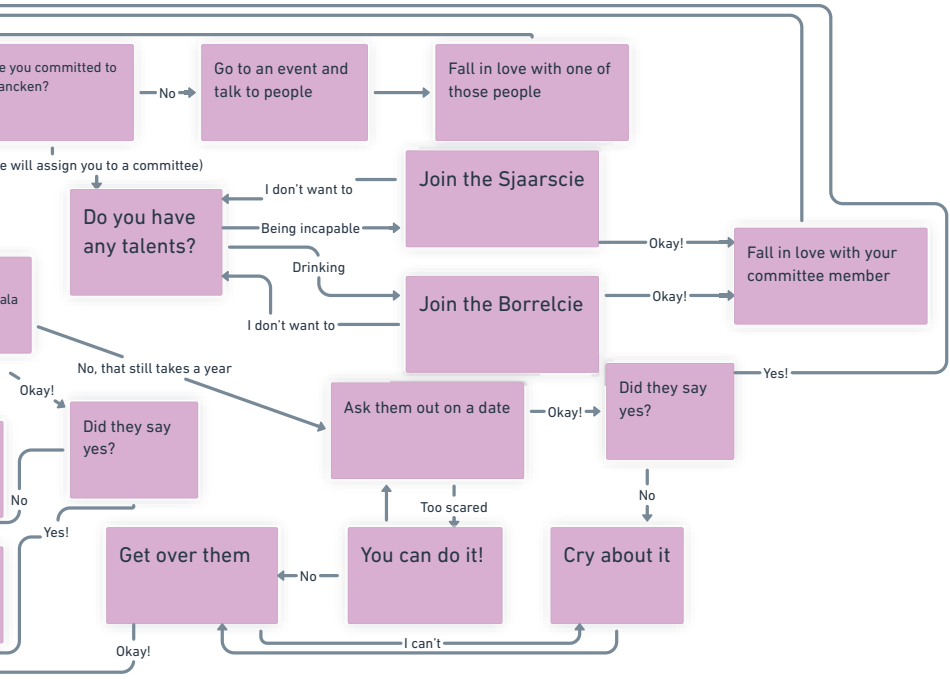

Are you in a relationship right now?
Yes
No
Winner!
Do you want to be in a relationship?
No
Are you sure?
Congratulations, you are an independent (wo)man
Yes, I am fine on my own
Join a sport/book club to meet new people
No
Yes, but not within Francken
Do you think love can be found online?
Yes
Install a dating app on your phone
Are you a guy or a girl
Girl
Guy
100% success rate guaranteed
Make your first picture with a very big fish
Yes
No
Do you have your eyes set on anyone yet?
No
Duh! (W
Yes
Are they available?
Yes
Ask them out for the next g
Too scared
You can do it!
Yes, but they are a sjaars
No
Ew please don't do that
Get over them
No
I can't
Cry about it
Okay!

Guide to get a partner

By Hannelys Posthumus

Using this flow chart, you will be able to find your romantic partner in no time. A small explanation: You start at the most upper left box and from there you can answer and follow the flow chart, which guides you towards getting into a relationship.

Sadly, if you are a sjaars you are stuck in a loop and you will never be a winner, but I guess that is the life of a sjaars. Luckily you will only be a sjaars for a year. Hopefully.



Life after Francken

By Sergio Dharamraj

Five years ago, I never would have anticipated the journey I would be taking on in my years of university ahead. Now when it came to what to study, I knew more or less what to go for, since I always had a thing for science. In the end, It was decided that I was going to study Physics (surprise, surprise). However, I was torn between two choices: pursue the Applied Physics programme at the TU/e in Eindhoven where lots of my high school friends were moving, or dive into the deep end and choose Physics in Groningen, far in the north, and far from everyone else I knew. Ultimately, and unsurprisingly considering that I am writing this piece, I chose Groningen. Whether that was due to my preference for the curriculum, or wanting to start fresh in a place where nobody knew me is up to debate, but it's a choice I do not regret to this day.

I was always aware of the existence of study associations like T.F.V. 'Professor Francken', but never really ended up participating in events much, for one reason or the other. That is until I heard about a very interesting trip being planned, for which I spontaneously signed up. That trip was the SLEF 2021 to Switzerland & Italy. Signing up for this trip had quite the butterfly effect, as you will come to understand by the end of this story. After what was an incredible trip and a very memorable experience for me, I started feeling a bit more comfortable around the association and fellow members. Now I was never a heavily active member, but from that point onwards I would make appearances in the association room, participate more in events, and eventually also join some committees.

