

Nuclear Democracy

As many countries all over the World, Hungary learns the democracy in these years.

One year after the free elections two old women complained to the mayor of a North East Hungarian village: they had difficulties with breathing in their bedrooms. Their home was flooded with carbon-dioxide of natural origin coming from the soil. The mayor - elected by 80 % majority of the village - declared emergency situation in the two houses, asked for the help of the Member of the Parliament represents the region, and alerted both the Civil Defence and the Governmental Health Office. Within a month the government gave 7 million Hungarian Forints (100 thousands US Dollars) to the village for survey and mitigation operations from the National Catastrophe Fund. An Operating Committee was created to co-ordinate the work of 25 different institutes. Research was done in a small part of the village, foundation of the two houses were reconstructed in nine months for a cost being equal to the value of the houses themselves. It is a happy end, is not it? – But where is the democracy in this story? Breathing problems due to the carbon-dioxide can be detected even by dictators, and if they have enough money available to solve the problem in this way they even can show spectacular results. People's gratefulness will be guaranteed.

In this village not only carbon-dioxide but also radon enters the houses. Radon is a radioactive inert gas. It is present everywhere all over the world in various concentrations. You can get radioactive dose from radon as well as from any other natural or artificial radioactive sources. In many countries there are laws setting a limit for radon concentration in homes, this limit varies from 150 to 400 Bq/m³ from country to country. Experts agree that living in a house of 400 Bq/m³ through a year is equivalent receiving 20 millisievert dose. 20 millisievert is about the highest dose per year a worker got in in the last ten years in the Hungarian nuclear power station.

The problem can be solved without any lesson on democracy in a country where there is radon law setting upper limit for buildings, offers financial support for the survey and for the mitigation. (It is another question whether the law was born in a democratic way or not.) But in Hungary the Law speaks only about the artificial radioactivity. Unluckily human biochemistry does not know whether an ionizing particle was originated in an artificial or natural radioactive source. What should be done in our small North East Hungarian village when we find dozens of houses above not 400 Bq/m³ but 1000 Bq/m³?

The first question is how to identify the high radon level houses. In a totalitarian regime it is easy to do. You should convince one person: the Leader of the community that the survey is important; he will order to measure in the whole village, even he will find the financial support for that. Or will not. But in the latter case you know: there is nothing to do. In a democratic society it is much more complicated.

First of all you have to teach some nuclear physics to the elected leaders of the village on a level where they understand enough to convince themselves of the necessity of the exploration of the radon in the village. The leaders are not physicists, they are farmers, miners or workers of the nearby brick factory. They are much more interested in unemployment problems in the village, they are much more interested in the condition of the roads or in the new telephone network of the village, and of course, in local gossips and in their own prestige. This is understandable: the next election is approaching. Most of the leaders are old enough to have forgotten all the physics learned in school, and anyway no nuclear physics had been taught for them. In our village we were lucky: at least the mayor of the village – originally an electrician – was ready and able to learn what is radon. The other members of the village council smiled at his efforts, so he needed a continuous mental support or/and pressure from us to find and to execute the possible solutions.

The occurrence of radon in the village was discovered by physicists. The radon problem in living rooms is a new one in Hungary, beforehand no one paid any attention for that. We had greater problems. Physicists working on this field now became excited. But they are also human beings, they have to survive, they have to buy more modern equipment and pay scholarship for graduate students. They live also from the market. They asked for financial compensation for their survey. When the government's aid was over, they withdraw from the village. In those days no one did know how many percents of the houses are heavily effected by radon. It is a shaky question whether a physicist has moral obligation to continue the work without compensation and convince the local or national authorities about necessity of this work, or he has to wait at the contract of the authorities. In the case of our Hungarian village the physicists who started the work declared, that the whole village had to be surveyed and they waited for financial contract from the mayor. But the Hungarian state budget is in the negative.

