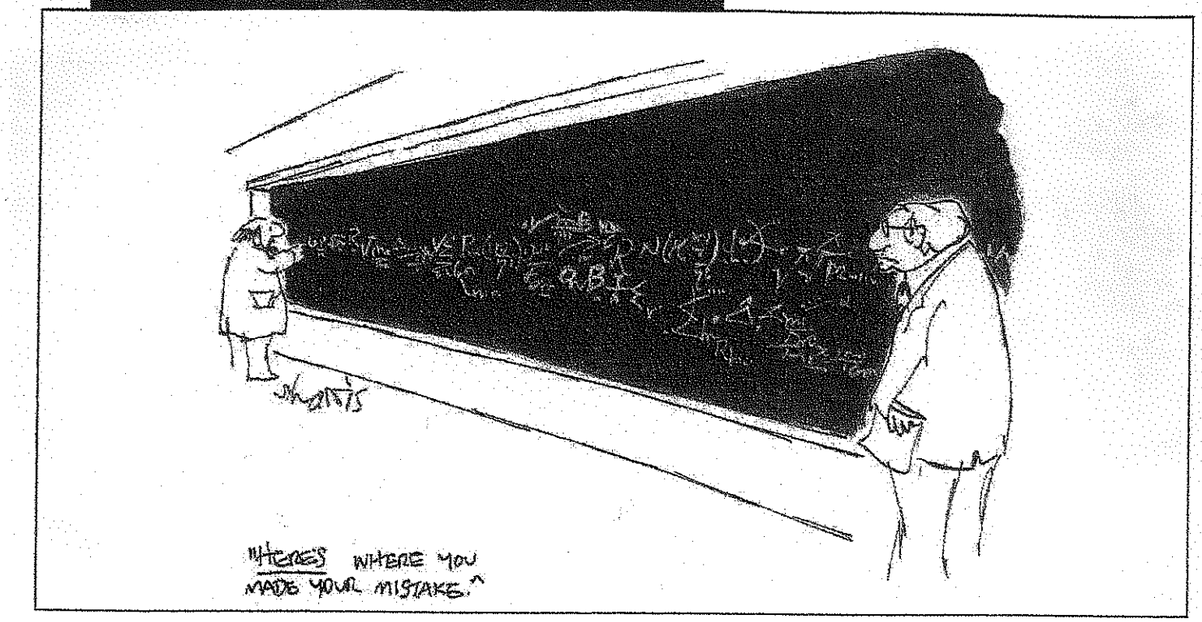
Physics Humor



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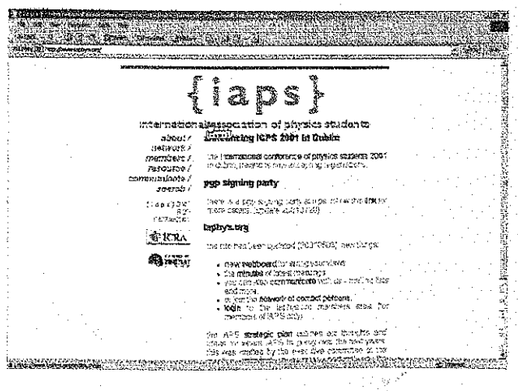

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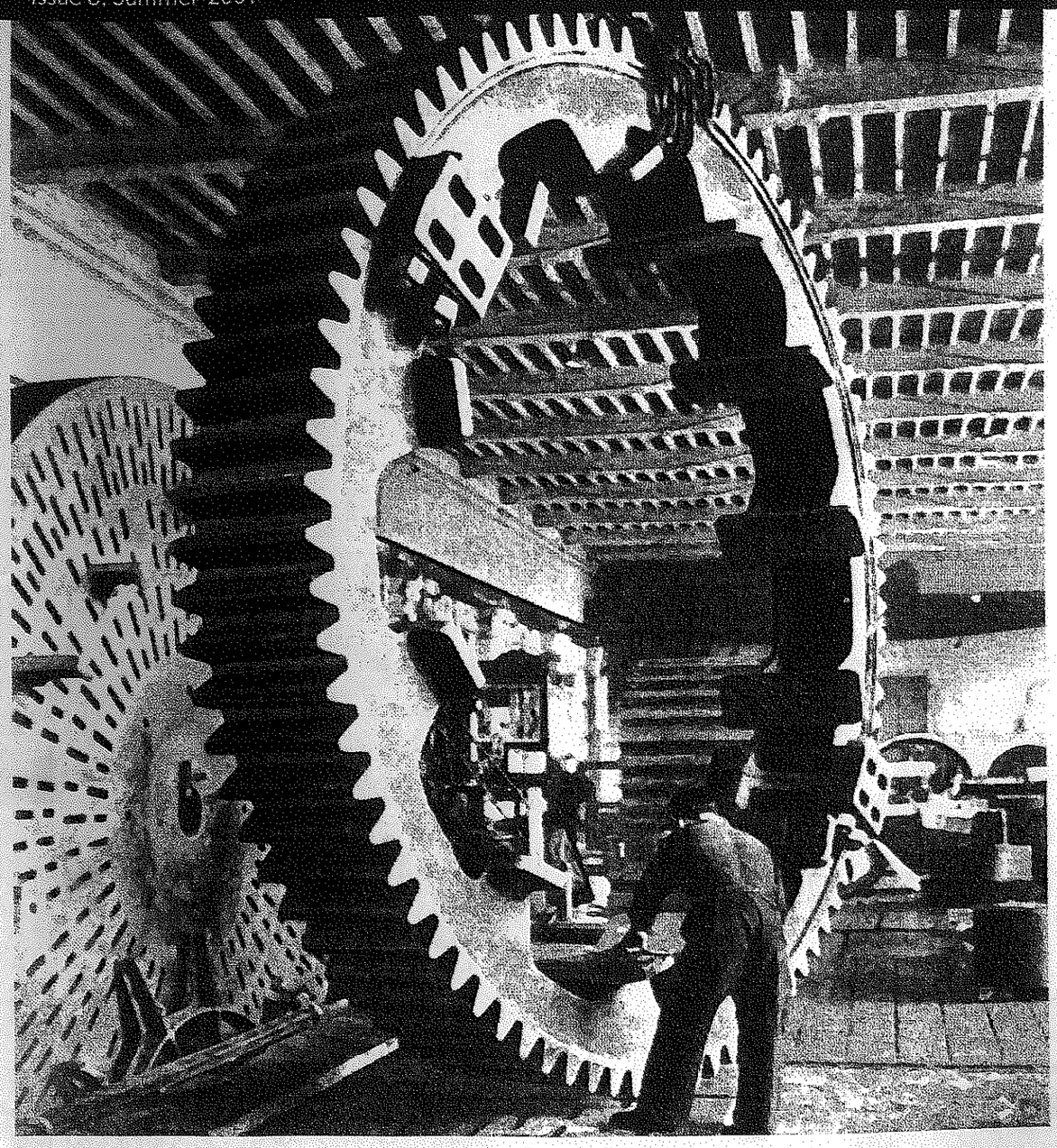
The Journal of the International Association of Physics Students