As some months passed, the next trip was being planned. I was a bit hesitant to sign up at first, given that I had already been on a trip that same academic year, but eventually I was convinced to by my new friends in the association. It was on this trip that we visited ITER in the South of France, and where an interest in nuclear fusion research really started brewing for me. In fact, I ended up joining the Buixie committee the following year where we managed to organise a trip to JET in the UK! After seeing ITER, I already had a feeling as to what I wanted to further my career in, but seeing JET really solidified it for me. I wanted to join the world of fusion energy research. I ended up doing my bachelor's thesis in the field of nuclear energy, where I characterized BaF2 detectors to see if they were suitable for molten salt reactor research. This, of course, is in the field of fission and not fusion, but was a nice way to dip my toes in the nuclear field already.

In the Netherlands, there is conveniently one master programme that specializes in fusion energy. So, in a somewhat funny twist of fate, I ended up studying at the TU/e in Eindhoven anyway, the university that I was heavily considering going to just a few years prior. This is where I am today, where I'm busy finishing up a few extra courses I'm taking before I go off to do my internship and thesis. In this programme, either your internship or thesis must be done abroad. As such, I have plans to do my thesis at CIEMAT in Spain, but we'll see exactly how that plays out in the coming year. After this, I am strongly considering continuing with a PhD in the field, but again, only time will tell!

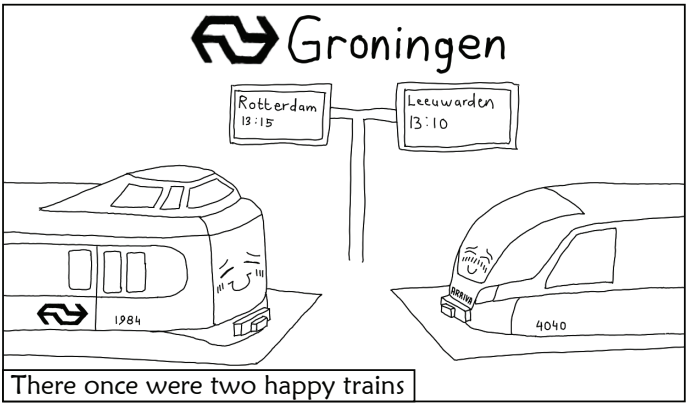
Over the past year, I learned a lot about fusion energy. Not only about the physics, but

also about the engineering and economics behind current experiments and even potential future power plants. I even had the opportunity to visit ITER again, on an annual trip planned for people doing my master's programme. This time it was much more insightful though, as I was more knowledgeable about fusion energy and the project itself now. I should probably mention that we don't only focus on the mainstream approaches. In fact, my interest currently lies more in stellarators, as opposed to tokamaks like those of JET and ITER. Fusion is of course more than just magnetic confinement, so I was also exposed to other approaches like inertial confinement or magnetic-inertial hybrid concepts. That being said, the fusion energy community is still quite small, though there has been a bit of a boom in the private industry over the past few years. It's been very interesting looking into the various creative approaches some of these companies have, with some approaches being a bit more fanciful than others of course. Meeting with and discussing vastly different approaches with experts from both the public and private sectors is always fascinating, as no single person knows which approach will prevail in the end. So, naturally, I'm always down for a chat about fusion. Feel free to shoot me a message if there's anything you'd like to discuss!

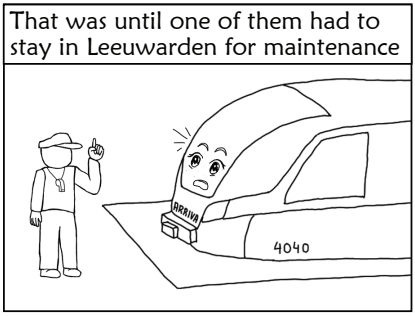
All in all, there is much left to learn in the field of fusion energy. I am excited to see where my career will take me, but even more excited to see how the fusion energy landscape will develop as we invest more money, resources and attention into it. I will always think back and be grateful for my experiences with SLEF and Buixie, as without having gone on those trips, I probably would have never ended up where I am today.

