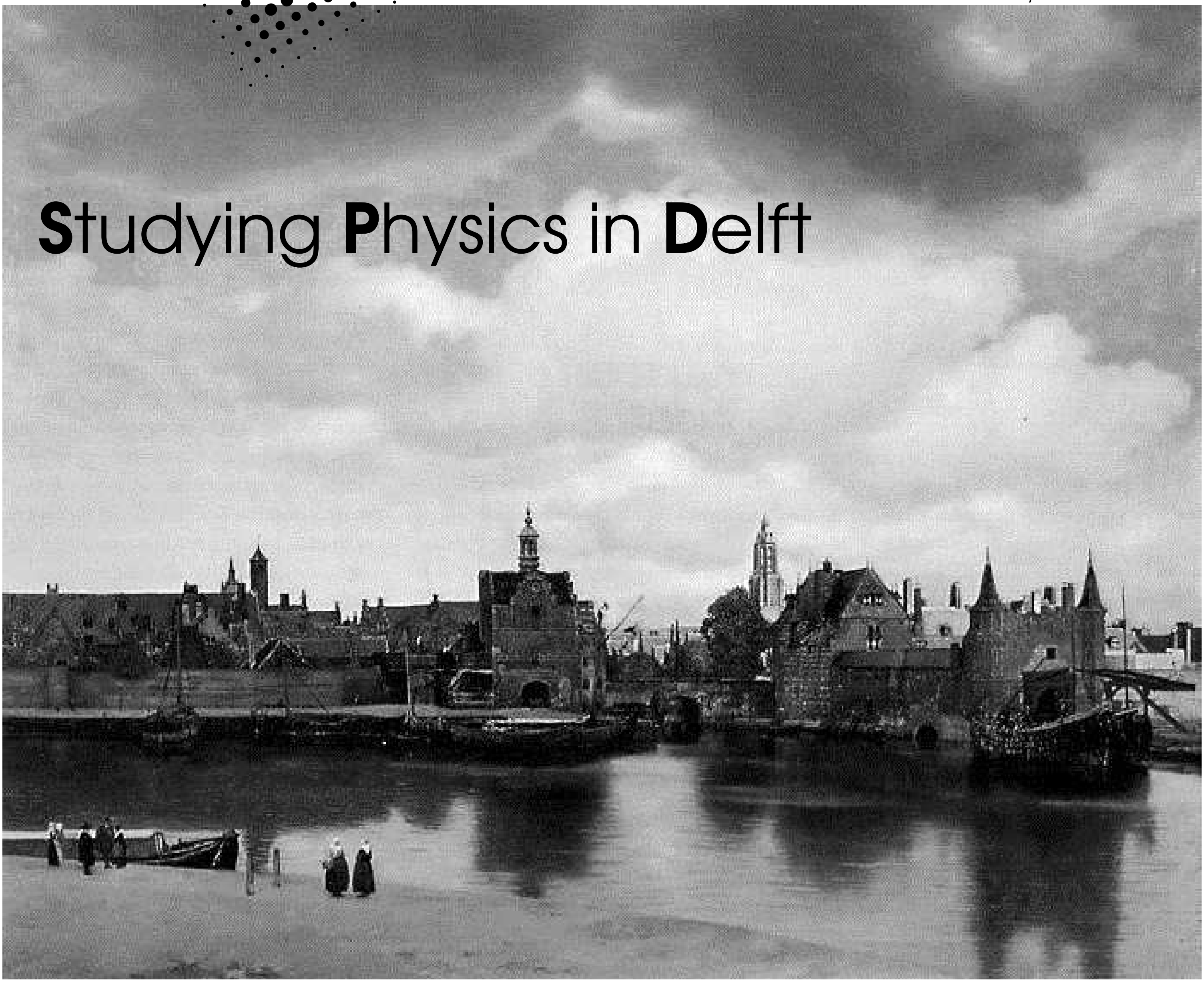
JiAPS

The Journal of the international Association of Physics Students

The New JiAPS. Issue 3, Summer 1997

Studying Physics in Delft



Jan Vermeer's "View of Delft" (1660-61)

Central Office Report

Quantum Dots

IAPS Alumni

Summary

Credits

JiAPS is the Journal of IAPS
(the International Association of Physics Students)

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<http://glyphs.com/art/vermeer/delft.jpeg>
Back Cover Picture:
Crest of the University of Granada

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The Editor Speaks

This is the last issue of the year. It is also, in all likelyhood, the last issue I will be editing, although it is by no means the last time I will contribute to the Journal. This is a good moment to look back on a year's work, and I experience mixed feelings: of satisfaction for the accomplishments and regret for the little failures along the way, of relief for the gained freedom (it takes a lot of time to edit a journal) and longing for an exciting work.

The contents of this third issue of JiAPS are more varied than those of previous ones. We have another article on student life -this time in Delft, Holland, by Olav Frijns- and one article about Physics (more precisely, quantum dots) by Jorg Janssen, which I hope will start a trend. I have had to write less pages myself that in issue 1, and from it all one would get the impression that the journal is receiving more contributions than it used to. However, this is not so. I must say that the process of 'extracting' the contributions has been painstaking, and if the issue will add to the ICPS activities it is not by design, but because I failed to produce the issue in June as planned. This and other problems need to be tackled quickly and with decision, and I'm sure the General Meeting will do their best to find solutions.

On the other hand, JiAPS had never before been printed on paper for so long, and it had never been read by so many people as it has this year. The reactions from the readers have been very positive, and the Journal has attracted the interest of the Physics community outside IAPS proper (see, for instance the article about EUPEN in this issue). The postscript files for JiAPS can now be downloaded from the internet (check <http://www.nikhef.nl/pub/iaps/jindex.html>). The credit goes to Kjetil Kjernsmo for getting us some disk space in a Norwegian ftp server. I think JiAPS is on the right track and in the future we should continue along the same lines. JiAPS is a valuable resource of IAPS, and it can play a very important promotional role as it is clearly 'something we do' apart from the ICPS.

In this issue you will find, apart from the articles I have mentioned already, the Central Office Report by the President and Secretary; an article by Dwight Neuenschwander of SPS about a pressing concern, namely the lack of communication between the Physics community and society and its consequences, and a piece of news from Norway in case you thought: *«it can't happen to me»*; and an article about the IAPS Alumni from Bent, our Past-Past-President. The problems section, which was proposed at the last ICPS, can't seem to catch the interest of the readers. Maybe it is too soon, but ideally I shouldn't need to publish my solutions, or even my own problems: the contributions of the readers are essential! One funny detail about the cover is that 'two out of three JiAPS covers are works by Dutch painters'

I wouldn't want to finish this introduction without thanking the Faculty of Sciences at the University of Granada for their support (monetary and otherwise) in the production and distribution of these three issues of JiAPS. Their help was not properly aknowledged in issues 1 and 2, and I am entirely to blame for that omission. Without their support it would have been very difficult to make JiAPS reach the readers.

Read and Enjoy,

Miguel Carrión
JiAPS Editor

The hidden meaning of an ICPS

Central Office Report

by Oscar Pleguezuelos-García, President,
and Daniel Aguirre-Molina, Secretary

The ICPS is coming!... but these words will surely mean different things depending on the observer (you know, relativistic matters). If you're not an inertial observer, the ICPS will have no special meaning for you but... if you are going to Vienna, just those 4 letters will surely make some feelings come to your mind and, probably, you'll belong to one of the following groups:

No Lecture Participant: For you, the ICPS means the chance to meet old friends and/or make new ones, sightseeing in one of the most beautiful cities in Europe (excluding Granada, of course), drink beer (it's a real shame that there's no cheap Palinka in Vienna), and if you're lucky, see a Kangaroo?... NO, in Austria there're no Kangaroos (a joke for the Austrians).

Lecture Participant: In this case you will surely have the same feelings as in the previous case, plus the chance to present your work to an audience of over 100 physicists coming from more than 20 countries.

Organiser: I'm sure that in this case your feelings will be divided. On the one hand, it's the chance to show the World how hard you've been working for a whole year but, on the other hand, the ICPS will mean a terrible week full of last-minute problems, beginning with participants that don't arrive on time, and delays at the airport.

Afternoon-Evening Participant: In this case, the ICPS means the chance of drinking beer or any other local drink (i.e., Palinka during last ICPS in Szeged) in an foreign country for a whole week. This kind of participant usually just attends lectures in the afternoon, (and usually he/she doesn't even go to have breakfast).

