
perio*diek
recurring at regular intervals volume 2015 number 2
CARACAS
DUBLIN
INTERNATIONAL EDITION

Contents

In this Periodiek

From the editors

Imagination, spring is the time of imagination. During this time of the year, farmers plant their seeds in hope for a good harvest, birds find their own trees and build their nest, in expectation of their eggs; while for us this is the time to plan our holidays. We search the web and the magazines, looking for the nicest beaches and the hottest nightlife.

It is only fitting that this edition of the Perio*diek is therefore dedicated to all the international students. More than anything else, studying abroad is an experience of imagination. When you made your decision to go studying abroad, you had lots of expectations of the country where you were going to study. You imagined how great this time was going to be, or maybe you had plans and imaginations to study abroad. If you do, the articles of the international students here at Groningen might boost your expectations even more.

Perhaps this period of expectation is even better than the experience itself. Maybe you also have lots of expectations for the Perio*diek. We as editors have tried to meet all of your expectations in this edition. So, enjoy this period of imagination with this beautiful magazine.

— Douwe Visser

Editors Derk Rouwhorst, Douwe Visser, Maike Jaspers, Klaas Hakvoort, Walewein Noordam en Martine Schroor.

Scribblers Jan Bakker, Kleber Noel, Roel Tempelaar, Walewein Noordam, Liu Xiaomeng

Advertisers ASML (p. 6 - 7), Philips (p. 13), Talent & Pro (p. 16), AIESEC (p.25), Schut (p. 28)

Your ad in Perio*diek? Contact: bestuur@fmf.nl.

Edition 1100 stuks

Press Gildeprint

ISSN 1875-4546

De Periodiek is issued by the Fysisch-Mathematische Faculteitsvereniging and is released five times per year. Previous editions of Periodiek are available at perio.fmf.nl. The editors can be reached at perio@fmf.nl.

FMF

In the news

Astronauts to start year-long stay at the ISS

Friday 27th of March, three astronauts were launched from Kazakhstan to the International Space Station. Two of them shall remain in orbit for an entire year, and be the first to do so. According to NASA, they will test "the limits of human research, space exploration and the human psyche." The test subjects are the Russian Michail Kornienko and the American Scott Kelly.

Kelly has a twin brother, Mark, also an astronaut. They share the same genes, physique and background. By comparing the twin brothers, scientists can better compare how the human body changes during an elongated stay in space. The low gravity causes mussels, bones and eyes to decay.

The third crew member is the Russian Gennadi Padalka. Before this journey, he has spent 710 days in space. During his journey, he will pass fellow Russian Sergej Krikalev as the human with the longest time in space. Krikalev has spent more than 800 days in orbit. When Padalka returns, he will have stayed approximately 900 days in space.

nu

Two most destructive termite species forming super-swarms in South Florida

Two of the most destructive termite species in the world, responsible for much of the $40 billion in economic loss caused by termites annually, are now swarming simultaneously in South Florida, creating hybrid colonies that grow quickly and have the potential to migrate to other states.

Scientists from the University of Florida entomologists have documented that the Asian and Formosan subterranean termite simultaneously produce hundreds of thousands of winged males and females. Both species have evolved separately for thousands of years, but in South Florida, they now have the opportunity to meet, mate and start new hybrid colonies.

While researchers have yet to determine if the hybrid termite is fertile or sterile, it likely poses a danger according to Nan-Yao Su, one of the researchers. "Because a termite colony can live up to 20 years with millions of individuals, the damaging potential of a hybrid colony remains a serious threat to homeowners, even if the hybrid colony does not produce fertile winged termites," Su said.

UF scientists previously thought the two termite species had distinct swarming seasons that prevented them from interacting. Their new research indicates not only an overlap of seasons where the two species are interbreeding; it shows that male Asian termites prefer to mate with Formosan females rather than females of their own species, increasing the risk of hybridization.

Thomas Chouvenc, an assistant researcher who works with Su said: "If hybridized colonies have the ability to produce large numbers of fertile alates, this new termite menace could inherit the invasive qualities of both parental species and make its way out of Florida."

"Right now, we barely see the tip of the iceberg," Su said. "But we know it's a big one."

University of Florida

Scientists make chocolate healthier, and it tastes better to!

Before cocoa beans end up in the supermarket as a tasty chocolate bar, they have undergone a lot of processes. First the seeds have to be collected, before the cocoa beans can be removed from these seeds and fermented. Then the beans are sun-dried, and subsequently roasted. This last processes gives them their taste, but also removes healthy anti-oxidants.

Researchers wondered if it was possible to make tasty chocolate, without destroying too many of the anti-oxidants. They first looked into storing the beans before the fermenting process. It turned out that the amount of anti-oxidants was highest if the beans were stored for seven days before fermenting and roasting them.

Next, the researches looked into the roasting process itself. Usually the beans are roasted for 10 to 20 minutes at 120 to 130 degrees Celsius. However, roasting the beans for 45 minutes at 117 degrees increased the amount of anti-oxidants. The resulting chocolate also was sweeter than the short roasted chocolate.

The researchers propose that the sweet pulp surrounding the beans during the seven day storage period alters the composition of the beans. This altered the fermentation process, increasing the amount of anti-oxidants and improved the taste. In the future, researchers want to 'play' some further with the processing process to further increase both the healthiness and the taste of chocolate.

Scientias

Curiosity discovers nitrogen compounds on Mars

Marsrover Curiosity has found an important ingredient for life on Mars: nitrogen compounds. If there ever was life on Mars, there is a high likelihood that it used these nitrogen compounds.

Thus is reported by researchers in Proceedings of the National Academy of Sciences. They base themselves on research done by Curiosity in the Martian Gale-crater. Inside, Curiosity collected and analysed sediment and dust samples and detected a form of nitrogen that can be used by lifeforms.

Nitrogen is crucially important for life as we know it. It is a building block for DNA and proteins. It was already known that Mars' atmosphere contains nitrogen. However, lifeforms need specific nitrogen compounds to make these molecules. And apparently, these compounds also appear on Mars.

Nitrogen oxidation, the process that produces the useful nitrogen compounds, is a largely biological process on earth, done by bacteria that can bind atmospheric nitrogen. The existence of these compounds on Mars however, does not mean that similar bacteria are to be found there. Lightning strikes and volcanic eruptions can also oxidise nitrogen. This is likely what happened on the red planet.

All in all, the possibility that there ever was life on Mars seems to have increased with the discovery of these compounds.

Scientias

Chameleon uses crystals for camouflage

The panther chameleon changes colour rapidly by rearranging the crystals in its skin, as was discovered by Swiss researchers. Unlike other animals, the chameleon does not use pigment for camouflage, as was thought before.

Some amphibians, fish, and reptiles chance colour, because they have cells with pigment inside their skin, which reflects certain wavelengths of light. The pigment heaps up and disappears again, changing the animals' looks. This method mainly changes the brightness of their skin colour.

To discover how the chameleon uses its crystals, researchers removed some skin from a chameleon that was at rest in its cage. Under a microscope, it revealed that its nano-crystals lie very close together. Researcher Milinkovitch: "As a result, only light with short wavelength, such as blue, is reflected by skin cells. Because the skin itself has yellow pigments, the result is a green skin colour." This is a good colour for the chameleon to use, whilst eating between the leafs.

Next, they let a male fight another male chameleon. Immediately after that, they removed some skin from the excited animal and examined it underneath a microscope. "In this state, the distance between the crystals increases. Each cell now starts to reflect certain longer wavelengths, e.g. yellow, orange, and red", said Milinkovitch.

