Foreword

This is the handbook for the 14th International Conference for Physics Students (ICPS'99), which was held at the Department of Physics, University of Helsinki, during 14th - 20th August 1999.

The conference was organised by an Organising Committee nominated by IAPS Finland r.y., which is the Finnish National Committee of the IAPS (International Association of Physics Students), and Resonanssi r.y., which is the association of physics students at the University of Helsinki.

Approximately 250 physics students from 39 countries attended the conference. The participants gave a total of 59 lectures and presented 45 posters representing various fields of physics.

A Proceedings of some of the papers presented was also published in the "University of Helsinki: Report Series in Physics".

This handbook contains both abstracts of all the lectures and posters and practical information about the conference.

We thank all the authors and hope that you will find this useful during your stay in Finland

On behalf of the ICPS'99 Organising Committee,

Tomi Salminen,

ICPS'99 Publications Coordinator

The Organising Committee of ICPS'99

Antti Lauri (chair), Annikka Hyttinen (vice-chair), Veera Vainio (secretary), Johanna Airaksinen, Tommi Bergman, Anssi Collin, Marcus Gustafsson, Kristian Jaakkola, Lauri Laakso, Ilkka Rinne, Walter Rydman, Tomi Salminen, Mika Sirviö, Anne Tuukkanen.

ICPS'99 Publications volunteers

In addition to the Organising Committee, the work done by the following volunteers has been invaluable in the creation of the Conference Handbook and the Conference Proceedings:

Erja Keränen, Risto Kuusterä, Vesa Muhonen, Sanna Sipilä.

More information on ICPS'99 can be found at the conference web site:
`http://www.physics.helsinki.fi/iaps/icps99`

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Chapter 1

Conference information

1.1 Greetings

Dear ICPS'99 participant,

It is great to have you here in Helsinki with us. I hope this conference will be as enjoyable for you as the previous ICPS's have been for us.

If you are an experienced ICPS participant, you know what to expect. If you are a first-time participant, I'm sure you will notice the various aspects of the ICPS during the next week - and even during the following years. It is not just lectures and posters. It is not just parties and other social events. It is not just getting acquainted with a new city. It is all this and much, much more. Making friends with colleagues from all around the world and exchanging opinions and experiences are things that will show their full value during the years, as life passes by. ICPS is a great opportunity to understand the world a little bit better.

As I'm writing this, the conference is still four weeks ahead. We have now worked for almost a year and a half for the ICPS'99. Most of the arrangements are ready, but there is still a lot of work to do. But I'm confident that we will get everything done and the conference will be successful.

We wish to thank our supporters, sponsors and partners:

The Department of Physics of the University of Helsinki, The Rector of the University of Helsinki, Ministry of Education Finland, Nokia Research Center, Fortum, Finnair, Datex-Ohmeda, The Student Union of the University of Helsinki (HYY), Limes r.y., European Physical Society, Finnish Physical Society (Suomen fyysikkoseura r.y.), The Physical Society in Finland (Fysikersamfundet i Finland r.f.), Finnish Association for Mathematicians, Physicists and Data Processing Scientists (SMFL)

Many thanks to all the people who have supported and helped us with our work during the past year. We would especially like to thank Merete Lillemark, Hugo Natal da Luz, Stephan Witoszynskyj and the IAPS Central Office: Pawel Wrobel, Beata Toczek and Michal Zawada. You made our work a lot easier.

Last but not least, we would like to say a very special thank you to you, ICPS'99 participant. Without you this event wouldn't be possible. Without you the work we have done wouldn't have been so much fun. We hope you will have a week you will always remember.

On behalf of the ICPS'99 Organising Committee,

Antti Lauri

Chairman

Dear ICPS'99 Participants,

It is a great honour for me to have an opportunity of writing a few words of greetings to you on behalf of IAPS leadership.

Many of you will take part in ICPS activities for the first time. I am sure there will be also large number of people, who are almost veterans. For all of us ICPS is a great holiday of physics students. This is the only time in a year, when we can meet so many colleagues from different countries. In spite of so different culture and tradition, we can exchange our opinions and talk about our work together without any misunderstandings and prejudices. These are the advantages of being a physicist. Don't waste this experience.

I wish you all a very successful stay in Helsinki.

Yours sincerely,

Pawel Wrobel

President of IAPS

1.2 Finland

Geographical data:

Area 338 145 km^2 (68 % forest, 10 % water, 6 % cultivated land), of which: land area 304 530 km2 Highest point: Halti 1 328 m Lakes with an area of 500 m^2 or more total about 188 000.

Population: (1998)

Total population: 5 160 000

Population density: 16.7 inhabitants/km^2

Population in largest municipalities, end-1998

Helsinki: 546 317 Espoo: 204 962 Tampere: 191 254 Vantaa: 173 860

Life expectancy at birth: Males: 73,5 Females: 80,8

Total energy consumption by source in 1998

Oil 28 % Coal 11 % Natural gas 11 % Nuclear power 18 % Hydropower (incl. wind power) 4 % Peat 6 % Wood fuel 19 % Other 1 % Net imports of electricity 3 %

Unemployment (1998): 11,8 %

Inflation (1998): 1,4 %

Literacy-rate: 100 %

Number of Universities: 20

Number of mopeds: 94,093

GNP per capita (1994): 18 850 US$

Independent since: 1917

1.3 Helsinki

Founded 1550

Capital since 1812

Total area: 686 km2

Green areas and parks: 31 %

Inhabitants per km^2: 2,873

Islands 315

Mean temperature in 1997

Whole year: 6,1 C Warmest month, July 19,1 C Coldest month, January -3,2 C

Culture and leisure

City library loans per inhabitant: 16.7 Recreation areas and parks: 6.114 hectares Recreational trails and jogging tracks: 214 km Sport halls, swimming halls: eq. 65 Outdoor sports grounds: eq. 404

1.4 University of Helsinki - Brief Historic Overview

The Royal Academy of Turku The history of University of Helsinki begins when the Royal Academy of Turku was founded in 1640. Finland was part of the Swedish realm at that time. The foundation document signed by the government of Queen Kristiina is dated 26th of March 1640 and the grand opening ceremonies were held in mid July in the same year.

There were four faculties in the academy and 11 professors, three in theological faculty, one in both law and medical faculties and six in philosophical faculty.

Latin was the dominant language for long. The use of Swedish e.g. in thesis works got more common after mid 18th century. Finnish had no official status, but for practical reasons the skills in Finnish were controlled for example for new priests.

Still continuing tradition for promotions came in use 1643, when the first ten students were promoted to masters of philosophy.

Imperial Alexander University When Finland was annexed to the Russian Empire in 1809, it didn't immediately alter the status of the academy, except for the fact that the academy was now The Imperial Alexander Academy after the Russian Czar Alexander the Second. The name Imperial Alexander University of Turku was also used.

The Great Fire of Turku in the beginning of September in 1827 inflicted great damage to the academy. The new main building (built in 1817) was not completely destroyed, but most of the property of the academy, the library and the special collections were destroyed.

By the Imperial order given by Czar Nikolai the First in 21. October in 1827 the university was ordered to move to Helsinki, which had earlier became the capital of Finland. The Imperial Alexander University started it's operation in temporary facilities in fall of the year 1928.

Swedish overthrew Latin bit by bit as teaching language. The effort to strengthen the status of Russian were pretty much a failure. The teaching of Finnish was given by the lecturer (since 1828), and it's main purpose was to ensure the official's skills in Finnish. The status of Finnish in teaching and research begun to strengthen after mid 19th century. First professor of Finnish language was founded in 1850, and the first thesis in Finnish appeared in 1858.

Both technical and economical studies were left out. In addition to the university two separate uni-

versities were founded: The University of Technology (1908) and Helsinki School of Economics and Business Administration (1911).

In the late 19th century also women were allowed to study in university, although they had to apply for a special permit for this until the year 1901. The first female doctor in Finland finished her thesis in 1896 in medicine and the first female professor was appointed in 1927.

The University of Helsinki When Finland became independent in 1917 the official name was changed to The University of Helsinki (founded in Turku in 1640).

In the University Act and Statute the teaching language for the University of Helsinki was defined to be Finnish and Swedish. To solve the lengthy language and nationality arguments quotas were later reserved for Swedish speaking staff and students (in 1937). These quotas are still implemented.

There are nine faculties in the University of Helsinki nowadays, these are the faculties of theology, law, medicine, arts, science, education, social sciences, agriculture and forestry and veterinary medicine.

The Department of Physics Physics has existed as a discipline within University of Helsinki since its foundation in 1640. The Department of Physics was established in the 1830's.

There are four divisions in the department: general division, accelerator laboratory, high energy physics divisions and theoretical physics division. The areas of specialization are materials physics, condensed matter physics, applied physics and particle and nuclear physics.

The current facilities were made in 1911 with some addition in 1930, 1958, 1960 and 1969. The department will move to Kumpula in 2001 when the construction of new facilities will be finished.

1.5 Where to Get Information?

The Information Board There is one primary source of information about everything that happens during the conference: the Information Board at the entrance hall of the Department of Physics. You will find there our contact information, updated schedule for the day including changes in lectures and other events. The Information Board will be updated as soon as we know about some changes. There will also be another Information Board at the Hostel Academica with information about changes in the conference program.

Please visit the Information Boards daily to avoid missing important information. The most important and urgent messages will be placed under label "Important!". There will only be few messages here to make sure they catch everyone's attention.

If you notice some incorrect information on the Information Board (about your lecture/poster, for example) please tell someone of our staff about it as soon as possible. IMPORTANT! Please do not change the information yourself even if it concerns you! This is because we at the Organising Committee have to know about all the changes in the conference program.

But I want to leave a message to my friends! Guess what? You can! Beside the Information Board at the Dept. of Physics and at the New Student House there are other bulletin boards called the Message Boards. Like the virtual message board at our Web page this space is also intended for all the participants to leave messages to each other. You could write a note to your friend about where you have gone and when will you be back, for example. Please remove your old messages from the boards to avoid misunderstandings.

Come And Ask Us About It! Finally you can always ask any of our staff about anything. The voluntary workers and us OC members will have a yellow ICPS'99 t-shirt with a text "Organiser". If none of us is around, you should try the Conference Office at the New Student House (Mannerheimintie 5 A). It will be open at the following times during the conference:

Saturday (14.8.) all day (check in); Sunday closed; Monday 8.00 - 24.00; Tuesday closed; Wednesday 8.00 - 24.00; Thursday 8.00 - 14.15; Friday (20.8) 11.00 - 15.00

The phone number to the Conference Office is 09 628742. In case of emergency please do not hesitate to call the main organiser on duty 24 hours every day to number 050 5986539.

1.6 Accommodation

We have reserved accommodation for every participant of the ICPS'99 from two hostels near the center of Helsinki.

Satakuntatalo	Hostel Academica
Lapinrinne 1A	Hietaniemenkatu 14
phone: 09-69585231	phone: 09-13114334

Both hostels are open 24 hours every day and easily reached from all important conference places.

Breakfast will be served at both hostels 7.00 - 9.00. At Satakuntatalo you can buy refreshments from the reception and at Hostel Academica you can visit the UniCafe-cafeteria downstairs.

1.7 UniCafe Restaurants

When you have time for a lunch between lectures and excursions you can go to any of the many UniCafe-cafeterias around the city.

	opening hours	lunch time
Porthania, Yliopistonkatu 3	Mon-Fri 08.00-16.00	10.00-15.00
Domus, Hietaniemenkatu 14	Mon-Fri 10.00-16.00	11.00-15.30
	Sat-Sun 11.00-16.00	11.00-15.30
Metsätalo, Fabianinkatu 39	Mon-Fri 09.00-15.00	10.30-14.30

You will get one lunch ticket for every day of the conference. You can use the tickets in the cafeterias that are named on the ticket. Breakfast will be served at hostels 07.00 - 09.00

A lunch at Unicafe-cafeteria includes also bread, salad, drink and potatoes or rice which you can take yourself from pickup tables. Dessert costs usually extra 4 - 6 FIM.

Here's some abbreviations used in menus: L = nonlactosic, G = nonglutenic, K = vegetable meal and Ve = vegetarian meal.

1.8 Moving around in Helsinki

All conference places are easily reached by foot but here's also some very useful public transport connections.

Buses

Bus 18:

Mon-Sat from 6.00 to 1.00
Sun from 7.00 to 1.00

Liisankatu (Department of Physics) – The Railway Square (next to the railway station) – Kamppi (subway station situated near both hostels).

Bus 55:

Mon-Sat from 6.00 to 24.00
Sun from 7.00 to 24.00

Kaisaniemi (Department of Physics) – The Railway Square – Kamppi – Lapinrinne (the hostels)

Trams

Tram 7A/7B:

Mon-Sat from 6.00 to 23.00
Sun from 7.00 to 23.00

Liisankatu (Department of Physics) – Aleksanterinkatu (main shopping road,centre) – Mannerheim-intie (centre).
Both trams have the same circular route but they go to opposite directions.

Tram **3B/3T:**

Mon-Sat from 6.00 to 1.00
Sun from 7.00 to 1.00

These trams have an eight-shaped route. 3T is a popular tourist route because it passes many important sites.

Subway (Metro)

You can easily use the fast subway connections because both hostels are situated near Kamppi subway station.

1.9 Practical Information

Money, Banks & Post-offices

1 FIM (mk)	=	100 p
1 Euro	=	5.94537 FIM

The ATMs work with Visa, Diners, Mastercard etc.

Banks	Mon-Fri 09.30-16.30	
Forex money exchange	Mon-Sun 08.00-21.00	Railway Station.
The main post office	Mon-Fri 07.00-22.00 Sat-Sun 10.00-18.00	It is located at Mannerheimintie 11, next to the Railway Station.

Shops

Sokos	Mon-Sat 07.00-22.00 Sun 10.00-22.00	METRO tunnel of the Railway Station.
Stockmann	Mon-Fri 09.00-21.00 Sat-Sun 10.00-18.00	Aleksanterinkatu
Alepa	Mon-Sat 07.30-22.00 Sun 10.00-22.00	METRO tunnel of the Railway Station.
Other shops	Mon-Fri 09.00-21.00 Sat 10-18	

Transportation

The tickets mentioned below are valid inside Helsinki in buses, trams, metro, trains and the Suomenlinna ferry. The tickets can be bought from the driver or in advance from the R-KIOSKI's, that can be found in almost every corner of the town. The map of routes can be found in the telephone catalogue.

Single	10,-/8,-	(valid 1h, transfer allowed)
Tram	8,- /6,-	(transfer not allowed)
10-times ticket	75,-	
Tourist ticket	25,-/per day	Sold in Metro railway station
Regional single	15,-	(Valid in Helsinki, Espoo, Vantaa and Kauniainen)
TAXI	40-…	(Depends on time and distance, tel. 700 700)

Prices (FIM)

Bread	20,- /kg	
Fruits	5-20,- /kg	
Orange juice	5,- /lit.	
Cheese	30-50,- /kg	
Pork	25-45,- /kg	
Beer	6,- /bottle	
Wine	30-50 /bottle	(See ALCOHOL below)
Cigarettes	20-25,-/20 pcs's	
Pizza	25-35,-	
Big-Mac meal	35,-	(Not recommended)
Chinese	40-...	
Lunch	30-60,-	
Dinner	50-...	
Beer	15-25,-/half liter	In a restaurant
Wine	15-... /glass	In a restaurant

Telephone Numbers

Emergency:	112
Police:	10022
Medical information:	10023
Dentist (24h):	736 166
ICPS-OC (24h):	050-5986539
TAXI:	700 700
Out from Finland	994, 990, 999
To Finland (Helsinki)	+358-9-...

Alcohol

Wines and spirits are sold only in special shops called ALKO. Beer, cider and long drinks are sold in normal shops until 21.00. Alko's in the center of Helsinki:

Stockmann's alko	Mon-Fri 09.00-20.00 Sat 09.00-18.00	(Wines & Beers only)
Kauppakeskus Kaisa	Mon-Thu 09.00-18.00 Fri 10.00-20.00 Sat 09.00-16.00	(METRO Kaisaniemi)
Arkadia	Mon-Fri 09.00-20.00 Sat 09.00-18.00	(Opposite to Kiasma)
Kaivopiha	Mon-Fri 09.00-20.00 Sat 09.00-18.00	(Opposite to the Railway Station)

Pharmacy

Yliopiston Apteekki	Mon-Sun 07.00-24.00	(Mannerheimintie 5)
Yliopiston Apteekki	24h	(Mannerheimintie 96)

1.10 Computing during the ICPS

The computer classes are located on the third floor of corridor C and on the third and fourth floor of corridor D in the Department of Physics.

1. Login

The workstations are equipped either with Windows NT 4.0 or MS-DOS + Windows 3.1.

If you use one with Windows NT 4.0, first press ctrl-alt-del. Then type fyl_icps at the login prompt and xxxxxx at the password prompt.

When using a workstation with an MS-DOS prompt, type k:login fyl_icps. When the workstation prompts for password, type xxxxxx.

2. Applications

For telnet connections you can use the F-secure SSH application. Netscape Communicator is available for surfing. You can also use Microsoft Word, Excel and various other applications. Printing is also possible.

In order to run Windows 3.1 in the MS-DOS workstations, type netwin.

3. Logout

IMPORTANT!!! Before leaving the workstation, always remember to close the session.

With the NT workstations this can be done by selecting the "close all applications and log on as a different user" behind the "start" button and with the MS-DOS workstations type logout.

1.11 Daily Programme

	Saturday, August 14th
20.00- 22.00	On Saturday there is no official programme. However, a cup of coffee or tea with a sandwich will be served at the Hostel Academica canteen. If you arrive later, you will get a juice with a sandwich from the Hostel Academica reception.

	Sunday, August 15th
	Note! Remember to take a towel, a swimming suite, something warm to wear, because there is no possibility to visit the hostel between the beginning of the Opening Ceremony and the end of the Opening Party, latter of which will be spent outdoors. If you want to participate in the sports events in the evening, also take sports clothes with you.
08.15	Gathering in the front of the hostel reception desk. Departure to the University main building.
09.00	The official Opening Ceremony begins at the University main building. Please arrive in time. (Aleksanterinkatu 5)
10.30	The first invited lecture will be given by Prof. Cecilia Jarlskog. The lecture will begin just after the Opening Ceremony at the same place.
11.45	Conference photograph will be taken in front of the University main building.
12.15	Buses to the excursions depart from the Senate's Square (Senaatintori) (in front of the main building of the University of Helsinki) Lunch will be served during the excursions.
16.30- 17.30	Arrival to Nuuksio National Park (no visit to Helsinki in between)
18.00	Opening party starts. A light supper will be served. Games and sauna.
22.30	The buses depart back to Helsinki.