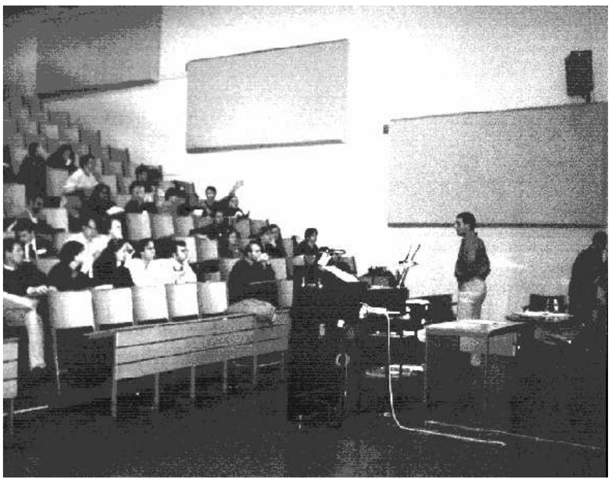
But an ICPS is much more than a week full of lectures of participants, a handful of parties and a beautiful city to be visited. There's also one meeting where all member of IAPS have the chance to listen the reports of the IAPS Executive Committee and member committees, and take part in the planning of new strategies for the future development of IAPS. We call it the 'The General Meeting'.

There, this Central Office and the rest of the Executive Committee will present their reports to the rest of members of IAPS, and a new IAPS Executive Committee will be elected. But, ... what has this Central Office been doing during this year?

It's nearly a year since the moment we took from Ramon, Olav and Jorg the responsibility of keeping in touch with physics students from all around the world. Once the bureaucratic work was under control, and the incoming e-mail mailbox wasn't longer than the list of people passing the Mechanics September exam, we focused our efforts on making IAPS a better known organisation.

A first presentation of IAPS was made in September at the MOSAIC Meeting in Bergen (Norway), where students from over 25 universities were represented (I forgot to tell you that MOSAIC means Meeting of the Students Aiming the Integration of the Coimbra Group, and represents all the students of the European Universities that belongs to the Coimbra Group).

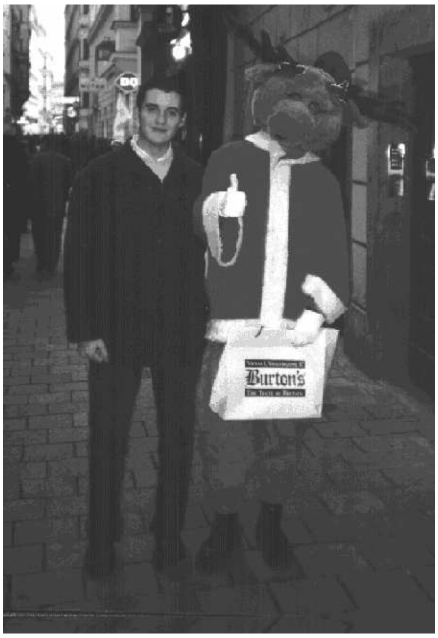
Nevertheless, that was just a rehearshal of the next step: representing IAPS at the United Nations World Youth Forum (UNWYF). As you know, the UNWYF took place last November in Vienna, and it gave us the chance to make IAPS better-known to the United Nations System (not only to the Youth Unit!) and spread our brochures



Presentation of IAPS at the Mosaic Meeting in Bergen

over the 5 continents; (Remember that over 400 participants attended the UNWYF, representing more than 200 different organisations). Of course, we have kept the contact with the UN system, and with people from other organisations represented at the forum.

Weeks were passing by, and we tried to keep some rates under control: no more than 72 hours to reply e-mail messages, and daily answer for the urgent or important ones. Besides, we also worked on the Web page (our presentation card for the world) to make it as good as possible.



Shopping in Vienna during the UNWYF

In February we went to Ghent (Belgium) with a double purpose: take part at the Erasmus Students Network Annual General Meeting (ESN-AGM'97), and establish the co-operation between IAPS and EUPEN. As you know, Ghent is the site of the EUPEN (European Physics Educational Network) Secretariat. We had some meetings with Mr. Hendrik Ferdinande (EUPEN Chair), and one month later we had the acceptance of EUPEN to include IAPS in their organisation as a co-partner (don't forget that EUPEN is composed by 107 European Universities).

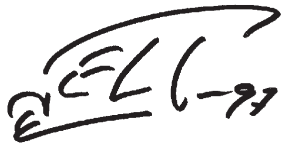
Meanwhile, through Ed Neuenschwander, our contact on the States, the IAPS magazine (the well-known JiAPS), was widely spread: Ed published, under permission of authors, some articles of JiAPS 1 & 2 in a couple of issues of the SPS Newsletter, and this means that probably more Americans than Europeans got to read those articles; Thanks Ed!.

At the same time, IAPS was growing day by day. More than 20 e-mails were received daily, and at least a couple of students each week were interested in joining IAPS. Most of them asked us for the application form, and those who finally decided to fill it and send it back to the Central Office doubled the number of individual members. In addition, we now have a new National Committee in Portugal and a new Local Committee in Caracas (Venezuela).

Working as a contact between physics students, our work has been extremely varied: from trying to find out something about the physics of playing a piano, to getting EMSPS students in touch with other physics students at their host university.

Certainly there're so many things we haven't done, and many others we could have done differently, but on the whole we have a very good impression of the past year: IAPS presence at international forums has been greatly increased, relationships with the European Physical Society have been established, and we also have new members from different new places and the number of members has also increased; besides, the Web page has been periodically updated, and 3 JiAPS have been edited (with big efforts from our editor, that can't be better, Miguel; Thanks indeed, Miguel!!).

But time goes by, and when results start growing it's time to pass the responsibility to a new Central Office. We're sure that the new elected President, Secretary and Treasurer, and the other members of the Executive Committee will do their best to keep in touch with physics students from each corner of this world that is getting smaller day by day.



Studying Physics in Delft

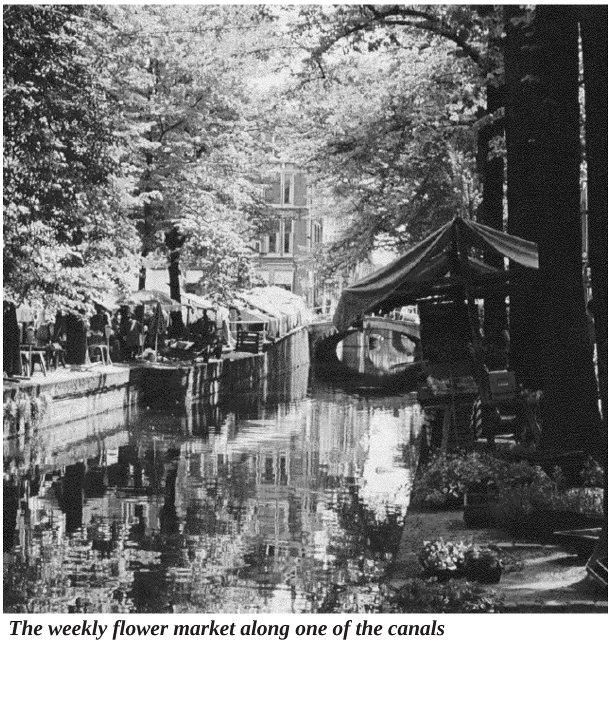
by Olav Frijns, 5th year student in Applied Physics at the Delft University of Technology

Last night I was cycling from my student club back home in a slightly intoxicated mood. I cycled along the beautiful Old Delft canal towards the leaning tower of the Old Church which bathed in its illumination, standing as a guardian of the most beautiful canal in Holland. I asked myself, why did I go to Delft to study physics?