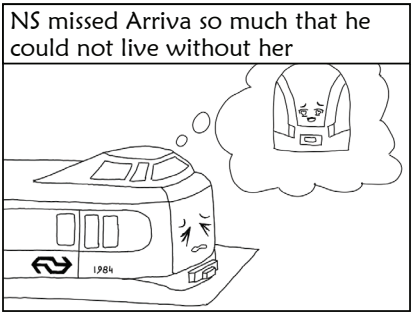
Comic

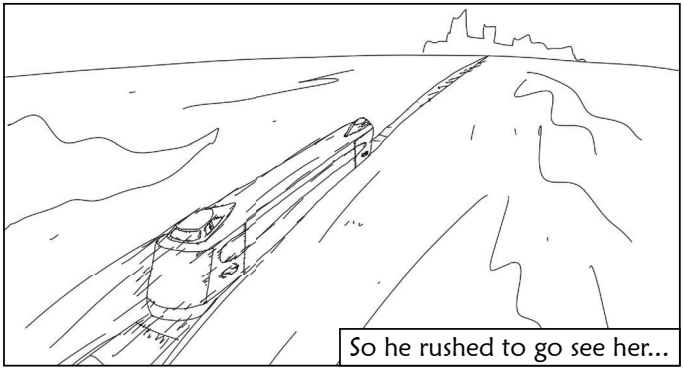
By Tania Ovramenko & Gerrit Boonstra

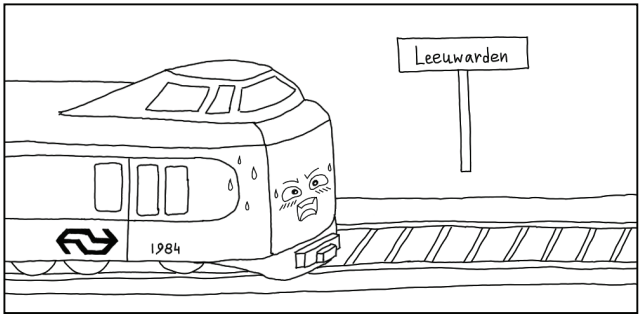


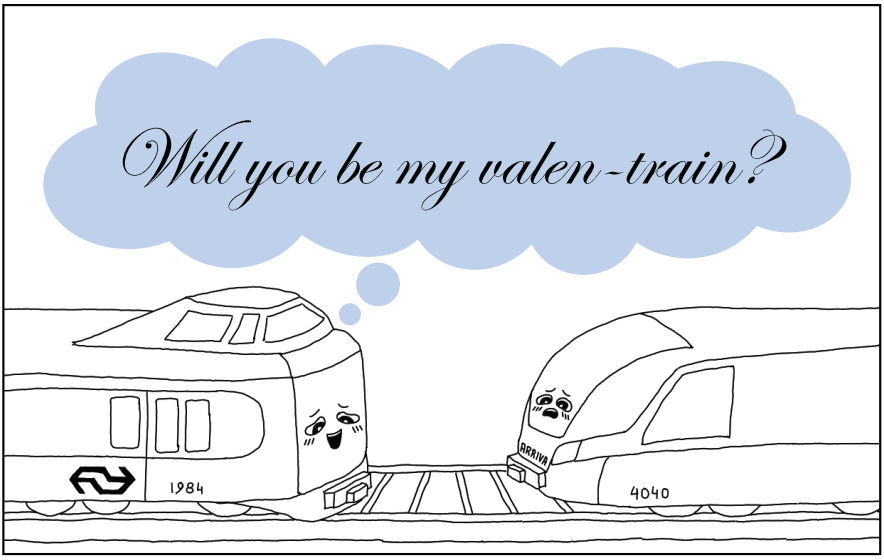
There once were two happy trains



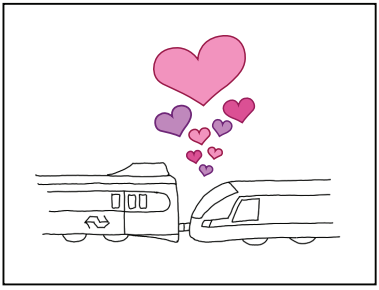








The

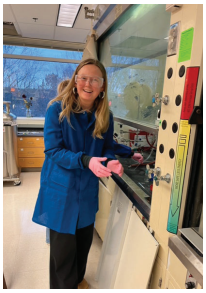


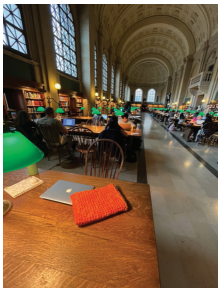
End

Francken Abroad:
Hes in the US

By Hester Braaksma

After spending almost 6 years in Groningen, I decided it was time to explore new territory, so since last October I have been living in Boston! Why did I move to the USA you ask? Valid question, since it's not because of their choice in president, to see the Chiefs win another superbowl or because I like spending 11 dollars excluding tax and tip on a beer, but because I am writing my Master's thesis here!