In the Hungarian high school physics we teach nuclear physics for a month since 1981. We explain radioactivity as the "cooling" of nuclei, which as many experiments as possible using simple Geiger counter. At the beginning we measured the activity of artificial sources made for schools. From 1986 we used the Chernobyl fall-out as a source at hand. A few years later after Chernobyl we had to find a new source of radioactivity. We collected dust particles from the air with a vacuum cleaner and measured the radioactivity of the radon daughters. At the end of '80-ies a school network was created in Hungary to measure the radon in the air. Students and their teacher learned the technique to measure radon. They found differences in different buildings, in different towns, in different seasons, but never found too high activity concentrations in living rooms. They have learnt from books that in some countries the radon activity is unacceptable high, they have learnt the risk of radon exposure, they have read about how the houses have been mitigated in other countries. The radon work for these

students and their teachers was live and interesting but without any real responsibility. Then on 15 March 1992 a phone call came from that small North East Hungarian village ... Some people thought that might be university professors, school teachers and their students could do also some useful work.

At long last we have found a place where there is high radon activity in real living rooms, not only in books. At first it was not easy to enter the houses. Before our arrival to the farmer village a crowd of white-collar people invaded them, and they were so busy that they had no time to inform the people about their work, about radon, about the measured data. Radon was a mystery. When we had arrived to the village I asked the local physics teacher for a permission to speak to the pupils about the nature of radon, I offered simple charcoal absorbers what the children could take home and after a week they would know the radon level in their own room. The pupils went home, they informed their parents what happened in the school and asked them to let them bring home the charcoal absorbers. My students from Budapest (aged 13-15) helped me: they had to give a very serious exam after short course of nuclear physics, and only after a successful exam they were allowed to join the radon expedition to the village. For half a year we used charcoal and ATMOS (ionization chamber + air pump to measure momentary radon activity concentration in 20 minutes) with the help of the local pupils. The charcoal absorbers were evaluated by Ge(Li) gamma detector at the Eötvös University, Budapest. We have discovered that higher radon concentrations occurred not only the region where research institutes worked before but also elsewhere all over the village. Together with the students we have decided an extended exploration of the village. Up to now we have measured the radon activity concentration by alpha track detectors in 50 % of the houses. The bulk of the work of the evaluation of the detectors was done by the Budapest students and their teachers. Local students helped in the local communication with the local people. The Atomic Physics Department of the Eötvös University checked our work continuously with more complex methods. All these were done with youthful enthusiasm and interest, without any financial support. Now we have thousands of data on the spacial and seasonal distribution of radon activity concentration. What should we do with these data?

There are several possibilities to reduce the radon level in a living room. The simplest way is to ventilate the room especially in the evening before you go to bed. In the case of high activity this is not enough. In such cases some reconstruction of the building is needed, which can be different in the houses of different structure. To change the living habit (e.g. moving to the less affected room or ventilating regularly in the evening) or to reconstruct the structure of the building needs the co-operation of the inhabitants and it needs money. How to obtain the co-operation of the people, who never attended high school? How to create money for the mitigation in a poor evolving democracy where there is no Big Brother to watch and help us? This has become the key question.

We – students and their teachers – have decided that we give the data to the house owners directly, and simultaneously we explained the data. This means that we had to teach the people of the house of higher activity how to ventilate their rooms. We also tried to find out whether we should give these data to the Operating Committee: they

may be ready to start the mitigative operations or they may say: no money – no action. It has turned out that the old roots of autocratic habits do not let this Committee to solve the problem in co-operation with the citizens but they are still discussing about the "ultimate solution" for all the houses. Together with the students we have rejected their method. We believe more in democracy.

Our recipe is very simple indeed: we try to teach the citizens as well as the leaders of the village how to live together with radon. When we have measured a home we *give the data to the citizen*. In the most effected houses we introduce the inhabitants to the measuring techniques: we teach the people how to read the data directly from the continuously operating equipment. In this way they experience directly the beneficial effect of ventilation. We *explain the meaning of the results* and try to answer all the questions. We try to find a solution for the supressing of the radon level by thinking together with the inhabitants. We also share our doubts with them. So the people feel *they are involved* in solving the radon puzzle. They feel their opinion is important, they have to make decisions. *They learn democracy: decision making based upon grasped informations.*

I believe, because my young students believe, that our effort will not only decrease the radon level, but it will increase the democratic spirit in this village. We face a lot of problems, both scientific, educational and social problems.

