{ jiaps }

The Journal of
the International Association of Physics Students

...and now it's my turn

As I got off the plane from Novi Sad and planted my feet safely on Norwegian soil, I still didn't quite know what I had thrown myself into. I like big challenges, and I think this is one of those things where I act first and think later. Not until the evening after when mails from Milla started to pour in did I get it. A small chill went down my spine as I was thinking: "What are we going to do now?". I can honestly say that I still get the chill, but now I also have a small sense of control.

My experience with IAPS is limited to the last two ICPS-conferences, that's it. It's like the first swim of the summer; some jump or some go step by step into the cold water. I'm a jumper, but I do have a lot of experience with committee work and university politics, however the difference between IAPS and university politics is that kindergarten experience should be required when dealing with professors… But in the long run I am still a rookie. I guess that means that I still have these rare fantasies that we can make a difference, change the world. I would guess that this approach to life fades as you get older, and so I will use this now while I've still got it.

A new autumn has arrived but the summer and ICPS still feels like it happened yesterday. Even though it is almost a year till we meet again in Coimbra, Portugal, the IAPS executive committee will do its best to make time fly. A lot of exciting things will happen throughout this next year. And you will know all about it by reading mIAPS, our monthly news-mail, or JIAPS, as you are doing right now.

This year is especially exciting since 2005 is the World Year of Physics (WYP). We have to use this opportunity to try and influence people all over the world to believe that physics is exciting and fun, like we do. For this part, we need your help. We as physics students have a responsibility to spread the joy of physics to non-physicists, after all we will benefit from this since more people will actually understand our jokes ?

"It's me and my new microscope!"

At times we can wonder why we should try to change people's opinions about physicists. Does it really affect us? But after all, there are some advantages to a good public image, isn't that the only way of getting money from the politicians? And of course a good reputation brings about more physicists, and then we can have a bigger shot at getting the knowledge of everything?

Throughout 2004/2005 we will engage ourselves in the traditional IAPS-activities such as IAPS-summer school, trip to CERN, cultural exchange programs and of course making another great ICPS. More about these activities will be posted on the web, mIAPS and JIAPS. We will also try to arrange other activities such as celebrating Einstein's birthday (the 14th of March), getting a job-fair at the end of ICPS in Coimbra and helping organise WYP arrangements. If you have good ideas or comments, please mail us: **iaps@iaps.info**.

Until next issue, we will work hard doing IAPS stuff and of course do a little bit of studying. As you can see from the images, I have finished my master's exam. The topic was a transmission electron microscopy study of steel, and for finishing my friends bought me a microscope. Isn't that the coolest thing ever?? So I told my PhD-supervisor that from now on I could do the microscopy part at home. I hope you all have a nice and snowy winter. Well at least for the ones that have that possibility.

Annett Thogersen (the president)

Summary

JIAPS 3/2004

Head editor:
András Zsom

Proofreader:
Jim Grozier

Online version: ISSN-1811-0029

Printed version: ISSN-1811-0010

Front page photograph:
András Zsom

Contact information:
jiaps@iaps.info

IAPS

4 rue des Freres Lumieres

F-68200 Mulhouse

France

IAPS summer school '04

A nice volleyball game, sauna with a refreshing swim in the lake (every night!), PhD in Physics playing guitar while you sip your port wine. IAPS summer school is all of this – and much more!

The second IAPS summer school was held in the Hyytiälä forestry field station in Juupajoki, southern Finland, some 200 km north of the capital of Finland, Helsinki. A group of 24 Physics students gathered together to attend this mid-August event. Although not as popular as the first summer school held in Portugal two years earlier, I doubt that the fun of this summer school lost out to the first one. Most of the participants originated from Nordic countries, but there were students from Germany, Ireland and Portugal as well.

The title of the summer school was "Role of Organic Aerosols in Cloud Formation". The Nordic graduate school CBACCI (Biosphere-Carbon-Aerosol-Cloud-Climate Interactions) offered great help in the organisation by offering renowned lecturers for the course and some financial support for the participants from the Nordic countries.

The programme of the course was very intensive. There were only five days for the course, and a lot of lectures to cover the subject: first some basic aerosol dynamics and organic chemistry, then introduction to cloud dynamics, chemical analysis and measurement technique, finally followed by lectures on the properties of organic aerosols and the presentation of a real cloud model. The participants even got an opportunity to make some runs on the model using their own parameters. The course programme included a visit to the SMEAR II station (SMEAR = Station for Measuring Forest Ecosystem – Atmosphere Relations), which has produced data for aerosol scientists for ten years – one of the longest continuous measurements of atmospheric aerosols in the world.

Some group work had of course to be included as well. However, once again it was proved that students are very durable: even after the hard programme of the day, most participants joined the sauna session, followed by a swim in the lake (which was getting colder day by day). Nice discussions usually followed – sometimes with a bottle or two of beer.

The August weather in Finland can be unpredictable. This surely became clear to all the participants. Nice, warm sunny days were followed by heavy rain, but no weather whatsoever was able to ruin the magnificent atmosphere of the course.

As always, the end of the course came sooner than anyone expected or hoped for. Before that everyone had to take part in an oral exam. The exam results showed that all the participants had learnt a lot, so it was time for the great farewell party, which was seasoned by port wine, cheery Chilean music and some live music presented by one of the lecturers, Dr. Harri Kokkola.

As the organiser of the IAPS summer school I was very happy after the course. All the arrangements went fine, the course was interesting and the participants satisfied. Now I'm looking for the next IAPS summer school – wherever and whenever it will be – to attend as a participant. IAPS always means lots of fun! So folks: stay tuned on the IAPS channel!

Antti Lauri,
University of Helsinki, Finland

There is this farmer who is having problems with his chickens. All of a sudden, they are all getting very sick and he doesn't know what is wrong with them. After trying all conventional means, he calls a biologist, a chemist, and a physicist to see if they can figure out what is wrong. So the biologist looks at the chickens, examines them a bit, and says he has no clue what could be wrong with them. Then the chemist takes some tests and makes some measurements, but he can't come to any conclusions either. So the physicist tries. He stands there and looks at the chickens for a long time without touching them or anything. Then all of a sudden he starts scribbling away in a notebook. Finally, after several gruesome calculations, he exclaims, 'I've got it! But it only works for spherical chickens in a vacuum...

ICPS '04

Let me tell you one strange story!

It all starts when I found one cool thing by wandering through the Internet, last May. On a website I read that each year since 1985, more or less at the end of August, a group of approximately 300 quite crazy young people studying physics called IAPS, meets somewhere in the world under the name of an event called "International Conference of Physics Students" (ICPS).

Either by plane, car, train, boat or whatever, some members of most of the major physics students' associations plus interested individuals reach the designated place and spend a week or so there.

More than 20 posters were presented by students of all levels of study.

There were rumours (coming from some Finns I met on IRC chat) about what they do: they present reports on the scientific researches they are doing, they organise parties that last all night, they listen and learn from lectures by renowned invited scientists, they gather in assemblies and define international objectives, they visit the host country discovering the local culture, and they of course make friends with one another.

After some thoughts (and after having passed all the possible deadlines for participation confirmation) I decided that I was crazy enough to take part in this strange meeting, so on the 11th of August of this year I took the car and decided to leave my beloved Mamma and Pasta for some days in order to see what really was this mysterious ICPS.

Now, the suggested plan was to write here a well-organised diary from day-one to day-six, but as I'm Italian and chaotic by nature I thought I could present my view on ICPS in a more "Brownian" way.

A good story must have a striking beginning, so let us start with the parties :) By quoting Prof. Darko Kapor in his invited lecture about "Physics and Physicists – How Do They See Us?" on day-five. It's admirable the fact that you can carefully listen and participate in scientific seminars in the morning even if the programme presents parties all night.