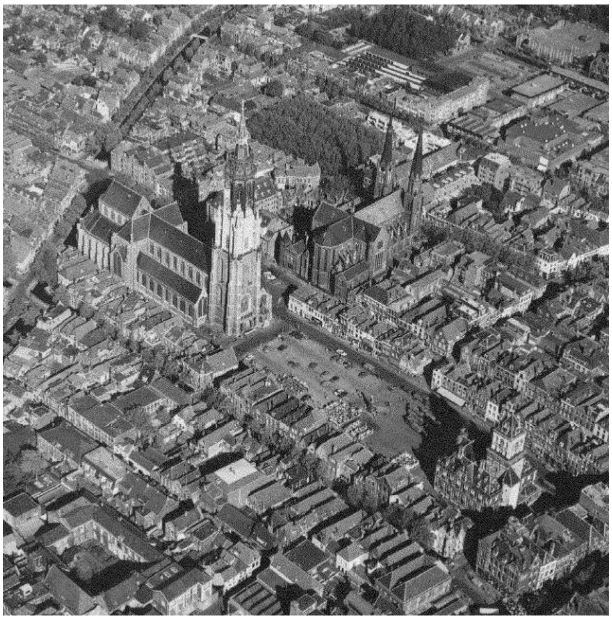
Looking at the canal, part of the extensive system to keep Holland dry (normally there should be water several meters above our heads), I thought about the really marvellous technical achievement this had been in the Middle Ages. Technique has always kept me busy and it was one of the reasons to go to Delft. Delft is not an ordinary university but a *technical* university. Started as a school of Civil Engineering, it is now an outstanding technical university combining disciplines like Mechanical Engineering, Aircraft Engineering, and Civil Engineering --well known for the famous construction of dikes and flood barriers and polders-- with more basic sciences as Electrical Engineering, Mathematics and of course Physics. The Physics department of Delft is often called 'Technical' or 'Applied' Physics to distinguish it from the Physics department at the general University in Leiden. This term is a bit misleading as the courses are almost the same. Here in Delft we also study quantum mechanics and theory of the solid state. The difference is only a matter of emphasis. The research and education in Delft is more focused towards applying Physics in industry, while investigating pure fundamental physics as in the 'normal' university. This extra technical aspect in the Delft programme gives its graduates the extra title of Engineer.

The Physics Building at TU-Delft

Let me tell you something about the course. It is a five year course. The first year is a bit introductory with mathematics and some basic physics and leads to the 'Propedeuse' exam, a piece of paper which is supposed to show you are able to finish the study some time. Some students get it in one year, some take 4 years to get theirs. Half of the students never make it to their 'P', as it is abbreviated in Delft, and leave the University. This is probably the price we pay for not having any entrance exams. The four years after that consist of a basic program (D1) of two years in which you get some basic subjects like solid state physics, theory of waves, transport phenomena, electronics and quantum mechanics. The subjects are called 'vakken' in Delft slang. A 'vak' can be best translated as a 'craft' (like shoe repairing). It reveals a bit of the technical background of Delft and the great abundance of other future engineers, like bicycle repairmen (mechanical engineers) and concrete farmers (civil engineers). The final 2 years are reserved for the D2, in which you can choose the subjects yourself. These are usually the more specialised and advanced courses, which can be relevant for the final part of the programme: the graduation project in one of the research groups. During this graduation project you participate for one year or so in the actual research done at the University, leading to a graduation thesis about your own project. This is usually very time-consuming as you are supposed to work on it full-time for a year. The experience you get in working in a team on an actual project is very valuable though, but sometimes I get the feeling that after the studies we are



The weekly flower market along one of the canals all very good experimenters and researchers with already some experience under our belts, but our knowledge of Physics is perhaps a bit limited. Because Delft is the largest Physics Department in Holland (600 students) there is a vast choice of research groups to do the graduation project in. Almost every field is covered by a group. We have transport phenomena, optics, acoustics, solid state physics with quantum transport and nanophysics, pattern recognition, computational physics, radiation physics and even reactor physics as we have our own experimental nuclear reactor. The large range of possible fields of graduation was one of the main reasons for me to choose Delft.



A bird's-eye view of Delft

But let's go back in my cycling tour. When I was bending around the tower, almost running over a local inhabitant and killing a duck, I had to pedal so hard to get through the force-9 gale that I almost bumped on a friend. This is the really good part of Delft, the social factor. Delft is small; 20% of the population can be considered a student, which means that you bump into each other quite often. The supermarket around 6 o'clock is one big meeting place and if you cycle across the centre you're sure to meet at least two or three friends, and certainly during the summer. Some of them may even be relaxing in their small rubber boat in the canal, drinking a cold beer.

The reason that so many students are living is Delft is simple. First, it is a great city to live in; second, most students in Delft come from quite a distance away (for Dutch standards 100 km is far away) so they can't stay with their parents. Thus they rent a room in one of the student houses. These can be huge concrete flats or old houses along the canals. These houses are great places to stay, as there is always something going on, ranging from weird parties to simply sitting on the couch watching television. Especially during exam periods people are very creative in not having to study. As a result many students prefer the library to study to pass some exams, but I guess this is not very different in other cities.

That fact that I met my friend reminded me of something else quite special about Delft, or rather about Dutch university life: the existence of large student associations or clubs, which is a difficult phenomenon to translate. Delft has four big clubs and another dozen smaller ones ranging from the very traditional old-fashioned, which resemble Oxford fraternities, to the most absurd anarchists who don't feel bad about having a topless service behind the bar. The two big ones each have about 2000 members, which makes them very influential in Delft student life. Actually, most of the fun in Delft is happening within the walls of their respective buildings, in the case of my club an old monastery. This has the disadvantage that there is not much social life outside the clubs, as in bars and discos, but within the clubs things are happening which would otherwise not be possible on that scale. It is more than just a place to drink a cheap beer. The clubs are centres of fun, parties, culture, debating, singing and also sport. The large clubs have their own sport clubs, which sometimes tend to get a bit too social to win matches. I would like to tell you more about it but that's outside the scope of this article, perhaps in a later edition of Jiaps. If you get the chance to visit Delft in the third week of August or sometime around that date, you'll witness the OWEE, the introduction week for the freshmen. This is the only week all the clubs open their gates and organise a lot of activities for everyone. The streets will be teeming with students. Bands will be playing in every club and there will also be traditional activities like the beer line and the canoe beer race through the Old Delft, the canal along which four clubs are located.

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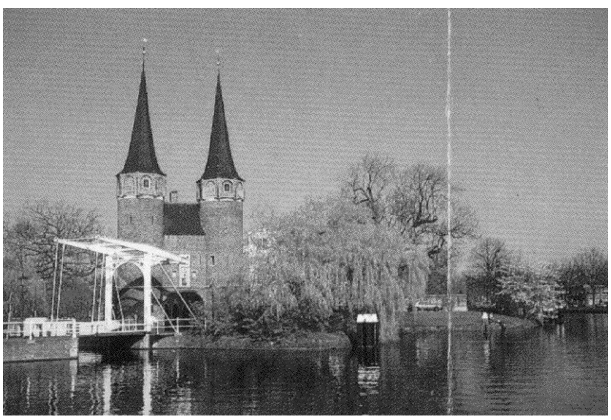

The Eastern Town Gate

Editor's Note: This article is adapted from a speech delivered at Arizona State University (Tempe, Arizona, USA), at the Zone 16 meeting of the Society of Physics Students held on April 12, 1997.

Hobbits, Wizards, and Physicists

by Dwight E. Neuenschwander
Director, Society of Physics Students

This article points out three disturbing trends: declining public support for research, rise in pseudosciences, and (in some nations) declining numbers of Physics majors in university. It suggests that the culture of Physics itself is partly to blame, then suggests two responses: "Hit the Road!" and "Know Who Your Friends Are!". The main point is that the newest generation of physicists ---such as current ICPS members--- will be the Physics establishment in a few years, and are thus poised to change the culture of the Physics establishment when they're in charge of it a few years hence.

In *The Fellowship of the Ring,* the first volume of J.R.R. Tolkien's trilogy *The Lord of the Rings,* many years after Bilbo's return from the Lonely Mountain the hobbits detect unsettling signals that all is not well in the Wide World outside their beloved Shire:

> There were rumours of strange things happening in the world outside; and as Gandalf had not at that time appeared or sent any message for several years, Frodo gathered all the news he could...
>
> There were dwarves on the road in unusual numbers... They were the hobbit's chief source of news from the distant parts- if they wanted any; as a rule dwarves said little and hobbits asked no more. But now Frodo often met strange dwarves of far countries, seeking refuge in the West. They were troubled, and some spoke in whispers of the Enemy and of the Land of Mordor...
>
> The Dark Tower had been rebuilt, it was said...Orcs were multiplying again in the mountains...

Hobbits were a jolly, diminutive folk who preferred a good meal and a good pipe over adventures. There is a bit of the hobbit in we physicists: like those provincial inhabitants of the Shire, we wish to work uninterrupted by the troubles of the Wide World. But there is a bit of the wizard in us too: like Gandalf, we are among the first to sense trouble in the world, and can produce the fireworks to meet it.

Like the hobbits hearing rumours from Middle-earth, physicists have noticed some unsettling movements- not Dark Towers or goblins, but something more slippery to confront: indifference to physics that runs wide and deep in society. This indifference manifests itself in three signs:

1. Declining public investment in research;
2. Popularity of the pseudosciences;
3. In some countries, declining number of physics students.