These "democratic" and "educational" experiences are among the reasons that in next year (22–27 August 1994) an International Science Education Conference on Environmental Problems will be held in Hungary with the title **RIO FOLLOWUP**. (See more details on the leaflet in the enclosed ICPE Newsletter.) The place of the conference is a beautiful, old and small city: Eger. Eger is only 30 km far from our village. We invite you for this conference, and we offer an excursion to the interested participants to visit our village, to meet its friendly people, its folklore, its radon and carbon-dioxide. And we hope we can learn from you how to solve our radon problems in an effective democratic way.

(Esther Tóth)

Entrance Examination Problems from Brasil *

Example 1. (Rio Grande do Sul – 1991)

In 1989 it was widely advertised in the media and among scientific circles that there were new alternative methods to obtain nuclear fusion. The expectation were not confirmed. What is truly known today, is the same as was known at that time: nuclear fusion is obtained at temperatures as high as those existing, and, unlike the process of nuclear fission used in nuclear power stations, radioactive wastes.

Indicate the answer that will correctly complete the two empty spaces in the text.

* The problems are chosen from the article M. de Fonseca Elia, S. Lehrer de Souza Barros, S. Costa Ribeiro: University Entrance in Brasil; Physics Examinations for University Entrance, edited by P. Black, Science and Technology Education, Documents Series n° 45, UNESCO, 1992.

- (A) in the surface on the Earth – produces
- (B) in the surface of the Moon – produces
- (C) in the surface of the Moon – does not produce
- (D) in the surface on the Sun – does not produce
- (E) in the surface on the Sun – produces

Example 3 (FUVEST agency of 3 universities Sao Paulo – 1989)

In May 1988 Mars had its closest approach to Earth. On that particular day, people observing the planet were watching the light emitted by the Sun some time before. Approximately how long before? Consider the orbits of the Earth and of the Mars as being perfectly circular and coplanar, with radii of 150.000.000 km and 231.000.000 km, respectively.

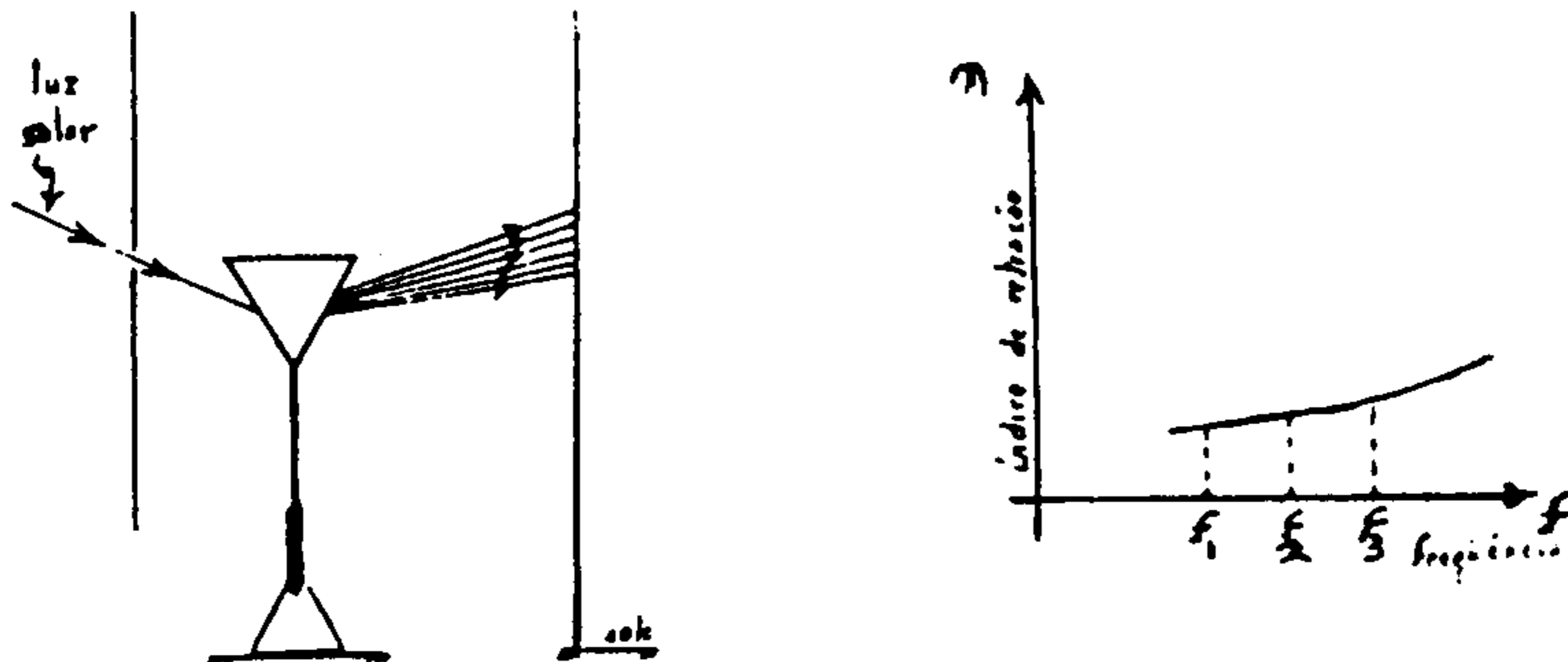
- a) 81 light years, b) 2 hours, c) 30 seconds, d) 8 minutes, e) 17 minutes