Tell us more about your project!

Professor van der Wal introduced me to Matthew Rosen, a faculty member at the Martinos Center for Biomedical Imaging and an Associate Professor at Harvard Medical School. He was kind enough to welcome me into his lab! His research focuses on ultra low magnetic field MRI technology and one of the very interesting subjects they are looking into is the opportunity to use hyperpolarization to increase resolution in metabolic MRI to aid in cancer treatment, which is the focus of my thesis. As their very own 'Hydrogen girl', as some lab faculty has called me before, I am using parahydrogen to hyperpolarize pyruvate, an important biomarker in tumor development, by applying SABRE (Signal Amplification By Reversible Exchange) technology.

That last sentence probably made no sense so let me try to explain it to you. We use parahydrogen, hydrogen with the spins of both nuclei in opposite directions, since it has a high spin order and is relatively simple to obtain: cooling hydrogen gas below 35 K does the trick. Through an exchange reaction it is possible to transfer this high spin order to many molecules, but I want to transfer its polarization to Pyruvate. If you are in biomedical engineering or chemistry you may have heard about this molecule before, but for our average physics Francken member I'll give a little more context: Tumors show high pyruvate to lactate conversion, which makes Pyruvate an important biomarker for early cancer detection. The goal of my thesis is to use this hyperpolarized Pyruvate as a contrast agent to do in vivo experiments using our low field (6.5 mT) MRI scan and make some very cool, high resolution images.

What's Boston like?

Enough about my project, there is so much more to moving to the other side of the world than my thesis of course. My American dream started in Brookline, an area west of the city, or town as locals prefer to call it, but I have moved to Back Bay, a neighborhood in Boston which you may know from the movie/book 'It ends with us': Lily Bloom opened her flower shop in this area. Here I live in the penthouse, aka I walk a lot of stairs everyday, of a house I share with four Dutch guys. Together with two other houses inhabited by Dutch (mostly medical) students in the same street, we have our own small community with whom I hang out, work out, party and go sightseeing with. As far as culture goes, there is not much of that in this country, but I try to explore as many American things as possible. For example, I have been to a tailgate, which is basically just a bunch of Americans that own trucks getting drunk in a parking lot of a football stadium before watching a game there. I also attended a Kamala Harris/Elizabeth Warren rally on election day, casually encountered Don Toliver and G-Eazy in clubs and tried to keep my calm while some interesting people did some questionable things a few feet away from me during my commute on the subway. I already feel like a real 'townie'. As far as food goes, I'm trying to tick off all the fast food chains here, with my favorites currently being Chick-Fil-A and Raising Cane's.

Can you believe that I haven't been to McDonalds yet since I moved to the States? I know, shocking.

The US beyond Boston

Since I arrived in the US, I've been on quite some adventures already: I've seen the beaches and clubs in Miami, tried some Poutine in Montreal, searched for Walter White in the mountains of New Hampshire and went on a chemistry side quest to NC State University in Raleigh. About the latter I want to tell you a bit more, since this was a lot of fun and an important trip for my thesis. The chemistry department of NC state houses Thomas Theis's research group, which is focused on using hyperpolarization to boost NMR and MRI signals. Their group told me everything there is to know about sample preparation, chemical knowledge necessary for my project and many useful lab skills. With me now having extended my knowledge from just physics to also chemistry, don't be surprised to see blue substances show up on the streets of Boston. Next to all the academics, I also had the opportunity to explore a bit of North Carolina during my stay there, including farmers markets, flea markets, Glenwood (aka Poelestraat of Raleigh), Costco and stores that sell shirts saying 'I am voting convicted felon 2024'. So next to a lot of useful skills that I can use researching in Boston, I also picked up a bit of a southern accent.

Miami baby!

As far as a culture shock goes, Boston is a very European city, so it reminds me a lot of The Netherlands. Let me tell you a story of when we stepped on a plane towards Florida and our culture shock actually began. If you're not very familiar with American states and stereotypes: The way that Europeans look at America, that's how Americans feel about Florida, so we were in for a treat. Our destination was the capital of South-America: Miami. On the plane we met this 'networking coach', who reminded us of an influencer that would try to scam you into buying a course on how to get rich. We decided to share a cab with him to Miami beach and during this drive he invited us to a networking dinner. After an elaborate discussion on what to do, we channeled the classic 'do it for the plot' mentality and decided on going. During the

networking event we met a bunch of nobodies and millionaires, while enjoying free food and drinks. We were in Miami for the night life, but since it is the most expensive city in America we asked around what was a nice place to go out to if we did not want to spend a lot of money.