Issue 8, Summer 2001



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The Editor

Hello,

as JiAPS editor, I'm entitled of writing a few words for you. I will start to present myself: my name is Hugo Natal da Luz and I am from Coimbra, Portugal. In the last IAPS General Meeting during ICPS 2000 in Zadar, Croatia, I was honoured of being responsible of one of the most important information tools of IAPS. I felt this big weight on my shoulders, but I found it a really interesting challenge! However I didn't realize how dependent a JiAPS editor is on the participation of all members: on one hand those who will read the journal, on the other hand those who contribute with some material. In a very short way I would specially like to thank all those who gave me some kind of contribution for this issue, not only the authors, but also those who gave me ideas and hints.

In this journal everybody is invited to write, so come on! Sit at your desk and start writing. Why not about your university? Why not about your studying-abroad experiences? Why not about the research work you are doing? We need more active participants in JiAPS. It is up to you to raise this number.

That's what the JiAPS is. Changing ideas and experiences. That is one of the big aims of IAPS. And with JiAPS we can do it!

I'm sure you are all anxious to read the journal, so I will just finish telling you that it is really gratifying to participate in this way in such an association like IAPS and that IAPS is waiting for you.

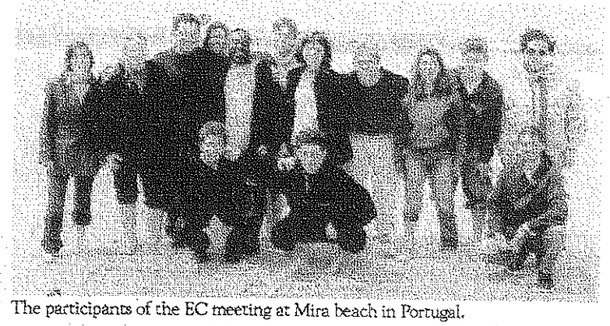
Regards
Hugo (hugo@gian.fis.uc.pt)

Summary

Printed by Instituto Português da Juventude
Delegação Regional de Coimbra

Front page picture taken from "A Ciência do Século XX"; Pierre Rousseau; Publicações Europa-América

Patrícia Antónia Maduro, president of IAPS



The participants of the EC meeting at Mira beach in Portugal.

Dear Colleagues,

During this last year I've been with IAPS, I've worked with several people I'd like to introduce to you in this article. I'm going to speak not only about the Central Office, which is constituted by me (Patrícia Maduro), by David Fial and by Pedro Isidoro, but about all of the Executive Committee, the set of people that keeps the structure of IAPS working.

I got to know IAPS in 97, when some colleagues from Lisbon, already in contact with it, came to my city, Coimbra, and convinced us that this would be the perfect city to receive ICPS'98. After a lot of discussion we decided to accept and, after making a presentation in Vien, we organized ICPS here in Coimbra. That week linked me to IAPS and greatly motivated me to be a part of this organization.

I find it remarkable that, when a set of people gathers together to participate in one of IAPS' activities, they do so in such a healthy and enthusiastic way, that these moments always seem too short.

My closest co-workers are Pedro and David. Pedro was in the ICPS'98 organizing committee and is now the treasurer of IAPS. David participated in ICPS'98, though he was still a freshman, and is replacing Ana, who unfortunately, due to her work, couldn't continue as secretary.

Although I don't know particularly well the other members of the Executive Committee, I would like to, at least, speak a little about their work with IAPS.

I'll start with the Exchange Coordinator, whom everyone knows. Major Marton is the previous president of IAPS and, in his present function of Exchange Coordinator, represented IAPS at IAESTE Conference, where he signed a protocol that promotes the interchange of physics students through that organization.

Our official Past President, who helps with opinions and advices, is Michael Pienn from Graz.

The JIAPS' Editor is Hugo Natal da Luz. He also participated in the organization of ICPS'98.

This year, the best-known persons in IAPS are, undoubtedly, Brian MacLochlainn and Julia Maddock, who are organizing ICPS'2001, where we are all going to meet soon. Julia and Claire Blay are this year's Fiscal Counsel's dynamic duo.

George Ofori-Boadu is probably the next president of IAPS, which would mean that IAPS would have, for the first time in its history, an office in America.

Last, but certainly not least, I would like to talk about our Internet coordinator, Ivan Stegic. It isn't easy to describe all of his contributions to IAPS because, not only did he build our much anticipated server, but also got an independent IP for our association, created IAPS' new web page and created our new symbol. He has been permanently involved in all of IAPS' affairs.

Although Stephan [..] was not elected at the General Meeting, he created our new Network of Contact Persons, which has been shared with EPS.

With this article I wanted, above all, to show that behind this organization there is, not only the ICPS' organizers or the members of the Central Office, but an entire set of persons with various functions, that maintain and protect the proper functioning of IAPS.

Before finishing, I would like to speak to you about what I believe will be the most important steps IAPS needs to take in the future.

The registration of IAPS is scheduled for the end of the summer and will take place in Mulhouse, France. After that, IAPS will be able to start applying for funding from the UE and from International Organizations. This will provide the necessary stability and independence IAPS needs to continue its international expansion.

I also think that it's extremely important for IAPS to implement new relations as the ones we have with EPS, EUPEN and IAESTE. Although, for these kinds of collaboration to thrive, it's essential that IAPS' executive structure and IAPS' members collaborate with each other in a productive way with common objectives and practical results.

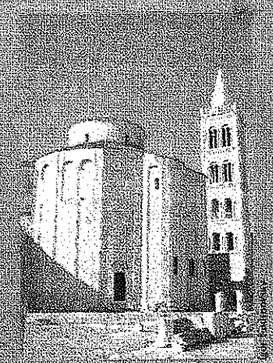
As member, I would like to whish you a rewarding relation with IAPS. I hope everyone benefits from the work I have tried to develop in IAPS and that IAPS continues to grow in size and scope at least as much as it has been growing until now.