I suggest that the physics community may partly be the author of these woes because of a

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It's mainly because of the clubs and the technical nature of the University that Delft has such a typical culture. It can be best characterised by the standard Delft student: the Delfterik (as he's called in Dutch). He --the average student is usually male-- is blunt, very blunt, very direct and honest, like a piece of concrete. This is probably caused by the total lack of women in Delft. He is very uncomplicated and always has some simple solution. Diplomacy was not invented in Delft, large concrete flood barriers were. The Delfterik is said to be a sexist brute. The truth is otherwise, but a group of students from Delft always show off because of their behaviour (shouting even harder than a normal group of Dutch would) and their typical slang, which might be considered inappropriate among normal people.

The two major setbacks of Delft, namely lack of women and a boring town nightlife outside the clubs, are easily overcome if you consider Delft as being part of the Randstad, the concentration of cities in the west of Holland. Going to Amsterdam takes only three quarters of an hour by train, just as far as from Paris north to south, and trains run the whole night. Besides that, the minister has given us a card which allows free public transport in the whole of Holland, train, bus and metro.

There's enough to do in beautiful Holland. With the friend I met I discussed the possibility to go sailing for a weekend. Holland has beautiful lakes and wind is always available. The beach is also very near and you shouldn't be surprised to see students sitting on the beach of Scheveningen pretending to study for their August exams.

I hope I've given you an idea about studying in Delft. Of course you're always welcome to visit Delft to see it with your own eyes, as a guest student or just passing by. Who knows, when will we meet again?

professional culture grown too provincial. The newest generation of physicists -today's students, such as ICPS and SPS members- are poised to do something about it, because you will be the physics establishment in a few years.

1. Cuts in Research Funding

Consider cuts in government funding for research. We say: How can the Ministry or the Congress, how can the public fail to realize the greatness of our work, and the smallness, by percentage, of its demand on the national budget? Criticizing policy makers may be justified, but should not every sentence of criticism be accompanied by another of reflection?

For instance: we know that one cannot purchase a dye laser on a professor's salary. Yet some professors have also told me they will not drive their students 60 km to a professional meeting where their students could present papers, unless the trip is funded with somebody else's money. In contrast, some primary school teachers spend a lot of their own money buying supplies for their young pupils. Do professors think the public does not notice these things? Where's the professor's critical review of his or her own attitudes?

2. Pseudosciences

Last spring my family and I watched Comet Hale-Bopp with our 3" reflector. Hale-Bopp was magnificent. We felt kinship with the generation that last saw it four thousand years ago. In pre-scientific societies comets were seen as messengers of doom.

This brings us to the pseudosciences, whose proponents claim to offer easy answers, as was illustrated so dramatically a few months ago in San Diego, California. How ironic that the comet of 1997 was seen by the computer-literate "Heaven's Gate" cult as a fateful omen! Here was a technically sophisticated group that earned its income building Web sites, but lacked a single shred of scientific skepticism concerning the existence of a spacecraft they claimed was trailing the comet. Technical competence is no substitute for a spirit of science. Pseudosciences are as rampant in our high-tech society as superstitions were in primitive ones.

I cannot respect Heaven's Gate as a religion either. Their doctrine contained a curious mixture of pseudo-Christianity and Star Trek, but unlike responsible religion, it did not offer a message that would help humankind find meaning in existence, or offer guidance on how we should use the gift of life. Unlike saints and martyrs who gave their lives for others, even in mass suicide the Heaven's Gate members thought only of themselves.

Of course, Heaven's Gate is an extreme case. But one need only enter the nearest grocery check-out line to witness on the tabloid covers the spectacle of a pseudoscience free-for-all in technologically wired societies.

But again, before we criticize the public too harshly, we physicists might look at ourselves. The very success of science has given the pseudosciences an undeserved appeal by naive association. Perhaps too few scientists trouble themselves explaining the difference in layman's terms. Like the hobbits of Middle-earth, we say little to outsiders. Instead, do we not secretly relish the status of Wizard among the rustic hobbits? If the larger society is turned off by physics, could the aloofness of the physicists be partly to blame? One refreshing feature of the ICPS physicists is that they are definitely not aloof! May you never lose that enthusiastic engagement with the non-physists around you!

3. Physics Enrollments

A third signal that all is not well in the physicists' Middle-Earth is the declining trend in the number of physics students, at least in some countries. This problem stems partly from the job market, but perhaps from the culture of physics too, as we shall see.

Having sighted a few goblins on the horizon, I would hasten to add that there is no reason for physics to despair. One is reminded that in the late 15th century, on the very eve of the great voyages of discovery and the Renaissance, the mood in Europe was one of gloom and pessimism. The two centuries from 1050 to 1250 exhibited an emerging vitality, but this "first Renaissance" stalled in the 14th century. Europe seemed washed up, decimated by the Black Death, fragmented from within, threatened by invasion from without. But despite these serious problems, European civilization contained within it the seeds of imagination and creative energy that were about to burst into action.

Likewise, perhaps we will soon see a flowering of physics as never before. Physicists do not lack the imagination, creativity or personal energy to transform problems into opportunities. Towards this end, let us imagine two possible responses to the three signals described above. They represent proposed changes in the culture of physics. I call them "Hit the Road" and the *Know Who Your Friends Are."

Hit the Road!

To address the challenge of public indifference, we can hit the road and practice physics outreach. I am talking about doing something local and personal, which if made part of the expectations of professional culture would be more lasting than any program tied to government funding.

Seven-year-olds are among the world's most perceptive scientists, because with great enthusiasm they ask the right questions: "What makes the Sun shine?" "I want to know if space ever ends." "What makes planes fly?" "What makes light?" "How can the planets orbit the sun when they're on nothing?" "How did the dinosaurs die?" These are questions I have collected from children of this age, questions they sent to our SPS chapter prior to our bringing a "Physics Circus" to their school. But by the time these pupils reach age 10 or 11, certainly by age 13, most no longer ask such questions, having learned that "science" is a list of "facts" to be memorized from a book.

In a wonderful letter following a visit to her class, a third-grader said,

> ***Please come back again and see us, we would be happy if you did. I was thinking that if I were to be a scientist I could be in your class. It would be lots of fun. Do you have another place?***
> ***Your friend Tasha.***

I hope Tasha feels the same way ten years from now. Statistically, she will not.

If we depend on the public's support, shouldn't we support with career-building recognition those physicists who promote physics appreciation among the public and school children? When you are the head of your National Physics Society, will your meetings have sessions devoted to "taking physics on the road?"

Presenting an astronomy slide show at a local Business Club meeting should be as esteemed by our profession as presenting a contributed paper in a regional conference. Being invited to serve on a primary school committee designing a science curriculum should be as respected by our profession as serving on a physics society committee. Such volunteer activities should be as expected of us by our peers as reviewing research papers. When you are the Physics Department Chairperson, will your faculty members be promoted for outreach activities as well asresearch?

Know Who Your Friends Are!

Unlike the chemists who have a conspicuous chemical industry, we physicists do not have an obvious "physics industry." So after graduation many newly minted physicists move into jobs where society calls them "engineers", "software developers", "patent lawyers", "actuaries", "consultants", "medical doctors", or other titles. They are society's "Hidden Physicists".

We have much to learn from the Hidden Physicists. They have shown us that the discipline of the physics curriculum teaches certain skills and habits of mind that are highly transferable. Unfortunately, the community of Explicit Physicists maintains little contact with the Hidden Physicists. When we see indifference towards physics in society, why are the Explicit Physicists so surprised, when they ignore so many of their own alumni?

As a matter of principle, the Hidden Physicists deserve the community's respect because their physics degrees were honorably earned. As a matter of self-interest, the physics establishment should embrace the Hidden Physicists because physics needs friends outside its small circle of PhD's. The public's perception of physicists includes a caricature of Einstein and visions of hydrogen bombs. Physics needs informed friends who know the discipline and can share it with sectors of society where Explicit Physicists have little influence. We have such friends in the Hidden Physicists! Let us remember who our friends are! When you are President of your National Physics Society twenty years from now, will you find ways to engage the Hidden Physicists?

The experience of the Hidden Physicists suggests an aggressive recruitment strategy for university physics departments: We should recruit the Hidden Physicists students as enthusiastically as we recruit the future Explicit Physicists. "Study physics to maximize your options" is a recruitment strategy that works!