Welcome Party, Serbian Party, National Party, Farewell Party: four nights arranged to encourage "the nerdy physicists" to get acquainted with one another, discover how people have fun in Serbia, perform some highly cultural national entertaining mini-show (see the picture), taste the food and "maybe" the drink (...erhm...) habits of other countries. The hostel in which we were accommodated was really comfortable and well suited for partying: a quite big "dance hall" on the first floor and a suggestive open-space in the middle where people could sit down and talk or sing till the morning. Oh, what's more, the weather and temperature were perfect. I could spend some more tens of pages on the parties, but I guess some pictures (see the semi-official picture gallery at **http://gallery.iaps.info/**) will communicate the atmosphere of those nights much better that what my poor words could do. I know that I'm supposed to write something about my point of view on ICPS, so allow me to be partial for a couple of lines when I write a report about something. Just … Booming! Even if I didn't drink (never... isn't it, Hungarians?) in party-time I really enjoyed myself and made friends with many girls and guys (guess the proportion :)) with whom I'm still in contact, and now planning international visits!

Then let's come to the official main part of ICPS: the scientific side.

The plan presented more than 50 lectures prepared by students (ICPS participants) arranged in 3 days (more or less 25 min per lecture) and approximately 20 posters presented in the afternoon of day-five. I tell you, it was impressive. Almost all lectures were pretty crowded and there were often questions and interest by the listeners: I personally guess that some unofficial collaborations among students have

been established. There were seminars taught by freshmen as well as researches presented by Doctoral students, and some of those lecturing were at ICPS thanks to a scholarship based on what they were presenting. ICPS is ultimately a unique springboard for training in explaining science (in English) to a competent audience, a skill that we will all have to develop. All kinds of subjects were somehow reviewed, from Nuclear Physics to Nanotechnology, passing through Solid-state physics, Astrophysics, Quantum Foundations, Geophysics … a great opportunity for the new entrants to have a sneak at all fields of studies. People attended the two guest lectures with enthusiasm. "Physics of Today, is Engineering of tomorrow, and Business of the day after tomorrow", this was the opening by Prof. Tristan Hübsch (Howard University, USA) who gave an interesting introduction to Super-strings, focusing on the physical point of view of the theory. Prof. Darko Kapor of Novi Sad Physics Department was definitely less technical but really fun, he suggested some actions that society could take in order to improve physics education and the not-so-appealing figure of the scientist, which is one of the main reasons for the "declining student numbers" alarm launched by UNESCO with the declaration of the "World Year of Physics" (WYP 2005).

I really think that ICPS is a very useful experience for every young researcher or student. We wouldn't study physics if we were not so hungry and so curious as to feel at least stimulated and interested (if not enthralled) by learning new scientific things! Even if Albert Einstein told us that "imagination is more important that knowledge" I guess that ICPS is a good opportunity to acquire both in an overwhelming way.

But ICPS is also a meeting of all the National Committee of IAPS, the opportunity for giving reports of activities throughout the year and defining new projects, strategies, and responsibilities for the years to come. In one word: ICPS hosts each year IAPS's General Meeting, the decision-making organism of the association. For two long days (one extraordinary GM of 4 hours at day-one, and the AGM of 7 hours at day-four) representatives of local and national associations in the world sat in a room in order to define the short-term, medium-term and long-term directions of the association. The new Executive Committee was elected, future ICPS plans were approved, fresh ideas about the WYP were collected. I personally participated actively, so actively that I decided to become half-Hungarian (I joined Mafihe, the Hungarian physics association) and to assume the responsibility for the presidency for next year. I felt really charged up by meeting so many students like me that want to work in order to multiply the opportunities for young scientists and to improve the social attitude towards science in our society.

Throwing away the "political" stuff, we shall not forget that the organisers of ICPS flavoured the stay with opportunities to enjoy the local culture. From the Serbian National Party (day 2) to the awakening in the morning (day 4, see pictures), we could appreciate some local traditional music. As usual in all ICPSs, we were led to the exploration of the Capital and the neighbourhood (monasteries …) for one day. My Italian comment about the local culture concerns the food. When you go to an Italian restaurant and ask for some meat, you probably get 1 little steak. In Serbia you get 4 sausages, some pig meat (2 steaks cooked in a different manner) plus some chicken for sure. More or less 1kg of meat, and all for a small price. Great country.

It's time to conclude, and I've never been good on concluding. Somebody said that "A conclusion is simply the place where someone got tired of thinking" and this is probably quite true for scientific works, but when we write a report things are different.

What I learnt is that ICPS is IAPS's award for itself, it has always been the place in which the association refinds its identity: a group of young motivated people that love life and science, that are ready to struggle in order to make extraordinary their and other students' lives.

Davide Venturelli, Italy

IAPS workshop in the open air...

Nobel meeting in Lindau

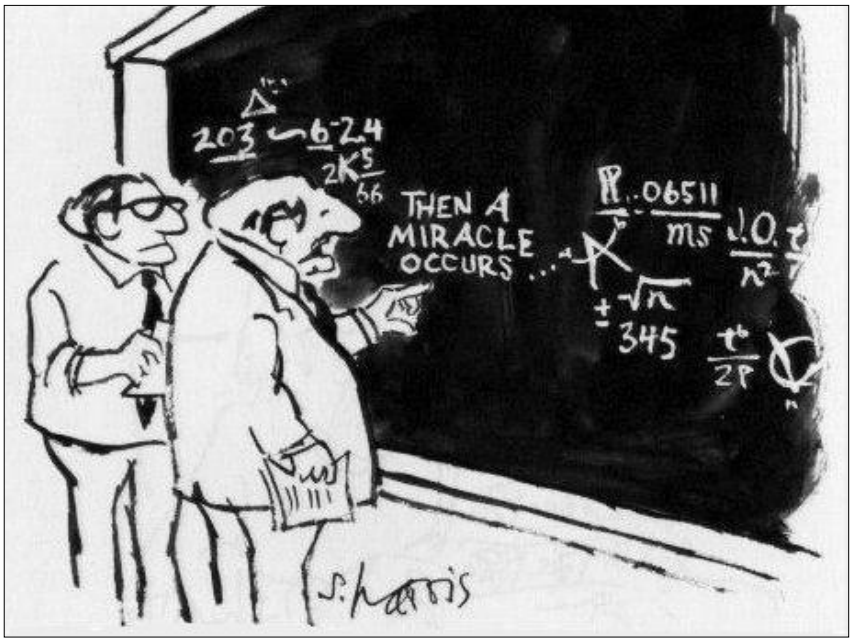
I attended the conference of physics students and Nobel Prize winners in physics in Lindau, Germany, in June-July 2004. I was given the opportunity because I worked the summer in the headquarters of the European Physical Society (EPS). I didn't really know what was lying ahead when I left Mulhouse, which was my hometown in the summer. I knew that I would attend a conference for physics students and young researchers and that it had something to do with the Nobel Prize, but that was it.

The train trip took four hours. I left early - early for me, I mean - on a sunny Sunday morning. The railway went first along the Rhein and then near Lake Constance, with snow-topped mountains on the other side (beautiful!), and since I had never seen any of them, I really enjoyed my trip. I left the train station by following a relatively narrow street with beautiful old houses on both sides. I had a map of the island Lindau and the address of the house in which I would be staying, and I found the place in no time.

The conference was in a building called Inselhalle. I didn't have any problems in finding the place but I didn't know what I was supposed to do in there. I chose the time-honoured strategy of doing what everybody else did. While queuing to get an information folder, I met a girl from Sweden, originally from Thailand, and it happened that I spent a lot of time with her during the week.

The opening ceremony was nice, though a bit dry, as they tend to be. We heard music and several speeches during which I found out the relation between the conference and the Nobel Prize: there were 18 laureates, 16 of whom would give a lecture. The audience of around 700 people was mainly students (more than 500), but there were also some teachers (university professors) and relatively many representatives of the media.

Monday morning started with a round-table discussion about astrophysics. Four of the laureates were sitting behind two tables and between them, behind another table, there was a chairperson from the Royal Swedish Academy of Sciences.



"I think you should be more explicit here step two!"

The chairperson opened the discussion with a short speech and each laureate gave a speech of a couple of minutes before the discussion. This was followed by three specialised lectures, and after lunch we were given an opportunity to visit the island in groups, guided either in German or in English. We walked some narrow, picturesque alleys, heard the main points of the history of Lindau and saw the essential sights of the town.

In the afternoon the scientific programme continued with discussion between the students and the laureates who had given lectures that morning. The space was divided into three smaller ones with chairs in them, and only students and young researchers were admitted. The young asked questions and the laureates tried to answer, even though they didn't always know the answer.