Patrícia Maduro

Our world...

The Zadar Manifesto

In order to clarify the events that led to the creation of the Zadar Manifesto this will include a summarized history of IAPS, and a description of ICPS. The items in the manifesto itself will be discussed in further detail later in this text.



IAPS is a non-governmental association run by students for students and recent graduates in physic, though its activities are open to other students interested in physics. It was created in the wake of the first International Conference for Physics Students: this conference was a success, leading to a second one where a charter was signed, creating IAPS. The IAPS's principal objective is to encourage physics students in their scientific and professional work in an international context as well as to promote relations between physics students from all over the world. It also aims to supplement their education with an international scientific experience. There are 18 European and American National and Local Committees affiliated to IAPS though individual members are allowed. Its most important activities are the organization of training periods for its members, visits to Universities and Research Institutes and the annual Conference, the ICPS.

The International Conference for Physics Students (ICPS) is the annual conference of IAPS. Every year, one of the IAPS committees organizes ICPS in a different city.

The ICPS has many different aims, which make it a unique event for Physics students, giving them the opportunity to meet physics students from other countries, present their work to an international audience and hear news from many different fields of Physics.

During ICPS 2000, in Zadar, a round table was formed: on one side, the invited speakers and two young physicists, on the other, the ICPS participants. The topic of the discussion was "Young Physicists in the aging physics community: Where is the perspective?" and it was organized so that participants could send questions to the table. This event, unprecedented in ICPS's history, gathered an impressive number of students from around the world (approximately 250). Some concerns from young physicists and students were repeatedly brought to the attention of the group. These concerns were viewed as important by the majority of the participants and it was suggested that they be made public, leading, upon consensus and unanimous approval at the General Meeting of IAPS, to the creation of the Zadar Manifesto.

The topics in the manifesto might be better explained thus:

1) Uncertainty in the future of young researchers

1.1) Lack of long-term security

Most young (and not so young) physicists wishing to make a career in fundamental research won't be received in a permanent job reasonably early in their careers. On the contrary: they will probably be forced to jump from scholarship to scholarship, from institution to institution in order to sustain themselves and their families. The scholarships are often too short to provide any stability in the lives of the researchers (typically 6 months to a year) and there are frequently distressing periods of wait between scholarships (either because the scholarship as yet to be approved, or because it starts long after the end of the previous one).

One of the more uncanny aspects of this problem is

that researchers are frequently still in this precarious situation at an age that would allow their entry in a permanent staff in other professions.

There have also been reports stating that the increase of research funded by governments is jeopardizing the funds for fundamental research, by forcing the reallocation of funds that would usually go to fundamental research.

1.2) Inability to express creativity due to lack of autonomy

The general opinion is that this problem starts in the courses themselves because the student's creativity is often not stimulated. One way in which this happens is the highly theoretical approach of some institutions and the highly standardized/rigid practical approach of others (though there are distinguished exceptions).

As far as the actual research is concerned, it is frequent that research is organized by one or two senior researchers who usually don't have time or are otherwise unable to evaluate the younger participant's opinions and creative thoughts. The only exceptions are those research groups were the general research options are discussed in frequent meetings in which the young researchers can express opinions that are subsequently analysed by the entire group.

2) The needs of physics students are not met as:

2.1 and 2.2) Students emigrate in search of better research conditions and aren't able to remain in their preferred field of research.

Some students in many countries will have to complete their studies in other countries in order to develop their skills in their preferred field of research. When these studies are complete, many of those students won't find in their country the structures necessary to work on the field they've studied, even though this would contribute to the development of research in that country. This means they will have to emigrate and that the next student will be met by the same situation.

In other cases research requires funds that are prohibitive for any single country, forcing international research ventures that may not be able to absorb all the interested students, if those ventures even exist that is.

Please, reply to the President of the International Association of Physics Students: **Patrícia Antónia Maduro IAPS (care of Physis) Departamento de Física Faculdade de Ciências e Tecnologia da Universidade de Coimbra 3004-516 Coimbra Portugal e-mail: pmaduro@ci.uc.pt**

THE ZADAR MANIFESTO

After discussions at the Round Table of the XV International Conference for Physics Students, held from August 4th to August 11th 2000, in Zadar, Croatia, we, the members of the International Association of Physics Students have concluded that:

I. Young physicists wishing to continue their career in fundamental research are uncertain about their future. This uncertainty is expressed in the following:
- the lack of long-term security, and
- an inability to express creativity, due to the lack of autonomy given to undergraduate students, post graduate students and to postdoctoral researchers, during their academic careers.

II. The present system of physics education is not able to satisfy the needs of physics students. These needs are not met as:
- many students are not able to remain in their countries to perform high quality research, and
- many students are not able to remain in their own preferred field of research.

We would welcome feedback and support from the addressed institutions on the issues that we have raised.

Circulation list:
European Physical Society and its National Member Societies
European Union/Commission Of The European Communities
UNESCO
IUPAP
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Submitted for publication to:
Europhysics News
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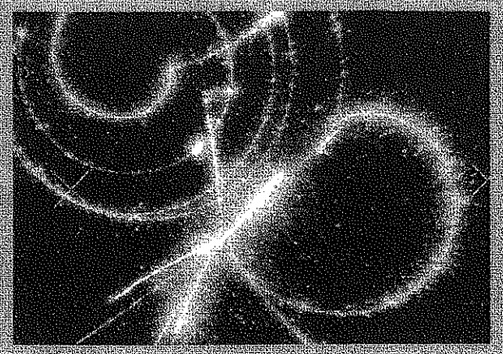
Physics Today

IAPS Activity..

The IAPS Trip to ETH Zurich, PSI and CERN

"(...) let me introduce myself, my name is Stephan Witoszynskyj and I study physics at the Vienna University of Technology (Austria). I have been quite active in IAPS and the local physics students society at my university for some years and for some reason I became 'IAPS Trip to CERN Organiser' last fall. (...)"



It seems that one of the tasks of someone who organises an event for IAPS is to write an article for JiAPS. Well, I am not very good at writing, but it seems that I have to, because no otherwise there would not be any article about the IAPS trip to ETH Zurich, PSI and CERN. But first let me introduce myself, my name is Stephan Witoszynskyj and I study physics at the Vienna University of Technology (Austria). I have been quite active in IAPS and the local physics students society at my university for some years and for some reason I became "IAPS Trip to CERN Organiser" last fall.