	Monday, August 16th
08.15	Gathering in front of the hostel reception desk. Departure to the Department of Physics.
09.00	The lecture and poster sessions start at the Department of Physics. Excursions to the laboratories of the Department of Physics.
11.00	The second invited lecture will be given by Prof. Anton Zeilinger.
12.00	Lunch at the Unicafe restaurants Metsätalo and Porthania.
13.30	The lecture session continues (until 16.00). Excursions to the laboratories of the Department of Physics.
16.30	Gathering in the New Student House and the Department of Physics. Departure to the Town Hall.
17.00	The reception of the Mayor begins in the Town Hall (address: Pohjoisesplanadi 11-13) Remember to bring your invitation card
18.30	The excursions and IAPS workshops start. Sauna at the Ida's. (address Ida Aalbergintie 1) until 01.00. See the Excursions chapter for further information.

Tuesday, August 17th

	Note! Take a towel and a swimming suite with you if you want to go swimming during the Suomenlinna excursion. It might be a good idea to take sun lotion and a cap with you if the weather is sunny.
08.30	Gathering in front of the hostel reception desk. Departure to the Main Market Square.
09.15	Helsinki by sea: the boat takes off.
11.00	Arrival at the Suomenlinna sea fortress. A chance to visit the museums, have a picnic or swim in the sea. IAPS workshops. A light lunch is served.
16.00	The boat departs from Suomenlinna. (Gathering at the Information Centre near the bridge.)
18.00	The first part (foods, drinks, brochures) of the National Party begins at the New Student House (Mannerheimintie 5 A).
20.00	The second part (shows) starts at the Old Student House (Mannerheimintie 3). **Note!** The shows should last no longer than five minutes each.
04.00	The National Party ends.

Wednesday, August 18th

09.00	The excursions and IAPS workshops start (**Note!** Those who are going to attend the IAPS General Meeting in the afternoon, should attend the excursion to Nokia Research Center in the morning, because the second Nokia presentation will be given at the same time as the General Meeting starts).
11.00	Lunch at the Unicafe restaurants Metsätalo and Porthania.
12.00	The lecture and poster sessions start at the Department of Physics.
13.30	The poster session ends, the lecture sessions continue.
16.00	The lecture sessions end.
16.00	Nokia Research Center presentation starts.
16.00	IAPS General Meeting starts at the New Student House (5th floor).
17.15	The excursions start.

Thursday, August 19th

	Note! Please remember to take **all** of your luggage with you.
08.00	Gathering in the front of the hostel reception desk with all the luggage, which is taken to the New Student House for the night. You can take your luggage to the ship if you like.
09.00	The lecture session starts at the Department of Physics. Excursions to the laboratories of the Department of Physics and the Helsinki Institute of Physics (HIP).
11.00	The third invited lecture, given by Doc. Kari Enqvist, starts at the Department of Physics.
12.00	Lunch at the Unicafe restaurants Metsätalo and Porthania.
12.00	Everyone **must** be checked out from the hostel.
13.00	Departure to the terminal from the New Student House.
13.30	Gathering at the Viking Line ferry terminal in Katajanokka. Boarding to the 20 h cruise.
16.00	The Closing Ceremony starts at the conference hall.
19.30	The Closing Ceremony ends.
21.00	Supper in the Buffet Baltica restaurant.
Night	Farewell Party all over the ship.

	Friday, August 20th
07.30- 10.00	Breakfast in the Buffet Baltica restaurant.
11.00	Arrival in Helsinki. Getting the luggage from the New Student House. Departure from Helsinki.

1.12 About Lectures at ICPS'99

How to give an enjoyable and understandable lecture at ICPS'99. Practise beforehand. Prepare clear transparencies, make sure the letters are large enough so that everyone can see the text. Prefer quality before quantity. Diagrams and figures often make your subject easier to understand. In the beginning, tell a little bit about yourself and give a short introduction on what you are going to talk about - do not jump to details right away. Use simple language, remember that English is a foreign language to most people. Talk clearly and loudly enough. If you must use terms or concepts that may be unknown to the audience, try to explain them first. Each session has a chairperson who *will* stop you when your time is up, so plan the timing of your lecture. The length of your talk should be 20 minutes, followed by 5 minutes of discussion (questions, answers) and a break of 5 minutes before the next lecture.

How to enjoy a lecture during ICPS'99. Arrive to the lecture room before the starting time of the lecture. Arriving late is impolite and causes a disturbance. Remember, the speaker has done a lot of work to be able to present his/her work at ICPS'99. Because the lectures are short, ask questions only at the end. Ask questions. Discuss. Argue. Enjoy!

1.13 Excursions

During the ICPS there will be dozens of different kinds of excursions. They are divided in two main classes: scientific and cultural excursions. No one will have the time to participate in all the excursions we arrange, so take your time and choose carefully. Feel free to ask the Organisers for tips and suggestions. Note that each excursion has its specific registration time and place. Don't miss that! Some excursions are free, some are not. Those excursions, which are not free, must be paid upon registration. If the number of participants is limited, register as early as possible in order to ensure your participation to the excursions you especially wish to experience.

During the week there are some excursions for the whole ICPS'99 participant group. The Tuesday morning will be spent on a boat taking a look at Helsinki by sea. Afterwards we will arrive on Suomenlinna sea fortress full of museums, restaurants and magnificent sights.

Please note that the numbers after the starting places of visits state the location on the map attached to the Handbook.

1.13.1 Scientific Excursions

During the scientific excursions of the ICPS we are going to get acquainted with various aspects of the physical research in Finland. We will visit for example the laboratories of the Departments of Physics of the University of Helsinki and the Helsinki University of Technology, Nokia Research Center and Heureka Science Centre. The theme of the Sunday afternoon excursions is the past, present and

future of the energy production in Finland. Everyone is expected to attend the Sunday excursions. The Opening Party will start right after the excursions.

Loviisa Nuclear Power Plant		
Visit starts	time	Sunday, 15th of August, 12.15
	place	The Senate's Square (15)
Visit ends	time	18.00
	place	Nuuksio National Park
Max. number of participants		50
Estimated price		0 FIM
Registration	time	Saturday, 14th of August 08.00-24.00
	place	New Student House, conference office
Facts		The Loviisa nuclear power plant, about 90 km from Helsinki, has two Russian-built 500 MW pressurized water reactors. Visitors to Loviisa cannot enter the power plant itself (due to maintenance at the time of the excursion), but can see the Information Center and the new underground final repository of reactor waste.

Kopparnäs Energy Park		
Visit starts	time	Sunday, 15th of August, 12.15
	place	The Senate's Square (15)
Visit ends	time	17.00
	place	Nuuksio National Park
Max. number of participants		50
Estimated price		0 FIM
Registration	time	Saturday, 14th of August 08.00-24.00
	place	New Student House, conference office
Facts		The Kopparnäs Energy Park is a research area specializing in renewable energy sources. On display are operating solar panels and large wind generators, as well as biomass production areas. The park offers the visitor an unique opportunity to learn about energy production in the future.

Porvoo Oil Refinery		
Visit starts	time	Sunday, 15th of August, 12.15
	place	The Senate's Square (15)
Visit ends	time	17.30
	place	Nuuksio National Park
Max. number of participants		50
Estimated price		0 FIM
Registration	time	Saturday, 14th of August 08.00-24.00
	place	New Student House, conference office
Facts		The Porvoo oil refinery is among the biggest in the world.

Billnäs Hydroelectric Power Plant		
Visit starts	time	Sunday, 15th of August, 12.15
	place	The Senate's Square (15)
Visit ends	time	17.00
	place	Nuuksio National Park
Max. number of participants		50
Estimated price		0 FIM
Registration	time	Saturday, 14th of August 08.00-24.00
	place	New Student House, conference office
Facts		The Billnäs hydroelectric power plant dates from 1906 and is still operating. It also acts as a museum, situated at the beautiful river Mustiojoki, which has been used as a source of power since 15th century. The visit will include a bus tour of the area, which has a long industrial history.

Fortum Technology Center		
Visit starts	time	Sunday, 15th of August, 12.15
	place	The Senate's Square (15)
Visit ends	time	17.00
	place	Nuuksio National Park
Max. number of participants		50
Estimated price		0 FIM
Registration	time	Saturday, 14th of August 08.00-24.00
	place	New Student House, conference office
Facts		The Fortum Technology Center has laboratories working on more efficient, economical and environmentally benign products and services.

The X-Ray Laboratory		
Visit starts	time	Monday, 16th of August 1st group 13.30 2nd group 14.30 3rd group 15.30 Thursday, 19th of August 4th group 09.00 5th group 10.00
	place	Department of Physics, in front of lecture hall 1 (1)
Visit ends	time	30 min later
	place	Department of Physics, in front of lecture hall 1
Max. number of participants		10 each
Estimated price		0 FIM
Registration	time	Monday, 16th of August 08.45-12.00 Wednesday, 18th of August 11.45-16.00
	place	Department of Physics, information desk
Facts		The main research fields of the X-Ray Laboratory are solid state spectroscopy, studies on crystalline materials and studies on weakly ordered materials.

Laboratory for Aerosol and Environmental Physics		
Visit starts	time	Monday, 16th of August 1st group 13.30 2nd group 14.30 3rd group 15.30 Thursday, 19th of August 4th group 09.00 5th group 10.00
	place	Department of Physics, in front of lecture hall 1 (1)
Visit ends	time	30 min later
	place	Department of Physics, in front of lecture hall 1
Max. number of participants		10 each
Estimated price		0 FIM
Registration	time	Monday, 16th of August 08.45-12.00 Wednesday, 18th of August 11.45-16.00
	place	Department of Physics, information desk
Facts		The research is divided in two main fields: Atmospheric Aerosols and Forest-atmosphere interactions. Aerosols, especially nucleation and condensation, are examined both theoretically and experimentally, some industrial applications are also studied. Main topics in Physics of Forest are the water transport and the gas exchange of trees. The laboratory has also two field stations, another located in Northern Lapland and the other in Southern Finland. The measurements at the stations are carried out in co-operation with the Department of Forest Ecology. The laboratory employs about 30 people.

Laboratory for Electronic Research		
Visit starts	time	Monday, 16th of August 1st group 13.30 2nd group 14.30 Thursday, 19th of August 3rd group 09.00 4th group 10.00
	place	Department of Physics, in front of lecture hall 1 (1)
Visit ends	time	30 min later
	place	Department of Physics, in front of lecture hall 1
Max. number of participants		10 each
Estimated price		0 FIM
Registration	time	Monday, 16th of August 08.45-12.00 Wednesday, 18th of August 11.45-16.00
	place	Department of Physics, information desk

Facts	Electronics Research Laboratory specializes in electronic and computerized measurement methods. Main emphasis is to develop methods suitable for the needs of industry. To support these goals, research work concentrates on several applied physics disciplines, the main areas being fibre optics and confocal microscopy, photoacoustics and ultrasonics, and thermal wave imaging and characterization.

The Accelerator Laboratory		
Visit starts	time	Wednesday, 18th of August, 18.00
	place	The Department of Physics (1)
Visit ends	time	20.00
	place	City Centre
Max. number of participants		50
Estimated price		15 FIM (0 FIM if you have a bus ticket)
Registration	time	Wednesday, 18th of August 08.45-14.00
	place	Department of Physics, information desk
Facts		The Accelerator Laboratory has the longest tradition in Finland in the use of ion beams in basic and applied research. It is devoted to ion beam related research at high international level and to training students in research.

Laboratories of Medical Physics, Positron Physics and Cold Physics		
Visit starts	time	Wednesday, 18th of August, 13.00
	place	The Department of Physics (1)
Visit ends	time	16.00
	place	City Centre
Max. number of participants		50
Estimated price		25 FIM
Registration	time	Monday, 16th of August, 08.45-16.00 Wednesday, 18th of August, 11.00-12.00
	place	Department of Physics, information desk
Facts		The study programme of Engineering Physics in HUT was nominated a national center of excellency by the Ministry of Education in Finland in 1998. In the five different physics laboratories research is carried out in very diverse fields. First visit is to the Low Temperature Laboratory, which is one of the world leaders in ultra low temperature research and neuromagnetic brain studies. In addition, we will visit the laboratories of Physics (positron and surface physics), Biomedical Engineering and Advanced Energy Systems.

Heureka Science Centre		
Visit starts	time	Wednesday, 18th of August, 08.00
	place	In front of the reception desks of the hostels (2,3)
Visit ends	time	11.50
	place	City Centre
Max. number of participants		50
Estimated price		70/80 FIM
Registration	time	1) Monday, 16th of August 08.45-16.00 2) Monday, 16th of August 16.00-24.00
	place	1) Department of Physics, information desk 2) New Student House, information desk
Facts		Scientific centre Heureka is a place where both children and adults can get familiar science in an interactive way. In addition to basic science exhibition there are also always changing exhibitions. At the moment they are concerning technology and ancient cultures. The excursion costs 70 FIM or 80 FIM. The latter price includes also a 3-D show on Verne-theatre.

Nokia Research Center		
Visit starts	time	Wednesday, 18th of August, 09.15
	place	In front of the reception desks of the hostels (2,3)
Visit ends	time	11.30
	place	City Centre
Max. number of participants		80
Estimated price		0 FIM
Registration	time	1) Monday, 16th of August 08.45-16.00 2) Monday, 16th of August 16.00-24.00
	place	1) Department of Physics, information desk 2) New Student House, information desk
Facts		During this excursion you can hear about the research in the Nokia Research Center. Sari Korolainen from Corporate Communications: "Welcome to Nokia Research Center, Ruoholahti House" Marianne Talvitie from the Mobile Networks Laboratory: "Interdisciplinary Research" Hannu Kauppinen from the Mobile Networks Laboratory: "The Interface Between Academic Research and Industrial Research and Development" **Note!** Those who are going to attend the IAPS General Meeting in the afternoon, should attend this excursion in the morning. For the others it is possible to attend the Nokia Research Center presentation in the afternoon.

Helsinki Institute of Physics (HIP)		
Visit starts	time	Thursday, 19th of August 1st group 09.00 2nd group 10.00
	place	Department of Physics, in front of lecture hall 1 (1)
Visit ends	time	30 min later
	place	Department of Physics, in front of lecture hall 1
Max. number of participants		15
Estimated price		0 FIM
Registration	time	Wednesday, 18th of August 11.45-16.00
	place	Department of Physics, information desk
Facts		The Helsinki Institute of Physics (HIP) is the national research institute for theoretical and particle physics in Finland. The main fields of research are high and low energy theoretical physics, experimental particle physics and technological research related to particle accelerators. The Institute also supports graduate education at universities and training at CERN.

1.13.2 Cultural Excursions

The cultural excursions during the ICPS'99 give you an idea about the Finnish traditions, art and the way of the life of this northern people as well as the pleasures of a modern urban Finn. Have fun!

A Walking Tour through Southern Parts of Helsinki		
Visit starts	time	1st group Monday, 16th of August, 18.30 2nd group Wednesday, 18th of August, 09.00
	place	The Senate's Square (15)
Visit ends	time	2 hours later
	place	the hostels
Max. number of participants		20 each
Estimated price		0 FIM
Registration	time	1) Monday, 16th of August 08.45-16.00 2) Monday, 16th of August 16.00-24.00 (2nd group only)
	place	1) Department of Physics, information desk 2) New Student House, information desk
Facts		Route: The Senate's Square - The Market Square - Kaivopuisto park - Eira - the hostels (6 km). The route depends on weather conditions. Comfortable shoes recommended.

A Walking Tour in North-West Helsinki		
Visit starts	time	1st group Monday, 16th of August, 19.00 2nd group Wednesday, 18th of August, 09.00
	place	In front of the reception desks of the hostels (2,3)
Visit ends	time	2 hours later
	place	City Centre
Max. number of participants		20 each
Estimated price		0 FIM
Registration	time	1) Monday, 16th of August 08.45-16.00 2) Monday, 16th of August 16.00-24.00 (2nd group only)
	place	1) Department of Physics, information desk 2) New Student House, information desk
Facts		Route: the hostels - Töölö - the Finlandia House. The route depends on weather conditions. Comfortable shoes recommended.

The Finnish Sauna - once again!		
Visit starts	time	Monday, 16th of August 1st group 19.15 2nd group 20.45
	place	The Paasikivi statue (17)
Visit ends	time	2 hours later
	place	City Centre
Max. number of participants		1st group 100 2nd group 50
Estimated price		20 FIM (5 FIM, if you have a bus ticket)
Registration	time	1) Monday, 16th of August 08.45-16.00 2) Monday, 16th of August 16.00-20.15
	place	1) Department of Physics, information desk 2) New Student House, information desk
Facts		Didn’t get enough of sauna at the Opening Party? Here’s the solution! Gathering at the Paasikivi statue (next to the bus station, in front of Alko, across from Sokos). You can also come straight to the sauna on your own (address Ida Aalbergintie 1). Take bus 40, 41, 43 or 43B from the bus station and ask the driver to stop at the Pohjois-Haaga shopping centre. From there walk along Ida Aalbergintie until you come to number 1 (restaurant upstairs). The sauna is downstairs.

Rock		
Visit starts	time	Monday, 16th of August, 19.00
	place	In front of the reception desks of the hostels (2,3)
Visit ends	time	many hours later
	place	City Centre
Max. number of participants		20 each (two groups)
Estimated price		50 FIM (plus the beverages)
Registration	time	1) Monday, 16th of August 08.45-16.00
		2) Monday, 16th of August 16.00-18.45
	place	1) Department of Physics, information desk
		2) New Student House, information desk
Facts		During this visit we will visit the hottest rock clubs in the city. The first group visits some clubs that are specialized in Finnish live rock. The second group visits some really groovy discoes.

Linnanmäki Amusement Park		
Visit starts	time	Wednesday, 18th of August, 17.30
	place	New Student House (4)
Visit ends	time	22.30
	place	City Centre
Max. number of participants		∞
Estimated price		0-100 FIM
Registration	time	1) Monday, 16th of August 08.45-16.00
		2) Monday, 16th of August 16.00-24.00
		3) Wednesday, 18th of August, 11.00-16.30
	place	1) Department of Physics, information desk
		2) New Student House, information desk
		3) Department of Physics, information desk
	place	Department of Physics, information desk
Facts		Linnanmäki is the oldest amusement park in Finland - it has thrilled the Finns for nearly fifty years now. It features traditional attractions such as the wooden roller coaster and the Peacock theatre, as well as many modern attractions.