A classic 'Florida man' present at the dinner gave us the advice to just stay home, combining it with a story in which he spent 35K at a club and got kicked out anyway. We did not let this break our spirits, and with small 30ml bottles of vodka hidden in our socks we bluffed our way into a club for free and had one of the best nights ever.

'do it for the plot'

More to come...

While I'm writing this, I am still in the US with a lot of adventures and interesting physics yet to come, but it has already been an amazing experience. With trips to New York, Georgia, Tennessee, Alabama and California planned, I am going to try to tick off as many states as I can during my time here. Don't worry, over the summer I'll be back in the Franckenroom to tell you all about it! I will try my best to gather as many crazy/fun stories as I can, as you are used to. If you read my piece and think 'wow I also want to go on an adventure like this!' you can always send me a text or give me a call. I would be more than happy to help you out!

COME BY THE ROOM FOR

A CUP OF COFFEE

Try the new BEANS!

Lustrum 40: A (very objective) review

By Eline Mijnlieff

This year, we had the pleasure of celebrating our 40th anniversary – AKA our 8th lustrum! Promotion kicked off strong a few weeks before, with a cinematic murder mystery movie trailer setting the tone for the week and revealing the theme; 'The Ruby Rampage'. With a packed schedule of diverse events, there was never a dull moment. Each day dedicated to the boards that came before us, the past and present came together in the best way possible, creating a wholesome week of happiness and celebration! Meanwhile, the murder mystery unfolded at each event and was documented on instagram, keeping everyone on their toes. A huge shoutout to the Lustrum Committee for their hard work and creativity that made this week a great success! Read on to relive the highlights of each day – or see what you missed!

Day 1; Nuclear

The first day, dedicated to board 'Nuclear', was a day full of sugar and celebrations. The afternoon started with beautifully decorated (and free!) cupcakes. Topped with bloody fondant knives on a bed of icing, they were a visual masterpiece (and incredibly delicious). They, of course, vanished in not time, but those lucky enough to grab one were in for a real treat.

In the evening, there was a neon-themed opening party at Wolthers. Everyone pulled out all their 80s, bright colored clothes and accessories to match the highly decorated space and cool outfits of the committee. While the crowd wasn't as big as expected, the energy was high and the vibes were electric, with lots of karaoke, celebratory chugs and dancing. And even a professor with a couple of PhD students showed up! A glowing start of the lustrum, that's for sure.

Day 2; Charm

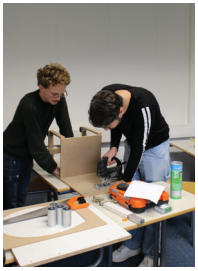
After the neon-fueled chaos of the night before, day two – dedicated to board 'Charm' – started nice and cozy with a 'hangover brunch'. We picnicked on the floor of the Franckenroom, replenishing our energy with baguette, dips, fruits, veggies and a bunch of water to fix our dehydration. After that, the stress began; figuring out what to wear for the fairy-tale themed gala that night!

As expected, everyone cleaned up ridiculously well for the most glamorous event of the week. Hosted at the Loods, with decorations all around, this event was fabulously top-tier. Free drinks all around, a massive dance floor, a DJ that actually knew what he was doing, and a photobooth where our guy Rayan made sure we all had photographic evidence of how great we all looked and how much fun we had. The board invited the other FSE boards, and friends from CB, FMF, Cover and even a lost Lugus board member all found their way to the greatest gala of the year! Lustrumcie had more surprises for us all; crowning people as King & Queen, cutest couple, best outfit, and more. Lot's of fun! Speaking of cute, Francken couples showed up in full force; proving that love can, in fact, survive a lustrum week, even at Francken! What. A. Night.

Day 3; Half-life

Day three, dedicated to board 'Half-Life', turned the engineers among us into Bob the Builders during the AP challenge! The

mission? Build something useful (or at the very least mildly entertaining) for in the Franckenroom, using a limited supply of random materials. Each team was granted the same amount of coins, which they could use to "buy" materials from shady stock manager Adri. After hours of intense craftsmanship, the teams presented their masterpieces to the jury in the Francken room. Creations were judged on creativity, aesthetics and functionality. In the end, the jury crowned Bradley and Ian the winners, with their regal-looking chair for Pluis! The sketchy woodworking setup in a random campus room? Just part of the Francken charm.