Before I tell you more about this great trip (I think the participants enjoyed it very much), I want to clear up a common misunderstanding that students have concerning student societies: often I have heard questions like "why doesn't your society organise this or that event". Well, it seems that people forget that those who are organising events are students like themselves. And any event needs someone who organises it, therefore the more students get involved in doing something the more they will be able to participate in excursions or whatever. It's the same for IAPS events, IAPS can only be as active as it's members. So if you think that it would be cool to see, for example, DESY or ILL than think of organising a trip yourself and write an e-mail to the IAPS lists - it is not that much work. If you are organising an activity for your local student society, think about taking some students from other countries with you and there will be another IAPS activity -that's the way how the trip to ETH Zurich, PSI and CERN got started.

Let me start at the beginning. How did I end up being the "IAPS Trip to CERN Organiser"? It happened last fall. I think it happened one day in the morning while I was taking a shower. Well, I usually claim to have good ideas under the shower to have an excuse why I use the shower that long sometimes (it is really a good place to think about things) and because I often do not remember when a idea came into my mind. Somehow the thought that it would be really cool if the local physics student society organised a trip to CERN and some other research institutes like the Paul Scherrer Institute (PSI) for the physics students at my university (I think I had this idea because I would have liked to visit PSI once). So I talked to some friends and everybody agreed that it would be a great idea and that we should do it. Then a second thought came across my mind, "hey, there was no IAPS trip to CERN organiser for 2000/2001 and it wouldn't make that much difference to take some international students with us". The others agreed and I wrote an e-mail to the IAPS list saying that I would be interested in organising the IAPS Trip to CERN. That's how I became the "IAPS Trip to CERN Organiser". You see it is not difficult to get involved at all and that's the way IAPS activities start.

At some point, I do not remember how and when, I got into contact with the physics students society at the ETH Zurich (Eidgenoessische Technische Hochschule Zuerich -Swiss Federal Institute of Technology Zurich). One of their leaders, Paolo Losio, agreed to organise the trip with us and to be responsible for the visit to ETH Zurich and PSI. So the whole thing got started and finally we all arrived in Zurich on April 17th.

In the weeks before it turned out that the interest in the trip was huge and only those who signed up first could participate in the end our group consisted of 49 participants from three different countries (Austria, Germany and the Netherlands). Among the participants there were first year students as well as students who were just about to finish their master's degree.

The programme was quite dense. Because the majority of the participants arrived early in the morning the Swiss decided to organising a city tour and a visit to the Accelerator Mass Spectrometer (AMS) of the ETH Zurich for them. Actually it turned out that all but the German group arrived early (they got lost in Zurich). So almost everybody saw the AMS. In the evening a small welcome party with lots of food was organised. The food was a Swiss speciality - no, it was not fondue - it was Raclette. I am not sure how I can describe it, basically you heat up a special cheese until it melts and than you eat it - it tastes wonderful, at least if you like cheese like I do.

The next day we spent at PSI. PSI is a world famous Swiss research institute where research in many different fields is done. Although the institute is financed by Switzerland, research groups from all over the world are doing their research there. We visited the neutron spallation facility, the new synchrotron radiation facility SLS (Swiss Light Source) and a department that is involved into research of alternative energies (solar power, fuel cells, biomass, ...). The PSI is an amazing place and all Austrians became extremely jealous, because one could see what a small country can achieve if there is will. Although many of us would have liked to stay there longer, we had to go back to Zurich. But a party helped us to get over it in the end.

On Thursday we had to get up very early - I really mean very early. To explain the reason I have to tell you a little bit more about our accommodation. One of the major goals while organising this trip was to make it as cheap as possible. Which was not that easy, because Switzerland is quite expensive. The consequence was that we took the cheapest accommodation that was available - no, it was not under a bridge - civil protection shelters. Switzerland is full of public civil protection shelters, because if you build a house you have to build your own shelter or pay for a place in a public shelter. The result is that 99% of the Swiss population can be put into shelters. To help financing this system of shelters groups can rent a shelter at an extremely low price. Of course they are not very comfortable and one has to clean them up at the end of the stay. But hey, we are students, we are not supposed to be able to afford fancy hotels and we are happy if we can save some Euros. So we had to get up early to clean up our shelter before we visited the ETH Zurich. Afterwards there would not have been enough time, because we had to catch our train to Geneva. At the ETH we were able to see many different research groups. I am not going to count them all and to describe what we have seen. It would take to long, but I can assure you that you missed something.

Geneva - another shelter. Actually this shelter was a little bit nicer than the one in Zuerich. The walls were painted in different colours instead of being plain concrete, but this time we did not have separate beds but there was one mattress next to the other. It reminded me a lot on skiing trips. The next day we had an official CERN tour and met an old friend. Our CERN guide turned out to be Patrick Degion, whom some of you might know from an ICPS or from one of the IAPS Trips to CERN that he organised - that was a huge surprise. The programme of CERN visits is very different from what they used to be because of the shut down and dismantelling of LEP. I wonder what they are going to be in future, because it will not be possible to access LHC experiments due to the high radiation levels. We were shown the assembly hall and pit of the CMS (Compact Muon Solenoid) experiment as well as the control room of the SPS and LEP/LHC accelerators. CMS is one of the two future multi purpose LHC experiments and although it is called compact it is huge (well, compared to the other experiment, ATLAS, it is compact) Thanks to my supervisor we were able to see the test beam installations of the ATLAS experiment on the next day.

Afterwards we had to clean our shelter and to say good bye to everybody, because it was time to go home. From what the participants told me, I think that everybody enjoyed the trip and had a great time. As far as I am concerned I am really happy that the trip was a success and it was a great experience to organise it (I needed some sleep afterwards though). Once again I want encourage you that if you think that visiting a place would be a great idea and no one else is organising a trip, do it yourself it is not too much work and it is worth all the effort.

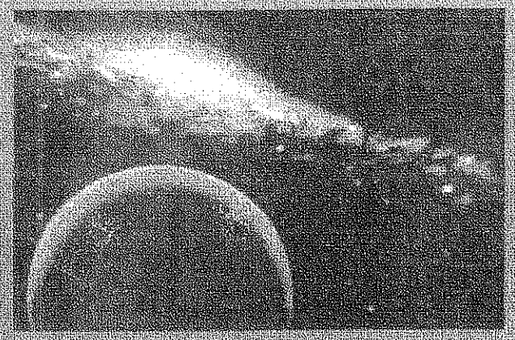
Stephan Witoszynskyj

About Physics...