The physics community has seen the Dark Tower of indifference in its Middle-Earth. When the Middle-Earth of the hobbits faced its greatest threat, Frodo sought Gandalf's advice before he set out on the Quest on which rode all the hopes of Hobbits, Elves, Dwarves, and Men:

> ***«For where am I to go? And by what shall I steer? What is to be my quest?...»***
> ***«...You cannot see very far," said Gandalf. «Neither can I... »***
> ***«No indeed" said Frodo, "But in the meantime what course am I to take?»***
> ***«Towards the danger, but not too rashly...» answered the wizard.***

The challenges ahead offer splendid opportunities for the newest generation of physicists to apply wisdom and self-reflection, moving towards the danger, but not too rashly. May the spirits of Frodo and Gandalf inspire you.

Norwegian physics under fire

by Kjetil Kjernsmo, President, Norwegian Association of Physics Students.

I got suddenly a lot to do after my last exam, because the Norwegian Research Council issued a "strategic plan for physics, electro-subjects and materials science" and it is strongly disliked by everyone in the physics community.

The reason is, the Norwegian Research Council hasn't got any idea what basic research is! They seem to define research as something that has potential applications, and the difference between 'basic' and 'applied' research is that 'basic' is long-term and 'applied' is short-term. Which is good, of course, because one makes use of Maxwells equations today... Basic research is driven, we tHink, by curiosity, not because somebody needs some invention. Who could realize the commercial needs for Maxwells equations before they were put up? The thing with basic research is, all paths traveled have been worthwhile, even if they ended up nowhere. You don't know that until you have tried.

So we have a problem. The Norwegian Research Council has decided, without asking the physics community, that this plan is not going to be discussed further. The latest news, though, is that those who wrote the plan weren't told that it wasn't going to be discussed either. And it says explicity a number of projects will not receive further funding, even though the comittee also says explicity that they haven't got the competence to deal with specific subjects. For instance, Norways involvement in CERN will be greatly reduced, we will be involved in only ALICE and ATLAS. Though a large fraction of the students on particle are looking for Higgs, using mostly DELPHI, according to a friend who just started looking for Higgs.

I am sure there are lots of critical questions that could be asked about CERN projects. Critical questions is a very important ingridient in any scientific debate. Here, however, the Research Council doesn't ask questions of scientific nature, they ask "Why should Norway spend large resources on CERN activity when this activity is of very little relevance to norwegian commerce and society?" Wrong question! What countries invest in CERN because of its relevance to commerce and society? Later in the plan, they want to put a great effort into "Atom Optics", which is of course a very interesting field. But what if Higgs isn't found? What if the Standard Model falls? The Research Council doesn't think about what implications this will have, and that is something that worries me.

This plan has of course unleashed rather hard comments from the physics community. My department wrote a pretty sarcastic 30-page report... And then NoFFo became involved. I have been sending a few e-mails around, and if the council suddenly turns around and find they will have to listen to reason, I will be writing a letter.

My main objection to the plan is this: They are going to build down the research motivated by curiousity. In Norway, physics experiences a pretty dramatic failure to recruit students, caused mainly by a very poor state in elementary school. In NoFFo we find that most students choose physics out of curiousity, not because thay want a career. If you wanted a career, you would study law or medicine or something.... At school you must look very hard if you are to find what makes you curious about physics, that is the main reason for the dramatic state today. If they destroy the curiousity-driven research, that will certainly kill any recruitment to physics, we think. Which is what I will write about in my letter.

Anyway, this case got NoFFo some publicity. We did some work about it, and some of theh higher people in the physics community noticed it. Which is good, because we are striving to really get into the physics community proper. Because of one of e-mails I wrote, I was also interviewed on national radio on prime-time (that is, when everybody is sitting in their cars, driving home) about the importance on basic research for the society and for technology.

The situation is somewhat unclear at the moment. The physics community hopes that with the amount of 'noise' created, the Research Council will turn around and revise the plan. We then hope to get our view through. I fear, however, that the problem goes deeper than this plan: People, academic or laymen, don't have the historical background, they are unable to see the value of science because of modern society's narrow sence of efficiency; evaluation of knowledge has become more important than knowledge itself, and the ability to answer the questions has become more important than questioning the answers. Students, educators and professors need to realize the need for public education, and take it seriously.

Artificial atoms

by Jorg Jansen

In this article I would like to present the nice physics we can find in so-called "quantum dots". Due to the fact that the number of electrons is a small integer, quantum dots can be regarded as artificial atoms. Indeed we (that is, myself and several other people) found a number of "atomic" properties in our device. But, since we can influence the energy levels by applying a magnetic field, we can also explore regions inaccessible in normal atoms. The outline of this article is as follows: first I describe the layout of the sample we used; measurements are then discussed in three different paragraphs, each regarding a distinct property.

Sample layout

In a thin InGaAs disk, with radius more than ten times the height, electrons can move around freely. In figure 1 it is the middle of the three small layers. The motion in this quantum well is effectively restricted to two dimensions. By sandwiching the disk between two AlGaAs layers —which act as so-called "tunnel barriers"— and n-GaAs as contacts we can probe electron transport through the dot. Electrons can only enter the well by tunneling through the AlGaAs barrier. The quantum well is surrounded by a metallic gate which is isolated from the well. Now the motion is confined in lateral direction as well and the energy spectrum of the dot becomes quantized.

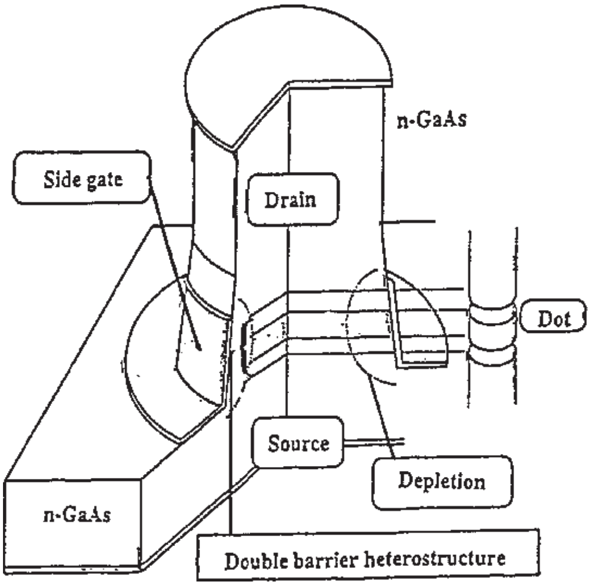

Figure 1. Schematic layout of the device. The size of the actual dot is exaggerated for clarity.

The ladder of energy states can be moved up or down by adjusting a negative voltage on the gate. A small bias voltage across the two n-GaAs contacts creates an energy window. Each time an energy state comes into this window a current can flow, due to electrons tunneling on and off the dot. Energy states with lower energy than this window are filled, states with higher energy are empty. Pushing a filled state to an energy above the energy of the window empties the state. While the state is crossing the energy window a peak can be seen, as a function of gate voltage. Before and after the peak the total number of electrons in the dot differs by one.

Shell structure

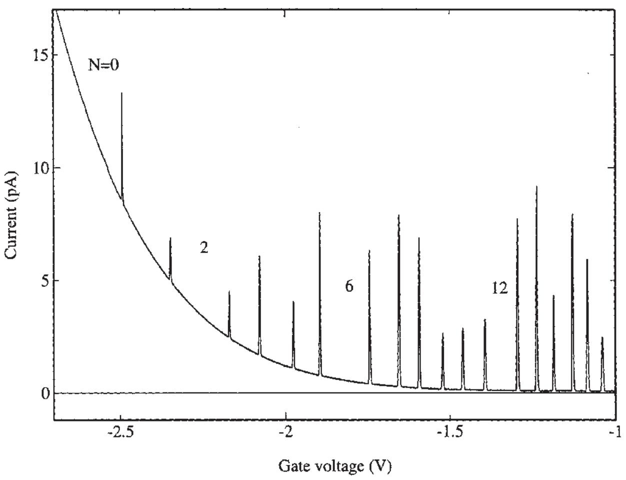

Figure 2. Gate voltage sweep at zero magnetic field showing the peaks for the first 18 electrons in the dot. The *magic numbers* for which a complete shell is filled are indicated.

The difference in gate voltage between two of the peaks discussed above is a measure of the energy needed to add the next electron to the dot. In figure 2 a gate voltage sweep is shown. Several distinct peaks are observed while between the peaks the current drops to zero. In this region the dot is in the *Coulomb blockade* (see the references at the end of this article). When sweeping to very negative gate voltages the current does not drop to zero completely due to a leakage current to the gate. From the size of the dot and an estimate of the depletion as a function of gate voltage, as well as from sweeping to even more negative gate voltage values, we know that the leftmost peak corresponds to the first electron entering the dot.