Seurasaari Island		
Visit starts	time	Wednesday, 18th of August, 17.15
	place	New Student House (4)
Visit ends	time	21.00
	place	City Centre
Max. number of participants		30
Estimated price		35 FIM (20 FIM, if you have a bus ticket)
Registration	time	1) Monday, 16th of August 08.45-16.00
		2) Monday, 16th of August 16.00-24.00
		3) Wednesday, 18th of August, 11.00-16.30
	place	1) Department of Physics, information desk
		2) New Student House, information desk
		3) Department of Physics, information desk
Facts		We are going to visit the Seurasaari outdoor museum. There we can see old Finnish housing culture.

Korkeasaari Zoo		
Visit starts	time	Wednesday, 18th of August, 17.15
	place	The Senate's Square (15)
Visit ends	time	20.45
	place	City Centre
Max. number of participants		30
Estimated price		10 FIM
Registration	time	1) Monday, 16th of August 08.45-16.00 2) Monday, 16th of August 16.00-24.00 3) Wednesday, 18th of August, 11.00-16.30
	place	1) Department of Physics, information desk 2) New Student House, information desk 3) Department of Physics, information desk
Facts		In the Korkeasaari Zoo island we will have a guided tour in English. The theme is Finnish animals. The tour takes about 1,5h-2h.

Hanging over the market place		
Visit starts	time	Wednesday, 18th of August, 09.00
	place	In front of the reception desks of the hostels (2,3)
Visit ends	time	11.00
	place	City Centre
Max. number of participants		∞
Estimated price		Free except the hang over drinks
Registration		No registration required
Facts		Route: as short as possible. Coffee tent in the Market Square. Coffee and sympathy. Hang over is a social experience.

Kuu **A Finnish restaurant**		
Visit starts	time	Wednesday, 18th of August 1st group 19.45 2nd group 22.15
	place	New Student House (4)
Visit ends	time	2,5 hours later
	place	City Centre
Max. number of participants		40 each
Estimated price		125-185 FIM
Registration	time	1) Monday, 16th of August 08.45-16.00 2) Monday, 16th of August 16.00-24.00
	place	1) Department of Physics, information desk 2) New Student House, information desk
Facts		In Kuu you can try the very basic, traditional Finnish tastes. Please note that you must choose the preferred menu already upon the registration for the excursion.

Ateneum **Finnish National Gallery**		
Visit starts	time	Wednesday, 16th of August, 18.00
	place	New Student House (4)
Visit ends	time	19.30
	place	City Centre
Max. number of participants		30
Estimated price		10 FIM
Registration	time	1) Monday, 16th of August 08.45-16.00 2) Monday, 16th of August 16.00-24.00
	place	1) Department of Physics, information desk 2) New Student House, information desk
Facts		A guided tour (English-speaking professional guide) of the Finnish National Gallery, Ateneum. A large collection of famous Finnish paintings and sculptures, all the way from 18th century rococo portraiture to the experimental art movements of the present century.

Spårakoff **Restaurant Tram**		
Visit starts	time	Weekdays 11.00, 12.00 ... 22.00 (not 17.00) Saturdays 11.00,12.00 ... 17.00
	place	Mikonkatu tram stop (16)
Visit ends	time	45 minutes later
	place	Mikonkatu tram stop
Estimated price		30 FIM
Facts		Spårakoff is a nice and extraordinary way to do a Helsinki-sightseeing. The price includes a big glass of beer, cider or lemonade or a cup of coffee or tea. A do-it-yourself excursion. Definitely worth trying.

1.14 Cruise on m/s Cinderella

Departure - 19th of August, 15.00

The ships departs from and returns to the Viking Line terminal at Katajanokka. Departure to the terminal in groups from the New Student House, 13.00. Take only the things you will need on an overnight cruise with you to the ship and leave the rest of your luggage at the New Student House. You must be at the terminal **13.30** to get your cruise ticket. Don't be late, the ship won't wait!!

Accommodation at the ship will be in four-person cabins. In all the cabins there will be bathrooms and showers. The ship will visit Estonian waters but there will be no landing so no visa required. Do not forget your passport!

The Closing Ceremony at the ship takes place at conference auditorium. Prizes and diplomas for best lectures and posters will be awarded there. All the votes for best lecture/poster will participate in a lottery.

Buffet dinner at Buffet Baltica includes all drinks. Next morning the Sea breakfast is served also in Buffet Baltica. You can buy relatively cheap candies, tobaccos, wines etc. at the tax free shop (cheap

at least compared to the price level in Finland).

The farewell party will be all over the ship in restaurants, bars, cabins etc. Some of the bars are playing pop music and some music for older people so choose the one that pleases you the most. Late at night don't go to the upper deck alone. If you want to watch the night sky take someone with you.

Return - 20th of August, 11.00

1.15 A Brief History of IAPS

The International Association of Physics Students has its origins in 1986. Hungarian students organised an international conference for physics students in Budapest. Being a great success a second conference was held in Debrecen, Hungary, the following year. On the 12th September 1987 the participating students signed a charter, officially establishing the International Association of Physics Students, IAPS.

Since then conferences have been held in Prague (1988), Freiburg (1989), Amsterdam (1990), Vienna (1991), Lisbon (1992), Bodrum (1993), St. Petersburg (1994), Copenhagen (1995), Szeged (1996), Vienna (1997) and Coimbra (1998).

IAPS is run by an Executive Committee that consists of a President, a Past President, a President Designate, a Secretary, an ICPS organiser, an Exchange Coordinator and a Treasurer.

During every ICPS a General Meeting is held, where the members decide upon amendments of the Charter and Regulations and elect a new Executive Committee.

IAPS exists to promote the academic and professional development of physics students, and to provide a space for international networking among them.

IAPS helps physics students in their academic and professional work in an international context. By establishing a network between physics students world-wide it hopes to promote understanding and trust between physics students throughout the world.

The activities of IAPS

- The XIV International Conference for Physics Students ICPS'99 is held in Helsinki, Finland in August 1999. The conference gives physics students from all over the world the opportunity to give a lecture on their work or visit those of others. Scientific visits and a social programme are organised during the conference. These activities offer the opportunity to get in contact with fellow students from other countries in an informal way.

- JiAPS, the Journal of IAPS is a magazine published electronically and on paper. It is currently edited in Croatia and sent all around the world. It gives students a chance to engage in scientific communication and to exchange their thoughts on various topics. These topics include scientific issues, IAPS activities, physics outreach programs and exchange possibilities.

- IAPS has established a network of contact persons, students at the universities throughout the world, who are willing to help fellow students from other countries in their effort to study abroad. The network of contact persons is an up-to-date database of students involved in IAPS from universities all over the world, including their field of work. Other students interested in a special field of research can access that database to establish personal contacts.

- IAPS uses an electronic mailing list to keep its members informed. Up to date information relevant to physics students is distributed on this list. You can receive them by subscribing to the mailing list.

- IAPS organises visits to scientific sites, like the annual visit to CERN in Switzerland.
- IAPS has established contacts with professional physics associations such as the EPS and the APS. In February 1997 IAPS became a member of the EUPEN consortium, an EU supported cooperation of all European associations devoted to the promotion and teaching of physics.
- In addition you are invited to participate in all the events our members organise on a regional or local basis.

1.16 IAPS Workshops

IAPS workshops were lately held during ICPS'96 in Szeged (Hungary). We have decided to organise them at ICPS'99, because there is a lot of subjects we would like to discuss with you - ICPS participants. In this way you will have an excellent occasion of taking part in development of our association.

IAPS is now on the best way to transition from amateur association to a professional and worldwide organisation. To make this transition possible, we have to change its structure and regulations. We would like to invite you to this discussion, because we would like to know your opinion on following topics - how you imagine future shape of IAPS activities, what should be improved to make IAPS more visible in your country, in what direction we should continue IAPS development, what should be IAPS role in future, etc.

Each ICPS participant will be informed in details about IAPS workshops at the registration desk. He or she will have also an opportunity to decide to which discussion group he or she would like to belong. Remember that participation in IAPS workshops is not obligatory.

1.17 The IAPS General Meeting

Wednesday 18th, 18.00. The New Student House, 5th floor.

Agenda:

1. Restoration of voting rights
2. Approval of agenda
3. Election of chairman and minute-taker
4. Approval of new members for IAPS
5. Report on activities of the previous period
    - Central Office
        - President
        - Secretary
        - Treasurer
    - Financial Control Committee
    - ICPS'99 Organising Committee
    - JiAPS editor
    - Network co-ordinator

- Exchange programme co-ordinator
- IRC Channel co-ordinator
- Trip to CERN co-ordinator
- National and Local Committees who wish to report

6. Release of the IAPS Committee
7. Summary of IAPS workshops
8. Reform of IAPS Charter & Regulations
9. Membership fee
10. IAPS external relations
11. Election of IAPS representatives
    - Central Office
      - President
      - Secretary
      - Treasurer
    - President Designate
    - Past President
    - Financial Control Committee
    - ICPS 2000 Organisers
    - ICPS 2001 Organisers
    - Network co-ordinator
    - Exchange programme co-ordinator
    - IRC Channel co-ordinator
    - Trip to CERN co-ordinator
    - JiAPS editor
    - Web editor
12. Any other business
13. Closing

1.18 Bathing in the Sauna

Instructions

- When you come in the sauna don't start throwing water on the sauna stove at once. First get used to the warmth and sweat a little. That way you can bath longer and the experience is going to be a very comfortable one.

- Throwing the water on the stove also has it's own "secrets". Don't throw too much water because then you most probably can't stand the heat and have to go out, which more or less ruins the experience.

- When it feels that you have sweated enough or don't feel comfortable anymore go out to cool a little. Swim in the lake or just stand outside. And maybe take a beer or something else to drink.

- After cooling you should go back, sweat little bit more and use whisks of birch. Repeat this procedure as many times as you want.

NOTE 1: You'll notice whisks of birch in the sauna. These are meant for gentle switching when you are in the sauna. The switching stimulates the blood circulation and gives a pleasant sensation. The whisk is usually taken into use only after the first round of warming and cooling off.

NOTE 2: You should bath only as long as it feels comfortable! Remember that sauna not only a place to get cleaned but also a place to relax and be in peace. So loud yelling, quarreling and cursing is out of the question.

1.19 Vocabulary

The following is a vocabulary of some useful Finnish words and sentences. Most people, however, especially younger ones, can speak English. Usually quite many can speak Swedish and older people often speak German instead of English.

English	**Finnish**	**English**	**Finnish**
Yes	Kyllä	No	Ei
Help	Apua	Hello! / Hi!	Hei! / Moi! / Terve!
Good Morning	Huomenta	Good Evening	Iltaa
Goodbye	Näkemiin	Welcome	Tervetuloa
Thank you	Kiitos	Please	Ole hyvä
Sorry / Excuse me	Anteeksi	Cool!	Siistiä!
Damn!	Perkele!		
Ticket	Lippu	Tram	Raitiovaunu
Underground	Metro	Bus	Bussi / Linja-auto
Taxi	Taksi	Car	Auto
Train	Juna	Ship	Laiva

English	Finnish	English	Finnish
University	Yliopisto	Department of Physics	Fysiikan laitos
Old Student House	Vanha ylioppilastalo / Vanha	New Student House	Uusi ylioppilastalo / Uusi
Restaurant	Ravintola	Shop	Kauppa
Liquor store	ALKO	Bank	Pankki
Cafe	Kahvila	Post Office	Posti
Pharmacy	Apteekki	Hospital	Sairaala
Police	Poliisi	Sauna	Sauna
In the sauna you hit yourself with this; made from birch	Vihta / Vasta		
Breakfast	Aamiainen	Lunch	Lounas
Dinner	Päivällinen		
Food	Ruoka	Drink	Juoma
Bread	Leipä	Butter	Voi
Salad	Salaatti	Potato	Peruna
Fish	Kala	Baltic Herring	Silakka
Chicken	Kana	Meat	Liha
Milk	Maito	Water	Vesi
Ice	Jää	Ice-cream	Jäätelö
Beer	Olut	Cider	Siideri
Long Drink	Lonkero	Wine	Viini
Red wine	Punaviini	White wine	Valkoviini
Most popular Finnish vodka	Koskenkorva / Kossu		
Telephone	Puhelin	Mobile telephone	Kännykkä
Pen	Kynä	Paper	Paperi
Stamp	Postimerkki	Clock	Kello
Ice hockey	Jääkiekko		

English	Finnish
Where is nearest . . . ?	Missä on lähin . . . ?
What's the time?	Mitä kello on?
What's this?	Mikä tämä on?
What's your name?	Mikä on sinun nimesi?
I need . . .	Tarvitsen . . .
Which tram / bus goes to . . .	Mikä raitiovaunu / bussi menee . . . ?
How much is this?	Kuinka paljon tämä maksaa?
I want to exchange money	Tahdon vaihtaa rahaa
One beer (0.4-0.5 l), please	Yksi iso tuoppi, kiitos
One glass of . . . , please	Saisinko lasin . . . , kiitos

Chapter 2

Invited lectures

2.1 Particle Physics

Cecilia Jarlskog

The history of particle physics began with the discovery of the electron in 1897 by Joseph John Thomson (1856-1940). By itself, the existence of this particle is a mystery that has not yet been resolved. Nonetheless, the electron is a very "useful" particle. Without it we would not have existed - neither would have most of our utilities such as electricity, the television, etc. To the best of our knowledge, the electron is a "point particle", i.e., a particle that has no geometric size or internal structure. The electron is by no means alone in the world of particles. There are many more. There are also antiparticles.

In this talk I intend to briefly address the following questions and issues:

- How does one study particle physics?
- What are the main concepts in particle physics?
- The standard model of particle physics
- Spin-offs from particle physics
- Open questions

References

`http://outreach.cern.ch/public/gb/Page1.html` gives a multilingual variety of web-pages on particle physics

`http://pdg.lbl.gov/cpep/adventure.html`
`http://www.fnal.gov/pub/hep_descript.html`

2.2 Experiment and the Foundations of Quantum Physics

Anton Zeilinger

Instead of having to rely on gedanken (thought) experiments, it is possible today to base discussions about the foundations of quantum mechanics on actually performed experiments because of enormous technological progress in recent years. Such experiments not only have been realized with individual particles as massive as buckyballs, with entangled pairs and triplets giving a stronger basis to the discussions about the nonlocality of the theory, they have also led to the development of a new field, quantum information science, where quantum teleportation and quantum computation are some of the most interesting topics.

2.3 New Directions in Cosmology

Kari Enqvist

Chapter 3

Lecture abstracts

3.1 Atomic/Subatomic physics

3.1.1 Breakup of 42 MeV ^{7}Li Projectile on ^{58}Ni Target

Dhruba Gupta

Saha Institute of Nuclear Physics 1/AF, Bidhannagar, Calcutta 700064, India

Starting from a general description of direct and sequential breakup reactions, the measurement of 42 MeV ^{7}Li-projectile breakup on ^{58}Ni target is discussed. When the resulting fragments from breakup are detected at equal angles near the grazing angle, Coulomb breakup is seen to dominate, whereas outside the grazing angle when the fragments are detected at unequal angles, nuclear breakup dominates. Some indications of contributions from the higher sequential states (above $7/2^{-}$ 4.63 MeV) of ^{7}Li are found. Outside the grazing angle, direct breakup is reduced to a large extent compared to the sequential breakup. This aspect has important consequences for identifying unknown resonant states of the newly discovered halo nuclei.

3.1.2 Elastic Peak Monitoring for the CLAS

David C. Vermette and Gerard P. Gilfoyle

Physics Department, University of Richmond, VA, USA

We have developed code to monitor one of the large, particle detectors (CLAS) at the Thomas Jefferson National Accelerator Facility (TJNAF). TJNAF is a large electron accelerator designed to elucidate the quark nature of matter. The software collects data generated from collision events in the spectrometer and periodically analyzes it. The elastic scattering peak in the W spectrum is fitted to a Gaussian curve to measure its position and width. The position of the elastic peak is a measure of the accuracy of the detector calibration. The width of this peak is proportional to the resolution of the data. The fit procedure is subjected to several tests to ensure quality. A minimum number of counts is required in the elastic peak region and the range of the values of the uncertainties is restricted. These results are stored in a database and can be viewed over the Internet. We will present plots of the elastic peak data and related parameters to analyze how the detector's response can be monitored over time.

3.1.3 Determination of Trace Pollutants in Waret Using Photothermal Laser Spectroscopy

George Ofori-Boadu, Kirk M. Peterson, Joshua Mangana and U. Hömmerich

Research Center for Optical Physics, Department of Physics Hampton University, Hampton, VA 23668, U.S.A., Tel: 757-727-5829,Fax: 757-728-6910

Pollution in water and other substances has been and is still a major concern for members of the global society. Some diseases have been incurred by people from drinking polluted water and eating food containing pollutants. Several experiments and methods have been performed and used to trace pollutants. We try to measure and monitor trace pollutants in water with high precision using photothermal laser spectroscopy.

Photothermal laser spectroscopy (PLS) has been applied to environmental monitoring and chemical analysis. Following a colorimetric reaction a pump beam is partially absorbed by a water sample, which results in a spatial modulation of the refractive index. The change in refractive index change is monitored by the deflection of a probe beam. Initial results on applying PLS to monitor trace amounts of pollutants (e.g. phosphate,iron, etc.) in water will be presented. In the future, we believe this method can be used in monitoring trace pollutants in water, crystals and gases.

3.1.4 Nuclear Level and State Density

Neven S. Fuckar

University of Zagreb, Department of Physics, Croatia

Experimental facts and qualitative conclusion that energy levels of heavy nucleus are very closely spaced and that their spacing decrease rapidly with increase of excitation energy required theoretical description even in the early days of development of nuclear physics. From the overall view nuclear level density is important ingredient in nuclear reaction calculation, particularly in heavy-ion reaction and nuclear astrophysics.

More then 60 years ago Bethe realized that general behavior of the level density (number of nuclear levels per unit energy) would not on the average be significantly altered by the nuclear interaction and that nucleons in nucleus could be, for current purpose, viewed as a Fermi gas of free particles. Statistical method (or thermodynamic approach) used on stated model produced first theoretical expression for density of nuclear levels and states (number of nuclear states per unity energy) in dependence of energy for total magnitude and additionally in dependence of angular momentum for specific states. Further theoretical development within the limits of thermodynamic approach produced other formulas which can be adequately adjusted to the existing experimental data in certain energy range, like the constant temperature formula (CTF), or on entire spectrum, many others. In this work particularly is addressed the formula of Gilbert and Cameron (1965) as standard Bethe formula (SBF), which extends original Bethe formula to include the effects of paring and shell- correction energies introducing the energy shift. Following similar line of reasoning Paar and Pezer (1997) introduced generalized Bethe formula (GBF) which posses important capability of encompassing the SBF and the CTF as limiting case.