Contact: "A Stimulating Relativistic Acurate Trip"

Luisa Velho Arruda[1], Paula Stella Teixeira[2]
Faculty of Sciences, University of Lisbon

"*Imagination*
is more important than knowledge,
knowledge is limited,
Imagination encircles the world."
Albert Einstein 1879-1955



The purpose of this work is to provide a short digression or discussion of the physics underlying Carl Sagan's book "Contact". We will focus on how the Message was transmitted and on the possibility of relatively rapid interstellar travel for human beings through wormholes, in the words of Kip Thorne, "a stimulating relativistic accurate trip".

The Message consists of a radio signal originating from the neighbourhood of Vega (a star 26 light-years away). It carries encoded information and, we assume by hypothesis that this signal travels through a similar type of wormhole as used by the daring characters of the book.

Interstellar travel

WHY BLACK HOLES CANNOT BE USED

Following the book "Contact", the Message contained information on the construction of a machine that would allow humans to travel to Vega. Carl Sagan's first thought was to use black holes as the means for this voyage. Nonetheless, he discussed it over his friend Kip Thorne, a cosmologist from Caltech, to verify its plausibility.

It turned out that Sagan's initial idea had to be dismissed by a number of reasons. Any black hole is continuously bombarded by tiny vacuum fluctuations and by tiny amounts of radiation. These get accelerated during their fall by the black holes gravity, blue shifted and so more and more energetic. The voyager is thus subject to a lethal shower on his journey - if he happened to survive the tidal pull experienced at the horizon of the black hole.

At the horizon of a black hole of mass M, tidal gravitational forces produce enormous relative accelerations between the head and feet of a voyager of length L, accelerations with magnitude

$L(2GM/c^3)^{-2}$ which is approximately $(10g)(L/1m)(M/10^4 \text{ solar masses})^{-2}$.

Survival, at this point at least, is possible only if the black hole is more massive than 10^4 suns, thus having an horizon of circumference $4\pi GM/c^2>$, which is larger than 10^5km.

Another point against using black holes is that, since they are a one-way membrane, a two-way travel would render impossible. Things can fall in but nothing can emerge. Even in one-way travel the object at the other end, from which the voyager emerges, cannot be a black hole. It must be a white hole - an even more bizarre object!

But all was not lost, Thorne came up with a better solution for Sagan's problem: wormholes.

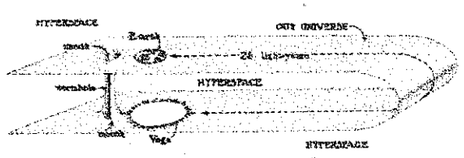


Fig. 1: Embedding diagram representing a wormhole (not drawn to scale). Travelling throwgh space-time in our universe the luminous path would be 26 light years, whereas through the wormhole the path is much shorter.

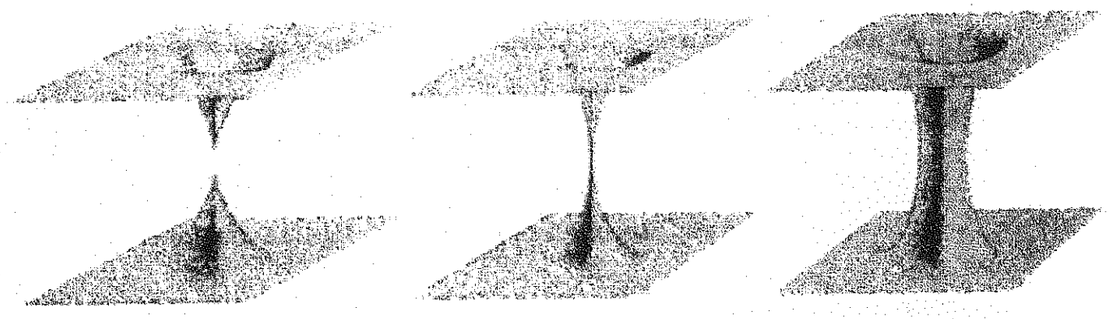


Fig. 2: Dynamical evolution of the Schwarzchild wormhole

WORMHOLES

Wormholes were first discovered as solutions of Einstein's field equations in 1916 by Ludwig Flamm. In 1935, attempting to construct a geometrical model for an elementary particle, Einstein and Rosen stumbled again on wormhole solutions, the so called "Einstein-Rosen bridge". However, the wormhole solutions stayed dormant and forgotten until the '50s when Wheeler started working on them. The field, if we may call it so, received the final boost with Sagan's problem. A wormhole is a hypothetical shortcut for travel between two different regions of space-time.

The wormhole has two entrances called "mouths", in this case, one near Earth and the other in orbit near Vega, 26 light-years away. These mouths are connected by a tunnel, whose minimum circumference is called the "throat".

It's possible to visualize a wormhole through an embedding diagram, which idealizes the space-time as having only two spatial dimensions. In this diagram the wormhole's mouth is represented by a circle so in a 4-D space-time it would be represented by a sphere. The mouth would look something like the spherical horizon of a nonrotating black hole, with one key exception: the horizon is a one-way membrane as explained above. By contrast, the wormhole's mouth is a two-way membrane, it can be crossed in both directions

SCHWARZCHILD'S SOLUTION

Sagan's fiction required a transversable wormhole, so Flamm's initial solution, Schwarzchild wormhole, had to be discarded. A Schwarzchild wormhole is dynamical, as time passes it expands from zero throat circumference (two disconnected universes) to a maximum circumference, and then recontracts to zero circumference (the universe again disconnected). This process is so rapid that even moving at the speed of light, one cannot pass through the wormhole without being cut in the crunch of recontraction and being killed by tidal gravitational forces.

So what are the traversability conditions?

TRAVERSABILITY CONDITIONS

- In order to simplify the calculations, a spherically symmetric and static metric has to be used;
- The Einstein field equations must be obeyed everywhere;
- The solution must have a throat that connects two asymptotically flat regions of space time;
- There should be no horizon (it would prevent two-way travel);
- The wormhole has to have small tidal forces;
- The time necessary to travel through the wormhole has to be reasonable from the point of view of both the time traveller and the people outside the wormhole;
- Any radiation effects has to be minimal
- The stress-energy tensor must be physically reasonable;
- Stability of the solution in face of small perturbations is also required;

In order for a wormhole to maintain its stability (and not pinch off or collapse on itself), it's necessary to resort to exotic matter. This exotic matter would have to thread the wormhole's throat, pushing the wormhole's walls apart. Why does this matter deserve the name "exotic"? It is quite different from any material have ever met. The inward pressure on the tunnel is so great that the matter needed to

counteract this pressure has to exert an outward tension comparable to the pressure at the centre of a neutron star (1014gcm-3). This means the radial tension has to be greater than the total density of mass-energy of the wormhole itself. In other words, the exotic material must have a negative energy density as measured in the reference frame of an observer travelling through the wormhole at a velocity very near light speed. Exotic matter violates several energy conditions imposed by important theorems.