On Monday evening there was a "social get-together" in the Inselhalle, including dinner and dancing. I arrived before the doors were opened and met some other participants. Rafael was an energetic German who started to talk to me and soon we were accompanied by Peter from Switzerland. Inside the Inselhalle we first took some food and then entered the conference hall to search for seats that were now around tables. In the middle of each table was a sign with the names of one of the laureates and his wife. Rafael was keen to sit at the table of Arno Penzias and I followed him while Peter went to another table.

We met a professor from Dusseldorf and an American who studied interstellar matter, if I remember correctly. Somebody asked Mr. Penzias about the discovery of the background radiation, for which he had been awarded the prize together with Robert Wilson, and he told us the real story about pigeons and everything. I have to admit that I didn't quite follow, but the drawing about a pigeon warming its feet inside the antenna thing was cute.

When almost everybody had finished dinner, the music started and we were invited to form two lines, one for men and the other for

women. I wasn't interested in dancing so I continued my discussion with Rafael and Mrs. Penzias. Soon we went out onto some kind of a patio to admire the sunset and to have some fresh air. The weather was warm and after having apparently finished another story, Mr. Penzias joined us. I left at about ten o'clock and since the professor from Dusseldorf was also leaving, he kindly walked me to Mrs. Fink's house.

The scientific programme continued on Tuesday morning with two sets of three lectures, two of which were more accessible than Monday's, so I benefited more from the second morning than the first. In the afternoon I attended the discussion with Arno Penzias. The title of his lecture had been "A classical View of Cosmology" and since I had read a couple of books about the history of cosmology, the subject seemed very attractive. I didn't ask any questions myself but the others didn't hesitate and we had a very good afternoon session.

On Thursday morning there was another round table discussion. Four of the laureates discussed the distinction between fundamental and applied physics. They all seemed to agree that there are many areas of physics that can't be put in just one of the categories and that drawing a definite line isn't possible.

One of the last two lectures was "Supertheories" by Gerardus t'Hooft. I hadn't studied the subject but for me it was the most interesting of the whole conference. I felt very disappointed when I heard that he had to leave before the afternoon session, and again more than pleased when we were told he had delayed his departure by a couple of hours. The discussion was shorter than the others but fruitful, and it had such a great impact on me that it will probably affect my future choice of my major subject.

Friday was dedicated to a visit to the Isle of Mainau at the other end of Lake Constance. It was raining heavily during the boat trip but the rain ceased soon after we had got off the boat. Just before lunchtime Countess Sonia Bernadotte, Professor Riccardo Giacconi and one of the students gave final speeches – Mr. Giacconi underlined that he hadn't volunteered – and after that the conference was officially over. We spent the afternoon on the island and saw butterflies and lots of flowers, and a peacock in a tree. He kindly flew to us after we had waited for (quite) a while.

On the boat back to Lindau I met some interesting people. (How come it always happens in the last hour?) We first landed near the hotel of the laureates and gave them a final big hand. Then the boat continued to Lindau island and the students who hadn't already left by bus on the island got off and said final goodbyes to one other. I left the town next morning and felt surprisingly lonely with all the new friends gone.

On the whole, I really enjoyed the conference and I'm grateful for being given such an opportunity. It came a bit early for me since I hadn't chosen my major subject yet, but thanks to that I got some ideas for the future. Furthermore, it was several months since my physics courses in the university had ended, so I had started to be thirsty for information. The conference gave me a lot of new energy and I hope it will do the same for very many students in the coming years.

Eeva Metsälä, Finland

Cosmology marches on!

European Science week - trial 1

The first Euro Science Open Forum (ESOF) was organised in Stockholm, Sweden on August 25-29 2004. The original idea was to offer a European counterbalance to AAAS (American Association for the Advancement of Science) Science Week. This aim proved somewhat elusive but nevertheless, ESOF offered some four days of interesting debate on present-day and future science and its role in society.

My original reason for participating in the whole event was an invitation by the World Academy of Young Scientists (WAYS) to attend their workshops. I checked the programme more closely, and found it interesting enough to seriously consider participation. After that I had quite a hard time finding a good reason to explain to my boss that I should really take some more days of vacation from my job as Finnish World Year of Physics coordinator and go to Stockholm. The versatile Science in the City programme considerably helped in this purpose and I was ordered to gain lots of new ideas for the outreach of physics.

When I entered the main hall of Stockholm City Congress Centre to attend the opening plenary of ESOF I have to admit I was a bit surprised. I had thought I would meet thousands of people from students to senior citizens, all enthused by science, mostly from Nordic countries. What I met was a more than half empty hall full of formally dressed, English speaking, more or less important looking people and felt myself, on average, some 25 years too young. I was told there were approximately 1500 participants, a fifth of whom were reporters.

European Top Science?

The premiss of ESOF somehow seemed very much unlike its American exemplar. Though I have never attended the AAAS Science Week, the one thing I know of it is that some hot results are usually published during the week. ESOF, on the contrary, seemed to try to balance between cutting edge results and outreach of science, without dazzling results in either.

That I did not hear any top results does not mean there were none, as there were up to twelve parallel sessions to choose between. Usually I would have wanted to be in at least two places at the same time. For a reason, unknown to even myself, I seemed to find my way mainly to sessions discussing outreach of science and science policies or ethics in addition to calling in to sessions from Science for Kids to European Research at the Cutting Edge and everything in between.

Perhaps due to the influence of the main organiser, most of the top scientific sessions discussed neuroscience, health and environment, none of which I found interesting enough to attend. I did listen to a couple of nanotechnology sessions, but the best offerings seemed to be that nanotech should learn from the mistakes of biotech and avoid a re-run of "killer tomatoes with genes" (*). The power of the media over the general public in scientific issues was discussed in these sessions as well as many others. The task of a science journalist is certainly not an easy one.

Diversity of events

Alongside the scientific sessions there were also various kinds of other attractions in ESOF. Among them was, for example, a career programme, arranged jointly with the Marie Curie Fellowship Association (MCFA) and Naturejobs. The career seminars handled topics such as researcher mobility and its obstacles inside as well as out of Europe, mixing family and scientific careers and young scientists' problems.

An exhibition of numerous research institutes, publishers, companies employing scientists and benefactors of science was also present at the conference centre. I learned many new possibilities for future employment and interesting places to visit as well as ways and sources of fund raising.

One of the main themes of ESOF was supposed to be the "Science in the City" programme, consisting of such things as science cafés, small science fairs and "soup theatre" performances in the very heart of the city. The science cafés were a great success, pulling closer to 200 people - more than could fit in the room - to listen to e.g. a lecture on strings, black holes and the creation of the universe. For a physics student it was rather amusing to see how these topics could be made somewhat understandable to the general public, even as concepts if nothing else, by a professor of theoretical physics.

Scientertainment

The social programme for such a huge number of participants was mainly taken care of by arranging scientific entertainment. Each evening there was an interactive, informal happening called the X-Change, arranged according to a convention approved in British Science week. A BBC science reporter, Quentin Cooper, hosted a panel assembling some of the most interesting speakers of the day to discuss the hottest topics. Though gathering only a handful of audience - in comparison to the total number of participants - I consider the X-Change to be one of the most successful events of ESOF.

Another entertaining event, though plagiarised from AAAS Science Week, was certainly the late night lecture by Marc Abrahams, probably best known as the father of the Ig-Nobels. The not-so-short presentation of Ig-Nobel-prize winning research and other topics on improbable research certainly made the audience think after the waves of laughter. What do you think of the man who shared his Ig-Nobel with his Patent Office for patenting the wheel?

Second trial

This first ESOF, "the first pan-European Scientific Meeting ever", perhaps did not succeed as well as it could have. The first time is always the most difficult; in two years the forum will be organised in Munich, Germany, and I hope the organisers of ESOF2006 learn something from the Stockholm event.

Nevertheless, in my opinion ESOF2004 was certainly worth participating in; there is so much more to tell than could reasonably be fitted into this article. I hope to be able to participate in the next one as well, and not to feel conspicuously younger than the other participants. Science needs the young generation, our opinions and views. Why were we not thought to need or be interested enough in the science? These are questions I hope someone will find an answer to, preferably by July 2006.

(*) More than one speaker referred to an interview study concerning genetic manipulation in the UK where some 50% of people believed that normal tomatoes do not have genes.