Second different theoretical approach used in this work is combinatorial. It yields more exact results, but for extensive use it is very time demanding computational technique. Large scale combinatorial calculation of level densities based on realistic single particle spectra were performed for selected nuclei up to high excitation energy using Gaussian polynomial generating function method (GPM), new and efficient method introduced by Sunko (1990). Fitting of advance Bethe's formulas to the GPM results were analyzed in dependence of proton and neutron number. The best fitting was apparent for the GBF most evidently because of the well introduced second additional parameter. Many different lines of investigation were pursued on given calculations, e.g. how modification of single particle levels manifests in overall results - most important was variation in vicinity of Fermi energy, etc.

Due to the obvious bounds imposed on lecture emphasis will be on basics of stated quantities and models, with selected results and general conclusions

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[3] Paar, V., Pezer, R.: Phys. Rev. C 55, 1637 (1997)

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[5] Paar, V., Sunko, D.K. et al.: Z. Phys. A 345, 343 (1993)

3.1.5 The Use of X-ray Diffraction to Investigate the Structure of Liquid Matter - Modelling of the Structure of Concentrated Aqueous Solutions of Indium Bromide and Lanthanum Bromide

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X-ray diffraction is presented as a spectroscopic method used to investigate the structure of matter. Information that can be obtained from X-ray diffraction patterns is given. Modelling and Fourier inversion techniques as tools for interpreting the x-ray diffraction patterns of liquids are referred.

Application of this method to the study of concentrated aqueous solutions has revealed its usefulness to elucidate the plausibility of the existence of long-range correlations in these systems. The results obtained from the investigation of very concentrated aqueous solutions of indium and lanthanum salts are discussed.

3.1.6 Quality Control of GEMs

Susete Teresa Gaspar do Fetal

Departamento de Física, Universidade de Coimbra, Portugal

The basic operation of gas detectors is described by atoms or molecules' ionisation, due to incident radiation. Gas mixture is enclosed within electrodes, which provide an electric field in order to separate and recovery electrons and ions. In high field regions, the electrons can be amplified in an avalanche process to produce a detectable charge signal. The microstructure based detectors (microstrip, microgap, GEM...) provide the electric fields required for multiplication charge. The results obtained with GEM (Gas Electron Multiplier) are very promising: amplification factor about several thousands, high count rate and spatial resolution better than 100 μm (RMS). Besides, GEMs are easy and low-cost to manufacture, so they are indicated for the new high luminosity colliders.

The detectors will cover a large area (> 100 m^2) and, due to technical constrains, will be assembled with small size elements (20 X 30 cm^2), thus a huge number of elements have to be manufactured. Quality control remains an important issue as, to avoid time consuming assembly and replacement, the defective units should be rejected immediately after manufacture.

Optical inspection is not acceptable because it is slow (> 1 hour per piece), can not detect defects smaller than 5 μm and does not give direct information on the electric characteristics.

The scintillation light, produced in GEM foils, when irradiated with x-ray, is observed with a CCD camera. Acquired images are a fast and non-destructive way to found defects in GEMs. In order to correlate defects, the images obtained with this technique were compared with images acquired with a microscope.

Recently a new, small volume, big window camera was assembled. This system is controlled by two step-motors to sweep all the area and to improve a homogeneity study of GEMs.

3.1.7 Statistical Properties of the Nucleus

Amund Bjerve

University of Oslo, Norway

In order to study hot nuclei with high internal energy, one can no longer perform classical spectroscopy since the spacings between the energy levels are much smaller than the experimental resolution. Instead, statistical models are applied to describe the nucleus under these conditions.
At Oslo Cyclotron Laboratory, University of Oslo, nuclei in the statistical regime are studied. The nuclear reactions used are $(^3\mathrm{He}, \alpha)$ and $(^3\mathrm{He},^3\mathrm{He}')$ on rare earth nuclei $(A = 140 - 190)$. This reaction leaves the nucleus with high internal energy and little collective motion such as rotation and vibration.
By using a subtraction technique, the first emitted gamma-quantas from each cascade are isolated from the rest. It is assumed that a so-called first-generation spectrum can be expressed as

$$\Gamma(E_x, E_\gamma) = F(E_\gamma) \cdot \rho(U)$$

where $\rho(U)$ is the level density of the nucleus at the final energy $U = E_x - E_\gamma$, and $F(E_\gamma)$ is a function depending on the gamma energy only. The level density may be interpreted as the number of microstates, and by taking the logarithm one gets the entropy of the system.
As simple models for these two functions, a Fermi-gas model is used for the level density, and a giant dipole-resonance is used for the strength function $F(E_\gamma)$.
A method has been developed for simultaneous extraction of the two functions, and the result can be compared to theory. Deviations from the pure statistical models may provide information about structures and non-statistical behaviour in the statistical regime.

3.1.8 Teleportation in Hole Vacuum

Constantin Leshan

Paper present the alternative method of teleportation that use hole technology. The ground station able to teleport macroscopic body as spacecraft on the distance of millions light years in no time.

3.1.9 Atomlasers

Per Kangru

In the recent years there has been a great progress in the field of experimental laser-cooling and Bose-Einstein condensation. This has lead to that we, during the last years, have seen some very interesting experiments regarding the subject of atom-lasers. Atomlasers is a very new and fascinating field of quantum-optics. It has been foreseen by theory for many years but has been regarded as something purely theoretical, now once it has been achieved we are rapidly gaining knowledge about its inner workings.

I will discuss and present the most recent advances in the field and present some of the most interesting findings regarding atom-lasers.

3.2 Quantum physics

3.2.1 Loss of Coherence in Quantum Measurement

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As it is well known, Copenhagen-interpretation of quantum mechanics does not yield a satisfactory explanation for the measurement theory. The idea of decoherence as a partial solution of the quantum measurement problem comes from E. Wigner. This theory describes the process, as the interference of quantum state is smeared, due to an interaction with the environment. It is pointed out, that the collapse of wave function (which is not to be mistaken for decoherence) is not assumed in our investigations. This lecture has the aim to demonstrate the environment induced decoherence The presence and role of decoherence is shown on simple models. The general theory is also applied to some more realistic models that can be a basis of real measurement processes, such as particle detection. In our investigations a special attention is devoted to the temporal behaviour of decohering systems, i.e. we obtain estimates on the duration of measurement process.

3.2.2 Quantum Physics of Solar System

Igor Kudrnovsky

University of Zagreb, Croatia

Ever since the early civilization, people have viewed the universe and the solar system as being symmetrical and thus perfect, which was continued with Kepler's belief that a resonant structure created order in the solar system. Using simple classical laws of gravity it can be shown that the solar system might have a resonant structure, similar to those proposed by Rutherford and Bohr for the hydrogen atom. This lecture shall not go into those quantum principles, but will try to show that they are attainable.

3.2.3 Twin Observables for Mixed States

Vladan Arsenijevi and Edib Dobard

From the very beginning of the modern quantum mechanics, the correlations of the subsystems composing the isolated quantum system have been attracting much attention. In fact, the description of the total system by its quantum state is essentially global, making the questions on the behavior of the subsystems much more subtle; the attempts to apply the classical intuition led to a number of paradoxes.

One of the problems frequently considered in this context is the possibility to perform the measurement of some of the subsystem observable, with the results being equivalent to measurement of some other observable of the remaining subsystem. This problem has been completely solved for the special case, when the total system, $\mathbf{S}$,

composed of the two subsystems, $\mathbf{A}$ and $\mathbf{B}$, is prepared into the pure state, $|\Phi\rangle$. Then, this state determines the mixed states of the subsystems, described by the statistical operators, $\rho_{\mathbf{A}} = \mathrm{Tr}_{\mathbf{B}}|\Phi\rangle\langle\Phi|$ and $\rho_{\mathbf{B}} = \mathrm{Tr}_{\mathbf{A}}|\Phi\rangle\langle\Phi|$. For each $\mathbf{A}$-subsystem observable A, commuting with $\rho_{\mathbf{A}}$, there is uniquely defined $\mathbf{B}$-subsystem observable B, such that the measurement of $A \otimes I_{\mathbf{B}}$ on the total system gives the same predictions as the measurement of the observable $I_{\mathbf{A}} \otimes B$ (B compatible with $\rho_{\mathbf{B}}$), i. e.

$$\mathrm{A} \otimes I_{\mathbf{B}}|\Phi\rangle = I_{\mathbf{A}} \otimes B|\Phi\rangle.$$

The aim of this paper is to generalize this result to the case of the mixed composite state, described by the statistical operator ρ. Such a generalization is interesting for the description of the complex systems, which can hardly be prepared into the pure state. For example, it may be important to know the properties of the electrons subsystem that can be determined by the measurement of some ionic observable in the thermalized solid, described by the canonical distribution.

3.3 Material physics/Applied physics

3.3.1 Lithography, an Industrial Application of Physics

Olav Frijns

ASML in the Netherlands

As this conference will probably be filled with all kinds of very interesting lectures about research projects, I want to put a different accent: Is there physics outside university and research institutes? The answer is yes, in some industries physics is a vital part of the business and it's no miracle that many graduated physicists end up in such places.

An example is the industry, which makes lithographic tools for microchip manufacturing. In the lecture I will show where physics comes into the lithography game and focus on the optical principles of micro-lithography including the relevant parameters and some numbers.

A short overview of the future of lithography will be presented with the theme "How low can we go?" In this overview I will address some critical points, like the problems with optical materials, vibrations and optical designs. Finally I will devote a few words on how life of a physicist outside university can look like: what are the advantages and the disadvantages.

3.3.2 TEM, HREM, SEM and X-ray Diffraction Study of Iron doped TiO2

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Functional properties of TiO2-based ceramics can be improved by a small amount of doping. Improved photocatalytic efficiency of iron doped TiO2 has been attributed to the action of the iron ions within TiO2 matrix inhibiting photogenerated charge pair recombination. TiO2 was used in many applications such as integrated wave-guides and photovoltaic cells, gas and humidity sensors, inorganic membranes, catalyst supports and electrochemical displays. In the present work, nanosized iron-doped TiO2 with Ti/Fe ratio=1:0.15 was synthesised by modified sol-gel method. Ti (IV) isopropoxide and iron (II) sulphate were dissolved in isopropoxide under inert (nitrogen) atmosphere and hydrolysed with PEG (polyethylene glycol) dissolved in doubly distilled water. PEG acts as a surfactant stabiliser, suppresses the coagulation, affects the pores and particle size distribution and improves homogeneity, microstructure and other properties of the final product. The suspension obtained after four hours of hydrolysis was dried and a resulting solid product was denoted as Sample 1. Sample 2 was obtained by, first, pressing of Sample 1 into the tablet and, then, by thermal treatment at 5000C for two hours. Samples were analysed by TEM, HREM, SEM, EDS and X-ray diffraction (XRD). High-resolution

electron microscopy (HREM) was performed by using JEOL JEM 2010 200 kV microscope, having point resolution of 0.19 nm. SEM with energy dispersive X-ray analysis (EDS) was performed in JEOL-JSM-580 20 kV scanning microscope. XRD and ED (Sample 1) showed very broad peaks of anatase as the dominant phase. HREM image of TiO2-Fe2O3 of Sample 1 shows the distribution of grain sizes with an average of (3.3±0.8) nm. It appears that the amorphous phase A observed in Fig. 1 (a) belongs to PEG distributed into the pores of nanocrystalline anatase. Average pore size is (3.4±1.5) nm. Mapping of the constitutive elements was performed in the FeK, TiK, OK, SK X-ray lines. The homogeneity of the composition is observed in Fe, O, Ti, S mapping without taking into account the surface morphology of the sample. Dark field image with corresponding ED (Fig.2b) of Sample 2, gives evidence that in some regions the grains, having sizes from 10 to 17 nm, belong to rutil. According to ED pattern of Fig.2(b), Sample 2 consists of anatase (nanocrystalline rings) and the spots belong to rutile. The average grain size is 4.5 nm. The appearance of rutile phase at 5000C (Sample 2) could be explained by the influence of Fe2O3 on the kinetics of the phase transformation anatase to rutile. HREM images of iron doped TiO2 in presence of PEG (Sample 1) give more homogeneous material with respect to distribution of pores and grain sizes (Fig.1(c), (d)) compared to the results reported earlier (1).
(1) A.M. Tonejc et al. Mat. Sci Eng. B, 40 (1996) 177-184

SEM micrographs of Sample 1 shows homogeneity of constitutive elements (Ti, O) and mentioned additives (Fe). EDS showed the presence of Ti, O, Fe, and S. TEM micrographs (Fig. 1) showed the presence of amorphous phase (small quantity) and anatase (SAED insert in Fig. 1) with particle size distribution having maximum at 3.3 nm TEM micrographs of Sample 500 (Fig. 2) showed presence of anatase particles of 6.1 nm as dominant phase and rutile particles of 20 nm as minor phase. Sample 500 showed also the presence of a very small quantity of amorphous phase.

3.3.3 Co-adsorption of CO and K on a Stepped Copper Surface, Cu(115)

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Main Campus Odense University

The co-adsorption of potassium and carbon mono-oxide shows a different behaviour on the stepped copper surface Cu(115) compared to low-index copper surfaces, such as Cu(100) and Cu(110). CO on the clean Cu(115) looks very much like CO on the low-index surfaces, but when the alkali is added the CO will adsorb on the surface both molecular and, as a new phenomena, dissociative. This dissociation affects that carbonate is produced at the surface via the Boudouard reaction.

The stepped copper surface undergo an alkali induced reconstruction when a critical value of potassium coverage is passed. The reconstruction gives rise to steps twice as high and terraces twice as wide as for the original surface. This reconstruction is a possible condition for the dissociation of CO on the copper surface.

3.3.4 Determination of the Surface Structure of Thin Diblock Copolymer Films

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Diblock copolymers consist of two distinct polymers. We have studied poly-styrene (PS) and poly-dimethylsiloxane (PDMS) in an asymmetrical and in a symmetrical combination. In this lecture I will present results from the analysis of the asymmetrical combination. This diblock copolymer is 40.000 g/mol PS - 6.000 g/mol PDMS and is soluted in chloroform. Spin-coated films were annealed at 90 ^{o}C and 130 ^{o}C corresponding to temperatures below and above the glass temperature of PS. The samples were studied with X-ray photoelectron spectroscopy (XPS). The surface segregation of PDMS was quantified by analysis of the XPS peak shape.

3.3.5 The Search for the Blue Laser Diode - Applications of GaN Semiconductors

Nathan Langford

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(Based on work carried out at the Australian National University)

Blue LEDs and laser diodes have provided the technological world with one of the most dramatic advances of recent years, based on the use of gallium nitride (GaN). Yet, the resulting intensive research has not so far unlocked the secrets of this mysterious wide band gap semiconductor. During a summer vacation scholarship at the Australian National University, the photoluminescence properties of GaN related to defects introduced by ion implantation techniques were investigated using a broad band excitation spectrometer. This paper briefly outlines recent developments in GaN diode technology and describes the results of this particular study.

3.3.6 On the Magnetic Structure of Finite Multi-layers

Márton Major

Eötvös Loránd University, Faculty of Science, Hungary
solid state physics

The magnetic structure of Magnetic Multi-layers (MMLs) exhibits rich and varied magnetic properties not found in bulk magnetic materials. Theoretical studies however often neglect the effects related to finite size effects.

A magnetic multilayer is a pile of magnetic layers separated by non magnetic ones. Different kind of phenomenological couplings can be observed in different systems. A bilinear anti-ferromagnetic coupling can occur in Fe/Cr multi-layers. Understanding the behaviour of such a coupling is essential to go further in understanding the physics of giant magneto resistance (GMR) for example. The phenomenological model used widely in the literature consist of a few “classical” magnetic momenta (the objects of the model are the total magnetizations of the Fe layers) so it is not trivial, that you can neglect the effects coming from the *finite* number of layers.

With the help of a flexible program it is easy to take into account the above mentioned finite-size effects. The first results are astonishing (collective mode for ex.). Some interesting ’movies’ will be presented describing the behaviour of different multilayer systems.

3.3.7 Tracing the Laser damage: Defect Dynamics on the Femtosecond Time Scale

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Laser damage of transparent dielectrics has been an important area of studies for many years. Among the materials used in optical applications, several alkaline-earth fluoride crystals (CaF_2, BaF_2, LiF and MgF_2) play a prominent role for handling UV laser radiation, where optical elements have to meet highest standards with respect to both, optical quality and damage resistivity. Ablation thresholds and damage behaviour of the fluoride crystal surfaces produced by 248 nm/14 ns laser pulses have been investigated in our previous studies giving us rather clear picture about the damage mechanism. The ablation was found to be dependent from the thermoelastic properties of particular material and was created mostly by absorption of the laser light and the following heating. In our present studies the creation, separation and control of intrinsic lattice defects (F, H centers and self trapped exciton- STE) were examined by using femtosecond pulses in pump-probe mode. The sequence and kind of defect reactions was found to be dependent from electron-photon coupling in each material. The possibility of laser controlled aggregation of defects and growth of metallic colloids in dielectric crystals, as well as the application possibilities of those were shown.

3.3.8 The Effect of the Sr-Ca Titanate Doping on Phase Formation and Superconducting Properties of BSCCO

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One of the ways to increase critical current density in high temperature superconductor is adding chemically compatible non-superconducting phase. The most effective is the small-sized particles addition. In this work the interactions between BSCCO superconductor and non-superconducting strontium-calcium titanates were studied. Titanate powders of 20-25 nm particle size were obtained by oxalates thermal decomposition at 620C. They were added to the Bi-2223 superconductor, which was obtained earlier, and pressed into tablets. Also we studied doped samples of the same composition, but obtained from nitrate solution by its evaporation and thermal decomposition. The pressed tablets were sintered at 860C for 40 hours. Titanate lattice constants were calculated from Guinier diffraction pattern for all the samples: a=0.3901 nm for strontium-calcium titanate and a=0.3902 nm for strontium titanate, which is slightly less than for pure strontium titanate (0.3905 nm). Thus, strontium titanate with small (4%) amount of calcium is in chemical equilibrium with Bi-2223. The XRD data show, that the quantity of the Bi-2223 phase is bigger in the samples prepared from titanate and superconductor precursors obtained separately. In the sample doped by calcium-strontium titanate we also have bigger quantity of the Bi-2223 phase. The critical temperature in doped samples is 2K lower than in the undoped. The obtained results confirm that $SrTiO_3$ may be used as a pinning additive.