The colour change happens over the course of two minutes. How contact with a congener disturbs the skin is still unclear, but experiments done by the Swiss indicate that the skin cells bulge when excited and shrinks at rest.

Kennislink

ASML Master scholarships

ASML is offering 25 Masters scholarships

BY **ASML**

ASML is offering 25 motivated technology students a chance to embark on a Masters degree with an annual scholarship of € 5,000. The ASML Technology Scholarship is a program that supports students and encourages them to gain a highly sought-after Masters in Technology. Students who meet the requirements can apply from 23 March 2015. The closing date for applications is 1 May 2015.

Why issue scholarships?

Needless to say, a company such as ASML depends on talented technology professionals. However, in practice this talent is increasingly difficult to find. The introduction of the student loan system has done little to help in this respect. A survey commissioned by ASML reveals that one in three students who consider doing a Masters abandon the idea because of the student loan system. Students are also far less likely to undertake (expensive) elective options, such as an additional work placement and foreign study. This is unfortunate. It is also a waste of technology talent.

Peter Wennink, President and Chief Executive Officer at ASML, explains: "We hope these scholarships will encourage top technology students in the Netherlands to pursue a Masters degree. This is important not only for the future of high-tech companies such as ASML, but also for the innovativeness of Dutch society as a whole."

What is an ASML Technology Scholarship?

ASML launched the Masters scholarship program in 2014 in line with the commitments of the 'Technologiepact'. The program was an overwhelming success from the start. More than 200 students applied and Masters scholarships were awarded to 25 selected students.

Scholarship students receive:

- € 5,000 a year for a Masters programme for two years.
- A mentor in their area of expertise at ASML who provides support in the form of coaching, personal development recommendations and contacts.
- A two-year personal development and training program.

ASML

For students who think ahead

2014-2016 scholarship student Max Klaassen is doing a Masters in thermal mechanical engineering at the University of Twente: "This is a tremendous opportunity. It also looks great on your CV! ASML's innovative approach in the rapidly changing world of high technology makes it a very interesting company. And the training courses have been especially helpful. My studies are primarily technology oriented. So training in areas such as communication and leadership is a valuable asset. Although it is not compulsory, together with my mentor I am exploring the possibility of doing a work placement at ASML Wilton in the US."

Of course it sounds great, but we can hear you thinking, 'What's the catch?' Actually, there is no catch. Or very little. Scholarship students are not obliged to do a work placement at ASML, nor are they obliged to work for the company. All we ask in exchange is that students undertake to promote technology-related careers among young people. The way in which you do this is flexible. You agree with your mentor how you are going to promote a future in technology.

More information:

www.asml.com/scholarship

The hierarchy problem

About naturalness, fine tuning and balloons

BY **JAN BAKKER**

In physics we constantly try to improve our theories and solve the big mysteries of life, the universe and everything. But sometimes it can be hard for the uninitiated to understand why these problems, that keep the physicist awake at night, are such a big deal. The hierarchy problem for example, which happens to be the subject of my bachelor's thesis, so it definitely kept me from sleeping, but why is it so problematic and why would we care?

For the non-physicist reading this, let me outline what theoretical physicists tend to do in their research. Because we take our paradigm for granted, while other sciences can have completely different working methods[1]. We try to build models that describe nature, extract predictions from this, and change our models again and so on. The adjustment step can be specified a little more: roughly you add missing pieces or you try to get rid of unwanted pieces. An example of the first would be to try and include gravity in quantum field theories, an example of the second would be to get rid of constants that have to be fixed by experiment.

"All science is either physics or stamp collecting"

Naturalness

This effort to reduce the number of inputs from experiment brings us to naturalness. One of the most important considerations in evaluating physical theories is their beauty and simplicity, an opinion shared with some of my favourite physicists. Dirac (shown in the commemorative stamp in figure 2) encourages us that beautiful equations are a sure sign of progress [1] and Einstein (one of the many stamps bearing his face is shown in figure 3) states that it is the goal of science to maximize the predictions made by a theory while minimizing the "input" [2]. Naturalness is a similar idea, encompassing these things and then adding some. It is a concept that is also used, sometimes implicitly, in other fields. A definition given by Henry Dale (pharmacologist [3][2]): "Naturalness is the subconscious reasoning which we call instinctive judgements". This seems kind of vague and it is not a criterion on which a theory can be judged very easily; rather, it is an important inspirational tool to get to all the modern theories. Both Einstein and Dirac developed complex theories but they were inspired to build these theories by looking for a more beautiful and complete description of nature.

Putting it into numbers

Luckily for us, students of natural science, we can also rework the idea of naturalness into a quantitative statement. This variant is called numerical naturalness and it entails that all constants with similar meanings should be of the same order of magnitude. Take a physicists' favourite piece of fruit for example, the apple (figure 4). Numerical naturalness says then that if I take another apple, it should be of a similar size. One may be a giant Granny Smith while the other is

1 Although, to quote a teacher quoting physicist Lord Rutherford: "All science is either physics or stamp collecting". This did not make Rutherford particularly popular with any kind of stamp collector, but he still managed to get his face on some stamps (figure 1)

2 Or stamp collector, if you like.

FIGURE 1 Ernest Rutherford.

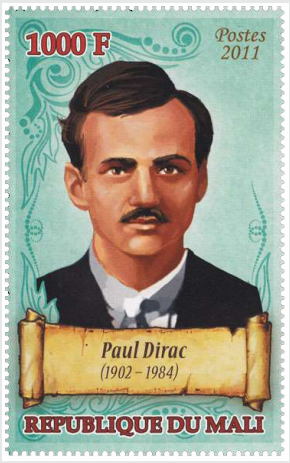


FIGURE 2 Paul Dirac.

a cute little Elstar, their masses are still within one order of magnitude. This does not mean that all fruits should be the same size: numerical naturalness is fine with currants (figure 5) being a lot smaller.

In theoretical physics, numerical naturalness (from here on out naturalness) is mostly applied to interaction couplings. In the Standard Model there are four fundamental forces (table 1). The strong, electromagnetic and weak force are somewhat comparable in strength (although the weak force is arguably a little weak already), but gravity is much weaker. This is what is referred to as the hierarchy problem of forces or hierarchy problem for short, since, when viewed from the naturalness perspective, this is a very unnatural situation.

As always, to find a solution you have to ask the right question. Another way of formulating the hierarchy problem leads to some more insight into solutions for it, but it will take some more physics to explain it.

Fine tuning

Imagine that someone holds a balloon in the air (figure 6) and says it is filled with an arbitrary mixture of gasses. Then they let it go and it floats, neither sinking nor rising, the weight of the balloon perfectly cancelled by its buoyancy: you would be surprised. You would expect that either the gas was not fully random or there is secretly some string attached to the balloon. Similarly, physicists do not like it when their theories require enormous cancellations to work, in other words, when they require fine tuning. If this does occur, we look for errors in the assumptions (the random gas) or for symmetries that protect the theories such that the cancellations are not needed (the string).

Cancellations play an important role in any Quantum Field Theory (QFT). In these theories, every particle (or field, which is kind of the same thing) has a bare mass. However, this mass is not the same as the effective (or physical) mass that we measure in experiment. This is caused by quantum effects: interactions with virtual particles. These effects happen on very small length scales, the length scales at which quantum mechanics takes over from classical mechanics.

The fact that interactions can change the effective mass can be understood by comparing the particles moving through space with physicists moving through a room full of stamp collectors. In this analogy, we use that

FIGURE 3 Albert Einstein.