Then came the evening event; the infamous 'rubber boat borrel', renamed to the 'body bag borrel' to fit the lustrum's murder mystery theme. If you weren't there, well… good luck figuring out what the rules were for the evening and what exactly the idea was, because I don't think many of us really knew either! In short; two teams, a bunch of ridiculous but fun challenges, and far too many drinks. Absolute chaos. Very fun. Maybe a couple of regrets, but that was a problem for future us. All in all a very good day!

Day 4; Fusion

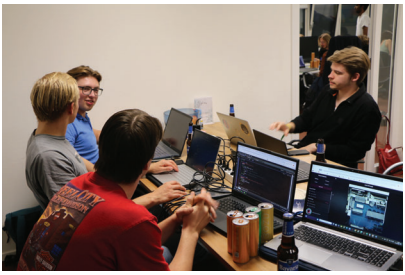
Day four, dedicated to board 'Fusion' started with a symposium on –you guessed it– nuclear fusion, because what would a Francken lustrum be without a bit of learning? With Jeff de Hosson as our chair of the day, the bar was instantly set high! We were treated with a series of fascinating talks, covering everything from plasma material choices to state-of-the art cooling techniques in fusion reactors. And of course, we were left with the key takeaway; fusion is only 30 years away! Classic.

After the symposium and a little borrel in the Francken room, it was time for some fusion of a different kind –cocktail fusion! We made our way to the 'Buurten bij Bernlef' space we rented for an evening of mixing, shaking and of course drinking at the cocktail workshop. Because of the cozy location, it kind of felt like bingo night, except instead of numbers, we got cocktails, and instead of intense competition, we just had great drinks and good conversation. A perfect way to unwind after a day of learning. Even if nuclear fusion won't happen in our lifetime, at least we learned how to successfully fuse alcohol!

Day 5; Freefall

Day five, dedicated to board 'Freefall', brought out our inner children with a massive bouncy castle/ obstacle course right in the middle of campus grounds. And let's be honest, who can resist that? Not just francken members, but also random students passing by and even a couple of kids visiting their families couldn't help but join the fun. Sure, it was freezing outside, but when you're racing through a bouncy obstacle course against a friend, who cares? We bounced, we fell, and we probably woke up a little sore, but it was 100% worth it.

Then, in the evening, it was time for the long-awaited Crash & Compile! In collaboration with Spheer.ai, a startup founded by former Francken members, participants (in teams) coded their way through a series of challenges, using whatever methods (and questionable coding skills) they wanted. Bonus points were awarded by completing side quests and of course drinks! Massive shoutout to the members of former s[ck] rip(t|t?c)ie, who put ridiculous amounts of work into making the website and the challenges, making the whole thing possible (and very fun). Another huge thanks to Spheer.ai for providing the venue and a bunch of pizza to keep our brains (somewhat) functional. I gotta say, witnessing this legendary event at least once in my life feels like an unlocked achievement. A very cool, very chaotic evening. Would 100% recommend.



Day 6; Alumni

The last day of the lustrum, dedicated to our amazing alumni, was a perfect mix of nostalgia, catching up, and meeting legends over a couple of drinks. We kicked things off with a couple of hours of pooling, where the current board could mingle with alumni and hear their glorious Francken stories and alumni could reminisce together about their own student days. After a full-on competition and a speech from the oldest Lustrumcie member (who may or may not have kakverhaald about the good old days for a little too long), we headed to Huize maas for dinner. The room was filled with laughter, drinks and good food, setting the scene for some real conversations and connections with Francken's finest.