Milla Karvonen

References:
Euro Science Open Forum:
http://www.esof2004.org/
http://www.esof2006.org/
Euroscience, the organisation:
http://www.euroscience.org/

The mean king problem

Based on Phys. Rev. Lett. 58, 1385,

L. Vaidman, Y. Aharanov.

The story being described in this article happened not many years ago. It involved love, hate, adventures, life hazards, and foundations of quantum mechanics.

Alice was an experimental physicist. She had a collaborator and lover, Bob, whom she had met on ICPS. They used to do experiments together, but then one of them was sent far far away from the other. They both remembered well their experiments, for example those made on a poor Schrödinger's cat. The animal was locked in a box with a decaying atom, a detector, and a portion of a poison. As long as the box was locked, the whole system was in a coherent superposition of a state in which the cat is alive and the atom is undecayed, with that of the dead cat and the decayed atom:

$$|\Psi\rangle = \alpha|alive\rangle_{CAT}|undecayed\rangle_{ATOM} + \beta|dead\rangle_{CAT}|decayed\rangle_{ATOM}.$$

This cruel experiment demonstrates two main principles of quantum mechanics. The first one says that, unlike in classical mechanics, the system can be in a superposition of two distinguishable states. The second brings us to the mystery of entanglement, which allows subsystems to be in undefined (mixed) states, in spite of our maximal knowledge about the whole system, which is in a pure state.

Naturally, when the box is opened, they find the cat dead *or* alive, so the atom did *or* did not decay, one of the two! Also the third rule of the quantum world plays a role in our story: during a measurement a state is being projected onto an eigenspace corresponding to the yielded result. For example, assuming optimistically that the creature survived its stay in the box, the state after the opening was

$$|alive\rangle_{CAT}|undecayed\rangle_{ATOM}.$$

One fateful day, Alice got a scholarship in the institute of Bob, and she took a ship to get there. But while she was crossing an ocean, a great storm came. The ship sank, and Alice got marooned on a remote island. As she took a breather on the beach, people of a king of this island, a great cat lover, caught her. Keeping in mind the profession of Alice and the story of Schrödinger's cat, he "offered" her a game. Every morning she would enter a wonderful quantum laboratory, in which she could do every action. She would leave it for lunch, and in that time, the king's people would do one of three measurements (represented by Pauli matrices σ_x,σ_y, or σ_z)on a qubit (a two-level quantum system). The measurements can give "+1" or "–1" as a result and have the following eigenbases:

observable eigenvalue	σ_x	σ_y	σ_z
+1	$\|+_x\rangle = \frac{1}{\sqrt{2}}(\|0\rangle + \|1\rangle)$	$\|+_y\rangle = \frac{1}{\sqrt{2}}(\|0\rangle + i\|1\rangle)$	$\|+_z\rangle = \|0\rangle$
–1	$\|-_x\rangle = \frac{1}{\sqrt{2}}(\|0\rangle - \|1\rangle)$	$\|-_y\rangle = \frac{1}{\sqrt{2}}(\|0\rangle - i\|1\rangle)$	$\|-_z\rangle = \|1\rangle$

Afternoons she would come back to the laboratory and continue her experiments. During supper, the king would announce which measurement had been done a few hours earlier by his people. As a response, he would like to hear the measurement result. If Alice gives a wrong answer, she will be beheaded immediately.

The important thing about these bases is that they are complementary, or in other words, mutually unbiased (MUBs). Their vectors satisfy the following relations:

$$|\langle +_i|-_j\rangle|^2 = |\langle +_i|+_j\rangle|^2 = |\langle -_i|-_j\rangle|^2 = \frac{1}{2}$$
$$i, j = x, y, z; i \neq j.$$

The expression means that if the system is in one of the states from one basis, we have equal probabilities to detect it in all states from other bases.

One of the interesting applications of such bases is a quantum cryptographic protocol of Bennett and Brassard from 1984 (BB84)(1). In one of its versions, Alice sends to Bob a photon in one of the states

$$|+_x\rangle, |-_x\rangle, |+_y\rangle, |-_y\rangle.$$

He is allowed to make a randomly chosen σ_x or σ_y measurement on it. The emission is repeated a number of times. After the whole series, they publicly discuss their choices of bases. They discard experiment runs in which they have chosen mismatching bases, and they are left with the sign sequence from cases of matched bases, which is known only to the two of them and can be used as a cryptographic key. Eve, an eavesdropper jealous about the relationship between Alice and Bob, may intercept a photon, make one of two measurements as well, and send another photon in a registered state to Bob. But as she has no idea which measurement should be made, in half of the cases her action not only gives her no information about the cryptographic key, but also introduces some error in the data possessed by Bob with respect to Alice's data. She can also mount a more sophisticated attack by partially entangling the photon to her particle, but then she also introduces some error. For security reasons, Alice and Bob sacrifice and publicly compare a part of their secret key. If the error rate is too high, secure communication is impossible.

In general, a full set of MUBs in a given Hilbert (quantum state) space allows us a convenient quantum tomography, an act of a transition between physical source and a density matrix written on a piece of paper. If the dimension of the Hilbert space is d, a density matrix is defined by d^2-1 real parameters. Statistics in every MUB would give us d-1 parameters, so we expect to have d+1 MUBs. Unfortunately, this is only a dream, which, for now, cannot be fulfilled for composite numbers not being powers of primes. For those dimensionalities, scientists have no idea how to generate a full set of MUBs. The good news is that a discrete Fourier transform always leads us to a pair of MUBs. Switching to ordinary vector notation for a moment, the two bases are:

$$a_k^j = \delta_{jk}; b_k^j = \frac{1}{\sqrt{d}} e^{i2\pi\frac{jk}{d}},$$

where

$$0 \geq j, k \geq d-1; \vec{a}^j, \vec{b}^j$$

are j-th vectors of the bases and k denotes their k-th component.

Actually, Alice's first idea was to leave her qubit in an eigenstate of σ_x and measure σ_z when she came back after the royal measurement. Let us see how this system worked. On Monday she was asked about a σ_x measurement, which was easy due to her preparation. A question about σ_z on Tuesday was also simple, because she had repeated that measurement when she entered the laboratory. If the king had only two bases to choose from, Alice would have no stress to face

him. But two is not enough for the mean king. On Wednesday, he was curious about σ_y. Since neither her preparation nor her measurement referred to the respective basis, she could only trust her luck. Thus every evening, she would have a probability equal to 1/6 that she would give a wrong answer. Acting with one qubit only is not enough to win the game.

She was extremely worried that evening, looking for a new, more efficient, or even, if possible, perfect solution of the problem. Looking through the achievements of modern quantum mechanics, she thought of saving herself with cloning.

In biology, by cloning we mean a procedure of creating a living creature, which is an exact genetic copy of another being. Although some differences between copies have been found, both biological clones are genetically identical.

In quantum mechanics, things are radically different. W. Wootters and W. Zurek(2) have proved that quantum information could not be cloned with an arbitrarily low error rate. The proof goes as follows: our cloning would refer to three quantum systems: (1) the system in a state to be copied, (2) another system of equal dimension that will be a copy, and (M) the machine. If we take the initial state of the machine as $|0\rangle_M$ and we clone two arbitrary states

$$|w\rangle_1, |v\rangle_1,$$

we can write the act as:

$$|w\rangle_1|0\rangle_2|0\rangle_M \rightarrow |w\rangle_1|w\rangle_2|1\rangle_M$$
$$|v\rangle_1|0\rangle_2|0\rangle_M \rightarrow |v\rangle_1|v\rangle_2|2\rangle_M$$

Since cloning is a quantum state manipulation, not a measurement, it must be unitary and conserve scalar product. Scalar products of left sides and of right sides must be equal:

$$\langle w|v\rangle_1 \langle 0|0\rangle_{2M} \langle 0|0\rangle_M (= \langle w|v\rangle) =$$
$$\langle w|v\rangle_1 \langle w|v\rangle_{2M} \langle 1|2\rangle_M$$

Even if we make an assumption that

$$|1\rangle_M = |2\rangle_M$$

the last equality can be satisfied only if

$$|v\rangle = |w\rangle$$

or

$$\langle v|w\rangle = 0.$$

Therefore, these states cannot be arbitrary.