Force	Coupling strenght
Strong	10^{0}
Electromagnetic	10^{-2}
Weak	10^{-7}
Gravity	10^{-45}

TABLE 1 The four fundamental forces with their coupling strenghts.

mass is the resistance to acceleration that an object has (it is hard to get a heavy object to move). If I would walk through the room, I would have little interactions (I am not particularly well known among stamp collectors), get to the other side quickly and therefore have a low effective mass. If Einstein managed to rise from the dead and walk through this room, it would be a different story: even among stamp collectors he will be recognised and all the stamp collectors that want to shake his hand will slow him down, making him effectively more massive, even though he has a bare mass comparable to mine.

The mass corrections

The bare mass is not measurable, but we can say something about the size of the quantum corrections by looking at the particle's Lagrangian, more or less the master equation governing the system. In the Lagrangian we can find which interactions are possible between the different particles. An electron emitting a photon is such an interaction. These are the interactions that influence the mass. This seems to violate energy conservation: where does the photon energy come from? In quantum mechanics, we are allowed to do this kind of thing if the proton is absorbed quickly enough. These particles, that violate energy conservation, can never be detected directly: we would then be able to catch nature in the act of violating its own rules. That is why we call these particles virtual particles, although their effect is very real.

For one loop, a particle emitting and reabsorbing another particle with a specific energy, the influence on the mass can be expressed in a function of the momentum. However, in principle the virtual particle can have any energy. This means that to calculate the effect of the loops, we have to integrate with energy from zero to infinity. The integrals encountered here are mostly divergent, which would make the correction to the bare mass infinite: not a very nice result.

Luckily, the particle cannot have just any energy. The theories we have now are not complete and they will not describe physics at infinitely high energies. At some high energy, some new theory will take over that describes physics that we cannot see at current energies. There is at least one aspect of physics not included in current QFTs and that is gravity, so as far as we know, this new theory will be a theory including gravity. This is where the hierarchy problem comes back in: because gravity is so weak, you need enormous amounts of energy to see the effects. The energy scale where gravity gets important is of order 10^{19} GeV (for comparison, the maximum energy of the Large Hadron Collider at Cern is of order 10^{4} GeV). We will have to integrate up to this energy scale in

FIGURE 4 Apple.

FIGURE 5 Currants.

FIGURE 6 Balloon.

our mass correction calculations; slightly better than dealing with infinities, but it is still a huge number.

Fermions and bosons

This has different consequences for different particles. These corrections can be visualized using Feynman diagrams, named after Richard Feynman, who is shown in figure 7. First, the fermions. The correction to the fermion masses is shown in figure 8. The straight line stands for its bare mass, the squiggly lines are virtual gauge bosons (photons, but also W and Z particles) and the dotted lines are virtual Higgs bosons. If we calculate the integral that goes with these diagrams, we obtain something that goes linearly with Λ, the cut-off scale (in our case the gravity scale). However, linear divergences are not allowed because of symmetry. The theory should be isotropic: there should be no preferential direction in space for physics; all directions are created equal. The linear divergence breaks that symmetry explicitly because it corresponds to the first power of a momentum, which introduces such a preferred direction (namely, the direction of that momentum).

Unfortunately, the integrals for the gauge bosons diverge with Λ^2. This corresponds to the square of a momentum vector, which is its length, a scalar quantity without a direction. Hence the gauge bosons appear to be in trouble. Luckily, once again there is a symmetry to save the day. This time it is Lorentz invariance (all inertial reference frames are created equal): you cannot form a Lorentz invariant quantity that goes like a momentum squared with the fields that describe these particles. This works for all the so-called gauge bosons, since they are described with a gauge field, a field that carries a Lorentz index (named after Dutch physicist Hendrik Lorentz, shown in figure 9).

The Higgs field is not so lucky: it is a scalar particle, which is automatically a Lorentz invariant quantity. This means that the Higgs boson does get a correction of the order of Λ^2. Since the physical mass of the Higgs, as measured at CERN, is only 125 GeV, this means that the bare mass has to cancel with these corrections very precisely, almost exactly. A true fine tuning problem, and this is the alternate formulation of the hierarchy problem I was referring to before: the Hierarchy problem is the fact that the Higgs mass is so tiny compared to the quantum corrections that are involved, a fact intimately related to the previous formulation (namely, that gravity is so weak compared to other forces).

A way out

There are multiple strategies to get out of this tight spot. They can be broadly put into three categories: the first is that you put a mass scale below the gravity scale. If this scale is above what the LHC can reach, this would explain why we have not seen any effects of it yet. With a new mass scale that is small enough, the

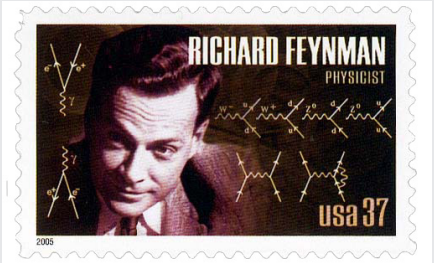


FIGURE 7 Richard Feynman.

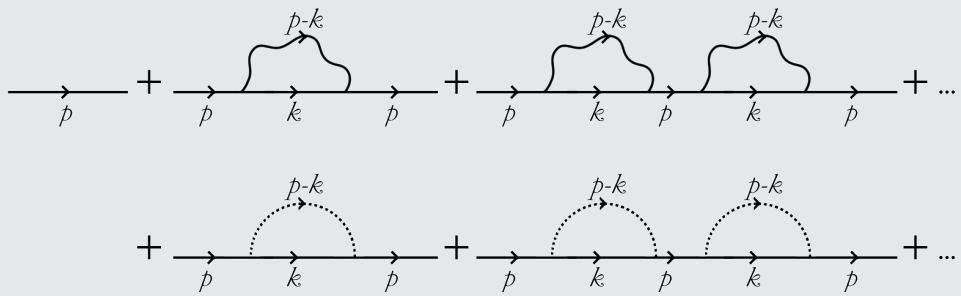


FIGURE 8 The correction to the fermion masses.

Λ^2 divergence is still there, but since Λ is a lot smaller now, the problem is more or less solved. An example of theories that works like this, are technicolour theories, which assume that the Higgs is a composite particle instead of a fundamental particle.

Another option is to make gravity stronger. This can actually be achieved fairly easily by assuming that there are more than three space dimensions in which gravity is present. Gravity is then "diluted" and if the extra dimensions are small enough this does not contradict current experimental findings.

Last but not least, one can introduce a new symmetry that also protects the Higgs particle (the metaphorical string to the balloon). This is actually the thing which I looked into in my bachelor's thesis. In my case, that symmetry was scale invariance, as explained in [4]. The Higgs mass term is the only term in the Lagrangian that breaks this symmetry and hence it is forbidden. By doing some neat tricks with a new field associated with scale invariance, the dilaton, one can then get everything to work with the correct Higgs mass.

Of course, this was more work than this last paragraph suggests, but really, understanding what the problem was, was the most important part of the project. So recapitulating: physicists like beautiful theories. This idea can be put into words and numbers using naturalness and fine tuning. The hierarchy problem is an issue that arises when we compare these ideas to experiments regarding the strength of gravity and the Higgs mass, but luckily there is a lot of interesting theories that can solve the problem. •

References

[1] "The Evolution of the Physicist's Picture of Nature" in Scientific American (May 1963)
[2] Ideas and Opinions (1954), pp. 238-239. Quoted in Einstein's Philosophy of Science
[3] Naturally Speaking. Gian Francesco, March 2008
[4] Scale Invariance, Unimodular Gravity and Dark Energy, Mikhail Shaposhnikov and Daniel Zenhäusern, 2008.