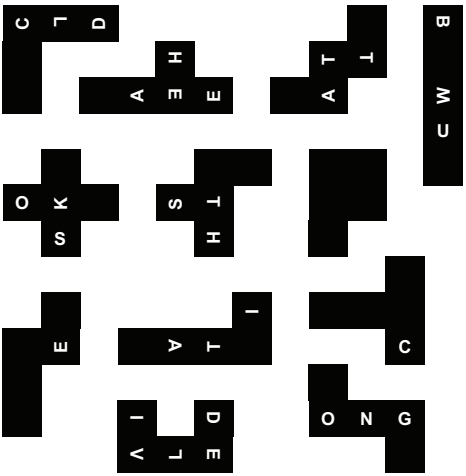
But the night wasn't over just yet. After a quick (okay not so quick) group picture, those still standing made their way to Unitas for the end party. Wholesome function chugs were shared between predecessors and slowly but surely more current members also joined the fun. The vibes were good all around and we were on the verge of escalating, when a couple of alumni pushed us (we all went willingly) over the edge by buying us a few more kegs of beer. Us measly students were in awe of their generosity, and more chugs were done to celebrate. More drinks meant more mingling, which led to more fun, which in turn led to more drinks. A glorious vicious circle, but not meant for the weak. The night escalated quite (maybe too) fast, but we were having way too much fun to care. We let loose for one final night and made it a legendary night to remember. What we also remember was the insane hangover the next day, but hey, that's what Sundays are for right?

And just like that, the Ruby Rampage came to an end, leaving us with a bunch of new and legendary memories, and the inevitable post-lustrum hangover. An amazing week of celebrations, chaos and nostalgia, honouring the past while making new memories that'll last a lifetime. Huge thanks to Lustrumcie and everyone else who played a part in organizing this incredible week. Personally, I loved every bit of it, and I'm already looking forward to the next one!

Coupling Pentaminoes

By David Dijkman

	III								
		IV				II		I	
			VI		II				V
			X						
VII		IX					IV		
						V			
				VII		VI			
IX						VIII			
	I								
					III		VIII		X



Solving this edition's puzzle may win you a prize. Be quick and send your solution to franckenvrij@professorfrancken.nl

Solution to previous edition's puzzle: ***forces***

Coupling Pentominoes

Info

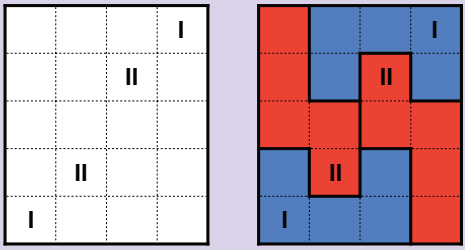
> A pentomino is a set of 5 orthogonally adjacent squares. 12 unique pentominos can be constructed(excluding rotations and mirrors). One variation of each unique pentomino is shown under the puzzle.

Rules

> Divide the grid into pentominoes

> Each pentomino has one roman numeral enclosed in its borders.

> Every pentomino that appears in the puzzle has a coupled copy of it that also appears in the puzzle, but is rotated 180 degrees around its enclosed roman numeral. The image below shows an example of a valid solution to a simple 4 by 5 grid puzzle. Note that the roman numerals are always located in the same position in their pentomino.



> Each of the 12 unique pentominos can only appear zero or two times in the grid(so the original pentomino and its rotation).

> After the grid has been solved, filling in the lettered pentominoes yields the solution. Aside from the grid outline, one border segment has been given;).

When worlds collide

By Tania Ovramenko

Science is driven by facts and logic. Art is driven by imagination and emotions. When they come together, they create a way to visualize the unseen: from the smallest building blocks on the quantum level to the deepest corners of the universe. And when the unseen becomes visible and brings knowledge to life, there is always a risk of reshaping it in a misleading way. Sometimes these distortions help digest heavy pages of equations into simplistic images which allow your friend from Spatial Design or Law to get a little peek into your world.

When you just started fueling your curiosity about the secrets of the universe years ago, for the sake of understanding, the images given to you in the textbooks were analogies made with the classic world. As the books became thicker and equations became harder, there were fewer pictures on the pages. All these invisible concepts that you have to grasp just by reading words and formulas. Here is where the art of visualization comes in.

A picture has an immense power to give an immediate access to the content. Throw in some words in addition to it and you get a perfect tool for learning. Or is it perfect? Google the word "atom" and go to Images. Having learned about the structure of atoms from many different courses, we know that electrons are not small balls orbiting the nucleus in circular orbits, but par-

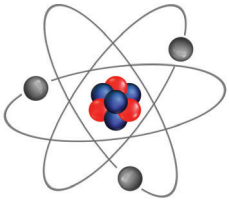


Figure 1: Simplified model of an atom, https://primaryscienceonline.org.uk/

ticles with a probability cloud and their position at some exact moment is uncertain and the nucleus is not static at all, but the protons and neutrons within are constantly moving around at a fraction of the speed of light. It would be quite hard to make a drawing of that, right? Don't get me started on what is happening in a proton or neutron... As we are trying to make our lives complicated on purpose, but without all this digging into meticulous details, those lives would be much shorter and more boring!