Taking a closer look we observe that the difference in gate voltage, and thus the addition energy, is higher for adding the third, seventh, and thirteenth electrons. These higher energies are explained by a shell model for our 2D system (similar to the shells in normal 3D atoms). The first shell is filled by two electrons, having principal quantum number $n = 0$ and angular momentum

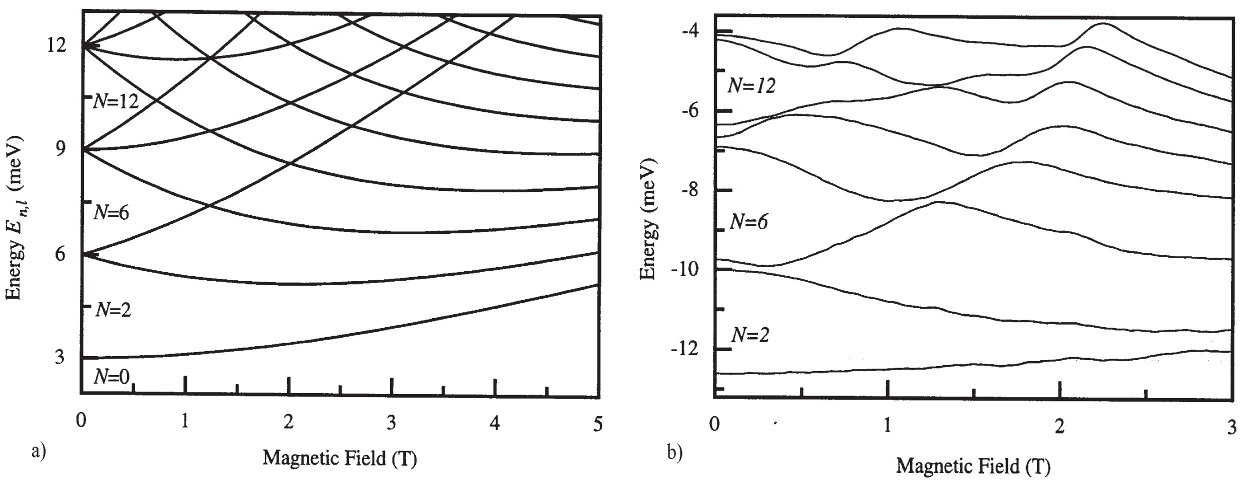

Figure 3. Magnetic field dependence of energy states in the dot: a) Calculated Darwin-Fock spectrum with the formula mentioned in the text. b) Measured spectrum in the dot; a constant between curves has been subtracted.

quantum number $l = 0$. Spin degeneracy is responsible for not violating Pauli's exclusion principle. The second shell can contain four electrons having $n = 0$, and $l = -1$ (two electrons) or $l = 1$ (the other two electrons). The numbering with n and l will become clearer in the next paragraph. The third shell can contain six electrons, the fourth eight, and so on. This results in completely filled shells for electron number 2, 6, 12, 20, 30 and so on. It is not shown, but the addition energies for the 21st and 31st electrons were also observed to be significantly higher.

Darwin-Fock spectrum

Already in the thirties Darwin and Fock calculated the dependence of energy levels on magnetic field strength for free electrons in a parabolic potential. They used the Hamiltonian

$$\hat{H} = \frac{(\hat{p} - e \cdot A)^2}{2m^*} + 12m^*\omega_0^2 r^2$$

in which the first term corresponds to free electrons moving in an external applied magnetic field described by the vector potential A in the symmetric gauge $A = 1/2(-y, x, 0)B$. The second term describes the harmonic, axially symmetric parabolic potential V. The solution for E in $\hat{H}\Psi = E\Psi$ is:

$$E_{n,l} = (2n + |l| + 1)\hbar\sqrt{14\omega_c^2 + \omega_0^2} - 12l\hbar\omega_c$$

ω_c is the cyclotron frequency given by $\omega_c = eB/m$, n is the principal quantum number, and l the angular momentum quantum number. The resulting spectrum is plotted in figure 3a.

We can study the magnetic field dependence of energy levels in our dot by converting the gate voltage to energy. We then plot the positions of the peak at various magnetic field with a little offset to obtain the magnetic field dependence. The result is shown if figure 3b (we subtracted a constant energy difference between the curves which compensates the charging energy of the dot —see references below). Only traces for odd electron number entering the dot are shown since, due to spin degeneracy, the even traces show similar behaviour. The similarity between 3a and 3b is striking, and the rather basic description of free particles in a box can explain our measurements to first order. However, looking more carefully at the odd and even traces small deviations are observed. We will discuss them in the next paragraph.

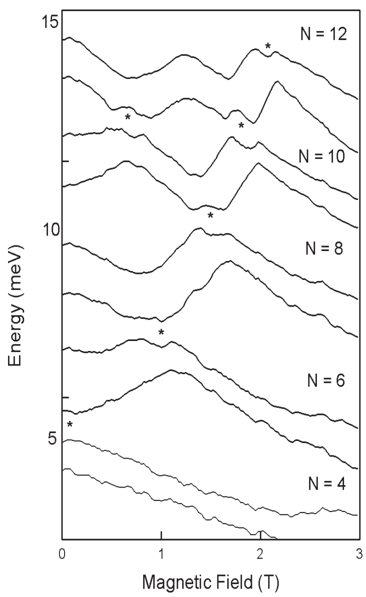

Figure 4. Hund's rule for 4 electrons in the dot and the generalization of Hund's rule for 6, 8, 10 (twice) and 12 electrons in the dot.

Generalization of Hund's rule

In figure 4 we plotted the traces for even and odd electrons entering the dot. After subtracting the charging energy a small offset is introduced between pairs of traces in order to make deviations from the Darwin-Fock spectrum more clear. For the fourth

IAPS Alumni

A contributing factor to the continuity and credibility of IAPS.

by Bent Grøver

Ever since I was elected president of IAPS almost three years ago, I have been trying to come up with schemes to maintain continuity within IAPS. At each General Meeting at the end of every summer, IAPS experiences a discontinuity in its momentum. Within a few hours after the elections, the ex-President has to pass over all his/her knowledge, plans and hints to the new President. The incorporation of President Designate and Past President was a step in the right direction, giving a potential future president the opportunity to prepare him/herself. However, most of the experience gained by each Central Office seems to be lost within one year of retirement. One way of collecting the different experiences and knowledge is to introduce an IAPS alumni club, which is the main topic of this article.

An alumnus is a graduate of a school, college, etc. Together the old students of a college form the alumni of the college. The private universities in the USA plus Oxford and Cambridge are strongly dependent on the contributions from their alumni - especially financially. Many student organisations and fraternities operate with alumni as well. Before I continue with the IAPS alumni, just let me give an example on how, for instance, a fraternity's alumni work.

A fraternity is a house where a group of students live together and socialise. New members are chosen by the students already living there, and everyday life is run completely by the students. However, if the fraternity needs any help or assistance, it always has its alumni of old members supporting them with advise, credibility and financial help. I envisage IAPS alumni being somewhat similar to this, where the members of the IAPS alumni club are former active members of IAPS.

I prefer to compare an alumni club to a bank account, and IAPS itself the (very young) holder of the account. However, when it comes to what kind of bank account we should go for, I am not sure yet. To be fair,

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and fifth electron entering the dot at zero magnetic field we observe the first deviation. At zero magnetic field the $n = 0, l = -1$ and $n = 0, l = +1$ states are degenerate. From Hund's rule in normal atoms we expect that the fourth electron entering the dot will not occupy the same orbital state (with opposite spin) as the third electron, but will occupy the other empty state and maximize the total spin. This reduces the addition energy by a small amount δ, as seen in figure 3. We measure not exactly the energy, but the chemical potential which is defined by $\mu(N) = E(N) - E(N-1)$. So the trace of the fifth electron is raised by the same amount δ. Although not clear from figure 3, similar reductions and increases of the energy are also seen for the ninth and tenth electrons entering the dot, and even for the sixteenth and seventeenth electrons. This is exactly what you would expect from the shell structure: Hund's rule applies when a shell is half filled, *i.e.* , for 4, 9 and 16 electrons in the dot.