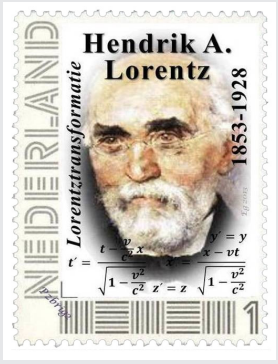


FIGURE 9 Hendrik Lorentz.

FIGURE 10 I would like to thank Elisabetta Pallante for her guidance in my project.

PHILIPS

Kleber on the Netherlands

BY **KLEBER NOEL**

Hi! Some of you may know me. I'm originally from England and I came to the Netherlands to study, and I have been living in Groningen for the last 8 months.

When asked to describe my experience so far and to write for the FMF newsletter I have no idea to begin; there is a lot to say. Maybe I can start painting the picture of my experience by appropiately starting two summers ago. The summer of 2013 was the summer that I finished my A-levels in England, I began September by doing a 'gap year'. Then, after a few months working, I planned to go travelling, the concept was to buy a bicycle and to cycle out of England. You see it's been a dream of mine to cycle out of England in summer, since I live in a small village close to the south coast it is really just one day to cycle to France. I planned that I might attempt to go to Spain; down the coast of France at the time. So I saved up and bought "Dawes Galaxy" for about £300, a classic English racing bicycle. I also casually decided to apply abroad due to the fact that I'd taken a liking to travel during my gap year. Studying abroad is also far cheaper than the price of tuition in England, at a ridiculous £9,000 per year. Among the other placed I looked at online when deciding abroad were Sweden, Denmark and the Netherlands. But by the time I had started looking, the only place left that I was able to apply for was a Mathematics program in Groningen, the Netherlands so I decided to apply.

FIGURE 1 Kleber Noel

It was time for my long awaited cycling adventure, so whilst awaiting reply from the university I left for Europe on my dawes galaxy touring bicycle, much to the horror of my parents who had noticed that I had only three google maps print outs on me along with a compass. My intention was either to: travel north, if I would received an email granting my entry to the university of Groningen, or to travel south if Groningen had declined me and cycle some more in France instead. Luckily, I was accepted, whilst in Belgium I found out this great news. Five long days after departure, and countless spinach fields later I finally arrived at Amsterdam. By this point, my tent was really falling apart, with broken poles and ripped fabric. I decided it might be a wise decision to take the train to Groningen, as I was also running out of time and money. After four or so days at "Vliegenbos camping, Amsterdam" I packed up my battered tent and made my way to Groningen. I stayed at Stadspark camping for inbetween 1-2 weeks.

So I arrived in August after a month after my first visit to stay and study. Somehow, I managed to get things for my room (mostly thanks to the miracle of searching "gratis" on marktplaats), but also due to the fact that I had made friendsduring KEI-week. Oh yes,

I remember that week; a great student experience. Not only did our KEI parents love us with all their drunken hearts, but they took us to countless bars around the city, making sure we had a drink in hand every night; KEI week is truly a great introduction to Groningen. The highlight of the week for me would probably have been diving into a mountain of foam outside a gay bar. For some reason at that point in time I was inclined to think that [foam density = water density] but I was never really a good physicist. My face met the concrete soon after I had realised I had been cheated by physics again. After KEI week I started attending class, and study really hit, almost as hard as the concrete floor at the gay bar; all of a sudden the easy experience of mindless summer partying and getting to know the city had turned into hard lectures, seminars and the expectation to use your brain. Fortunately, I had not killed all of my braincells during KEI week so after failing a few of my first exams I managed to pass the resits and get back on track passing all the courses of the first period. Into the second quarter of the year I made some closer friends some of which being: Dutch, English, Italian, Bulgarian and Lebanese…

"...mostly thanks to the miracle of searching 'gratis' on marktplaats"

I loved Christmas here too and, as with everything, it's actually a little different to England, in a few ways; the Sinterklaas boat, Zwarte Piet and marzipan being some of the differences I enjoyed! But there are still plenty of great celebrations and it is lots of fun to get to grips with new traditions. New years was spectacular! I think that the Dutch set off the same number of fireworks the English do in a year, but instead they do it in one day…. It was literally one of the most insane experiences I have ever had, gaving to duck away from miniature fireworks approaching me and my fourth bicycle. I have owned five bicycles since coming to Groningen of which only two survived.

Coming back down to earth, the thing that is likely to set my student life apart from yours, is that I do not yet have a government loan for living costs. I'll be honest, the last six months have been as close to poverty as I have ever been. With my parents being the only support, it is far from easy living elsewhere and asking your parents for money that they really cannot afford to give you. This has stressed me and really racked me with guilt at times. It was a quite stupid idealistic dream that I wanted to fulfill; to live and study in the Netherlands and I was really not financially fit to come. Amongst all the time I have spent here, I have had to deal with the repeated thought at the back of my mind; "Without a loan, I will have to go home and this will be all for nothing." This has probably been the worst aspect of studying in the Netherlands; my self inflicted suffering.

However, all is not doom and gloom! The future is bright! I found work at the end of February and it works great around my new study, ah yes, the bombshell has finally dropped; shortly after starting, I realised that mathematics is not the right subject for me and from reading a brief history of the last two years of my life I am sure you can agree; I am not a methodical person, nor am I patient, nor am I realistic. I am constantly distracted by my thoughts and I find myself battling with my mind in order to focus. Many of these attributes that belong to me negate the skill set of mathematicians and this is why mathematics has been a real struggle. I changed program at the end of January and I am enjoying my new study a great deal more. In no way am I saying that you should also drop mathematics and try something new, but doing something that really makes you happy is the key.

I understand that I have somewhat deviated from describing a "standard international experience" at the University of Groningen, but what can I say? The truth is that everyone's experience is unique, international, or Dutch and there are always great stories from University, this is just one of them. If you have a story you should also share it. •

talent&pro

Gezocht: bèta's in het bedrijfsleven

Via Talent&Pro krijg je de kans het beste uit jezelf te halen.

Wil jij jouw bèta-talent toepassen op vraagstukken in het bedrijfsleven? Dat is precies wat je in het actuariële traject bij Talent&Pro. Complexe berekeningen en analytisch vermogen zijn nodig bij vraagstukken als de woekerpolissen en het nieuwe pensioenakkoord.

Of wil jij liever werken op het snijvlak van bedrijfskunde en IT? Kun jij bruggen slaan tussen de gebruikers en programmeurs van informatiesystemen? In het business IT traject van Talent&Pro ga je onder andere aan de slag met grote data-analyses, procesoptimalisatie en automatisering.

Banken, verzekeraars en pensioenfondsen kunnen jouw hulp goed gebruiken. Via Talent&Pro doe je verschillende uitdagende opdrachten bij deze financiële instellingen. Bij Talent&Pro staat je persoonlijke ontwikkeling centraal: we bieden coaching en opleidingen zodat jij het beste uit jezelf kunt halen!

Opening the box of Schrödinger's cat

DOOR **ROEL TEMPELAAR**

A quick search on the internet reveals that the Austrian physicist Erwin Schrödinger spent a substantial part of the 1930's at Oxford University in the company of two women, and a cat named Milton. Whether he liked the cat or not remains obscure, but it is straightforward to associate Milton with the unfortunate animal that serves as the main actor in Erwin's gruesome thought experiment [1]. In this article, I will highlight the relevance of this experiment to the fields of organic electronics, and even molecular biology. In doing so, I will be touching upon the current research performed in various groups at the Zernike Institute of Advanced Materials.