An ideal quantum cloning would allow *instant* communication. Imagine that midway between Alice's and Bob's lab there is a source of entangled pairs, and both of them get one half of this pair exactly at the same moment. If Alice wants to send a one bit message to Bob she measures on her particle in one or the other complementary basis and gets a certain, but irrelevant result. Now Bob could make as many copies of a state of his particle as he liked and proceed with a state tomography so that he could say in which basis Alice had measured. However, this is impossible and quantum mechanics remains in agreement with Einstein's general relativity theory.

But some imperfect cloning schemes are possible(3). Alice again sets her qubit in, say, a σ_Z-eigenstate. But when she's back she does imperfect cloning and measures σ_X on one of the clones and σ_Y on the other. She can decide to use the universal cloning machine, given by a transformation:

$$|0\rangle_1|Q\rangle_M \rightarrow \sqrt{\frac{2}{3}}|00\rangle_{12}|0\rangle_M + \frac{1}{\sqrt{6}}(|01\rangle_{12} + |10\rangle_{12})|1\rangle_M$$
$$|1\rangle_1|Q\rangle_M \rightarrow \sqrt{\frac{2}{3}}|11\rangle_{12}|1\rangle_M + \frac{1}{\sqrt{6}}(|01\rangle_{12} + |10\rangle_{12})|0\rangle_M$$

which gives the error rate 1/6, or since in the afternoons the state has a form

$$\frac{1}{\sqrt{2}}(|0\rangle + e^{i\varphi}|1\rangle),$$

she can use the optimal equatorial cloning machine(4):

$$|0\rangle_1 \rightarrow |00\rangle_{12}$$
$$|1\rangle_1 \rightarrow \frac{1}{\sqrt{2}}(|11\rangle_{12} + |00\rangle_{12})$$

which would introduce an error in

$$\frac{1}{2}\left(1 - \frac{1}{\sqrt{2}}\right)$$

cases.

Back-of-an-envelope calculations show that by cloning her qubit Alice raises her chance to give a correct answer to 89% and 90%, respectively. But changing the mean lifetime of a human from 6 to 9 or 10 days is not really impressive!

She therefore thought about entanglement. If she offered the first qubit from a maximally entangled state

$$\frac{1}{\sqrt{2}}(|00\rangle + |11\rangle)$$

as the one to be measured, the state of the whole would collapse to

$$|00\rangle, |11\rangle, |\pm_x \pm_x\rangle$$

or

$$|\pm_y \mp_y\rangle$$

(a pair of upper or lower signs is always taken). At first, two-particle entanglement does not seem to be helpful. We end up with a product of two pure states, but initially we had no knowledge about a single qubit - it was in a maximally mixed state. But a basis of two-qubit states:

$$|\psi_0\rangle = \frac{1}{\sqrt{2}}|00\rangle + \frac{1}{2}(e^{-i\pi/4}|01\rangle + e^{i\pi/4}|10\rangle),$$
$$|\psi_1\rangle = \frac{1}{\sqrt{2}}|00\rangle - \frac{1}{2}(e^{-i\pi/4}|01\rangle + e^{i\pi/4}|10\rangle)$$
$$|\psi_2\rangle = \frac{1}{\sqrt{2}}|11\rangle + \frac{1}{2}(e^{i\pi/4}|01\rangle + e^{-i\pi/4}|10\rangle)$$
$$|\psi_3\rangle = \frac{1}{\sqrt{2}}|11\rangle - \frac{1}{2}(e^{i\pi/4}|01\rangle + e^{-i\pi/4}|10\rangle)$$

can be found and used to construct an observable

$$\hat{A} = \sum_{i=0}^{s} i|\psi_i\rangle\langle\psi_i|.$$

One can check easily, that it allows distinguishing between two states within every pair. Therefore Alice gives the answer to the king's question according to the table below.

Naturally, a game with an *ad hoc* known result is not exciting, because it stops being a game. After a month of hearing correct answers, the bored king decided to release Alice. She could finally reach Bob and they lived happily for some years afterwards.

Marcin Wiesniak
dokmwi@univ.gda.pl

Any questions related to this problem will be gladly answered if sent to the author.

(1) C. H. Bennett and G. Brassard, in Proceedings of *IEEE International Conference on Computers, Systems, and Signal Processing*.Bangalore, India, 1984 (IEEE, New York,1984),.

(2) W. K. Wootters and W. H. Zurek, *Nature* **299**, 802 (1982).

(3) V. Buzek and M.Hillary, *Phys. Rev. A.* **54,** 1844 (1996).

(4) C.A. Fuchs et al., *Phys. Rev. A**56**, 1163 (1997); R.B. Griffiths and C.S. Niu, Phys. Rev. A **56**, 1173 (1997); D. Bruss et al., Phys. Rev. A**62**012302 (2000).*

Royal measurement Alice's outcome	0	1	2	3
σ_X	+1	-1	+1	-1
σ_Y	+1	-1	-1	+1
σ_Z	+1	+1	-1	-1

Click here:

www.iaps.info

As another ICPS has entered history as a roaring success, it is necessary to thank the organisers of the ICPS 2004 in Novi Sad, Serbia and Montenegro one more time. We all had a good time! For those of you still feeling a certain emptiness and longing in your hearts; look at the pictures and start preparing for next year!

A temporary picture gallery from this year's conference can be found at this address:

http://gallery.iaps.info/

ICPS 2005 - When & Where

Next year's conference will be held in Coimbra, Portugal. There are lots of details to be explored already, just go to

http://octopus.fis.uc.pt/~physis/icps2005/.

CERN-trip '05

Have you never been in the world's largest particle physics laboratory? Or you have, but you want to go back once again? Now you have the chance!

Hungary is organising the second international CERN-trip! As last year we will also visit the ESRF in Grenoble.

For more information please contact to Balázs Karcsai at **cern@mafihe.hu**!

The number of the participants is limited so be quick!

IAPS World Year of Physics T-Shirt Design Competition

You might have heard that physics celebrates the 100 year anniversary of the publication of Einstein's three famous papers in 2005. Thus it was decided that 2005 is the World Year of Physics. The goal of the World Year of Physics is to raise the profile of physics and to reach as many people as possible. IAPS thought that a t-shirt worn by physics students might get physics noticed in a lot of places. But what should be on the t-shirt? We are sure that you can come up with a great idea.

That's why we proudly announce the 1st IAPS T-Shirt Designing Competition - and of course there's a **prize** you can win: **a conference fee for ICPS 2005**!

The rules: Your design should be for one side of a t-shirt. The design has to include something that is somehow connected with physics. How you get physics in your design is left to your creativity, but you should remember that the purpose of the t-shirt is to be eye-catching and to make the public aware of physics. If you use images, please respect copyrights and make sure that you and IAPS are allowed to use the image. Also, please, note that usually it's easier to print a design that has a limited number of colours.

Submissions: send your design in a common graphics format (e.g. JPEG, PNG, ...) to **iaps@ iaps.info**.

Deadline: December 1st, 2004

Education in Hungary

Part 1

In the last fifteen years, Hungarian education has been in the midst of continual change. The main problem is that most institutions could not react as fast as was required - that's why some say that the whole sector is in crisis. From my point of view, they are quite right.

Fifteen years ago, very few people were allowed into universities - most failed the entrance exams, only the best were able to pass them (and for several decades, the exams were under strong political influnce). This resulted in higher education becoming a kind of elite education: the professors were able to spend a lot of time with each individual student, so the standards became really high. Colleges (in Hungary, these institutions provide lighter and much more vocational education) were much easier to get in. People who graduated from here usually became teachers in elementary schools or employees in governmental and private organisations, while students graduating from universities were able to teach in high schools or could find a job in the academic area. Finding a job was not a problem for those who could finish their studies in higher education because they were quite few.

However, about fifteen years ago the government realised that new times were coming: many more people were needed to join higher education. The higher educational institutes being fairly independent, the state could influence this matter only indirectly. The finance of universites and colleges became based on the number of students learning there; and since the financial status of the instutitions became more and more dire along with the state of the whole country (and it was much more easy to take away money from higher education than from anything else, they found themselves practically forced to allow in most students).

Of course, it could have ended much better than it did: universities did not change the structure of their education, just let in more students - many of them not capable of meeting the standards. It meant that instead of five years, many students spent six, eight or even more years in the university. The lessons became much more crowded and professors had much less time for individual tutoring. However, the foundation of Ph.D. schools in major universities allowed Hungarian research education to preserve its internationally recognised status to some extent - it took over the elite status of universities.