Let's now take a look at the traces in figure 4 at finite magnetic field. For the sixth and seventh trace we observe a similar behaviour at the point where we expect the curves to "cross". At the crossing point the $n = 0$, $l = -1$ state and the $n = 2$, $l = -1$ state become degenerate. Coming from low fields the $n = 0, l = -1$ state is occupied with two electrons. At the crossing spin can be maximized by having one electron in the one, and one in the other state with both same spin. The energy is reduced, which is clear from the small cusps. Similar behaviour is seen for the crossings of the energy levels with eight electrons in the dot, twice for ten and once for twelve electrons. We propose a generalized Hund's rule stating that every time half filled energy levels become degenerate the electrons tend to maximize the total spin. This is a nice manifestation of the *exchange energy,* which tends to keep the spins of nearby electrons parallel.

The measurements were performed at Delft University of Technology, while the samples were made at NTT Basic Laboratories in Japan. I chose to give no references in the text, but for those who are interested in reading more about this topic a nice review on artificial atoms is:

[1] R.C. Ashoori: in *Nature* **379**, 413 (1996).

Part of the results presented here were published in

[2] S. Tarucha *et al.*: in *Phys. Rev. Lett.* **77**, 3613 (1996) (see also references therein).

Generalized Hund's rule and more results not presented here will be published in the near future. For detailed information please contact me via e-mail at < *jorg@qt.tn.tudelft.nl* >.

it does not matter much in the beginning. IAPS is very young as an organisation, and even the founders have "just" finished their studies.

A child might have too big expectations from his account. The interests from a newly opened account are usually not very impressive. Nevertheless, with patience and discipline, the amount on the account will grow, and in long terms, the interests will be substantial.

Students tend to think maximum one year ahead, which is natural given that their lives as students only last for three to five years. Therefore, many members of IAPS get disappointed after a few years with great plans from ICPS's fading away. This was well reflected in the comments on the IAPS mailing list last autumn. An alumni club will surely be a big disappointment to many who were hoping for more from it.

I see this club as part of a 20-year plan, establishing IAPS as a recognised strong and independent student organisation. It is only when the alumni reach the late 30s that we will see the great advantages of the club. With alumni in important positions within the physics community, acknowledgement, credibility and funding should be more easily obtained for IAPS. Until then we have to be patient, maintain a link between IAPS and its alumni, and try to find a right structure and aims for IAPS. We can still benefit from the experience the alumni have together. I remember all the questions I had when I became president; "Why was IAPS founded?", "What was the founders' vision of IAPS?", etc. I did not get the answers before last summer when I actually met the founders of IAPS, and not surprisingly, they were quite different from what I expected. Now, with an alumni, it should be easier for the active members of IAPS to get answers to essential questions.

There have been some discussions about an advisory/governing board (see the November '96 issue of JiAPS), and I would like to address this briefly in the context of alumni. Again this board was suggested as a means maintain continuity. Personally I do not think a governing board would fit a student-run organisation like IAPS. An advisory board, though, is perhaps more suitable. If you look at the Charter and Regulations of IAPS, you will find paragraphs on "Advisors". At the moment they do not exist outside those documents. Nonetheless, the intention behind the Advisors was to have faculty members present at a national level to ensure continuity in the National Committees. An advisory board is not very different from this, only it is on an international level. It would consist of a group of physicists, both IAPS alumni and eminent professors, and they would be passive and mainly respond when contacted by the IAPS Central Office. However, I suggest that we include a future advisory board in the discussions on IAPS alumni during the next ICPS in Vienna.

So what has to be done regarding IAPS alumni? First we have to 'open the account': announce that an IAPS alumni club exists and contact potential members (i.e. former active members). This has to be done before and during the ICPS'97. By starting on a small scale with room for changes, the club can easily adjust itself to suit IAPS better when IAPS has decided in what direction it wants to go. Then we must begin to 'deposit money into the account': recruit more members to the alumni and inform them about IAPS and its plans. After some time, we have to decide what kind of account we want. Only when IAPS has made its mission statements and found a structure it is comfortable with, we can write an official constitution for the IAPS alumni club, stating how it should relate to IAPS. Finally, we can 'enjoy the interests' while 'depositing more money'. As the alumni club grows larger and larger, IAPS will benefit more and more from it. One example is the simplification of promotion of IAPS. Whenever we want to address the Physics community, we just have resort to the alumni, who already know most concerning IAPS. Up to now, we have had to re-explain IAPS every time we have contacted a national or international organisation. I am sure we can find other ways to utilize the alumni in the future.

At any rate, the IAPS Alumni Club will be subject to discussions in Vienna this summer. The main intention of this article is to prepare you for the ICPS'97 work groups. I am looking forward to seeing you in Vienna!

What can IAPS expect from EMSPS, EUPEN and EGF'97?

by Hendrik FERDINANDE, EUPEN Chair,
and Anne PETIT, EUPEN Secretary.

EMSPS

The 'European Mobility Scheme for Physics Students' (EMSPS) was established in 1992. By a Convention, the presently 179 participating institutions from 30 different countries in Western, Central and Eastern Europe accept the exchange of physics students between the adhering universities. The convention guarantees that the student remains registered in his home institution during his mobility period of (at least) six months or (preferably) one academic year. She/he consequently does not pay any tuition fee in his guest university. A good co-operation between the local coordinating professors in both institutions and a pre-fixed study agreement by the moving student guarantees a full academic recognition for the studies during the mobility period when the student returns to her/his home university. Grants for students are available from the ERASMUS in SOCRATES programme of the European Commission for the exchange between universities in the EU and from the TEMPUS programme (from next year only) for the partners in Lithuania and Romania. We hope that starting with the academic year 1998/99 the Directorate General XXII of the European Commission will be able to integrate several Central and Eastern European countries in the presently EU-limited SOCRATES framework.

Students interested in a mobility period should address their application to the coordinating professor in their home institution. The list of the local coordinators is available from the EMSPS secretariat. Information on all academic and organisational matters is provided by the EMSPS database at the WWW site <http://info.mcc.ac.uk/emsps/>.

EUPEN

After the Conference 'Physics Studies for Tomorrow's Europe/L'enseignement de la physique pour l'Europe de demain' in Gent (BE) on 7 & 8 April 1995, a Steering Committee prepared an application for a 'Thematic Network' in the framework of the SOCRATES programme. During the current academic year 1996/97 the scheme received the first support from the European Commission for a project called 'European Physics Education Network'. The consortium consists of presently 107 European institutions delivering a degree course programme in physics plus 4 associations. From next academic year, the IAPS is one of the 4 associations and will profit

EUROPEAN PHYSICAL SOCIETY
EMSφS
EUROPEAN MOBILITY SCHEME FOR PHYSICS STUDENTS

from all the privileges of this membership. EUPEN hopes that IAPS students will actively contribute to the workshops set up by the consortium. In this Spring EUPEN made a detailed enquiry among its member-institutions, in order to gather information in a European comparative way on the following subjects, which are also the names of the five working groups in EUPEN.

1. The student experience;
2. Curricula structure and development;
3. Organisation of physics studies;
4. The physics career aspect;
5. Research in physics teaching, both
  (i) at the university and
  (ii) at the school level.

Up-to-date information on the status of the EUPEN programme can be found in the WWW at <http://allserv.rug.ac.be/~hferdin/eupen/>

EGF'97

The first 'EUPEN General Forum' (EGF97) will be held on Friday August 29 and Saturday August 30 in the Natienhuis, Grand Hotel Oude Burg in Brugge, Belgium. Apart from presenting and discussing the results of the EUPEN questionnaires (see preceding topic), this forum will offer an open platform for problems and solutions to educational and mobility topics fo physics related to the whole of Europe. The 'Arbeitskreis Optionen fuer der Zukunft' of the DPG (Deutsche Physikalische Gesellschaft) will also co-operate. We expect to find a large number of students under the participants since the conference fee has been kept extremely small for them. Updated information on this event can be found on the WWW home page: <http://allserv.rug.ac.be/~hferdin/eupen/forum/>

More detailed information can be obtained from:

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Houston, we have a problem!

by Miguel Carrión

Problems worthy of attack
Prove their worth by hitting back
—Piet Hein

This is the second issue of JiAPS to come out with serious problems ;-) A problem section is for the readers to send in solutions and more problems, so your participation is essential to make this section work. The layout of this section is simple: first a list of proposed problems is given, and then come the solutions (including yours!) to some of the problems from previous issues. No problem is ever closed. Even after a solution has been published, if a different solution, an extension, or a comment is received, it will of course be published. But let us get to the point:

The Problems

Problem #2: [Note: I could say there was a misprint in issue 2, but I will be honest and admit that the original statement of the problem was made with the wrong solution in mind. This is what happens when you propose a problem without knowing if your solution is indeed correct. A statement that I believe will not be misleading follows]
From the fact that an antineutrino has positive helicity (its spin and momentum are parallel), what can be deduced about the angular dependence of the amplitude of beta decay: $n^0 \to p^+ + e^- + \overline{\nu}_e$. [Hint: it is easiest to consider only the direction of motion of the outgoing antineutrino, even though it would be the hardest particle to detect in a real experiment]