3.3.9 Study of Tokamak Plasmas by Microwave Reflectometry Methods

Tiago Tamissa Ribeiro

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A brief introduction to nuclear fusion is made. The necessity of diagnosing the plasma in a tokamak reactor is stressed as result of the need of magnetic confinement and stability in a tokamak plasma. Microwave reflectometry is addressed as a powerful fusion plasma diagnostic. After analyzing the methods to extract information from experimental data in fixed frequency operation, the results obtained from some ASDEX Upgrade discharges are discussed.

3.3.10 Making Stars in the Laboratory

Heidi-Christina Bandulet

INRS-Énergie et Matériaux,Varennes, Québec, Canada. Laboratoire LULI, École Polytechnique, Palaiseau, France

This serves as a brief outline of the basics of **thermonuclear fusion** as the future's energy source. Discussed are elementary notions of **plasmas physics, fusion by laser beams and ultraintense laser-matter interactions**. As an alternative to the classical scheme for laser fusion, the *fast Ignotor* scheme relies on the presence of a collimated beam of fast electrons that can propagate deep into solid matter. Our experiments at the Terawatt Laser of the LULI are of critical interest for this scheme. The interaction with fused silica targets produce such electrons whose propagation and spatial distribution are provided by optical probing. The gathered images presented here confirm our expectations and are promising for the realization of laser fusion in the future .

3.3.11 Polluting Elements

Mirco Coccoli, Alessendra Mussi

The groups purpose was to measure nitrogen oxide and dioxide levels in the air of Milan. The period chosen is short (six days), however representative both of progress of a week and of pollution in Milan (obviously only referring to nitrogen oxides!). Using some devices, we have found what we attended: in the rush hours there is a peak in the graphic. On the contrary there is a hollow in the middle of the afternoon and a peak in the middle of the night. These facts are explained by the changes of thickness of the mixed stratus (the part of atmosphere in touch with the ground that is the part in which the dusts and the polluting elements are bound): as colder is the air, as thin is this stratus and vice versa. All this facts are clear from the graphic which represents the medium day. The graphic with the progress of all the recording days (March from the 3rd to the 9th) shows another point of view: the difference between the various days of the week. In fact the working days are quite different from the week-end ones: the very high peaks are in the late afternoon of Friday and in the mornings of Saturday and Monday. This mean that in Milan many people arrive on Monday morning for professional purposes and leave for the week-end to stay with the family.

3.3.12 New Compounds With Interest in Non-linear Optics

Francisco Villalobos Nascimento

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Organic molecules with an extended (-electron shell and a conjugated donor-acceptor group often have large polarizabilities and hiperpolarizabilities, exhibiting non-linear optical properties. A well-known example of such molecule is 4-Aminobenzophenone. When irradiated by LASER light, compounds based on this type of molecule show second harmonic generation, which has many technological applications in communications and optical data storage. In this work, new compounds with extended (-electron shells have been synthesised and their crystal and molecular structures characterised by X-ray diffraction. In addition, ab-initio calculations

using extended basis-sets of the minimum molecular energy conformations and of the optical properties using time-dependent Hartree-Fock theory have been performed and shall be reported.

3.4 Optics/Laser Physics

3.4.1 Nonlinear Optical and Relaxation Properties of Thin Fullerene-based Films by Modified Time-resolved Two-colour Z-scan Technique: Non-gaussian Laser Beam Approach

Anastassia Gosteva

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The work describes main principals of installation created to investigate third order nonlinear optical and relaxation film properties under picosecond laser excitation. The installation utilising combination of two different techniques: time-resolved longitudinal scanning and pump-probe method. The possibility to perform pump-probe experiment with different pump and probe beam wavelength allows reducing probe beam influence upon sample nonlinearity that was caused by pump beam irradiation. Experimental data analysis obtained by the two-colour time-resolved Z-scan was spread out into non-Gaussian laser beams. A number of comparative experiments on pulsed laser deposited (PLD) and thermal deposited fullerene films were performed. It was shown that despite of high stability of PLD films under laser irradiation their third order optical nonlinearity is much smaller than in thermal one.

3.4.2 Investigation of Synchronously Pumped KTP Optical Parametric Generator

Aleksandr Ovsianikov, Linas Urbonas

The work presents investigation results of the KTP OPO(second type phase-matching) synchronously pumped by CW Q-switched and mode locked ND:YAG laser SHG radiation. The pump laser generates 350 W power and 75 ps duration pulses. It was shown that the OPO with the fiber in the cavity must be used single mode fiber.

3.4.3 Optical Tweezers: Non-Invasive Manipulation (or a Light Spin Around the Traps)

Cavin Talbot

Department of Physics, University of Queensland, Australia

Optical tweezers, which are becoming a powerful tool in a wide range of fields from biology to physics, use the optical gradient force from a sharply focussed laser beam to trap particles. Moving particles without physically touching them causes minimum damage and makes this a powerful experimental tool. The working principle behind optical tweezers is briefly explained and some uses described. The University of Queensland Physics Department has used optical tweezers to trap and rotate cogs, which may be the first step towards micro-machines, and to manipulate chloroplasts in the study of plant cells.

3.4.4 Let There Be Light Made by Sound

Emanuel Alexandre, Filipe Rosa Ferreira

Sonoluminescense means, quite simply, light from sound. The idea is very simple: a small bubble, surrounded by some liquid, is bombarded with sound. Due to the high energies now in the bubble, it starts to luminesce, or produce light. When researchers first discovered this phenomenon, they called it sonoluminescense. While sonoluminescense was first discovered in the 1930's, it received little attention until recently. In the past few years, a number of discoveries have been made, opening up even more mysteries. While most people have heard nothing about sonoluminescense, it has great potential in many scientific areas. High on the list for many researchers are its applications to fusion, since it is predicted that as sound bombards a bubble, the temperatures can get so hot as to allow fusion to occur within the bubble. Accordingly, there is some exciting research going on in this new field, and, according to Science, it is "a remarkable laboratory for physics and chemistry".

3.4.5 Photorefractive Phenomena in Waveguides

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Since its discovery in 1966 the photorefractive effect has been widely studied and many applications have appeared. On the other hand the great development of integrated optics has opened a new field for many nonlinear optical effects. Photorefractive phenomena began as a inconvenience but now better understanding and control of waveguides preparation procedures have made possible the use of photorefractive phenomena in practical applications. In this paper, after a theoretical introduction, the photorefractive effect in α-phase proton exchanged $LiNbO_3$ waveguides is studied. A behavior very different to bulk samples is obtained.Some of the original results are: (a) Faster dark erasure kinetics and (b) Dependence of the saturation value of the diffraction efficiency with the recording intensity of light. These differences can be explained assuming the existence of other impurities, besides Fe as protons or shallow traps.

3.4.6 Geometrical Atom Optics: A Cold Atom Trampoline

C.V. Saba, P.A Barton, M.G. Boshier, I.G. Hughes, P. Rosenbusch, B.E. Sauer and E.A. Hinds

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Using lasers it is now possible to cool clouds of atoms to temperatures of about a millionth of a degree above absolute zero. According to quantum mechanics atoms at such low temperatures increasingly take on ?strange? wave-like properties and behave less like particles. To study these properties we need to develop new techniques that allow us to manipulate cold atoms without heating them. We manipulate light waves everyday using mirrors and lenses and therefore atom-opticians aim to design analogous instruments to manipulate atom-waves, such as atom-mirrors and atom-lenses. Our group has been involved in the development of atom-mirrors. Several techniques exist for reflecting atoms using either laser light or static electric or magnetic fields, each having their own flaws and merits. Using commercial video-tape we have constructed the world's first concave magnetic mirror. Below you can see an actual movie of a cloud of cold Rubidium atoms bouncing on this mirror and demonstrating the behaviour expected of atoms reflected from a high quality smooth concave surface. The ability to manipulate cold atoms to this degree of accuracy is important for any subsequent applications of laser cooling and atom-optics technologies. Atom optics is a burgeoning field and has a multitude of possible applications. These vary from the very applied such as the development of high precision gravimeters and the building of nano-structures to more fundamental physics challenges such as the possible construction of "quantum computers".

3.5 Astronomy/Astrophysics/Space physics

3.5.1 CCD Astronomy: the Electronic Photography

Ricardo Afonso, Emanuel Alexandre, Filipe Rosa Ferreira

Over the last decade, conventional photography was overtaken by a "solid state sensor array" for astronomical imaging. The perpetrators of this revolution have been the CCDs (charged couple devices). There are four great advantages of the use of a CCD over conventional photography: a much greater efficiency; the response is linear, allowing direct measurements on the image; great amplitude of exposure time and extensive chromatic sensitivity. The most surprising fact regarding CCD is their high quantum efficiency that ranges from 60 % to 70 %, instead of 3% to 4% of prime-grade photographic emulsions.It happens that the price range of scientific CCDs is out of the possibilities of most common physics students. So they had to come up with a viable alternative that is the adaptation of a Quickcam or other similar low-cost CCD-based camera. This practice has spread within amateur astronomers that,with the help of convenient software and procedures, are able to achieve surprising results. In this lecture, we intend to present the results of some observation nights and explain the methodology for processing astronomical images emanated from a CCD (in our case, a B&W Quickcam).

3.5.2 The U of a White Dwarf Home Page: Finding Charts,Positions and Other Information at the Click of a Button

Peter Jensen

University of Arizona, United States

We have created a World-Wide Web site which conveniently collects finder charts and published data for a significant fraction of the White Dwarf stars in the McCook & Sion White Dwarf Catalog. For each star, we display a finding chart, alternate designations, Hubble Space Telescope Guide Star Catalog coordinates and published photometric and astrometric data, with appropriate references. When available, we also include a listing from SIMBAD Astronomical database. We are in the process of completing this data set and hope to soon add additional information including photospheric and interstellar spectral line identifications, as well as optical, IUE, EUVE, ROSAT and similar spectra, with the assistance of our colleagues in the White Dwarf community. We also expect to soon augment this site with the capability to perform multi-field searches of the information in the database.

3.5.3 Globular Clusters in Our Galaxy

Sinisa Prugovecki

Globular clusters are the most ancient objects in the Galaxy and we could say the most simple large-stellar-structures in Universe. So, from analyzing them, we can learn a lot, just like biologists learn about the whole life analyzing the most simple life-forms. With the development of technology we made very powerful telescopes that can observe globular clusters in other, far-away galaxies, but they can't observe single stars in each cluster. And if we want to compare those clusters with 'ours' we must study every Milky Way's globular cluster not as a bunch of stars, but as a single large object. In this lecture I will talk about those 'global' characteristics of globular clusters in Milky Way.

3.5.4 Formation of the Solar System

Bojan Pecnik

A brief overview of the Formation of the Solar System, and the planetary systems in general, is given. Several models of formation will be shown, their physical mechanisms revealed and some points, which are still fairly poor understood, will be addressed. Lecture is conceived as an introduction to the problem of the Sol System Formation, with slides of the planets.

3.5.5 The Energetic and Relativistic Nuclei and Electron Experiment ERNE

Jarno Laivola

Space Research Laboratory, University of Turku, Finland

The Solar and Heliospheric Observatory (SoHO) is a joint space programs of the European Space Agency (ESA) and NASA for making the versatile long-term study on the Sun. One of the instruments on-board is the Energetic and Relativistic Nuclei and Electron experiment (ERNE) of University of Turku. ERNE investigates the solar atmosphere by detecting charged particles produced in various energy release processes. The main target of ERNE is to undertake the first systematic survey of Solar Energetic Particles (SEP). Various properties - like elemental and isotopic abundance, temporal variations, anisotropy etc. - of solar-originated particle flux are detected. In the instrument there's two sensors: Low Energy Detector (LED) and High Energy Detector (HED). With these detectors it's possible to identify elements and isotopes from H to Fe in a wide energy range. LED has an energy range of 1.3-13 MeV/n for H and He and 2.4-50 MeV/n for other nuclei. For HED the ranges are 11-120 MeV/n for H and He and 25-540 MeV/n for other nuclei. When there's no SEP production, ERNE observes galactic cosmic ray background from Milky Way. SoHO was launched in December 1995 and it's been observing the Sun from a halo orbit around the L1 (Earth-Sun) Lagrangian point. The mission is expected to continue until 2003, which allows it to observe the solar activity maximum around mid-2000.

3.5.6 X-Ray Observations of Micro-lensing Events

Kjetil Kjernsmo

Institute of Theoretical Astrophysics, University of Oslo, Norway

According to the General Theory of Relativity, light is deflected by gravity. In the case where a bright source is situated behind a massive object as seen from the observer, this may result in so-called *Gravitational Lensing*. In the special case of strongly lensed quasars, two or more images of the same object may be seen. In addition, any clumping of mass in the lens, such as stars, MACHOs or star clusters will split the image into several micro-images. These cannot be resolved, but the bending of rays from such masses will focus or spread the light rays from the source, and thus change the brightness of the images over time due to the relative motion of the lens, source and observer. This is known as *extra-galactic micro-lensing*. Micro-lensing may enable us to map mass distributions in very remote galaxies and can act as a powerful probe to quasar structure. Caustics are produced where light rays are focused on the observer, and High Amplification Events (HAE) are predicted to occur when such a caustic is crossed. Such an event has not yet been observed. X-Rays are thought to originate dominantly from the innermost regions of quasars, from regions that may be as small as our solar system. If this is correct, HAEs may be observed in X-rays with the new observatories now being launched. If this happens, it may give us a lot of exciting new information and very good constraints on the important parameters: lens mass and source size.

3.5.7 The Origin of Cosmic Rays - Galactic or Extra-galactic

Davor Krajnovic

The origin of cosmic rays is still unknown and the cosmic ray spectrum doesn't show a natural end. There are ultra high-energy cosmic rays that enter the Earth's atmosphere carrying as much energy as a well-thrown rock. A straightforward question is: do the cosmic rays, which we observe locally, fill up only our Galaxy or do they fill up the entire Universe? There are several recent hypotheses that suggest that origin of cosmic rays may be galactic or/and extra-galactic. The sources of cosmic rays might be: supernovas, galactic black hole accretion disks, gamma ray bursts and topological defects in the fabric of the Universe. Are they really straightforward answers?

3.5.8 Scintillation and Refraction of Stellar Light During Atmospheric Occultations

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Finnish Meteorological Institute, Geophysical Research Division, Helsinki, Finland

Stellar occultation is a method of measuring atmospheric constituents in the middle atmosphere. In stellar oc-

cultations the instrument measures stellar light through the atmosphere, and the atmospheric constituents may be retrieved from the measured spectra by inversion techniques. During its travel through the atmosphere the parallel ray bundle is strongly disturbed by the refractive effects of the Earth's atmosphere. There are basically three types of refractive effects: refractive dilution due to the atmospheric density gradient, scintillations due to density fluctuations and chromatic refraction due to the wavelength-dependent refractive index of the atmosphere. In this paper we will present the physical principles of these effects, their theoretical modeling as well as balloon-borne measurement data on scintillation and refraction of stellar light.

3.5.9 Sunspots and the Climate of the Earth

Lauri Laakso

Department of Physics, P.O. BOX 9, FIN-00014, University of Helsinki, Finland

Galactic cosmic rays ionize air molecules in the atmosphere. These ions can facilitate vapours like sulphuric acid to nucleate to particles. Formed particles can grow further to cloud condensation nuclei, which may affect the cloud properties and cover. A model has been developed in aim to estimate if this route of particle formation is possible and if it is possible to verify it by measurements. Preliminary results show, that the verification is possible in tropospheric conditions during intensive particle formation.

3.5.10 Total Solar Eclipse of 1999 August 11. Astronomical Expedition to the Total Solar Eclipse Path, Turkey '99

Sebastian Soberski

The expedition to the total solar eclipse path was organised by Grudziadz Astronomical Observatory.

Nearly four decades have passed since a total eclipse of the Sun was visible from Europe. The long drought finally ends with the last total eclipse of the Second Millennium on Wednesday, August 11, 1999. The path of totality begins as the Moon's umbral shadow touches down in the North Atlantic Ocean about 700 kilometers east of New York City.

First occurs after the shadow sweeps across the Atlantic and reaches England's southwestern coast. Cornwall and Devon lie in the path; Land's End stands on the centerline where the midmorning total eclipse lasts 2 minutes. Quickly traversing the English Channel, the umbra reaches the Continent along France's Normandy coast. The track runs through the French countryside where its southern limit passes just 30 km north of Paris. Residents of the City of Lights will enjoy a partial eclipse of 0.992 magnitude, in which 99.4 percent of the Sun's disk will be blocked. (Magnitude refers to the ratio of the overlapping solar and lunar diameters.) Continuing east through the Champagne region, the shadow swings across southern Belgium, Luxembourg, and Germany. Just north of the centerline, Stuttgart witnesses a total eclipse of 2 minutes 17 seconds. Munich's nearly two million citizens will also enjoy over 2 minutes of totality, provided skies are clear. As the eclipse path stretches through central Austria and Hungary, the umbra narrowly misses Vienna and Budapest, both of which experience partial eclipses of magnitude 0.99. As the shadow leaves Hungary, it briefly sweeps through northern Yugoslavia before continuing on to Romania. The instant of greatest eclipse occurs at 11:03:04 Universal Time in Romania's rolling countryside near Rimnicu-Vilcea. Here, the length of totality reaches its maximum duration of 2 minutes 23 seconds, the Sun's altitude is 59 deg., and the path is 112 km wide. Four minutes later, the umbra engulfs Bucharest, which stands squarely on the centerline. The shadow also enters northern Bulgaria before swinging out across the Black Sea.

The eclipse path reaches Turkey's northern coast and then continues southeast bisecting the country diagonally. Although Ankara lies 150 km south of the track it still experiences a deep partial eclipse of magnitude 0.967. The largest Turkish cities in the path of totality include Sivas, Elazig, and Diyarbakir.

The eclipse track begins to narrow and the duration drops as the shadow's trajectory takes it through Iraq and Iran. By the time the umbra enters southern Pakistan, central totality lasts less than 1.5 minutes. The five million residents of Karachi will experience a late afternoon total eclipse of 1 minute 13 seconds. Entering India, the track passes just south of Ahmadabad where a partial eclipse of magnitude 0.997 occurs. By the time

the shadow traverses the Indian subcontinent, the duration falls below 1 minute and the eclipse occurs shortly before sunset. Sweeping out over the Bay of Bengal, the umbra leaves Earth's surface not to return until the next Millennium on June 21, 2001.