The experiment that Erwin proposed is outlined as follows: inside a box is a Geiger counter, and a radioactive substance in such amount that the probability of a nuclear decay within an hour is exactly 50%. Upon registration of a decay, the counter tube will activate a hammer which happens to shatter a bottle containing hydrocyanic acid. Also in the box is a living cat (let's call him Milton), which does not interact with the aforementioned machinery, but will most certainly die upon a release of the poison. Considering this setup, Erwin may seem to be more of a dog person. However, rather than killing Milton, he designed this experiment to challenge the emerging Copenhagen interpretation of quantum mechanics.

"Schrödinger's Cat" illustrates a paradoxical situation that seems to inevitably follow from the quantum paradigm. The classical world is characterized by well-defined things like women, cats, hammers, and states such as dead or alive. However, in a quantum world here is a concept known as "superposition": the property of two states being simultaneously fulfilled. Although this concept is hard to appreciate from a classical point of view, experiments have demonstrated the validity of quantum superposition at very small scales. A famous example is the double-slit experiment, where the detection of an interference pattern showed that single electrons have traversed through both slits at the same time. As a generally accepted model for small scale phenomena, quantum superpositions should also apply to the radioactive atoms inside Schrödinger's box. This means that after one hour, the collection of atoms will be in a superposition of being decayed and being intact. Hence, the Geiger counter will be in a superposition of having registered a decay event, and having registered nothing, which in turn translates to the poison being both released and contained. As a result, Milton will be dead as well as alive. An additional complication arises due to the presumption that opening the box will make Milton "collapse" into a firm dead or alive state, complicating the verification of whether a superposition state indeed existed.

Schrödinger's proposed paradox arises when quantum phenomena are connected to large-scale classical objects, such as Milton. Classical objects are expected to be in classical states, yet quantum superpositions can apparently be projected onto them. It's been 80 years since Milton's partial death sentence was proposed, and throughout, this idea served as an inspiration for the further development of quantum mechanics. In this article, I will leave the paradox unresolved, and rather point out its relevance to the fields of organic electronics, and even molecular biology (which, compared to electrons and atoms, already forms a giant leap towards Milton).

Biology goes quantum

Although an introductory course may suffice to embrace the counterintuitive ideas of quantum mechan-

ics, it remains baffling to think of quantum concepts such as waveparticle duality, superposition and entanglement in relation to living creatures, not to mention Heisenberg's uncertainty principle. This is in part the power of Schrödinger's paradox; not only does it involve a macroscopic object, this object is alive (well, partly, at least). Still, over the last decades, indications have been found that quantum phenomena may indeed apply to biology. Perhaps the most striking example is the process underlying navigation of migratory birds. Similarly to what humans used to do before satellite routing, birds employ geomagnetism to find their way. However, instead of using a compass, they presumably are equipped with an intricate molecular switch located in their eyeballs, which works using an entangled pair of electrons that senses the Earth magnetic field lines. Ever since this process was suggested in the late 1970s [2], a scientific stream has emerged named "quantum biology", seeking to understand various biological phenomena based on quantum mechanics.

Very recently, signs were found that quantum effects plays an important role in photosynthesis. This particularly applies to various micro-organisms that have evolved to perform solar light harvesting under rather harsh conditions. For example, certain algae are living hundreds of meters below sea level, waiting for that single photon to make it through the heavily absorbing water layer. Once harvested, the photon is converted and stored as chemical energy, and a surprising high efficiency is reached in this process. One hypothesis claims that this efficiency is the result of quantum superposition states through which this photoconversion process is optimized [3].

The one-million-dollar question following from such quantum biological findings is: Can we employ the same effects in man-made devices? By the time of this writing, many research groups all over the world are seeking to address this, and the last discoveries prudently point towards a "positive" answer. The most important example applies to organic photovoltaics that form the prospected future alternatives for today's siliconbased solar cells. Several studies, including important contributions from Groningen [4], have indicated that quantum superposition helps to efficiently convert absorbed photon energy into a free electron, that can be collected as electric energy.

2D spectroscopy

All of the aforementioned quantum processes obviously take place in quantum's territory, that is, on the order of nanometers and femtoseconds. To unravel processes at these length and time scales, it takes state-of-the-art lasers embedded in an intricate setup of numerous mirrors, waveplates, and other optical components, to generate a sort of spectral technique that makes conventional absorption spectroscopy look prehistoric. The prime objective of such a setup is to generate a series of laser pulses, lasting no longer than

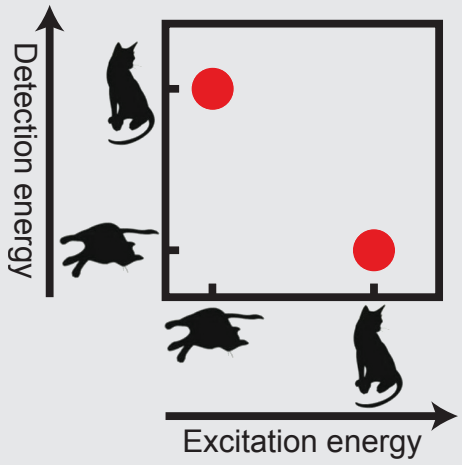


FIGURE 1 2D spectroscopy of Milton. A series of ultrashort laser pulses results in a two-dimensional spectrum of Milton, including an excitation and a detection energy axis. By looking at the "dead cat" excitation energy, and the "alive cat" detection energy, the quantum superposition between these states can be demonstrated (red circle). The same holds when the excitation and detection energies are shuffled.

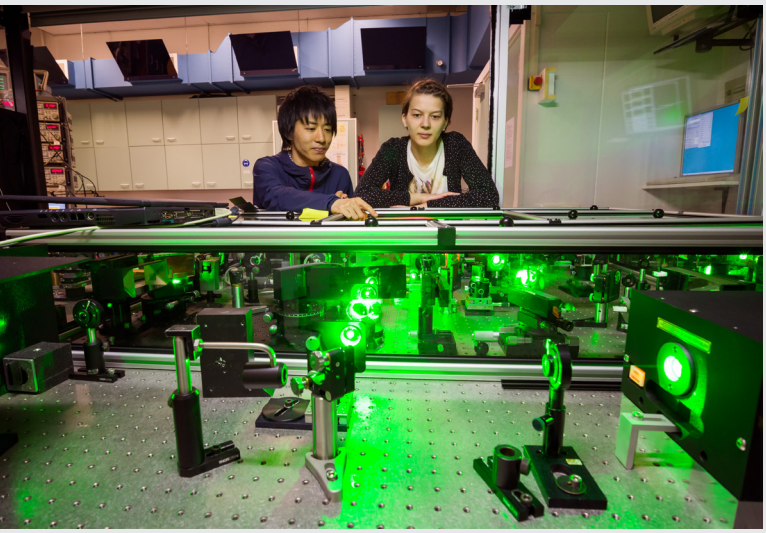


FIGURE 2 PhD student Evgeneyia Salamatova and postdoc Keisuke Shinokita from the "Optical Condensed Matter Science" group, accompanied by their optical setup. (Photo: Gerard Kingma)

1/100 of a picosecond each, and to send these pulses through a sample of light-harvesters or photovoltaic material. As a result of the pulses, the sample is first excited, and subsequently detected. The resulting signal can then be represented as a two-dimensional plot, hence the name 2D spectroscopy.

To be more specific, let's assume that the sample has two associated quantum states. Even better: Let's forget the light-harvesters and photovoltaic materials for a moment, and assume the sample consists of Milton the cat, which can be in an "alive" state ( ) and a "dead" state ( ). Finally, we also assume that these states have their own wellseparated energy levels to be measured using spectroscopy. Using the experimentally obtained 2D plot of Milton, the quantum superposition can be unraveled by studying the signal located at an excitation energy of and a detection energy of . (Vice versa also works.) As such, 2D spectroscopy allows us to peak inside the box designed for Schrödinger's experiment without making Milton to "collapse" into a classical dead or alive state. Moreover, by varying the time intervals between the ultrashort laser pulses, the dynamical evolution of Milton's superposition state can be followed.