The main problem with Hungarian higher education is its structure. Since universities were very difficult to get in for a very long time, its prestige is very high, even if graduating from here doesn't mean finding a job promptly after leaving university. Several areas became crowded with young people with a university diploma - which in a lot of cases meant too high standards and too little practical experience. Conversely, there are simply too few people in "higher educational vocational training" (it's a special and relatively new form of higher education concentrating strongly on the practical side of a profession, still on a higher educational level). It is much cheaper than university education and provides a lot of practical knowlege which would be welcomed on the Hungarian labour market.

One of the reasons the higher educational area was not able to respond quickly enough to the challenges is that the whole system is really rigid. Professors teaching at most fifteen students at once found themselves forced to teach forty or sixty, most of them unable to meet the unchanged standards. The instititutions were underfinanced - the government expected them to increase their income faster than they actually could.

And in the midst of this situation came Hungary's joining the Bologna Process. The cyclical educational structure is unfamilar to Hungarian higher education: university and college education are standing alone and are not easy to split up into Bachelor and Master phases: moreover this change is far too fast for this rigid system. Since it is still unavoidable and essential for Hungarian higher education to stay compatible with Europe, it will require an extraordinary endeavour from the institutions. The financing structure has also to be reformed - by the government.

The reforms are united into one large, state project called Hungarian Universitas Project (HUP) - and it also involves the institutional reform of universites and colleges. Currently, the academic staff decide on strategic, financial and educational matters - according to HUP only the latter would stay with them; the first two would pass into the hands of external experts (half of them appointed by the government, half of them by the university). This would result in a more flexible decision-making structure according to the govenment. Now, roughly half a year before its actual start, the mere raising of the idea resulted in a huge uproar amongst the academic staff.

Márk Balás, Hungary

Education in Hungary

Part 2

There are four places in Hungary where physicists are educated: Eotvos Lorand University (ELTE), Technical University of Budapest, University of Szeged and University of Debrecen. Altogether at the four universities, in 2004, three hundred and sixty-one students applied. Out of this number one hundred and sixty people registered for ELTE, so we can say that our university takes most of the applicants. Unfortunately we have negative experience with the statistics because although more than 160 people start university at the first grade only fifteen percent are able to get a degree at the end after the five years. You can ask, then, why do these universities give places to so many students? The reason is that they get a relatively high amount of money for each individual. They get this money in one sum that is enough for the five-year education of the particular student and the money stays in the possession of the university even if the person is fired.

The five-year-long education is made up of two parts. During the first three years you can acquire the basic mathematical and physical knowledge which is essential for further studies and research. The most difficult year is the third one, and people say that after finishing it, nobody can be deprived of his or her university degree. In the fourth year you have to choose two special fields. There are many possibilities including astrophysics, materials science, molecular physics, nuclear physics, particle physics, solid state physics and statistical physics. Fifth-graders have to choose between the two fields and have to continue their studies at only one of them.

There is also the possibility of doing Undergraduate Research (TDK) or Scientific Study Circle. The Council for Undergraduate Research (or TDK Council) supports students' extracurricular research activities by giving a framework to voluntary student-teacher partnerships established spontaneously for specific research projects. The main event of the TDK is the biannual National TDK Conference which is organised in several Sections at various institutes of higher education (i.e. universities and colleges). The annual forums of the TDK are the so-called House-Conferences which are also organised at the levels of sections and subsections. The winners of such conferences are awarded by the Dean of the Faculty on the Eotvos Memorial Day held on or around May the 11th, every year. Some of the best lectures are also repeated there in front of a wider audience.

It is not really common for foreign students to come to Hungary and study here because the university does not have too many lessons in English for them. However, it happens sometimes because some of the lectures are easy to follow without proper language skills, due to their being full of deductions.

We usually recommend Ph.D courses for foreigners instead. Many professors write out such programmes in different areas like 'Material Science and Solid State Physics', 'Particle Physics and Astronomy' or 'Statistical Physics, Biological Physics and Physics of Quantum Systems'. The university also has several departments. These include the Departments of General Physics, Solid State Physics, Atomic Physics, Theoretical Physics, Biological Physics, Physics of Complex Systems, and Astronomy.

Our beloved association, the Hungarian Association of Physics Students (HAPS, Mafihe) was established in 1988. Mafihe is a non-political organisation that is meant to help maintain the level of physicist education and international connections. Accordingly,

If you want to know what's happening in this picture, you should read the article!

members of Mafihe are mainly from the faculty of physicists, physics teachers, astronomers etc. We organise a lot of interesting programmes, like competitions, excursions etc., and we can provide remarkable subsidies for participants. Mafihe is an association of public utility since 1998. Our most important effort is to make the students' five, six or even seven years (this is the function of the failed exams...) unforgettable.

Mafihe is a national committee with four local committees located in Debrecen, Szeged and two in Budapest. These are the Local Committee of ELTE and the Local Committee of Physics-Engineers, and you can only apply for membership if you have your studies in physics or in other related subjects.

The main forum of Mafihe is the General Meeting. The Constitution can only be changed there, and it makes decisions about personal questions of the board and the Control Committee. The Control Committee supervises the work of the Management and the local committees. Each local committee has one seat on the National Committee. General Meetings take place twice a year, and the National Committee every second month. We have another decision-making organisation which is the Central Committee. Its main task is to look after the day-to-day running of the association.

Let's take a look at our programmes!

Our greatest event is the trip to CERN. This year for the first time we were able to organise an international excursion. Apart from the Hungarians there were Finnish, Polish and Austrian people and we also met students from Geneva. We visited the ESRF as well. Altogether we can say that we had a really good time during this trip.

We organised a cultural exchange programme in the Netherlands, which gave some of us the opportunity to visit Amsterdam and Eindhoven, and we could host Dutch students in Budapest. We shared each others flats, food (and women as well :)) for five wonderful days. We are planning to make other such programmes and we really hope that others might feel willing to join us in organising them.

The association has experimental as well as theoretical competitions. The most important of the experimental ones is the NYIFFF (Open-air Funny Exercises for Physics Students). Within this competition the participants have to solve interesting and funny physics-related exercises on the beach of Hungary's greatest lake, the Balaton. Another such competition is the FIVE, the Competition of Physics, which is held in Szeged.

One of the theoretical competitions that is worth mentioning is the Ortvay Problem-Solving contest. It is organised internationally, therefore the solutions and the tasks that should be solved are sent by mail. It is for individual competitors.

The highlight of the year in the life of Mafihe is the famous (or infamous?) freshmen's camp that is held in the last week of August. During this week we conquer the high and slopy mountains of Hungary while having fun, discovering new places and building new connections with future groupmates at university. This camp is totally different from the camps of the university's other departments as we are sleeping in tents and having different villages' fields as sleeping-places every night. We have a tradition that makes the life of the camp much more funny every day. This tradition is the system of the 'teasing tickets'. If you are given such a ticket, that means that the previous owner of it can make you do anything that is still moral and yet not serious and has some connection with the drawing of the ticket. For example: if you have a 'Romeo ticket' and you give it to a boy, you can ask him for instance to climb up a tree and sing love songs to one or even more girls. Other tickets are related to wood, tents, or food, etc., giving a wide range of creative possibilities for the participants. You can also take part in the Olympics of Fuzer (a little village in Hungary) where the main sports event is cramming into a hollow tree. This year the world record was broken: five people could manage to get inside the trunk!

Zsuzsi Kordai, András Zsom, Hungary

Netherland-Hungary cultural exchange

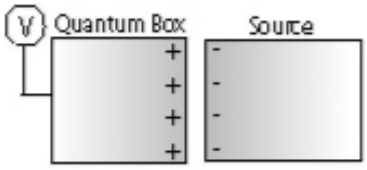
Introduction to Single-Electron-Tunneling devices

Introduction

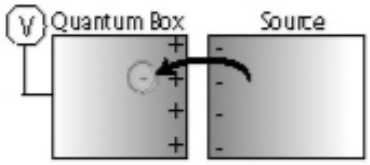
Following the "international roadmap for semiconductors" electronics will continue the miniaturisation trend for at least 15 years, in order to achieve higher and higher clock frequencies. This implies that the conduction channel length of conventional transistors will reach the de Broglie electron wavelength within the next 5-6 years; so engineers will need to deal much more with quantum mechanics in the near future than they did in the past. The challenge for miniaturisation could be won by adopting a new paradigm of computation, or a completely new electronic architecture for classical computing. Most of the innovative "nanodevices" on the solid state domain seem to exploit the known effect of "single electron tunnelling", as gaining control of a single charge can lead to fast manipulation of charge occupation states (the tunnelling time would theoretically allow us to build processors that could reach hundreds of Teraherz of clock speed) and to a very small dissipation of energy (a theoretical limit of 10^{-8} W for a typical device).