3.6 Computational physics

3.6.1 Can Simulation Replace Nuclear Weapon Testing?

Richard Williams

Sometimes setting up a research experiment can be too expensive or dangerous to be feasible. Is computer simulation a viable substitute for these experiments? This talk examines the current status of simulation physics through a case study of thermonuclear weapons. The thermonuclear device is dissected into the operational physics at work, including neutron transport, photon transport, hydrodynamic shock, and implosion fusion (among others). An overview of the problems that need to be solved is given and an estimate of the necessary computing power is made.

3.6.2 "Lyapunov Waves": Dynamical Instabilities in Hard Disk Systems in Equilibrium

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The basic equations we use to calculate the time propagation of physical systems are linear. But the world we try to explain is mainly governed by nonlinear interactions. The resulting equations are extremely sensitive on initial conditions and lead to so-called deterministic chaos. Infinitesimally perturbed systems strive away from their reference system at an exponential rate. The rate of divergence in different directions of phase space is described by the Lyapunov spectrum. In computer simulations of hard disk systems we have discovered wave like disturbances that are very stable. Depending on the particles' direction of deflection the waves are stationary or propagate in a very distinct pattern through the system. The waves don't seem to be an artefact of the method but all attempts to link them to physical properties have failed until now.

3.6.3 Radiosity: Physical Bases of This Computer Graphics Method

Michal Zielinski

Everybody realises that the computer graphics has a lot of applications in physics, especially in visualisation of various simulated processes, but only few understand how huge impact has physics on computer graphics methods. Mathematical and physical approach to computer graphics produces new efficient and giving realistic, visual effects methods. Beside ray tracing, which is now the most popular technique, a lot of new methods have been created. Radiosity is one of those techniques and it is strictly based on physics principles in a very large extent. The principle of conservation of energy, Southwell relaxation and photometry are necessary basics. Thus, physicists, thanks to their knowledge and mathematical workshop, have lots of possibilities in this domain of science.

3.6.4 Numerical Weather Forecasting

Tomasz Sikora

The lecture presents ideas of numerical weather prediction. There will be presented steps of generating forecast: from meteorological measurements, through process of data assimilation, to visualisation of results. There will be discussed accuracy of traditional (synoptic) and numerical weather forecast. There will be presented methods of improvement forecast accuracy.

3.7 Theoretical/Mathematical physics

3.7.1 Motion of Electron in Magnetic Field - Problem of Gauge and Boundary Conditions.

Pawel Wrobel

Motion of electron in magnetic field is a very well known problem. Everyone knows that classically it is determined by Lorentz force. Quantum mechanically we start from a hamiltonian, which is gauge invariant. We can find energy levels (called Landau levels) and wave function for this problem using symmetric or Landau gauge. Solution cannot depend on gauge, however it is very difficult to see any similarity between solutions obtained in both gauges. Another problem we meet, when we consider limit of weak magnetic field. One easily find that for zero magnetic field all energy levels collapse to one level, whose energy is equal to zero and which has infinite degeneracy. Shortly - we do not get solution, which describes free electron motion (i.e. in crystal).

In my lecture I will show a possible explanation for this problem.

3.7.2 Universality of Late-time Dynamics in Nonlinear Wave Equations

Nikodem Szpak

The Scientific Association of Physics Students, Institute of Physics, Jagellonian University, Cracow, Poland

For linear wave equations ($\Box\phi + V\phi = 0$), if V has no bound states, $\phi = 0$ is the global and stable attractor in time evolution. The late-time dynamics is dominated by so-called quasi-normal modes. Nonlinear wave equations ($\Box\phi + f(\phi) = 0$), on the contrary, may possess some nontrivial ($\phi \neq 0$) stationary solutions, which in time evolution play the role of stable or metastable attractors. Metastable may be critical points between two scenarios of later dynamics. The dynamics near the attractors – stable as well as critical points – is universal (does not depend on the initial data) and is also dominated by quasi normal-modes.

Detecting of gravitational waves from creation of black holes is based on the observations of quasi normal oscillations of the gravitational field around the arising black hole.

3.7.3 Contact: What Is Behind the Message? Encoded information by polarization modulation with wormholes as its highway

M. Luísa Arruda and Paula Stella Teixeira

University of Lisbon, Faculty of Science, Portugal

In Carl Sagan's novel "Contact" we are introduced to the newly-born application of polarization modulation and to thoughts of interstellar travel through wormholes.

The Message consists of an encoded binary electromagnetic signal artificially created by an advanced civilization in Vega. The codification is achieved by asserting a bit 1 to a levopolarized portion of an electromagnetic wave and a bit 0 to the corresponding dextropolarized portion.

In this discussion we assume that the Message is sent to our home planet Earth through the same type of wormhole that is used by Dr. Eleanor Arroway and her team in their voyage to Vega. Wormholes are very tricky creatures; the first difficulty on this issue arises around their birth, which Sagan avoided by bringing into stage an infinitely advanced extinct civilization who built an entire network of interconnecting wormholes, (we will follow his example). The underlying properties of traversable wormholes will be discussed, such as exotic matter necessary to maintain the wormholes stability.

3.7.4 Was Einstein Wrong?

Carlos A. Correa

University of Buenos Aires, Argentina

The purpose of this paper is to present my point of view related to the constancy or not of the speed of light. The physics involved in relativity are not just considering light as a constant. The possible consequences of such description could lead to the understanding of other problems not yet known. Background radiation, may be much more than a lost explosion.

3.7.5 Introduction to Supersymmetry

Marko Velic

Introduction. Weyl spinors and the two component notation. Supersymmetry transformation. Superspace and superfields. Chiral superfields and the toy model of spontaneous breakdown.

3.7.6 Biological Evolution with Feedback

Janos Asboth and Andras Vukics

ELTE, Budapest, Hungary

We present a simple mathematical framework for the modeling of biological evolution with the state of the environment being affected by the strategies of the competing species. So-called Evolutionary Singular Strategies can either be Evolutionary Stable or repellent, or they can be the source of speciation. Results in a one-dimensional strategy space are easy to understand. Multidimensional evolutionary dynamics can be more interesting: characterisation of Evolutionary Singular Strategies becomes difficult. This framework is applied to a specific model (Two-patch model) for the study of speciation.

3.7.7 The Effective Adiabatic Approximation of Three-Body Problem with δ-Potentials on a Line

D.V. Proskurin and D.V. Pavlov

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The effective adiabatic approximation (EAA) of three-body problem on a line with short-range attractive δ-potentials is constructed. The EAA lower bound for the energy with an absolute accuracy of order 10^{-6} is obtained. It is shown that EAA provides a true asymptotics of solutions and a correct behavior of the elastic scattering phase with an absolute accuracy of 10^{-3} in the interval $2 * 10^{-3} < q < \pi/6$ of the relative momentum below the three-body threshold for (3 to 3) scattering. The convergence of adiabatic expansion using for construction of the effective long-range potential in the framework of EAA is demonstrated.

3.8 Medical physics/Biophysics

3.8.1 CdTe Nuclear Stethoscope for Cardiac Gamma-ventriculography

Youri Arntz

Two projects involving a pixellated conception of γ-ray sensitive areas, based on arrays of semiconductor cadmium telluride (CdTe) detectors, have been developed for the assessment of cardiac performance in nuclear medicine. A γ-camera project, developed in the frame of a European Community contract, is dedicated to imaging of the heart region on the non-moving patient. The camera head which has a 15 cm x 15 cm field of view, is transportable out of the nuclear department, for instance in intensive care units for emergency examinations. A nuclear stethoscope has also been developed as a hand-size probe allowing up to 33 data acquisitions per second, for beat to beat assessment of the left ventricle volume variations on the standing and exercising patient. The physical characteristics of the two systems are presented together with the first images obtained by the camera and results of preclinical investigations by the nuclear stethoscope.

3.8.2 Physics of Breathing

Nuno Luis Barbosa Morais

Instituto Superior Tecnico - Lisboa, Portugal

Biomedical Physics is actually one of the most exciting research fields. Doctors and Physicists are now, more than ever, working together. You will get an overview of how this joint work can prevent you from being breathless...

There are some interesting physical aspects in Respiratory Physiology. Surface tension, gas laws and elastic forces are very important in the detailed study of the statics and dynamics of lung ventilation. Medicine is now using techniques based on physical concepts such as airways resistance or mechanical work to detect and fight against lung and respiratory diseases.

Today, simulations based on airflow models for the tracheobronchial tree are being made by some Biophysicists and their results fit experience quite well.

The nervous control of breathing is also an unexplored subject in which some experience in Physics may be useful...

3.8.3 Measurement of Object Properties by Complex Interferometry OCT

Maciej Wojtkowski

Nicholas Copernicus University, Torun, Poland

Optical coherence tomography (OCT) is a noninvasive imaging technique which provides microscopic tomographic sectioning of biological samples. This contribution presents a new OCT technique, which allows to detect the complex scattered field and compute the complex scattering potential of the object. The basic principle is outlined and experimental measurements in vitro and in vivo are shown.

3.8.4 Independent Component Analysis in Functional Magnetic Resonance Imaging

Andrzej Chojnowski

Recently Independent Component Analysis (ICA) has been introduced for functional Magnetic Resonance Images (fMRI) processing. The goal of that technique is to e a set of random variables as linear combinations of statistically independent components. In case of fMRI the random variables are images of brain activity sampled at a certain frequency. ICA tries to decompose them to component "maps" and their associated time courses. One assume that a single component map resembles a set of neurons involved with the same task and overall brain activity is simply a linear mixture of all cluster's activities.

The data shown beneath come from a subject performing language comprehension test. One tries to compare ICA and traditional, statistical analysis methods.

3.8.5 Raman Spectroscopy: Raman and SERS Studies on the New Ni(II) Cupferronato Complexes

I. Pavel(1), S. Cîntã(1), A. Deak(2), I. Haiduc(2), M. Venter(2), P. Rösch(3), O. Cozar(1), T. Iliescu(1) and W. Kiefer(1)

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The ammonium salt of N-nitroso-N-phenyl-hydroxil-amine $[PhN_2O_2]NH_4$ (cupferron) is a well-known analytical reagent. Additionally, the cupferron is a biologically active component, known to display carcinogenic, genotoxic and mutagenic DNA-damaging effect. In this respect, Raman and surface enhanced Raman scattering (SERS) spectra of the cupferron and new NiL_2A_n, L=$PhN_2O_2^-$, n=1, A=o-phenanthroline, o,o'-bipyridine and n=2, A=H_2O, o-aminopyridine, o-diaminobenzene have been recorded for the first time and discussed. Vibrational analysis of the neutral ligand and new prepared Ni(II) cupferronato complexes suggests the electron delocalization through the coordinated ONNO unit and the coordination of the anionic ligand to the metal center through the oxygen atoms. The NiL_2A_n complexes with n=1, A=o-phenanthroline, o,o' - bipyridine and n=2, A=H_2O were found to adsorb on the Ag colloidal surface, suggesting a preference for the nanometer Ag colloid particles. The SERS bands associated to the chemical interaction between the ONNO unit and Ag colloidal particles were observed, indicating a parallel orientation of N-N bond with respect to the Ag particles. o-phenanthroline and o,o'-bipyridine ring vibrational modes behavior leads to a perpendicular orientation of the molecular structure of these compounds to the Ag surface. Raman fingerprint band of the new Ni(II) cupferronato complexes was found at about 1300 cm^{-1}. SERS spectra of the title compounds bring additional arguments for the bidentate coordination of the ONNO group .

3.9 Miscellaneous

3.9.1 Space-time Philosophy

Sérgio Brissos and Bruno Ferreira

In this presentation we will study the indissociability of physics and philosophy, focusing our attention on the concept of space-time. The concept above mentioned is first tackled from the point of view of an individual who has no technical preparation in the modern theories of space-time, concepts such as the awareness of a geometry intrinsic to the universe will be discussed. We then move on to refer to the incorporation of the space-time concept in modern theories such as the theory of relativity and the quantum theory, always keeping in mind its philosophical implications. Finally we consider the path by which philosophical thought affects the creation and acceptance of a physical theory through the actions of a scientist, these ranging from religious and/or artistic to the proper context in which the scientist works.

3.9.2 The Interrelationship of Science, Technology and Society

Marc Meléndez Schofield

Universidad Complutense de Madrid, Spain

The purpose of this paper is to attract attention to the values which underlie certain advanced technologies and research projects, and which we tend to ignore. First, several examples demonstrate how technologies can be used for political ends. Then, we present some technologies which have a social impact which was not intended when they were designed. Lastly, we show how scientific research and theories also hide values which reflect the social context in which they were devised.

3.9.3 Finnish Association for Mathematicians, Physicists and Data Processing Scientists (SMFL)

Jouni Björkman, Chairman of SMFL

Finnish association for mathematicians, physicists and data processing scientists (SMFL) is a linking organisation for people having academic degree in mathematics, physics or dataprocessing science and students of those subjects. SMFL is a branch organisation in The Finnish Association of Graduate Engineers (TEK), which protects the interests of SMFL-members concerning collective bargaining and many other matters related to employment.

The membership is available for anyone who is graduated in physics, mathematics or data processing science. SMFL has special interest in having students of these subjects as undergraduate members. In co-operation with student organisations and TEK a nation-wide member recruitment system is under development and information happenings for graduating students in the University of Helsinki have already been organised.

Chapter 4

Poster abstracts

4.1 Physical chemistry

4.1.1 Comparative Vibrational Analysis of Acridine Derivatives in Free State and Adsorbed on Ag Colloidal Surface

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Vibrational Raman, IR and surface-enhanced Raman spectra (SERS) of 9-methyl acridine (9MA), 9-phenyl acridine (9PA), 9(10H) acridone (9A), and rivanol (2-ethoxy-6,9-aminoacridine- lactate) (RIV), have been recorded and analysed.

Applications to trace assays of such pharmaceutical molecules have received keen interest because SERS holds considerable promise as a high sensitive analytical tool in medicine as well as in basic research of biological sciences [1, 2].

Large fluorescence [2, 3] is typically for visible excitation of these molecules. Therefor, near-infrared Fourier transform Raman or other techniques of quenching fluorescence were required. Totally missing of the fluorescence at very low concentration of sample is a proof that the SERS effect takes place and a preresonance or either resonance Raman contribution is supplementary added to the total enhancement of the signal.. Excellent SERS spectra of 9MA, 9PA, 9A and RIV were obtained. Many similarities of vibrational feature in the spectra allowed to conclude about the influence of the substituents on the vibrational behaviour of the acridine skeletal ring. Different SERS spectra of these molecule indicate a chemisorption of 9MA, 9PA and 9A and a physisorption of RIV respectively, on the Ag colloidal particles [4]. Vibrational assignments of the observed bands have been proposed. The most probable orientation of the studied molecules on the Ag surface was proposed.

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4.1.2 Radiocarbon Dating Using Accelerator Mass Spectrometry

Sam Henry

University of Durham, United Kingdom

Radiocarbon dating has been one of the most significant discoveries in 20th century science and is now an indispensable tool in archaeology, geology, environmental science and many other subjects. The age of an object is determined by measuring the amount of carbon-14 it contains. This can be done in two ways: by measuring the radioactivity of the sample; or by directly counting the number of carbon-14 atoms using accelerator mass spectrometry.

In ordinary mass spectrometry ions are accelerated into a magnetic field allowing particles of different masses to be separated. In order to detect carbon-14 atoms it is necessary to accelerate the ions to a high energy so that other mass 14 particles can be eliminated.

4.1.3 Electron Transport in Ammonia

Sava Sakadzic, Nikola Paunkovic, Djordje Sarac and Zoran Petrovic

Institute of Physics, University of Belgrade, Yugoslavia

Ammonia is one of the most important technical gases and is a frequent pollutant of the atmosphere. In literature there are very few papers on swarm parameters in ammonia which makes it difficult to model a number of plasma applications that rely on e-NH_3 cross section and transport data. Amongst the most important applications where such data are required are: flue gas removal, atmospheric modeling, plasma processing [1] for microelectronics and nitrating. It is therefore really surprising that in the literature a large discrepancies exist for the transport coefficients in ammonia [2]. The most striking discrepancy is for the attachment probability (coefficient) where factor of 10 disagreement exists between the two available sets of data in the literature [2]. Data for the cross sections obtained by beam methods are more abundant and should be used to provide transport coefficients for plasma modeling since there is a shortage of experimental transport data. In this paper we present the calculations of electron transport coefficients for ammonia based on electron scattering cross sections and attempt to resolve some of the discrepancies from the literature.

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4.2 Theoretical/Mathematical physics

4.2.1 Thermodynamics in Special Relativity

Carlos Russo, Gina Caetano, Nuno Santos

I.S.T., Portugal

This issue was first investigated by Planck (1906) soon after Einstein's first results in 1905 on how mechanics and Newton's laws ought to be corrected. In the 1960's, Ott, Arzelies and Brotas reconsidered Planck-Einstein's theory and came to somewhat different conclusions, being the start of a new discussion.

However, discussions on how thermodynamics applies in special relativity hardly ever show up in books concerning either relativity or thermodynamics. This poster is designed to be regarded as a first approach into this subject, therefore exhaustive treatments are avoided.

It is shown how some quantities in thermodynamics change in a Lorentz transformation but special attention is given to pressure and heat.

4.2.2 Solitons in Field Theories

Lisa Freyhult <lisa.freyhult@teorfys.uu.se>

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In certain field theories there occurs stable finite energy solutions. These are called solitons. For certain Lagrangians it's possible to solve the equations of motion exactly or at least find some solutions. A few of these examples and some general properties of solitons will be discussed. If one could find solitons in some physical theory it would in principle be possible to find them in particle accelerators. They would be seen as lumps of energy, looking very much as particles. Solitons come in different shapes, as infinitely long strings, pointlike, torus shaped or even knotlike objects. Magnetic monopoles are a type of solitons and a bit about these objects will also be discussed.

4.2.3 Descriptive Methods for the Examination of Wormholes and Black Holes

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University of Munich, Germany

Starting from the simple Morris-Thorne-wormhole methods are motivated, which allow the description of highly generalized wormholes. This is done by the examination of null-foliations, which leads to the concept of marginal surfaces and trapping horizons. This terminology reveals a close relationship between black holes and wormholes, which even goes so far, that these two objects can be transformed into each other. Additionally the usage and meaning of Penrose diagrammes is explained and finally some special properties of wormholes are discussed briefly.