ASSEMBLING OF A POSSIBLE WORMHOLE

Another issue to be discussed about wormholes is how they originated. Sagan avoided this puzzling question by bringing onto the stage an infinitely advanced civilization, one whose actions are limited only by the laws of physics and not at all by lack of know-how. An interesting way to construct wormholes can be imagined, a quantum strategy that relies on gravitational vacuum fluctuations. This is random, probabilistic fluctuations in the curvature of space caused by a give-and-take of energy from adjacent regions of space. In a region the size of the Planck-Wheeler length, 1.62x10-33cm or smaller, the vacuum fluctuations are so huge that space, as we know it "boils" and becomes a froth of quantum foam. Quantum foam is everywhere, inside black holes, in interstellar space, in this issue of JiAPS, in your brain. Since the quantum foam is everywhere, the infinitely advanced civilization could find a tiny wormhole in the quantum foam and try to enlarge it to macroscopic size.

This is a partial exposition of our work, which is by itself, a first approach of the physics involved. The complete text can be found at http://www.fis.fc.ul.pt/~df23425/contact/contact.html

ACKNOLEDGEMENTS

We would like to thank our professors, namely, Prof. P. Crawford, Prof. N. Marques, and Prof. J. P. Mimoso. Our thanks also go to Patricia and Hugo for providing us an opportunity to have this work published.

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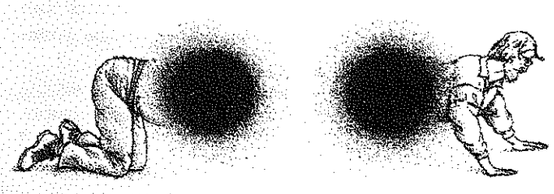
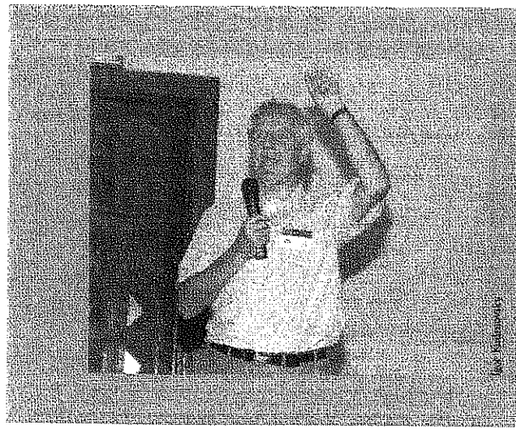


Fig. 3: Once these conditions are guaranteed, Kip Thorne can safely pass trough the wormhole.

Fig. 4: Embedding diagram showing quantum foam.

Interview with...

Professor Arnold Wolfendale



This interview was conducted by Patricia Maduro (IAPS President), Brian MacLochlainn (ICPS 2001) and Julia Rose (Nexus Rep), during ICPS 2000 in Zadar, Croatia.

ICPS, Zadar, August 8th

In which field do you think physics will surprise us most in the 21st century?

In my own field, by definition!

Any big developments that you are expecting?

To be quite serious, I think that this search for extra-terrestrial intelligent life could well throw up some surprises, and I imagine a period, which may start quite soon, when signals may well appear, which some people will think correspond to intelligent life. There will then be a very long period of argument, which may or may not reach the conclusion that there is intelligent life. My own views on this will be made clear at 8.30 this evening.{Sir Arnold gave a lecture on this topic during the ICPS conference}

Do you expect that we may see a repeat of the little green men situation & the pulsars?

That's the worst case scenario; that's right. To be more serious, I think the whole area of astronomy and astrophysics is one where you can almost guarantee surprises. The business of how did the solar system form? Its not at all obvious; there are competing theories and in a sense its rather necessary that we find out, just how we came into existence. In the whole area of star formation, as to how stars get rid of their angular momentum and the magnetic field problem with stars. Then going further back, how did galaxies form? How did the different types of galaxies come about? Then of course there is the origin of the universe. Are there more universes? What about the anti-matter business? The anti-matter problem is by no means solved. The whole area is full of exciting possibilities.

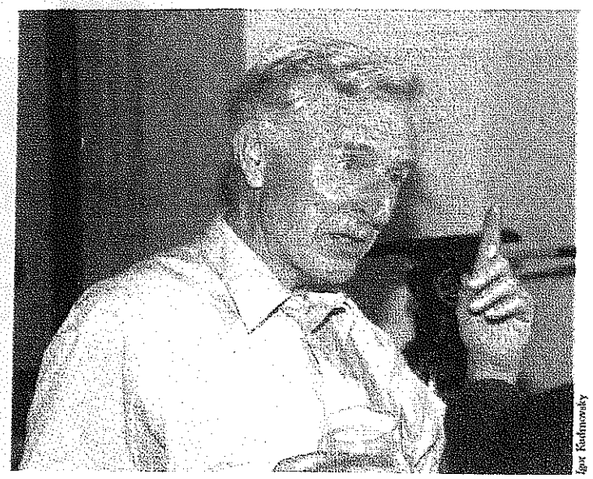
Do you agree that industry should invest and support more connected research so that it is financially supporting Universities more?

Well this is a difficult one. I think industry could and should do rather more, not so much by supporting projects but by supporting people. I remember in my youth, the ICI supported so-called ICI fellowships and these were awarded to young physicists or chemists, who were left to do whatever research they wished. So it wasn't the projects they were supporting, it was the people and I think that there is a great need for more support for people, as distinct from the projects.

Now the difficulty with projects and industry, is that so often industry wants a particular job doing and they see universities as providing a cheap solution. So I am against the use of industrial money on any large scale for research. I think there is nothing for it but increased government support. It is governments that are supposed to be having the long-term view and providing the science base for a country. Of course they do quite a lot of it, but I think they could do more.

Do you think that industry shouldn't be a driving force behind funding because of ethical concerns over the direction of research?