Theory & Optics of Condensed Matter

At this point, it should be noted that so far, nobody has ever managed to put a cat in a 2D spectroscopy setup. Moreover, even with small-scale samples such as lightharvesters and organic molecules, there are plenty of issues to overcome. One of the most prominent issues is that the detected signals are usually difficult to interpret. Oftentimes, a proper clarification of 2D measurements takes a high level of theory in optics, quantum mechanics, and chemistry. This is of course not a bad thing: it is exactly what keeps yours truly in business. As a PhD student in the research group "Theory of Condensed Matter", I explore a variety of topics associated with optical techniques such as 2D spectroscopy.

Probably, by now you are all enthusiastic to jump into the exciting world of the nanometers and femtoseconds, and perhaps you are even interested to go 2D. If so, then it's good to know about the annual course on Nonlinear Spectroscopy, given by prof. Jasper Knoester. Furthermore, the Zernike Institute of Advanced Materials contains two research groups dealing with the topics discussed here. Besides the aforementioned "Theory" group, there is also the "Optical Condensed Matter Science" group, which hosts several optical labs, equipped with the state-of-the-art lasers, mirrors, and waveplates. Both the "Theory" and the "Optics" groups are always looking for talented bachelor's and master's students •

References

[1] E. Schrödinger, Naturwissenschaften, 1935, vol 23, pp 807
[2] K. Schulten, C.E. Swenberg, and A. Weller, Zeitschrift für Physikalische Chemie, 1978, vol 111, pp 1
[3] G. Scholes et al., Nature, 2011, vol 3, pp 763
[4] A. Bakulin et al., Science, 2012, vol 335, pp 1340

{kxa} De dataspecialisten

Software Innovations

KxA software innovations is gevestigd in de provincie Groningen. Het is een uniek bedrijf dat innovatieve, gekke, grote, kleine, spannende, mooie, maar natuurlijk ook normale maatwerk software-opdrachten uitvoert. De overeenkomst tussen al deze projecten is dat het gaat om data in alle vormen en maten, bijvoorbeeld:

- Het Nederlandse verkeer in 400 miljard metingen toegankelijk opslaan
- In een stal het gedrag van koeien monitoren
- Software ontwikkelen voor de gigantische SKA radiotelescoop

van BIG BANG tot

- Hulpverleners in de zorg ondersteunen met VCA

Werken bij KxA

Bij ons vind je allerlei achtergronden (natuurkunde, informatica, AI, etc). Iedereen deelt het enthousiasme voor softwaretechniek en wat je daar allemaal mee kunt doen.

We hebben regelmatig afstudeeropdrachten, stageplekken én vacatures. Je krijgt hierbij een opleidingstraject om je helemaal in ons vakgebied te bekwamen.

Ben jij geïnteresseerd in het werken bij een High Tech bedrijf? Kijk dan eens op **www.kxa.nl**, of neem contact met ons op via mulder@kxa.nl

From the commissioner of Internal Relations

BY **WALEWEIN NOORDAM**

The final semester has begun and people are already looking forward to the summer, although there's still a lot to come. The (in)famous FMF may-month is up and coming and the guy responsible for the activities will tell you about his experiences from past year, of course I'm talking about our commissioner of internal relations, Walewein Noordam.

I am Apolonius Walewein Noordam, but I go by the name Walewein, although a lot of friends of mine like to call me by a few nicknames, like Waldo or Wallo. I'm a third year student Applied Physics. I live in Groningen and try to do a bit of studying besides my board year.

I decided to do a board year because I felt I was lacking and thought that the board could be very beneficial for my personal development. I also hoped it could bring about some lost motivation. Now that I have travelled a big part of the road I can say for sure that it was a good decision to do something like this.

Previously, when people asked me about my hobbies, I wasn't sure how to answer, since I had a lot of time on my hands and I didn't do much with it. But now that free time is scarce, I'm realising what my hobbies are. I really like to listen to music, I'm always trying to find new artists, discovering unreleased tracks and I am constantly contemplating about making my own, yet I don't have the know-how. I'm also a fan of poetry, reading Matsuo Basho, one of the greatest Haiku writers, or Dante Alighieri, writer of 'La divina commedia', is one of my favourite pastimes. Fashion is also something I got more aware of in the past few months. I like to be a bit more conscious about my usual get-up.

Now you might have some idea of the things that engage me, but I still haven't told much about my function in the board. As commissioner of internal relations I'm responsible for almost all the activities the FMF organizes. Sometimes it can be a bit hectic, and activating and motivating committee members is still something that's not easy. I'm also responsible for all the promo we make. All those beautiful posters that create an escape with their activities from the sometimes boring lectures.

Sometimes I reminisce upon the past year and try to think of the good experiences I had. One of them is all the people I have met this year, every individual, unique and interesting in his way. The Active Members Dinner was a staple as well. It was my way of saying thanks to all the active members that support our association.

I hope the few words I have written have been insightful and maybe motivated you to think about your own choices. If you'd like to apply for the board next year, which I can recommend, or maybe you'd just like to have a chat with me and share some of your own interests, feel free to hit me up in the NSFW or email me at intern@fmf.nl •

FIGURE 1 Commissioner of Internal Relations

Thai Chicken Soup with Cocos

BY **WALEWEIN NOORDAM**

Accompanying our international edition is a traditional Thai chicken soup. The soup is an easy and quick introduction to the Thai kitchen. Enjoy!

I found this recipe a long time ago, when I was still in grammar school. Back then, I had to cook something oriental for my geography subject. That was the time I stumbled upon this recipe. The soup requires few ingredients and still is very tasty. Almost everything can be found at your local grocery store and the ingredients aren't even expensive. The soup is smooth and spicy at the same time. It's a unique taste that can't be found in the Dutch kitchen

Ingredients

- 400 ml coconut milk (canned)
- 550 ml chicken broth
- 2 red peppers, in strips
- 1 stalk of lemongrass (sereh), bottom 6 cm's chopped up finely
- 3 lemon leaves
- 4 tbsp fish sauce
- 2 tbsp lemon juice
- 1 tsp sugar
- 1 chicken breast filet (ca. 200 grams), in strips

Accessories

- 1 small pot
- 1 big pot
- 1 can opener
- 1 stove

Preparation

Pour the coconut milk into one pan on low fire and stir the milk in the same direction to avoid clotting.

Heat the chicken broth with 300 ml water, the red peppers, lemongrass and lemon leaves in a bigger pan.

Stir the warm coconut milk through your broth. Add the fish sauce, lemon juice and sugar. Now boil the whole and let it simmer on low fire for about 5 minutes. You can add some more seasoning right now.

Boil the soup again and add the chicken strips one by one to avoid the chicken sticking together. Let the soup and chicken boil for another 3-4 minutes and then the soup will be done.

FIGURE 1

Result!

Now you have made your very own Thai chicken soup. You could add some garnish or some bread, feel free to experiment.

Variationtips

If you'd like the soup to be somewhat heavier, or you'd want to add some more spices, I can recommend you add the following:

- 250 grams oyster mushrooms
- 4 cm ginger (fresh if possible)
- 5 cm laos

You can add the mushrooms and the herbs to the soup when the recipe says that you can add some extra seasoning

Or the following:

- 2 heaped tsp purreed galangal
- 4 finely sliced shiitake mushrooms
- 1 finely sliced small carrot
- 200 grams little shrimps
- fresh coriander leaves

You can add the ingredients to the soup when the recipe says that you can add some extra seasoning, except for the shrimps, you should add those just after you put the chicken in.