4.2.4 Biological Evolution with Feedback

Asboth Janos, Vukics Andras

ELTE, Budapest,Hungary

We present a simple mathematical framework for the modeling of biological evolution with the state of the environment being affected by the strategies of the competiting species. So-called Evolutionary Singular Strategies can either be Evolutionary Stable or repellent, or they can be the source of speciation. Results in a one-dimensional strategy space are easy to understand. Multidimensional evolutionary dynamics can be more interesting: characterisation of Evolutionary Singular Strategies becomes difficult. This framework is applied to a specific model (Two-patch model) for the study of speciation.

4.2.5 Experimental Tests on Relativity

Carolina Alves, Luís Pedro and Verónica Malafaia

Description and analysis of a group of experiences which have allowed to test some aspects from Relativity (such as the Doppler effect, time dilatation, light deflection and the equivalence mass-energies). We have chosen the experiences which have a wider scope to the study of Relativity.

4.3 Medical physics/Biophysics

4.3.1 Analysis of Human Stabilogram Data with Statistical and Chaos Theory Methods

Janusz A. Urbanowicz

The poster presents application of various methods of data analysis - statistical (spectral analysis, probability estimation, distribution reconstruction), and chaos theory based (reconstruction of attractor, estimation of fractal dimension and others) in analysis of medical measurements data. The data sets in question, are human stabliograms. Main purpose of the analysis is to produce diagnostic method based on human posturography. Some results are presented.

4.3.2 Independent Component Analysis in Functional Magnetic Resonance Imaging

Andrzej Chojnowski

Recently Independent Component Analysis (ICA) has been introduced for functional Magnetic Resonance Images (fMRI) processing. The goal of that technique is to explain a set of random variables as linear combinations of statistically independent components. In case of fMRI the random variables are images of brain activity sampled at a certain frequency. ICA tries to decompose them to component "maps" and their associated time courses. One assume that a single component map resembles a set of neurons involved with the same task and overall brain activity is simply a linear mixture of all cluster's activities.

The data shown beneath come from a subject performing language comprehension test. One tries to compare ICA and traditional, statistical analysis methods.

4.3.3 The Methods of Nonlinear Dynamics in the Analysis of Heart Rate Variability for Children

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3 Nõmme Children Hospital, Tallinn, Estonia.

The aim of the study was to clarify the applicability of the characteristics of nonlinear dynamics to the analysis of heart rate variability for children. We analysed the data collected from 24-hour ambulatory ECG monitoring under normal daily activities and their sleep-wake pattern. There was group of healthy children (12 subjects, mean age 11,5$\pm$3,3 years) and group of children with clinically documented sinus node disease (SND, 6 subjects, mean age 11,5$\pm$1,9 years). Besides, there was a heterogeneous group of 12 subjects with miscellaneous diagnosis. Holter tapes were analyzed using Marquette equipment with operating program Premier IV to obtain the time-domain and frequency-domain parameters of HRV.

The following characteristics were calculated:

- the standard "linear" characteristics, such as average NN-interval, SDNN, SDANN Index, SDNN Index, rMSSD, pnn50;

- the characteristics based on phase space, such as Shannon entropy based on "words" distribution; density distribution of points in the 3D, 4D and 8D phase space;

- the scale-invariant characteristics, such as fluctuation function, Hurst exponent; distribution for low variability regions based on Zipf's law.

In the case of healthy children and children with SND, there is no evidence of low-dimensional deterministic chaos in the time series of heart rate. For some patients, the structures in the phase space are apparent; however, they are to be attributed to a simple respiratory modulation of the heart rhythm. For the given group of patients, the scale-invariant methods are more appropriate tools. For healthy subjects, the time series reveals multiscaling behavior, whereas for patients with SND, the behavior is monoscaling.

We found that the logarithm of the peak density distribution of points in eight-dimensional phase space and the length of the longest low-variability region revealed significant variations over the patients. They were significantly correlated with the diagnosis (better than Shannon entropy and correlation dimension) and cor-

relation with the other characteristics - such as SDNN, SDANN, pNN50 etc. - was remarkably low. All this suggests that these characteristics could serve as independent diagnostically useful parameters and can provide significant amount of additional information, not covered by the standard characteristics.

4.3.4 Functional Nuclear Magnetic Resonance in Imaging of Activity of Human Brain

Piotr Tomczak

In the poster is presented the method of functional Nuclear Magnetic Resonance (fNMR) and its application to biological and medical researches especially to imaging of activity of human brain.

4.3.5 The Interaction of Ultra-Violet Radiation with the Skin

João Paula Manuel Bettencourt, Rui Cardoso

During our live we are exposed to several kinds of radiation. We will talk about one of the most common kind of radiation that affects the human being, the Ultra-Violet, and focus mainly on his effects on the skin, where they are felt the most. We will approach this subject at a cellular level thus being able to establish the most relevant consequences of the interaction between UV rays and the skin.

4.4 Materials Physics / Applied Physics

4.4.1 PAC and Its Applications

Beata Toczek

In a poster I give a brief description of the Perturbed Angular Correlation (PAC) technique and its application to the study of hyperfine interactions in solid state.

The researching method consists in introducing radioactive probes into given material. Thanks the decay of these isotopes in a compound we can measure angular correlations in $\gamma - \gamma$ cascade and it let us come to conclusions about properties of this material. I would like to present results of my work using PAC spectroscopy to research materials containing isotope Lu(172).

4.4.2 Temperature Dependence of the Microhardness of Polycrystalline C_{60} Films

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Studies of temperature, light- and air- exposure effect on the physical, chemical and mechanical properties of fullerite C_{60} concerning the possible application of fullerite-based materials as a photoresist have attracted considerable attention. The aim of the present report was to investigate the temperature dependence of the Vickers microhardness of C_{60} films in the range of 300-680K. Fullerene films were prepared by thermal evaporation onto glass substrates at a pressure of 10_{-4} Pa. The film thickness was 0.7..1 μm. A nonmonotonous temperature dependence of the fullerite microhardness was found. Both the temperature-induced softening on heating above 400-450K and oxidation-induced hardening on heating above 470K causes such behaviour. It was shown that the thermo-oxidation-induced hardness change is irreversible contrary the properties of photo-oxidised fullerite. It is in agreement with the fact that photo-oxidation alters the structure of fullerite leaving the fullerene cage intact while thermo-oxidation proceeds through the cage-opening reactions.

4.4.3 The Surface Structure in Thin Diblock Copolymer Films Determinated by XPS

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Diblock copolymers consist of two distinct polymers. We have studied poly-styrene (PS) and poly-dimethylsiloxane (PDMS) in an asymmetrical and in a symmetrical combination. The asymmetrical combination consists of 40.000 g/mol PS - 6.000 g/mol PDMS, where the symmetrical one consists of 25.000 g/mol PS - 25.000 g/mol PDMS. Spin-coated films were annealed at 90°C and 130°C corresponding to temperatures below and above the glass temperature of PS. The samples were studied with X-ray photoelectron spectroscopy (XPS). The surface segregation of PDMS was quantified by analysis of the XPS peak shape. The surface morphology was determined as a function of annealing time. The two types of diblock copolymer-films form different structures.

4.4.4 Superconductivity

Peter Ahrendt

An introduction to superconductivity. Quite short and very basic. Gives and outline of the development in the area of superconductivity, has information on possible applications using s.c. and try to set a goal for the future.

4.4.5 The Effect of the Sr-Ca Titanate Doping on Phase Formation and Superconducting Properties of BSCCO

Makarova M.V.

Moscow State University, Russia

One of the ways to increase critical current density in high temperature superconductor is adding chemically compatible non-superconducting phase. The most effective is the small-sized particles addition. In this work the interactions between BSCCO superconductor and non-superconducting strontium-calcium titanates were studied.

Titanate powders of 20-25 nm particle size were obtained by oxalates thermal decomposition at 620°C. They were added to the Bi-2223 superconductor, which was obtained earlier, and pressed into tablets. Also we

studied doped samples of the same composition, but obtained from nitrate solution by its evaporation and thermal decomposition. The pressed tablets were sintered at 860°C for 40 hours. Titanate lattice constants were calculated from Guinier diffraction pattern for all the samples: a= 0.3901 nm for strontium-calcium titanate and a= 0.3902 nm for strontium titanate, which is slightly less than for pure strontium titanate (0.3905 nm). Thus, strontium titanate with small (4%) amount of calcium is in chemical equilibrium with Bi-2223.

The XRD data show, that the quantity of the Bi-2223 phase is bigger in the samples prepared from titanate and superconductor precursors obtained separately. In the sample doped by calcium-strontium titanate we also have bigger quantity of the Bi-2223 phase. The critical temperature in doped samples is 2K lower than in the undoped. The obtained results confirm that $SrTiO_3$ may be used as a pinning additive.

4.4.6 Nuclear Fusion: The Energy Problem Solution?

Tiago Tamissa Ribeiro

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Human energy needs and environmental damage already caused by the present day energy sources stress the need for new energy solutions. Nuclear fusion appears as a promising answer, not only because of its "clean" and "unending" nature, but also for its capability to satisfy the expectable human needs. The possible ways of building a nuclear reactor are presented. Radiation, radioactivity and risk assessment are also discussed.

4.4.7 Plasma Kinetics of He_2 Molecules in Fast Discharges of High Pressure Helium

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In this work temporal emission and absorption characteristics of He_2 dimers in high-pressure gas excited by a fast electrical discharge were investigated. The object of investigation is the discharge plasma in a commercially available miniature excimer laser PSX-100 (MPB Technologies Inc, Dorval, Canada). UV preionization and fast (10 ns) transversal pulsed discharge (maximum discharge current density of about 2 kA cm^{-2} and a pumping power density of about 20 MW cm^{-3}) were used for the excitation of helium gas.

In order to minimize possible impurities in the helium gas (initial purity 99.99%), additional purification during the gas filling stage was performed by passing the gas through a zeolite trap immersed in liquid nitrogen.

Time behavior of emission of the discharge in helium gas in 115-700 nm spectral range were investigated.

Besides the well-known three body reaction of excited dimers creation:

$$He^* + 2He \rightarrow He_2^* + He(1) \tag{4.1}$$

the reaction of direct electron excitation of dimers was taken into account:

$$He_2(X^1\Sigma_g^+) + e \rightarrow He_2^* + e(2) \tag{4.2}$$

were He_2 are quasibounded molecular pairs on the ground state. The density of these quasimolecules grows quadratically with pressure. The excitation of quasimolecules in the reaction (2) takes place in an initial stage of the discharge, while the formation of excited dimers by the reaction (1) occurs mainly on the late stages of the discharge. In the pure helium gas the He_2 molecules play the role of additives, which have lower excitation (ionization) potential compared with the atomic helium.

4.4.8 The Determination of Gold from the Alluvional Sands Trough the Fast Neutron Activation Analysis Method

Roxana Cristina Nat, Liviu Daraban

Besides a great number of chemical elements, the alluvial sands of the rivers consist of a large amount of gold with vary between 0-2500 ppm. The unsteady distribution of the gold asks for great number of fast analyses for the discovery of the samples which contain gold of a concentration greater than 30-40 ppm, and which is justified in the exploitation.

The use of the fast neutron activation analysis comes up against both lot of reaction interferences and instrumental interferences.

Taking into account the great unsteady number of elements contained in the sand, the work studies these interferences and sets up the concrete conditions on which these interferences can be avoided so that the minimal, detectable gold value can be of 10ppm.

4.4.9 Spectroscopy of $CsPbBr_3$ Nanocrystals (Quantum Dots) in CsBr:Pb

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Some years ago a new type of luminescent nano-crystals has been discovered: the $CsPbX_3$-type aggregates created in CsX: Pb crystals (X=Cl, Br) by prolonged annealing at 150-250 ^{o}C [1,2]. These crystals show very special luminescence properties caused by exciton quantum confinement effect due to very small (few nanometers) size of the aggregates (quantum dots) dispersed in CsX lattice. High efficiency, very fast (10^{-11}-10^{-10}s) decay kinetics of free exciton luminescence as well as high stability and simple preparation procedure of these nano-crystals may allow their applications in fast scintillators and solid state lasers.

In the present paper, absorption, emission and excitation spectra have been systematically studied at 4.2-300 K for $CsPbBr_3$-type nano-crystals in as-grown and in annealed at various conditions CsBr: Pb samples with different lead concentrations (from 0.005 to 1.8 mole $\%$ of $PbBr_2$ in the melt). It has been found that the intensity, positions of maximums and half-widths of the absorption and emission bands, the Stokes shifts as well as temperature behaviour of these characteristics depend on lead concentration and on the annealing temperature and duration. Polarisation of the free exciton luminescence of $CsPbBr_3$ nano-crystals in CsBr: Pb caused by anisotropy of the nano-crystals has been observed for the first time, and the polarisation spectra, temperature and angle dependencies of the polarisation degree have been studied.

The conclusions have been made on the connection of optical characteristics of $CsPbBr_3$ nano-crystals with their size and shape and on the orientation of anisotropic $CsPbBr_3$ aggregates with respect to the CsBr crystal axes. The mechanism of the nano-crystals formation in the process of the thermally stimulated diffusion of Pb^{2+} ions in CsBr: Pb crystal lattice has been discussed.

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4.4.10 Orientational Behaviour of Nematic Liquid Crystal under Oscillatory Flow*

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Orientational dynamic of nematic liquid crystal layer with weak surface anchoring subjected to the oscillatory flow is studied theoretically. The nematic layer confined between two identical substrates that provide the weak planar or homeotropic anchoring is considered. For the case of oscillatory Couette flow when one of the substrates moves periodically along the direction within its plane and oscillatory Poiseuille flow when the time-periodic pressure gradient is applied in the direction within the layer plane, the director motion within the

flow plane is analyzed.

The influence of the anchoring strength and surface viscosity on the director dynamics in the bulk of the layer and at the substrates is investigated in detail. The approximate analytical solutions of the nematodynamic equations for small flow amplitudes are obtained and compared with the results of full numerical simulations. The optical response of the nematic layer depending on the flow frequency, surface anchoring strength and surface viscosity is calculated.

The range of the flow frequency is found where the surface viscosity has the strong influence on the optical response and the experimental conditions that allow to estimate the surface viscosity more precisely are discussed.

⋆ Work supported by INTAS Grant Nr. 96-49

4.4.11 Fréedericksz Transition and Flexoelectric Effect in Nematic Liquid Crystal between Coaxial Cylinders⋆

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The orientational transitions in nematic liquid crystal confined between two infinite coaxial cylinders have been analyzed when the radial electric field is applied and flexoelectric effect taken into account. The problem with the director distribution $\hat{\mathbf{n}} = (n_r, n_\phi, n_z)$ depending only on the radius r in the cylindrical coordinate system and strong boundary conditions has been studied. Two typical initial director distributions: planar orientation $\hat{\mathbf{n}} = (0, 1, 0)$ and homeotropic one $\hat{\mathbf{n}} = (1, 0, 0)$ are considered.

Since without an electric field the director distribution is deformed due to the confining cylinders, the orientational transition occur even in the absence of external field depending on the ratio of the radii of the inner cylinder to that of the outer one [1,2]. The Fréedericksz transition in this geometry was analysed for the initial homeotropic orientation without flexoeffect [3].

Under an applied electric field one has the contribution of the flexoelectricity into the bulk free energy density in contrast to the case of plane nematic layer. The dependencies of the critical electric field for the Fréedericksz transitions (nematics with dielectric anisotropy $\epsilon_a > 0$ and $\epsilon_a < 0$ for the planar and homeotropic boundary conditions, respectively) on the ratio of the outside radius and inside one have been calculated. It was found that for planar orientation the new type of orientational transition caused by the pure flexoelectric effects can take place. The polarity of critical field depends on the sign of flexo-coefficient that allows to determine the value and the sign flexo-coefficient in experiments. The influence of the flexoeffect in case of the weak surface anchoring is also analyzed.

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4.4.12 The Improvement of the Metals Structure by Using High Frequency Ultrasonic Waves

Laviniu Lazar

The tests were made on soldered metals, but they can be made on any milted metal. The method used is completely new and consists in the interference of four high frequency ultrasonic waves in the center of the soldering bay, during the soldering phase, solidification and cooling process. We performed the following tests: - Microdurity test showed a growth with 25- Traction test indicated that the plasticity of the material was improved with 25- The metalographic analysis showed a massive growth of the number of cristalin clusters and also the reduction of their dimensions. - The angular plastic deformation was 5 times more reduced. - The RX difraction showed a reduction of the internal tensions (order II and III)and the difraction peaks were more

symmetric. The new method uses several times less energy than the traditional vibrational method, is harmless for the human operator and ensures a significant improvement of the structure and properties of the metals.

4.5 Atomic and Subatomic Physics

4.5.1 Investigation of Concentrated Aqueous Solutions by X-ray Diffraction

Ana Margarida Medeiros Gaspar

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What is X-ray diffraction? Which physical systems can be investigated by X-ray diffraction? Why to study aqueous solutions? How do ions and molecules are disposed in aqueous solutions? Results obtained for some solutions are presented and compared with adequate and inadequate models.

4.6 Astronomy, Astrophysics and Space Science

4.6.1 Heating of the Galilean Moons of Jupiter by Tidal Forces

René Højbjerg Larsen

Physics Department, Odense University, Denmark

I will give an overview of the calculations involved in approximating the amount of heat transferred to the Galilean Moons of Jupiter by tidal forces. This involves expressing the tidal potential in spherical harmonics and applying some results from the studies of elasticity in solids. By considering the displacement vector, and ultimately the strain tensor, for a component of the moon, I then obtain an expression for the amount of heat dissipated in the moon per second per volume element. Integrating this expression over the total volume of the moon and averaging over one orbit gives a fairly simple expression for the power of the heat dissipation in a Galilean Moon.

Finally, this theoretical result is compared with experimental data in order to determine if tidal heating is in fact the primary cause of the volcanic activity of Io, the innermost moon of Jupiter.

4.6.2 Chaos in Heaven

Luis Contreras Sedes

University of Granada, Spain

One of the most firmly established concept of the Chaos theory is the famous butterfly effect: The gentle flapping of a butterfly‘s wings in the tropics could be the origin of a tornado in Texas. Concretely,this represents the sensibility of certain system to initial conditions, as subtle variations can provoke unmense changes in the global results. This phenomenon appear in chemical process, stock exchanges, the weather...

Thus, a simple concept underlies the mechanism of very complex process. But what would happen if the chaos theory could explain the behavior of the apparently unchangeable structure of the universe? Sometimes we continue to perceive the cosmos as something distant from the laws that govern the earth. Nothing further from the truth! the physical laws we observe here are equally valid in every corner of the universe. The heavens are not perfect in the way of Plato believed, but obey the laws of Chaos.