No, not ethical concerns. I wouldn't regard these as ethical. Problems to do with the type of research, whether it should be blue skies research with no obvious practical application or whether it should be tied to particular industrial needs. You see years ago, most industries belonged to research organisations of their own which they funded and if they had problems, these research institutions solved them, that was there



Igor Kudrinsky

job. Of course if the company was very big, it had its own research laboratory but as time has gone on, they've done away with these and they feel that so often universities can do it for them. Well that's all right up to a point, but its getting a bit away from the main idea of basic university research which is to follow the hunches and the ideas of individual men and women who want to find out about things. That's the way science has always progressed in the past and I can't see any reason why it should change in the future.

Following the round table discussion do you think that we can train other professional such as economists and physicians to think and solve problems the way that a physicist does, so that this would reduce the percentage of physicists going into other areas not related to physics?

Well that's a rather mixed question, in a way. I'm not against physicists going into other professions. I think its very healthy for physics and very healthy for these other subjects. It's just a question of balance. How many go one way and how many go the other. The main requirement, it seems to me, is that people who work hard, who train, get their degrees and so on, should have the possibility of a satisfying and reasonably well paid career. And if they wish really in their hearts to stay in university research or research in some other institution in physics, good, we should make every effort to provide this possibility. On the other hand if they want to earn a lot more money, and go into finance or economics or whatever, so be it. If they want to go into politics, go that way, if they want to go into the civil service, go that way. There's a need for people, as you mentioned at the beginning, trained in ideas in physics in these professions. But I think one has to be a bit careful, it's so easy to be carried away with this view that physics and physicists can solve everything and anything. It's always much more complicated than that in real life, as I mentioned last night.

There seems to us to be an ambivalence to the fact that in many countires young physicists don't get financial support to stay in their own countries to do high quality research, and on the other hand if they try and leave then there own country won't be developing scientifically, so they are stuck with an impasse. What do you feel about this?

Well I have a simple view and that is that the senior physicists and other scientists in these impoverished countries, they have a duty, helped by physicists from elsewhere to work on their government to improve the funding of science. If you take a country like Croatia, the amount of money that goes into basic scientific research is something like 0.03% of the GDP (gross domestic product); well I don't believe that is a figure given by God that can't be changed. I think surely it can and should be increased, so what I'm saying is that the students who go abroad from these countries to do their higher degrees or perhaps even to act as postdocs should have the possibility of returning home to achieve their potential there. We in the developed world, such as Germany, Britain and America and one or two others, do not do these countries a service by siphoning the best brains off, we have a responsibility to ensure that they can go back, can return with dignity and try and help improve the science in their own countries.

You mentioned 0.03% GDP is given to science research, a cross-reference do you have any figures for comparision, such as what they would be in Britain and what the ideal be (and don't say 100% of GDP)?

No? Well the ideal figure is 99%, no, in Britain the equivalent figure is 0.3%, in other words, ten times and even that is considered by many (not just me) to be too low. If we look at America, it's higher, Japan, its higher, Germany, its higher and there are some other countries too, where its higher. But the senior scientists in these countries of central and Eastern Europe should stand up and shout and scream about these matters. I have to be a bit careful about what I say, but it's a bit disappointing that they don't do quite as much of that as one would hope. For example, we have in Britain, 'Save British Science', an institution, funded by its members (people like me) who pay a small amount each year and they work all the time, bringing to the government time and time again how funding is inadequate etc, etc. There's no reason why in every democracy there shouldn't be something equivalent. Its different if you are in a totalitarian state, if you are in China say, where you can be clapped in prison if you do this kind of thing. No doubt in a place like this (Croatia), you'd get in to a bit of trouble. But if you've made your career, a bit of trouble is neither here nor there. I think you owe it to the younger people, personally.

Do you think it is just a question of funding that drives people to other countries or do you think that there is an issue of prestige as well, as by travelling abroad you can go to renowned institutions?

Well, prestige certainly comes in to it. But the two are not diametrically opposite as I mentioned earlier. A young person can go abroad to do a higher degree or postdoctoral work and visit all these great centres and so on and get some ideas, but then go back. And endeavour to put their own country on the map. I mean these prestigious institutions in America in Britain or wherever, they've all been made by individuals. They didn't suddenly appear out of nowhere, its individual people and often the émigrés from other countries who are crucial in starting these prestigious groups. But – why did those émigrés go? Usually it was not economic matters, it was religious persecution or it was a political persecution, or in some cases, such as in Ireland as I mentioned last night, it was the fact that they were starving. There were very, very good reasons in those days for people going, but in my view the reasons nowadays have far less validity; there are far fewer of that type.

With regard to PhD students, do you have any suggestions as to what can be done to prevent students being used as essentially slave labour, doing the dull processing work which stifles their passion for physics research?

Yes, I do. Again I suppose it's an example of paternalism or something. The older you get the more paternalistic you become. I have this feeling that there ought to be a research students or research assistant's charter; such that the supervisor accepts a student or assistant more particularly, to work with them. Then that person has a responsibility to look after the career (or the initial parts of the career) of the person who is his slave, because let's face it, not all of course, but many supervisors benefit more from the students efforts (or more particularly the research assistants). Well the student gets his or her PhD, that is a reward isn't, that is good.

I think the slave part comes later with research assistants, people who've not got tenure, they've not got permanent jobs, but they are being used as number-crunchers or whatever and that is where I think the supervisor or the head of the group has a heavy responsibility. Now this is coming and I know many universities have people whose job it is to provide career guidance, but as usual, we're a bit late in this direction. It was much easier in my day, because jobs were much easier to find. There wasn't the same need to help people, but now there is a need and that of course is a difficult problem, because the supervisors are by definition older. They probably got their jobs much more easily than the contemporary people now, the present generation, will be able to. So that they are living, I'm afraid (or we are) living in the past, where as you are living in the present.

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Science and physics have a very bad public image. Would you agree that scientists have partially brought this on themselves by in the past being very secretive and aloof and not keeping people informed as to what they are doing, and trying to avoid admitting any mistakes until its too late?

Well I'm not quite sure, whether your first statement is completely true. Some areas of science have from time to time a bad image, but I think that on the whole the image is not too bad. But such bad aspects as we do have in the public eye, the problem can indeed be laid at our door. It's our fault, I suppose. It's a lack of the scientist understanding of the public. As I mentioned in my first talk, the responsibility scientists should have is for making sure that the only science that is conveyed to the media is science that is well thought through, high quality science that has been judged to be reasonable by one's peers. You only have to look at some of these problems, such as cold fusion and the recent genetic manipulation issues. You'll find that the problems there stem from scientists that release their work to the media before it has been peer reviewed and you can be damn sure that had it been peer reviewed, it would have been thrown out. And this led, in the case of Genetic Modification, to the unique situation of the Royal Society (a UK body of senior scientists) issuing a statement protesting about the manner in which the research had been released, as it had not been peer-reviewed and the media had accepted it. But the media are always looking for a cheap story, an exciting, exotic let's beat the scientists story.