Single electron tunneling

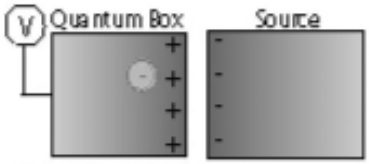
But how can we achieve control of single electrons? By exploiting a mesoscopic effect known as "Coulomb Blockade". The idea is to confine the electron in a zone with a small electric capacity so that the electrons can tunnel one at a time. In fact if the zone contains one electron, the electrostatic repulsion will be such as to prevent a second electron from "jumping". The picture shows a basic device: the single electron box. The box can be represented by a metallic grane (island) weakly coupled with two metallic leads. The tunnel barriers can be modelled like a two armors classical capacitor, so that a charge in the box will increment the energy of the system by $e^2/2C$. If the capacitance is small, this energy is significant and the process becomes energetically favourable only if the potential difference applied is sufficient. In practical terms, when the potential difference polarises the armor plates with a charge difference Q of less than e/2 (it is possible as it is a field effect!) the tunnelling is forbidden as it would increase the energy of the system. If it is sufficient to give Q=e/2 there is degeneration of the two states (electron to the right, electron to the left) and so tunnelling is triggered and the situation is returned to the same as before the tunnelling!



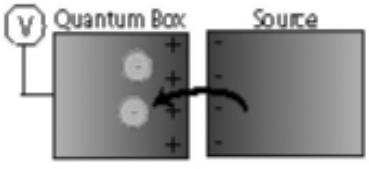
In the initial status of the quantum box the polarization charge on the junction is not sufficient to let an electron pass



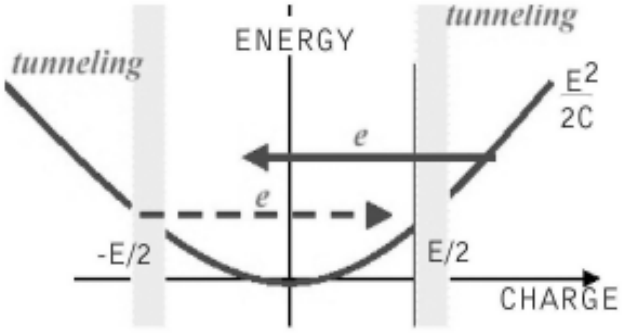
When the tension is sufficient (e/2C) there is degeneracy between the state with the electron in the source and the state with it in the box.



Once the electron has tunneled and the tension raised V=e/2C+ , if it is not discharged the situation is exactly like the beginning



If the tension is raised to e/C a second electron may pass as it will bring the system to the inital state (+ if we want to leave the electron in the box)



Single electron transistor

A normal field-effect transistor (FET) is a very simple device, conceptually. It exploits a p-n junction and a gate electrode in order to stop or trigger the flow of electrons. What's more it can act as an amplifier: the current scales linearly with the gate voltage under certain limits (saturation).

The corresponding single-electron device is the Single-Electron-Transistor (SET). A SET is basically an electron-box with an entrance and an exit, the incoming electron can be discharged by making it tunnel into a second metallic conductor. We can thus control the tunnelling rate by applying a tension between the box and the leads. In fact, the energy window determined by the electrochemical potential of the two leads would allow the occupation of a certain known number of charge states in the box.

In the picture there is a typical implementation of a SET that uses a semiconductor substrate polarised by some confining electrodes in order to make the island. The discrete energy spectrum of semiconductors is an additional feature that must be taken into account when we want to understand the flow of electrons (the available energy states must deal with the spectrum and the coulomb blockade, the resulting discrete steps of conductance represent the so-called "coulomb stairs").

Some application and details

Controlling single electrons is essential for building several elementary devices (single electron trap, single electron pump, single electron memory) for the future Single-Electron Logic that promises to replace the current electronics. Single-Electron transistors are very sensitive to nearby charges and so could be used as very precise electrometers. They could find striking applications in solid-state quantum computing as well. Unfortunately if we want to make all these simple devices work we need to create very cold environments as the energy associated with the charge tunnelling ($e^2/2C$) must be greater than the thermal fluctuations kT. This implies that either we make the island incredibly small (so that we have a small C) or we work under the 1 kelvin limit. Current technology doesn't allow capacities smaller that 10^{-15} F but room-temperature SET could possibly be achieved by integrating them into a single molecule. Some work has successfully been done in that direction.

Bibliography

Herman Grabert, Michel H. Devoret, Single Charge Tunneling. Coulomb Blockade Phenomena in Nanostructures, NATO ASI Series B, Vol. 294

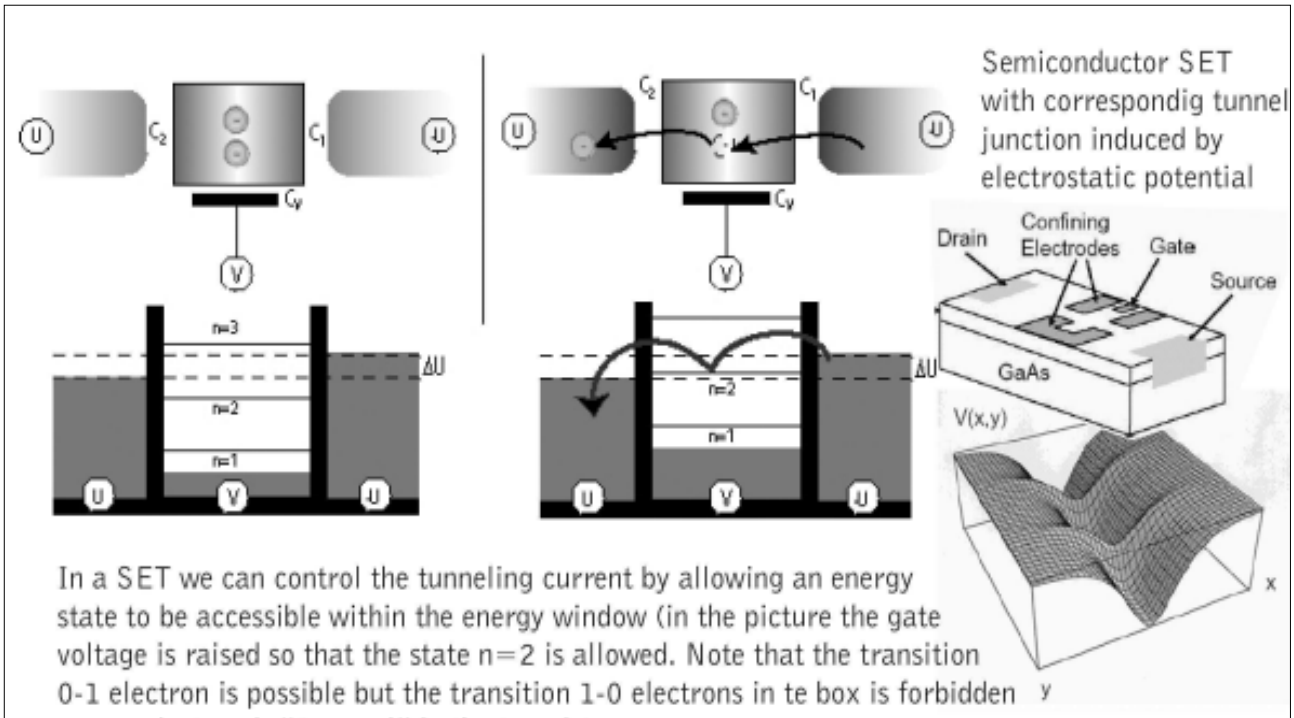
Lydia L. Sohn, Leo P. Kouwenhoven, Gerd Schon - Mesoscopic Electron Transport - NATO ASI Series E, Vol. 345

D. K. Ferry, S.M. Goodnick, Transport in Nanostructures - Cambridge University Press

S.M. Reimann and M. Mannien, Electronic structure of quantum dots - Reviews of modern physics, volume 74, october 2002

K. Likharev, Electronics Below 10nm (2004)

Davide Venturelli



In a SET we can control the tunneling current by allowing an energy state to be accessible within the energy window (in the picture the gate voltage is raised so that the state n=2 is allowed. Note that the transition 0-1 electron is possible but the transition 1-0 electrons in te box is forbidden so one electron is "trapped" in the transistor.