Winetip

- I'd recommend you don't drink any alcohol with this recipe, some milk or water will be just fine •

FIGURE 2 The ingredients

Difficulty:

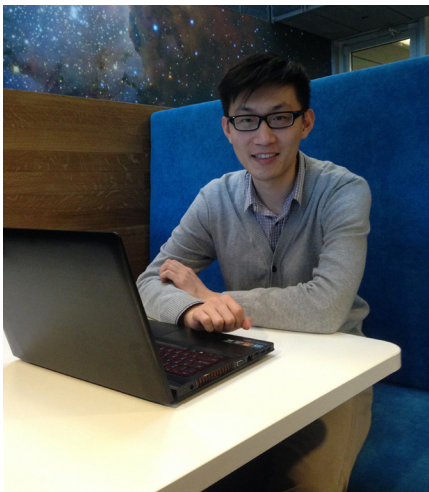
Persons: 2
Preparation time: +/- 30 min.

Feelings about studying in Groningen

BY **LIU XIAOMENG**

I started my master program study at the Faculty of Mathematics and Natural Science in September, 2014. This is the first time in my life that I study and live abroad. It is absolutely a great experience to me.

At the beginning, I was deeply attracted by the international atmosphere of the city and the university. People from all over the world all with different backgrounds and experiences gathered in this beautiful city for further exploration of this world. Despite the effort I took to study Dutch, the unfamiliar pronunciation made it difficult for me to get used to it. However, life in Groningen is much happier compared to the language itself. All of my neighbours and classmates are friendly and able to communicate in English fluently. The discomfort at the beginning disappeared soon. A nice tour of the Martini tower, a complicated guidance in the weirdly shaped Linnaeusborg, a heated discussion about the assignment and every kind greeting makes me feel even better than at home. The interesting courses were the highlight of my daily life. Every course was well organized and presented. Lecturers are eager to teach us this miraculous knowledge. They clearly explained not only the phenomena and theories, but also the prospective application. Strange looking equations could become reasonable, owing to the rigorous calculation. Besides, newly discovered results or methods developed in June 2014 would appear as examples during the courses in October. I also appreciate their patient replies to our questions during and after class. As one of the top 100 universities, the University of Groningen provides us with corresponding advanced facilities and equipment. I really appreciate the great convenience brought by the network system of our university. Well, actually the European college network. As long as I am a student of any European college, I could get access to internet via the wifi of any university, and that is really awesome. By utilizing the online workstation, we can use a variety of statistics, drawing and office software, without installing the software on our computer. Also, with the amazing amount of computers in every building, and the synchronized data of personal accounts, it is possible to work on a computer anytime and anywhere in this university, without the need for an USB drive. These practical functions seem to be normal and simple, but indeed impressed me a lot. In addition to the outstanding operational capability of those computers, tasks in demand of using computers could become easy and flexible. Apart from that, the frontier instruments and devices exhibited during our experiment course, as well as the tidy and rigorous environment of the laboratory, leaves me an excellent impression. Every time I pass by the ground floor of 5113 in the Physics-Chemistry building, the glimpse of these advanced instruments always stimulates my motivation for doing scientific research. Except for those good parts, there are also some funny times. Before I came here, I have already heard somethings about the Netherlands, for example, the rain. After being here for several months, I finally understand why my friend said that one third of the time is under-water-chaos-time. The rains are not like back home, which feel like someone is pouring water on the top of your head (which is even more annoying, because without an umbrella or a rain coat, it looks like you just washed yourself), but like tiny rain drops floating in the air, and they are always there. Now that I have been here for half a year, I would say I like it here really a lot. And last but not least, thanks to all my good friends, I am pretty lucky to have you all •



Life is not only about X and Y, AIESEC will show you why!

BY **YAN KUO**

As a pharmacy student, my ultimate goal would be helping other people with the knowledge and skills I acquired during my studies. That's why I attend the seemingly never-ending lectures, sometimes-useful tutor groups and lab practicals throughout the year. However, joining AIESEC a year ago completely changed my view on what I can do to help others!

I realized that the world is way bigger than the lecture halls and laboratories and that there are many great opportunities abroad! AIESEC is the largest international student organization in the world, which facilitates voluntary projects as well as professional internships abroad. AIESEC provides students with a roadmap and compass to volunteer for a wide range of projects and offers support in finding a professional internship at a foreign company (e.g. Electronic Arts (game tester), Microsoft (technical support), Huawei (Engineer)). Wherever you go, you will be accompanied by other international students and get to know more about them, their culture and experiences!

After doing an amazing voluntary project in China, I decided to opt for a second AIESEC project in the summer of 2014! I applied for an English teaching project in Taiwan. Two of my friends who went to Taiwan before told me they could imagine living there for a long time, because it's such a wonderful country. They could not have been more right! Taiwan is one of the safest and warm-hearted countries I have been to. It's the pinnacle of both worlds, the best of East meets West - all can be found on an island that is a bit smaller than Holland.

The name of the project in Taiwan was 'Dream School Project', for which I had to facilitate a summer camp for high school students in Taipei. It all started when I arrived at Taoyuan Airport: two Taiwanese AIESEC members with a big blue and white AIESEC banner in their hands asked me if I was Yan from Holland. I was glad they recognised me, because I had no idea who would pick me up at the airport! In the first week, the AIESEC volunteers from various countries such as Mexico, Singapore, Canada, Malaysia and Brazil were flying in for a get-together and general introduction. After that it was time for our project: as a team of foreign volunteers and local Taiwanese AIESEC'ers we conducted a summer camp at one of the universities in Taipei three times! Each time there were more than 150 students attending. Our responsibility was to engage them in an English learning environment, teach them about our countries and cultures, doing live performances and much more. In the end I learned a lot from the other AIESEC'ers, the Dream School Project and the local people in Taiwan. A special mention to my Taiwanese host family where I stayed for 2 months; they took great care of me and I want to especially thank them hereby!

What can I say?! It was a heck of an experience! Currently, I am even searching for a professional internship abroad! I can recommend everybody to start exploring the world and to go abroad with AIESEC! •

Are you interested in going abroad? Create a free account and browse for internships at our website internships.aiesec.org or visit our information desk at the first floor of the University Library (Tuesday and Thursday 15:00-17:00)!

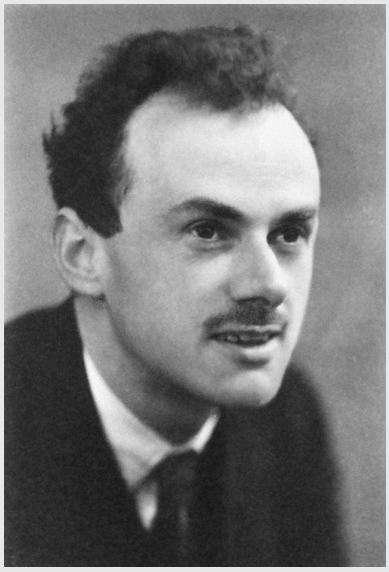
Previous Breinwerk

Spreekwoordenpuzzel

BY **THE EDITORS**

There were no submissions for the previous Breinwerk. Therefore we cannot declare a winner and thus nobody wins the quote of Dirac. We as editors are therefore disappointed that we did not succeed in bringing the students for technical and social studies closer together. For those who are interested in the story of Nobbie, below is a version which is readable for natural science students •

"In science one tries to tell people, in such a way as to be understood by everyone, something that no one ever knew before. But in poetry, it's the exact opposite."