Microturbulences in the sun follow chaotic pathways. Even the orbits of planets can be described through the KAM theorem according to which variations in the conditions can produce widely different effects. The strange attractors, key concept for the understanding of the implications of the Chaos theory, appear in astrophysical research. These are mathematical entities whose simple formulation can originate in a fractal, infinitely complex structure. A representative example is the large scale structure of the universe. Matter isn‘t distributed homogenously but the galaxies tend towards certain points as attractors.

This poster presents several examples of the applications of Chaos theory of complex systems in astrophysics, such as the planetary orbits, solar turbulences and the structure of the galaxies. The realisations of the true size of the universe, of our situation in it and the laws that govern it is not just entertainment for the astronomers, but leads to an advance in our way of thinking, reminding us of our humility and at the same time giving importance to all small things we daily do and feel.

4.6.3 Stellar Evolution

M.Carmen Pereira Gonzalez, Dolores Salguero Gonzalez

We are going to describe a stellar model based on the Hertzsprung-Russel diagram. A star can be represented at only one epoch, for the continual emission of radiaton from the surface requires that some process be taking place within the star to supply the outflowing energy.

Evolution is a consequence of the fact that a star is shining. Wet’ll trace the development of a star from the time it’s a dense cloud in the interstellar medium, through the pre-main-sequence, main-sequence and giant stages.

4.6.4 Neutrino Astrophysics

Helle Kaasik

Neutrinos moving in the Universe carry information about events in their place of origin as does the light. Neutrinos are generated in stars in thermonuclear synthesis. Weakly interacting neutrinos easily penetrate all matter on their way. Outer layers of stars and atmosphere of Earth, even the Earth itself cannot disturb neutrino observations. The same reason makes neutrinos hard to detect, so neutrino telescopes are very large and expensive. They consist of large volume of water with thousands of photomultipliers. Photomultipliers detect the Cerenkov light cone from fast electrons and muons, which get their kinetic energy in interaction with a neutrino in the detector. The detected radiation enables to determine the flavour, energy and direction of the neutrino.

Solar neutrinos. Observed solar neutrino spectrum is suppressed and distorted when compared to calculated one. From two possible explanations for it - new physics for Sun or for neutrinos - now the second is indicated by results of the largest neutrino observation experiment, the SuperKamiokande. A model using neutrino vacuum oscillations gives a rather good agreement with solar neutrino spectrum observed by SuperKamiokande and also with results of earlier radiochemical experiments. The vacuum-oscillation model is indicating that the

mass-squared difference of two neutrino mass eigenstates is 10^{-10} to 10^{-11} eV^2 with mixing parameter close to its maximal value. This result does not exclude possibility that a substantial amount of dark matter is neutrinos.

Aims and future of neutrino observations. Statistics and energy range of solar neutrino observations will increase. Neutrino telescopes can detect also supernova explosions. Observation of high-energy (E>TeV) neutrinos would allow deep observation of active galactic nuclei and would give important new knowledge about gamma bursts, ultra high energy cosmic radiation and (still hypothetical) weakly interacting massive particles. For this energy region of special interest for neutrino astrophysics 4 large projects for neutrino observation have been started: large water-Cerenkov detectors in natural water reservoirs. These projects have demonstrated and enhanced international co-operation among neutrino physicists.

4.6.5 Diffuse Interstellar Bands

Karolina Darowny

Nicholas Copernicus University, Toruń, Poland

The origin of diffuse interstellar bands (DIBs) is the longest standing unsolved problem facing astronomers who observe the spectra of early-type, bright stars. Near 300 absorption bands have been found in the ultraviolet, visible, and infrared regions of the spectra of stars obscured by interstellar gas and dust. Information allowing identification of the mysterious features may first of all come from four researches : 1. an analysis of DIBs' profiles, 2. correlations between DIBs' and interstellar molecules widths, 3. dependence of DIB strenght on color excess and characteristic features of interstellar extinction curve, 4. intercorrelations between DIBs.

The last one allows to form diffuse interstellar lines into groups, which are supposed to originate from the same carrier. The poster will contain results of intercorrelation between DIBs in the range from 470 nm to 560 nm and from 680 nm to 860 nm obtained by me.

4.6.6 Astronomical Observatory of Lisbon

Ricardo Afonso , Susana Sousa

The poster has been set up with the intention of presentation the activities of the Astronomical Observatory of Lisbon as well as presenting information on its history and its importance. Due to the tight relationship that the observatory has with the university we will also introduce the Astronomy and Astrophysics Group of the Science Faculty of the University of Lisbon, their research programs, the resources available and international relationships.

4.6.7 Timing Neutron Stars. RT4 - 32m. Radio Telescope, Torun Radio Astronomy Obserwatory in Piwnice, Poland

Sebastian Soberski

Radio pulsars are rapidly spinning, highly magnetized neutron stars which emit beams of radio waves and are observed to pulse when the beam crosses the Earth. They represent the end-point in the evolution of massive stars, and are excellent laboratories for the study of the bulk properties of matter at nuclear densities and beyond. Millisecond pulsars are old pulsars reborn through accretion of matter from a companion star, spinning so fast that the surface velocities approach the speed of light.

Pulsars are remarkable objects. In the quarter century since their discovery, they have had a impact on many fields of science. Understanding their composition is a challenge in nuclear and condensed-matter physics. Their elusive emission mechanism is a complex problem in electromagnetics, atomic physics and particle physics. Explaining their creation, evolution, and distribution is a classical astronomical task. The greatest contribution of pulsars observations, however, is their use as probes of other phenomena beyond pulsar physics. Pulsars provide great insight into the character of the interstellar medium. They provide fundamental beacons for astronometry, and they are also a most fertile ground for tests of general relativity.

The pulse trains emitted by pulsars are extremely stable, in at least one case comparable to the best terrestrial atomic clocks: arrival times of pulses from PSR 1937+21 can be predicted with two microsecond accuracy over a time span of nearly a decade (Stinebring et al. 1990). Pulsar rotation behavior fits an extremely simple model: in all but the youngest pulsars, the rotation period is a slowly increasing linear function of time; these two quantities (period and period change over time) are free parameters in the timing model. Propagation across the 5000-light-second-radius orbit of the Earth significantly affects the pulse arrival times on Earth, in a manner which depends on the position of the pulsar in the sky. Thus the position of the pulsar, described by the two further parameters, must be included in the model. Finally the absolute arrival time of a pulse is arbitrary, adding a fifth parameter. Many facts about pulsars emerge from this five-parameter model.

In Torun Radio Observatory there are two radiotelescopes: 32 m. RT-4 parabolic radio telescope with a horizontal stand and 15 m. RT-3 parabolic radio telescope (paralactic stand). Near 100 pulsars are frequently observed (1700 MHz). For this purpose is used pulsar machine called PSPM2 (Pen State Pulsar Machine 2). In this poster I am going to present the results of pulsar timing programme.

4.6.8 Weather and Climate of Polish Mountains

Tomasz Sikora

The poster presents weather and climate conditions of Carpathians and Sudety Mountains. There will be presented data concerning cloudiness, precipitation, temperature, winds and other elements of weather and climate. There will be presented possible methods of numerical simulations of atmospheric air flows over mountain terrain.

4.7 Artificial Intelligence

4.7.1 Chaos Theory and the Neural Networks

Dubravko Kicic

Zagreb University, Department Of Physics, Croatia

Relatively new development in computer science is field of neural networks (or so-called artificial neural networks). Development of neural networks was in teens in the 1960s, but recovered for reinassance in 1980s. Chaos is a new mathematical theory, dating back to perhaps the 1960s at the earliest and blooming only in the 1980s. The intersection of chaos theory and neurobiology has happened intensively back in perhaps ten years. The use of chaos theory in the development and study of artificial neural systems (a.k.a. neural networks) is newer still.

When we are talking about a neural network, we should more properly say "artificial neural network" (ANN), because that is what we mean most of the time in computer artificial neural-nets. Biological neural networks are much more complicated than the mathematical models we use for ANNs. But it is customary to be lazy and drop the "A" or the "artificial".

There is no universally accepted definition of an NN. But perhaps most people in the field would agree that an NN is a network of many simple processors ("units"), each possibly having a small amount of local memory. The units are connected by communication channels ("connections") which usually carry numeric (as opposed to symbolic) data, encoded by any of various means. The units operate only on their local data and on the inputs they receive via the connections.

Some NNs are models of biological neural networks and some are not, but historically, much of the inspiration for the field of NNs came from the desire to produce artificial systems capable of sophisticated, perhaps "intelligent", computations similar to those that the human brain routinely performs, and thereby possibly to enhance our understanding of the human brain.

Most NNs have some sort of "training" rule whereby the weights of connections are adjusted on the basis of data. In other words, NNs "learn" from examples (as children learn to recognize dogs from examples of dogs)

and exhibit some capability for generalization beyond the training data.

When talking about statistics we see that there is considerable overlap between the fields of neural networks and statistics. Statistics is concerned with data analysis. In neural network terminology, statistical inference means learning to generalize from noisy data. Some neural networks are not concerned with data analysis (e.g., those intended to model biological systems) and therefore have little to do with statistics. Some neural networks do not learn and therefore have little to do with statistics. Some neural networks can learn successfully only from noise-free data and therefore would not be considered statistical methods. But most neural networks that can learn to generalize effectively from noisy data are similar or identical to statistical methods.

Most computer scientists discover chaos in one way – through colorful graphic displays of Mandelbrot sets on their terminals. Most of these computer scientists are content to watch the filigree unfold on their CRTs during lunch hour without delving too deeply into the mathematics behind it.

Many of the times we see beautiful and complicated patterns drawn. That such complicated patterns can result from seemingly simple mathematics is one feature of chaos theory. Chaos is statistically indistinguishable from randomness, and yet it is deterministic and not random at all. While it is deterministic in the sense that a chaotic system (on a computer, for instance) will produce the same results if given the same inputs, it is unpredictable in the sense that you can not predict in what way the system's behavior will change for any change in the input to that system.

Chaos is often regarded as an undesirable property of complex systems, because of the difficulties analysing such systems. However, it seems to play an important role in the behaviour of, for example, biological systems. In particular, recent studies have shown the presence of chaos in neuronal systems. Scientists believe that chaos is an important functional property in biological neural systems and that much can be gained from using similar dynamics in artificial neural networks.

4.7.2 Artificial Intellect

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Artificial intellect is one of the most newest branches of science and is currently considered to be the fundament of programming in future. As a subject of computer science it studies a way to make machines to do such tasks, the performance of which would need as much intelligence as for the human being.

There are two dominant directions of artificial intellect: bionics and applied programming. The first direction investigates the functioning and structure of human brain from the neurophysiological and psychological point of view. The direction of applied programming investigates the way of making programmes, which would be able to solve the problems used to be solved only by the human being itself (including the creation of such programmes). There are variety of applications of this direction of artificial intellect in practically every field of human activities, covering also technical and scientific areas. From the applications in physics, recognition of the structure of molecule from it's spectroscopy data, object recognition and imaging in the navigation can be mentioned. Important feature of the artificial intellect is the capability to handle incomplete information about the system and offer solution possibilities for the people to choose.

In present studies several applications and principles of functioning of the artificial intellect, as well as it's future challenges are discussed.

4.8 Optics and Laser Physics

4.8.1 Nonlinear Cross Talk in Photorefractive Recording of Multiple Holograms

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The photorefractive (PR) effect [1] consists in a change of the refractive index induced in a photoconductor, electrooptic material under inhomogeneous illumination. The physical mechanism underlying the PR effect involves photoexcitation of charge carriers from impurity levels, migration of the carriers by different mechanisms (diffusion, drift, ...) and eventual recombination at trap sites. The consequent non-uniform redistribution of charge gives rise to a space-charge electric field. In turn, a refractive index modulation is induced via the electro-optic effect. Then, a phase hologram -replica of the original light pattern-is recorded in the PR medium. The most interesting features exhibited by PR materials are their high sensitivity and the possibility of either storing information for long periods, either erasing and reconfiguring the recorded holograms.

Most proposals of applications of the PR effect -holographic storage, optical real-time holography or optical processing [1] involve the simultaneous presence of several holograms within the same volume. When more than one hologram are recorded in a PR material, the generation of each hologram is not independent of the others. On the contrary, they are coupled through the intrinsic nonlinearity of the processes involved in the PR effect. As a consequence, the strength of the holograms can be strongly affected (the so-called nonlinear grating cross talk) [2,3]. Also, new spatial frequencies -absent in the original light pattern- may appear in the final recorded hologram (spatial frequency mixing) [4]. In our poster, we will show several examples illustrating the importance of these kind of effects in PR experiments.

First, we will describe the theoretical formulation explaining the appearance of nonlinear effects in multiple grating recording [2,3]. The main features and the parameters governing the strength of the nonlinear effects will be discussed on the basis of the model. Next, the theoretical results will be compared with available experimental data in different experimental situations. Finally, we will analyze the most important consequences of the nonlinear grating cross talk and its implications with regard to PR applications such as holographic memories or optical interconnections.

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4.8.2 The Cr^{3+} Photoluminescence in $ZnAl_{2-x}Cr_xS_4$ Spinel

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The Cr $^{3+}$ photoluminescence has been measured in the crystals of spinels $Zn(Al_{2-x}Cr_x)O_4$ at temperatures 77 and 300 K. The crystals were grown by a closed tube vapor method with $AlCl_3$ as a transport agent. The Cr^{3+} ions concentration was estimated from magnetic susceptibility measurements. Photoluminescence spectra were excited using radiation at 633 nm from He-Ne laser. Well known R-line (λ_{max}=771 nm, ^2E_g - $^4A_{2g}$ emission transition) and its vibronic sideband predominated in the emission spectrum in samples with low Cr concentrations (x<0.02). As the Cr concentration is increased the R-line and its vibronic sideband become less intense and disappeared. Two new wide bands of luminescence with λ_{max}=845 nm and λ_{max}=935 nm appeared in the emission spectrum when Cr concentration still more then 1% (x>0.02). The first one is result of increasing broad-band $^4T_{2g}$ - $^4A_{2g}$ fluorescence and estimation of gap between ^2E_g and $^4T_{2g}$ gave Δ =0.26 eV. The origin of band with λ_{max}=935 nm is not so clear. Probably that it is a result of influences of exchange interaction between ions of the Cr^{3+} on luminescence, as intensity this band increasing both at downturn of temperature and with increase of Cr concentration. For samples with x=0.28 only one band with λ_{max}=935 nm exist in the emission spectrum at all temperatures.

4.8.3 "Small Star"-Sonoluminescence

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A single gas bubble trapped in a standing-wave sound field can emit pulses of blue-white light with duration

less than 50 ps. The spectrum of the light flashed out once every acoustic cycle from their bubbles spans the whole visible spectrum, form red to blue, and then extend into the ultraviolet as far as the frequency at which water becomes an efficient absorber of radiation. Measurements of the spectrum are report for air bubbles levitated in water. Not everything yet understood.

4.8.4 Direct Numerical Treatment of the Nonlinear Light Wave in the Optical Fiber When Photons Are Present

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The propagation of nonlinear light wave in an optical fiber when phonons are present is described by the modified nonlinear Schroedinger equation. Direct numerical solutions of this equation have been obtained using the Runge-Kutta method. We have computed with different values of the phonon frequency and the intensity of photon-phonon interaction. Phase diagrams of regular and chaotical solutions are obtained. It is investigated conditions for the transition from regular to chaotical behavior.

4.9 Quantum Physics

4.9.1 Quantum Computation

Slawomir Soszynski, Ryszard Jabczynski

This presentation is in three parts: introduction to quantum computing, a specification of logic gate and a mathematical representation as well as a theoretical design of a quantum computer.

The quantum model of computation is a probabilistic model, similar to the probabilistic Turing Machine, in which the laws of chance are those obeyed by particles on a quantum mechanical scale, rather than the rules familiar to us from the macroscopic world.

[1] Gerschfeld, Neil and Chuang Isaac L. Molecular quantum computers, Scientific American, June 1998

[2] Simon D. On the Power of Quantum Computation

[3] Chi-Chih Yao Andrew Quantum Circuit Complexity

[4] Chuang Isaac L., Yamamoto Yoshihisa A Simple Quantum Computer

[5] Margolus Norman Parallel Quantum Computation

[6] Lloyd, Seth Quantum mechanical computers, Scientific American, October 1995

4.10 Miscellaneous

4.10.1 Physics in the German-speaking Literature

Barbara Fehér

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I would like to give you with my poster some ideas about the responsibility of Physicists. I ask couple of well-known representatives of the German[A-speaking literature for advice: Durrenmatt, Brecht and Christa Wolf. Durrenmatt is a Swiss playwright and novelist, whose work has affinities with black humor and the theater of the absurd. I examine the message of "The Physicists" (Die Physiker), a modern morality play about science, which is generally considered his best play. Brecht was the most important German playwright of the century. I draw conclusions from his "The Life of Galileo" (Leben des Galilei). I finish with the novel of Christa Wolf:

"Malfunction" (Storfall - Nachrichten eines Tages). She writes about the reaction of the laity after receiving the news of the catastrophe in Chernobyl.

4.10.2 Nexus - the Network of Student Physicists

Julia Rose

Nexus is the network of student physicists and Physics Societies in the United Kingdom. As a part of the Institute of Physics, members get all the opportunities the Institute offers but also a range of special activities only for students.

Nexus students all receive a termly magazine and have their own website. Through Nexus students have participated in a range of activities from paintballing to visiting CERN, football matches to watching the eclipse this summer! Crossing the boundaries between Universities allows students the opportunity to make valuable new contacts and compare experiences, as well as passing on information and tips such as how to find the best work placements.

4.10.3 Physics Relation to Psychology

Patricia Lourenço, Manuel Bettencourt

R. P. Feynman wrote “if our small minds, for some convenience, divide this glass of wine, this universe, into parts ■ physics, biology, astronomy, psychology, and so on ■ remember that nature does not know it!”. From a general point of view, this lecture weakens the gap between sciences historically known as natural and social. We will begin by explaining the applications of theoretical physics on psychological theories. On a second part we visit achievements on technological physics and point out their implications on the construction of cognition psychology and others psychological fields.

4.10.4 It’s Like That!! And That’s the Way It Is - Run D.M.C. vs. Jason Nevins

César Marques, Sónia Arroz and Catarina Casteleiro

The Physic’s thought, Math as a Physic’s tool or Physic’s as a Math’s tool, Big Bang is wrong?, creation or occupation, speed’s limit, are we special? ...and something else to think about.

Chapter 5

Appendix

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