Physics in an uncelebrated society

Letter

As the year 2005 approaches, the Physics community hopes to make a dynamic impact on the public as it celebrates the World Year of Physics.

The Physical sciences are a fundamental part of the science world, yet little does society appreciate the contribution of Physics, despite its tremendous contribution to society. Physics is a significant backbone to other fields like medicine, economy, industrial sector, biology, chemistry, engineering, information and communications technologies etc. For example, if Physicists like Zernike, Ruska and Nomarski had not developed and invented various more precise microscopes, what would Microbiologists work with? Also, recent developments in Magnetic Resonance Imaging (MRI) have made a significant contribution to the field of medicine.

In our own part of the world, however, Physics is rarely embraced. The genesis of this problem is the decreasing interest of youngsters in the subject, even though Physics is a prerequisite for most science studies, including natural sciences, computing, medicine and health, earth sciences etc.

It is shown that 15% of primary school pupils have a passion for calculations, while the remaining percentages only study to pass. Pupils aged one to seven years need amusing stories to engage their minds with counting or doing calculations. The psychological methodology of teaching calculations requires the incorporation of analogy into the teaching mode. *The youngsters need to see what they are told.*

It is revealed that only 60% of high school pupils have a basic understanding of mathematics even though it is a core subject, while a disappointing 17% of school pupils have a basic understanding of Physics. The factors responsible for the aforementioned include the mode of teaching the subjects, ambiguity, diversified interest, inadequate facilities, and the state of society.

In this part of the world, scientists are not reckoned with, let alone Physicists. There is a feeling of inferiority on the part of Physics students. There is also an impression that Physics is a difficult subject to pass. Research has shown that fifteen out of fifty pupils study sciences in high school while 2% of science pupils intentionally apply to study Physics in tertiary institutions. This cuts across universities, colleges of education and polytechnics. The orientation of pupils is to become an Engineer, a Doctor, Computer Analyst, an Accountant, a Banker or Business professional; this is because it is their belief that it is only this class of people that are recognised in society. A pupil might even be calling himself an Engineer right from primary school. Applicants would rather choose to study these so-called *famous* courses than studying Physics; most applicants take Physics as the last resort when no place of study is available in the *famous* courses.

The nonchalant attitude of the authorities has made things worse.

The question is, who will boost the morale of the youngsters towards Physics? A concerned mind will ask: when will an African win the Nobel Prize in Physics?

In other parts of the world, Physicists have contributed to the development of their society because of the opportunity to put theory into practice. Hardly does a minute pass without a new discovery in Physics. The human race will soon venture into the new age of nanotechnology, continuing the wonder of science. The way we look at the world continues to change because of what we continue to discover. John Von Neumann once said "man wants to know; when he ceases to do so, he is no longer man". There is no secret in knowledge, it involves ideas and creativity. The recognition of the risks to humanity brings about development to avert those risks.

Africa should see the year 2005 as a unique opportunity towards making the public aware of the importance of Physics and also the unique opportunity to influence the future of Physics by stimulating young children's interest towards studying the subject, so that there will be a purposeful dedicated progeny of Physics.

The present state of Physics could be addressed by: provision of facilities, simplifying the course modules, promoting researches, funding, aid and grants availability, improved state policies towards Physics, and integration of Physics into decision making that affects Physics.

I have a vision of a greater nation, a viable Physics community, with a professional Physics career. And world acknowledged African discoveries. I definitely look forward to a day when an African will be proclaimed the winner of the Nobel Prize in Physics. Then I will be glad because Physics is glorified.

Yomi Akintola, Ibadan,Nigeria

The Physicists' March of Mafihe

To the tune of *John Brown's body lies a-mouldering in the grave*

Hear Ye! Hear Ye! Come hither and hear of our great exploits!

We're the most beautiful out of all the multitudes
We're the most cheerful guys out of all the multitudes
We're the most enlightened out of all the multitudes
And the most humble of all!

You can go through the needle's eye seven times,
Can be as important as a condom on the night-
But still you can't come close to the good old physicist!
'couse physics is the BEST , the BEST, the BEST !

Canst thou integrate a P.D.E whenst it aproacheth a great singularity ?

Don't know how to integrate, so only perturbate[1]
And assuming of convergence might be a mistake.
But we create a new world with our every word and line.
So I'd say we're doing fine!

Should I be a particle or should I be a wave?
And if I were a dead cat then just how should I behave?
I need to find the answers and I need to find them now
But I really don't know how!

And thou shalt knoweth the simplest of physical systems!

Harmonic oscillator, hydrogen atom[2]
Whether there is anythin else, oh how could I know?
But if there's anything else, I don't give a sh*t -
That's a perturbation hit!

Should I be...

Hast thou heard of the might of Schrödinger's Equation?

Whether you take ICPS[3], beer or anything,
The Schrödinger's Equation will clarify everything!
Though, Feynman says we're missing the Moral and the Pig[4]...
(It's) just a perturbation hit!

Should I be...

"The next question was - what makes planets go around the sun? At the time of Kepler some people answered this problem by saying that there were angels behind them beating their wings and pushing the planets around an orbit. As you will see, the answer is not very far from the truth. The only difference is that the angels sit in a different direction and their wings push inward." -Richard Feynman

What knowest thou of the connection of physics and engineering, the expansion of the universe, the might and beauty of this lyrics, and generally, this whole [...] lot?

From the table of my knowledge all engineers are fed,
Space expands to make room for the thoughts inside my head!
At my command the world turns 'round and nuclei decay,
So, only one thing's left to say:
Should I be a particle or should I be a wave?
And if I were a dead cat then just how should I behave?
I need to find the answers and I need to find them now
But I really don't know how!

[1] The pornographic version cannot be regarded as authentic!

[2] To tell the truth, the H atom can also be viewed as a 4 dimensional harmonic oscillator...

[3] May be replaced by other events, eg. Nation's Party, trip to Belgrade, etc.

[4] See Feynman, R.P.:The Feynman Lectures on Physics.

Published by Dávid Gyula et al.
Translated by James T O'Connor (NC UK), Bruck József, Kövesárki Péter, Patay Gergely, Serényi Tamás (ICPS2002 OC). Further thanks to Emily Cook, and, for the last verse, to Jim Grozier (ICPS2004).

Q: How many general relativists does it take to change a light bulb.
A: Two. One holds the bulb, while the other rotates the universe.
Q: How many quantum physicists does it take to change a lightbulb ?
A: One. Two to do it, and one to renormalise the wave function. (Explanation - Renormalising the wave function is something that has to be done to a lot of quantum physics calculations to stop the answer being infinity and makes the answer always come out as one.)
Q: How many quantum mechanicians does it take to change a light bulb?
A: They can't. If they know where the socket is, they cannot locate the new bulb.
Q: How many Heisenbergs does it take to change a light bulb?
A: If you know the number, you don't know where the light bulb is.
Q: How many astronomers does it take to change a light bulb?
A: None, astronomers prefer the dark.
Q: How many radio astronomers does it take to change a light bulb.
A: None. They are not interested in that short wave stuff.

THE INTERNATIONAL ASSOCIATION OF PHYSICS STUDENTS

IAPS is an international student-run association seeking to promote peaceful relations among physics students around the world. Through exposing physics students to the international community and helping them to build professional relations we are fostering a collaborative attitude amongst young physicists across the globe.
Our biggest event is the legendary International Conference for Physics Students ICPS where more than 300 physics students get together every year to share scientific results as well as having a fantastic time making new friends from all over the world.
To find out more about IAPS, ICPS and the rest of our activities visit our webpage:

www.iaps.info

Or contact us at iaps@iaps.info.