Figure 2: Animation of the current understanding of the structure of the proton. Collaboration of James LaPlante (Sputnik Animation) and MIT

You probably agree that the drawings of Rutherford's or Bohr's models definitely helped you to understand Heisenberg's. Maybe those were "incorrect" or "misleading" visualizations, but they were also a needed step to set a foundation and continue your path to get deeper and more sophisticated knowledge. Now, when you look at electronic clouds, they do not look like a stranger to you, but rather like a friend that was hiding and revealed themselves at the right moment.

I bet that when I say the word "spin", you imagine an electron, for example, (of course as a sphere) spinning around its axis. The concept of spin is probably the most misunderstood in quantum mechanics, due to the name and the visual implications following from that. We do have quite a limited toolkit - the classical world that we see every day with our eyes - to visualize crazy things happening on a way smaller scale. So the only way to deal with such abstract concepts is to simplify the idea. As long as you remember what you are dealing with, the accurate scientific descriptions and formulas, a little simplification for a better visualization won't hurt.

Stepping up our game and moving to the other side of the size-scale, we get to the cosmic web, the large-scale structure of

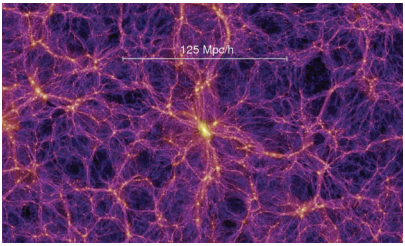


Figure 3: Slice of the Millennium Simulation, showing dark matter distribution that forms a web-like structure. Springel et al. 2005.

the universe. With the development of cosmology and our knowledge about mysterious dark matter, it was possible to build simulations of the matter distribution in the universe. These early simulations suggested an underlying web-like structure, which was later confirmed by large sky-mapping surveys. This structure is invisible with normal telescopes: many indirect techniques were used to create these large-scale maps. But the most fascinating thing is how close those simulations were to the actual reality, revealing the secrets and allowing us to "see" the cosmic web with our own eyes.

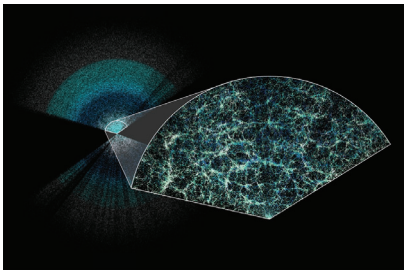


Figure 4: DESI has made the largest 3D map of our universe to date revealing the underlying structure of matter in our universe. Claire Lamman/DESI collaboration

In 2019, the Event Horizon Telescope took the first image of a black hole. Wait… But you did see images of black holes way before 2019 and they were definitely prettier than these orange blobs on a black background. The one from Interstellar is a true work of art! It was actually very close

Figure 4: The black hole at the center of Messier 87, https://eventhorizontelescope.org/

to reality, as scientists were involved in the creation of that depiction. The only things they had in their sandbox are the formulas, love of space and some dedication. And how close they actually got to the truth! Of course with the current resolution of those first images it is hard to compare the two, but the progress was definitely made and we did imagine black holes quite accurately! The EHT were more than happy to confirm that[1].

Figure 4: The image of a black hole produced for Interstellar. Paramount Pictures

We can finally return home from our little venture into science of art, or art of sci-

ence… Anyway, both are definitely friends, if not best friends which go together and pave the way for each other. As visual creatures we need some help understanding sophisticated concepts, mysterious objects and bizarre phenomena. And that's where art comes in handy with all the right tools, both simple and complex. We make guesses based on scientific knowledge developed about how small quirky things look like at that scale and try to picture it to make it make sense. On the scale of the universe, we view everything as static due to our oh-so-short lives. However, having developed some notion about the formation of everything, we can allow ourselves to picture things like black holes and make videos about galaxy mergers quite accurately. Misinterpretations are an inherent part of this progress: complex things must be simplified to be digested. Keeping in mind that fact, we can move on and enjoy the journey.

P.S. By the way, if you wish to "see" a proton, I advise you to watch a great video about it called "Visualizing the Proton: A Documentary", you will not regret it! This same documentary inspired me to write this piece![2]

References

1. https://eventhorizontelescope.org/faq/how-realistic-are-movie-depictions-black-holes-eg-interstellar
2. https://www.youtube.com/watch?v=e2FrALuacZ4

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