Een dag uit het leven van Nobbie

He, he, ***oost west, thuis best,*** dacht Nobbie toen hij vanuit het ***hondenweer*** naar binnen stapte. Buiten ***regende het pijpenstelen*** en daardoor was Nobbie nu zeiknat. Nobbie was ***van een koude kermis thuisgekomen***. Vanochtend was hij ***vroeg uit de veren gekomen*** om zijn vriendin te verrassen met een weekendje weg. Ze zouden samen als ***tortelduifjes*** naar Parijs, ***de stad van de liefde*** gaan. Ware het niet dat Nobbie toen hij bijna bij haar was, hij ***gedumpt werd***, en dat per sms! Dus toen zat Nobbie helemaal ***in zak en as***.

Toen pakte Nobbie willekeurig een bus en ging ***als een kip zonder kop*** reizen. Een aantal uur later en verschillende bussen verder begon Nobbie ***honger als een paard*** te krijgen. Dus stapte Nobbie uit in het eerst volgende stadje om daar zijn ***tranenbrood*** te eten. Bij het eten vroeg Nobbie om een borrel, waarop de ober vroeg: "Weet u zeker, dat u nu al alcohol wilt drinken? ***Er verdrinken tenslotte meer mensen in het glas dan in de zee.***" Maar Nobbie zei: "Mijn ***hart is gebroken*** dus heb ik iets nodig wat ***de pijn kan verzachten.***" De ober keek met medelijden naar Nobbie en gaf hem zijn eten met een borrel. Toen Nobbie zijn eten op had, kwam hij erachter dat hij ***ver van huis was geraakt***, maar nog erger, hij ***zat op zwart zaad***. Dus nam Nobbie ***de benenwagen*** en liep naar huis. Na ***enkele ogenblikken*** begon het toen te regenen en Nobbie was natuurlijk ***onbeslagen ten ijs gekomen***, dus moest Nobbie de regen zien te trotseren.

En ja hoor, alle ***goede dingen komen langzaam***, dus al duurde het lang uiteindelijk kwam Nobbie thuis. Eenmaal thuis gekomen nam Nobbie nog een ***slaapmutsje*** en ging daarna slapen. De volgende dag ***ging het leven gewoon door*** en dus moest Nobbie ook weer ***aan de bak***. Op zijn werk kwam Nobbie toen een beeldschone stagiaire tegen die hij de hele dag moest gaan begeleiden, ***eind goed al goed***.

New Breinwerk

Translation puzzle

BY **THE EDITORS**

Martine has plans for studying abroad and when she wrote an article for the Perio*diek something went wrong. She forgot which language she needed to speak and she thus has written a text in all sorts of different languages. The problem is that we don't know which piece is in which language. We therefore request your help in translating the text below. To aid you, you can find this periodiek online at perio.fmf.nl/breinwerk2015-2.pdf. You can send your solution before the 8th of May to perio@fmf.nl. Among the correct solutions we will raffle a traveling bag, to aid you in your international travels •

The problem

Le Chuo Kikuu cha Jimbo etibarən Groningen ter para planificar naredne godine un emplacement in Północne Chiny On the ugu olusempumalanga te maak. Para ser precisos, en ville Yantai Na wakazi milioni 6.5. A la derecha aquí parece 'n ongebruikte kampus olmaq nrog qhov chaw rau kwv yees li 10,000 tus menyuam kawm ntawv. Ils vont współpraca z Kina Agricultural University In Beijing.

Lakin, bu deyil die bedoeling om a Kineski univerziteta alkaen tehdä. De RuG yuav tsum profesores internacionales para asumir et minimiser chinois. Kwa kifupi, itakuwa chuo kikuu kimataifa. RuG kontinental Avropada ilk universitet olacaq imkan verir wat 'n sogenaamde 'branch campus' open in China. Ya existen tales asociaciones à l'étranger. mieć to New York University amagatsha e Shanghai et le yliopisto Nottingham yksi sisään Ningbo (ook in China).

Xroninqen kampus Inahitaji toleo ndogo Groningen en Chine vont être. The RuG stoga će ook die kurrikulum gaan bepaal uas ces kuj los ntawm Suav Ministry təsdiq edilməlidir. Kiedy to było do tej pory, lokhu kungaba inqwaba amabala na wymianę studentów musi wytwarzać.

Tej zaum koj yuav xav li cas tag nrho cov no yuav raug nqi. Ne améliorerait pas la RUG el dinero en Groningen xərcləyə bilər; w poprawie educación noma ekuthuthukiseni uphenyo. En hér er Háskólinn í Groningen varmaan ajatteli. Navidezno a University of Groningen sowieso nem rent ekhokhwayo, parce que les Chinois font. Indien jy meer wil lees e pā ana ki te kaupapa o te Whare Wānanga o Groningen i China, možete pročitati dalje, a de Ukrant.

Schut Geometrische Meettechniek is een internationale organisatie met vijf vestigingen in Europa en de hoofdvestiging in Groningen. Het bedrijf is ISO 9001 gecertificeerd en gespecialiseerd in de ontwikkeling, productie en verkoop van precisie meetinstrumenten en -systemen.

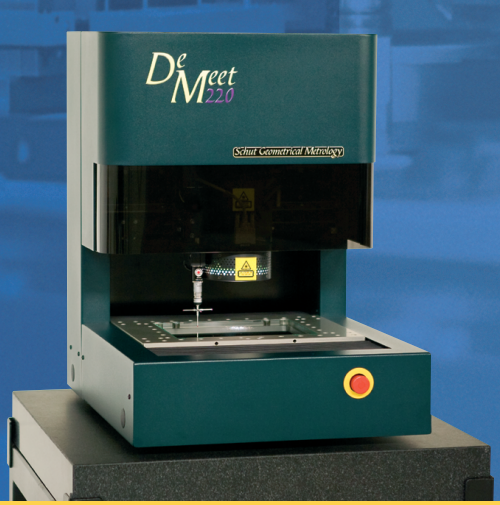
Aangezien we onze activiteiten uitbreiden, zijn we continu op zoek naar enthousiaste medewerkers om ons team te versterken. Als jij wilt werken in een bedrijf dat mensen met ideeën en initiatief waardeert, dan is Schut Geometrische Meettechniek de plaats. De bedrijfsstructuur is overzichtelijk en de sfeer is informeel met een “no nonsense” karakter.

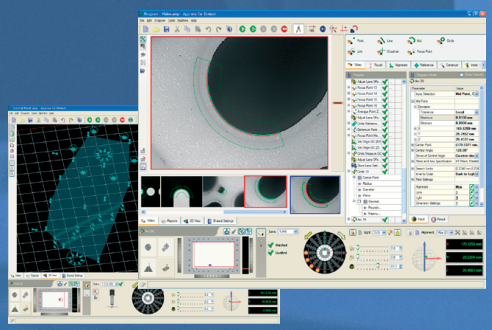
Op onze afdelingen voor de technische verkoop, software support en ontwikkeling van onze 3D meetmachines werken mensen met een academische achtergrond. Hierbij gaat het om functies zoals ***Sales Engineer***, ***Software Support Engineer***, ***Software Developer (C++)***, ***Electronics Developer*** en ***Mechanical Engineer***.

Er zijn bij ons ook mogelijkheden voor een technisch interessant **stage-** of **afstudeerproject**. Dit kan in overleg met de docent worden afgestemd.

Open sollicitaties zijn ook zeer welkom. Voor echt talent is altijd ruimte.

Voor meer informatie kijk op **www.Schut.com** en **Vacatures.Schut.com**, of stuur een e-mail naar **Sollicitatie@Schut.com**.





APPROVE for DeMeet