Problem #3: A disc of radius R moves in a perfect, incompressible, irrotational fluid with velocity v_0. Calculate the lift force perpendicular to the direction of motion. This is a two-dimensional problem; if you wish, you can picture a very long cylinder moving in the fluid perpendicularly to its axis, and calculate the lift force per unit length. [Hint: that the fluid is irrotational does not mean that the circulation of the fluid around the disc vanishes]

Problem #5: It is well known that an electric dipole in a uniform electric field experiences a torque tending to orient the dipole parallel to the field. For a neutral object without a permanent dipole moment, a non-uniform field gives rise to a net force. Prove or disprove the conjecture that a neutral conducting object in a uniform electric field will in general experience a torque. [Hint: a spherical object obviously experiences no torque]

Problem #6: Christiaan Huygens, the inventor of the pendulum clock, first observed the phenomenon known as 'entrainment' or 'phase locking', which can be described as follows. Two different clocks, having minute differences in length and mass of their bobs, would oscillate freely at slightly different frequencies and therefore develop a phase difference even if they started oscillating in phase. However, if those two clocks were mounted on the same wall, they would end up oscillating synchronously despite the difference in natural frequencies. Modelling the penduli by harmonic oscillators, though, this behaviour is not recovered. There are two fundamental modes and the general motion shows beats in the amplitude of oscillation but no phase locking. It seems that nonlinearity in the pendulum equation (and possibly damping as well) is essential to Huygens' discovery. What may or may not be essential is the fact that a clock is maintained by an escapement, i.e. that it is a forced oscillator. After all, the escapement is only necessary to compensate for damping.
Now for the problem: write a simple model of two weakly-coupled nonlinear oscillators (e.g. obeying the simple pendulum equation) and explain how Huygens' 'phase locking' arises, possibly giving conditions the natural frequencies must satisfy for the phenomenon to arise. [Note: this should be an exceedingly difficult problem to solve with more than 'handwaving' arguments, but that's precisely the point]

Problem #7: Consider a shallow canal filled with water to height h_0. A step-shaped wave front of height Δh moves with constant velocity. How does the velocity depend on the heights? What happens if a second step of height δh moves on top of the first?

Problem #8: A simple model for a quantum dot —see the article 'Artificial Atoms' by Jorg Jansen in this issue— is a pillbox-shaped potential well of 'depth' V_0 (the ionization energy). Does this 'artificial atom' possess infinitely many bound states? What conditions need to be imposed on the dot dimensions (diameter and thickness) for all the bound states to be two-dimensional?

The Solutions

Problem #1: A given volume of 'dry water' (as John von Neumann called 'perfect, incompressible' fluids) in a cylindrical vessel is rotated about the cylinder's axis at constant angular velocity. The whole system is immersed in a uniform gravity field. Assuming the rotation axis is parallel to the direction of gravity, deduce the shape of the free surface of the fluid.

Solution

Since the situation has cylindrical symmetry, we will solve it in cylindrical coordinates (r, θ, z). Although the problem is not one of static equilibrium, if we set a rotating reference frame with the same angular velocity as that of the vessel we will have a static situation with an additional radial (centrifugal) force $\rho\omega^2 r$ per unit volume. It is well known —if you haven't seen this before, try to prove it from the equation $\nabla p = f_{ext}$— that the free surface of a fluid is normal to the external force field. Now, the cylindrical symmetry allows us to restrict ourselves to the (r, θ_0, z) half-plane, with any constant θ_0. The force $\rho(\omega^2 r, 0, -g)$ must be normal to $(dr, d\theta, dz)$ (a generic tangent vector to the surface). We have

$$\omega^2 r dr - g dz = 0 \Rightarrow \frac{dz}{dr} = \frac{\omega^2 r}{g} \Rightarrow z = \frac{\omega^2}{2g} r^2 + z_0,$$

so the free surface of the fluid is a paraboloid of revolution.

This is a minimal answer, but we can expand a bit on it: for given volume V_0 of the fluid and radius R of the vessel, there is a maximum angular velocity for this answer to be physically meaningful. The volume of the fluid is

$$V_0 = \int_0^R 2\pi r z(r) dr = 2\pi \int_0^R \frac{\omega^2}{2g} r^3 + z_0 r dr \Rightarrow \frac{V_0}{2\pi} = \frac{\omega^2}{8g} R^4 + \frac{z_0}{2} R^2;$$

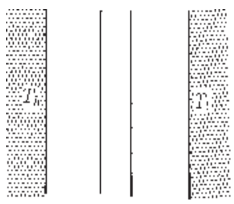
since the fluid cannot have negative height, $z_0 \geq 0$ and $\frac{V_0}{2\pi} \geq \frac{\omega^2}{8g} R^4$. This implies $\omega^2 \leq \frac{4gV_0}{\pi R^4}$.

[Note: as is known, an aberration-free telescope mirror is parabolic. Perfect metallic mirrors have been made in recent years by spinning mercury! There are technical problems associated with vibrations and with the impossibility to point the telescope at an arbitrary point on the sky, but grinding glass into a parabolic shape is also a very thorny problem.]

Problem #4: A black plane surface at a constant high temperature T_h is parallel to another black plane surface at a constant lower temperature T_l. Between the plates is vacuum. In order to reduce the heat flow due to radiation, a heat shield consisting of two thin black plates, thermally isolated from each other, is placed between the warm and the cold surfaces and parallel to these. After some time stationary conditions are obtained. By what factor is the stationary heat flow reduced due to the presence of the heat shield? Neglect end effects due to the finite size of the surfaces. (From the 1996 International Physics Olympiad)

Solution

Neglecting the finite size of the plates is equivalent to considering infinite plates, so that the problem has translational symmetry parallel to the plates, and also rotational symmetry about any axis normal to the surfaces. This means the heat flux must be normal to the surfaces, and since there is vacuum between the plates (and therefore no heat sources or sinks), it is also independent of the distace to the plates.



Now, the heat radiated by a blackbody per unit surface area is proportional to T^4. This means that in stationary conditions the net flux from the hotter to the colder plate is $\phi = \sigma(T_h^4 - T_l^4)$ (subtracting the heat radiated in the opposite direction by the low-temperatura plate). When the shield is used, the two new plates will achieve temperatures T_1 and T_2, and the heat flux per unit area will be $\phi' = \sigma(T_h^4 - T_1^4) = \sigma(T_1^4 - T_2^4) = \sigma(T_2^4 - T_l^4)$. It follows that

$$\left.\begin{array}{l} 2T_1^4 = T_h^4 + T_2^4 \\ 2T_2^4 = T_1^4 + T_l^4 \end{array}\right\} \Rightarrow 2(T_1^4 - T_2^4) = T_h^4 - T_l^4 + T_2^4 - T_1^4 \Rightarrow T_1^4 - T_2^4 = \frac{1}{3}(T_h^4 - T_l^4),$$

and hence the stationary heat flow is reduced by a factor of 1/3.

To Contribute to JiAPS

E-mail address: Contributions to JiAPS should be sent via **e-mail** to the Editor at **<iapsjournal@nikhef.nl>.**

Format: The preferred format is **ASCII text,** either as the body of the message or as an attachment. If the article is part of the message, it should be clearly distinguishable from whatever comments the e-mail may contain. These comment may include indications about the layout of the article (for example, if it contains illustrations, where to include them). Paragraphs should not be indented, either with tab stops or with spaces. They can be separated by blank lines.

Word Processors: Word-processed files are acceptable, although they may present problems of conversion. They should only be used if the article includes **equations** or other exceptional features. **WordPerfect 5.1** and **Word 6.0** are the preferred formats. However, if the article *does* contain equations, **TeX** (in any of its many forms) should be used.

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S-mail address: It is possible to submit contributions via surface mail (more appropriately known as snail-mail :-). This applies particularly to **illustrations** which cannot be (or have not been) scanned, equation-heavy articles or problem solutions which cannot be sent in TeX, and the like. The address of the Editor is

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Topics: Acceptable topics include anything related to **IAPS,** to **Physics,** or to **Science** in general, including problem proposals and solutions. In the unlikely event that too much material is received, publication of some articles may be postponed.

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Deadline: A tentative deadline for submission of contributions for Issue 4 of JiAPS is **October 1, 1997;** and for issue 5, February 1 1998.

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