Sorry wasn't there a case where peer review didn't work at all – supergalactic string theory?

I think that there is a distinction between the sort of exotic science that one reads about or one can publish with respect to astronomy or a number of subjects of that sort, where

the only impact is on the human excitement, reaction and so on, where there is no impact on the physical wellbeing of people or the financial status of people. If you take GM, there is a potential, serious effect on humans, so you have to be very careful. If you take cold fusion, there would have been a most profound effect on the financial well being of countries by way of fuel/energy resources. What I'm saying is you can make a complete hash of astronomy but be very careful in these other areas.

Do you think that a scientist's oath or code of practice would help this situation?

Funny you should say that… Yes, its true that's its difficult to engineer, but I don't think that should stop us trying. Indeed, I do know of a number of groups now, particularly our American colleagues are staring to get interested. Something I have put forward in various places, following Joe Rotblatts to get an international meeting in Budapest to put forward his view, but I like to think (don't we all?) that my version is superior (because it's later). In this version of mine, the oath would be of two parts. One would be that you don't do anything in your research that knowingly is to the detriment of the human race and secondly (and this is the important extra, that I've not seen referred to, through it may be) that you have a continuing duty, for the rest of your life, to watch what use is made of work you have contributed to. And if it turns out, because you can never predict, that your research was an integral part of some terrible weapon or other, then you have a duty to stand up and shout and scream, tie yourself to railings or whatever. And I think this would make not only a lot of people think twice about doing these things, but a lot of governments think twice about following certain directions.

As an experienced lecturer yourself, what tips would you offer to someone trying to prepare a lecture?

I suppose what one would say is look around and think about the good lectures you've heard and try and use some of the ideas, I do endeavour to codify as you may have read in EPS news {Newsletter of the Eurpean Physical Society} what one should do.

And this follows the word HICCUP.

H for humour

I for incompleteness to get across the idea that we don't know everything

C for controversy, nothing better

Another C for Culture, if you can bring a bit of culture in, you usually can. It's a hackneyed word, but you know what I mean, none-science, a bit of history or even play some music. When we go on these cruises, I usually nowadays play at bit of music part way through or at the beginning or end or all three. Its another dimension and people are interested in it.

U for understanding, you've got to try and get a bit of understanding across, because usually the topic you are talking about is hopefully something people can understand. Certainly in my area.

P – our beautiful physics. Amen.

What do you think the students have got out of this week (ICPS 2000)? Would you recommend (and if so how heavily) for other students to come along in future years?

I think that what the students get out of this is not talking to old fogies like me but talking to one another, sharing experiences and giving their own talks. I must say I've been very, very impressed, by the care students have taken, their professionalism. There has never been any sort of joking about it or tittering and all the rest of it. They've really taken it seriously. And the subject matter has been interesting; the techniques that they have adopted have been uniformly good. I think the students also get quite a bit out of the new physics that they've heard, they get something out of hearing other people speak and thinking 'hey that's a good idea – that's a nice way of putting it'. And if they've also given a talk themselves, they get a feeling of pride, and so on.

But I do feel, as I've said elsewhere and as I've said to the officers [of IAPS] what I do really feel you should do, is produce a document and some sort of resolution that you can all argue about at your final meeting. If you did that, the prestige of this meeting (which is already high) would go even higher. There are an awful lot of physics students out there who are not here. They would think "hey – these people are working on our behalf; we ought to give them a bit more support and go to the conferences or whatever". And you'd become a sort of power in the land. Now you might say, oh my God we don't want to be that, but you have a responsibility to act as a powerhouse for change in the subject. There is a lot of wisdom from the students from all sorts of countries, who see the subject from different perspectives and encounter different problems, as well as some common problems, so I think you've got it going for you.

Patricia Maduro
Brian MacLochlainn
Julia Rose

Studying in...

Coimbra in an exange program

Leslie Baldwin is a Canadian student from Vancouver. In this past year she choosed to study in a different country, to meet new friends and to get in touch with new culture. Let's see what she has to say about her impressions.

Ten months ago I stepped off the train in Coimbra, Portugal after travelling 38 hours from my home halfway around the world in Vancouver, Canada. I was hot and tired and ready to take in a years worth of experiences in Portugal (after a good long nap anyways…)

It has been a wonderful year of new people and ideas, different flavours and melodies and a plethora of sights and emotions. In terms of academics, I have had to adapt to new teaching methods including less homework, more discussion, more theory and along the way, I've had to learn a little Portuguese, the language of instruction.

While I didn't, in general, find my classmates overly friendly (partly due to my communication difficulties in the beginning…) the professors I encountered were both welcoming and helpful. All of my professors were either young, female or young and female, a welcome change to the over 50 male bracket professors I was used to at home. Teaching appeared to be just as important as research.

After a few months the sounds of Portuguese began to sound a little more familiar and I was able to pick up a few ideas in the classes instead of just relying upon the English texts I was reading at home. Probably the most valuable part of my year in terms of education was the opportunity to learn physics simply for the sake of learning physics. My marks here have little significance at home so the philosophy that what I learn is more important than the marks I get – a philosophy that often gets lost in the stress of the weeks leading up to the exam – was more easily adhered to. Moreover, the pace of the university system in Coimbra is such that there is much more time to review and to "digest" the concepts learned in class than there is in Canada. If you didn't get it the first time (and I often didn't, given that the first time was in Portuguese) then there is still time….

But nonetheless important, it was a year full of other non-academic experiences. Weeks of classes are punctuated with holidays: national, religious and school, and given my status as an exchange student I felt I had more freedom to 'invent' holidays as well. Instead of studying on the weekend, or "reading" during reading week, we took impromptu trips to Lisbon, and to the beach, we went camping and hiking in the mountains or discovered villages tucked away off the beaten track by foot or bus or bike. I learned of Fado music, and saudade, of the flavours of Portuguese cooking and the layered history of tradition in Coimbra; I've learned of home and I've learned of myself.

My mixed feelings about coming here last September have been replaced by mixed feelings about returning home, but I guess that's the best I could ask for. I still love home as home, but I've made connections to and grown fond of another place too.

Leslie Baldwin