Example 9 (Rio de Janeiro – 1989)

A passage of Newton's Optics is transcribed below

" ... in a very dark chamber I made a small hole in the window, in such a way as to let a certain amount of light come through. I placed a glass prism (triangular), in front of the hole, in such a way that the refracted light will be incident upon the opposite wall. It was a very agreeable amusement to observe the intense colours there projected ..."

The figure below illustrates the experiment. The dispersion curve for frequencies in the visible is also shown, for the material of the prism.



Consider three colours, 1,2, and 3, that have frequencies f_1 , f_2 and f_3 . Locate, in increasing order, the heights in relation to ground of the projections of these colours as they appear on the wall. Justify your answer.

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International Conference Thinking Science for Teaching: The Case of Physics

In the last 20 years research in physics education (and also in other natural sciences) has been concerned mainly with the disciplinary didactical aspects starting from the acknowledgement that mastery of the discipline is a necessary but not sufficient condition for organizing learning activities. The result of the research on mental representations of students have called for more research on learning problems, on strategies aimed at fostering conceptual change, on the use of the new technologies and on the need (for the teachers) of a historical and epistemological competence.

However one may observe from the literature that the contents of physics considered by the research are those of Classical Physics, with little attention to the increase of knowledge observed in the last century. This is in contrast, on one side, with the increasing interest on the Science/Technology/Society interactions and, on the other, with the claim that contemporary physics knowledge is a fundamental part of today culture. Thus it is the time for research to examine again the necessary condition for a good physics teaching, that is the disciplinary knowledge, with reference to contemporary research and development in physics and to epistemological reflections. The aim of the meeting is to stimulate such reflection by confronting the points of view of the researchers in physics education with those of researchers in physics with an interest in epistemology or education on the theme "Thinking Physics for Teaching". – *In the very provisional program the leading themes are:* The conceptual structure of physics; the language of Physics; Interdisciplinary aspects of Physics; Round table discussion: Perspectives and development of the research in Physics Education. – *First list of speakers that have accepted the invitation:* A. Arons, D. Goodstein, D. Hawkins, G. Parisi, M. Cini, D. Gil Perez, P. Guidoni. – The school level more apt for such a confrontation will be the university level and teachers' education.

The conference will be held **September 22 – 27 1994, Roma, Italy**, with invited papers in the mornings and contributions by participants in the afternoons. – The number of participants will be restricted to 100.

Submitting a paper. Presentation format will include: individual papers (20–30 minutes); poster presentation. – Paper proposal must be accompanied by an abstract of up to 500 words. Deadline for proposal is November 30th, 1993. – The organizing committee will choose, in agreement to the aims of the conference, the papers to be presented. – Deadline for receiving the full papers June 15th 1994. – We expect to publish the Proceedings of the Conference as soon as possible after the closing of the Conference.

Further details. A registration fee of 100\$ will be charged. A second circular, including an outline programme, registration form and information about accommodation in Roma, will be sent out in September 1993 for those who indicate his/her interest. General enquires about the conference and ask for participation form should be addressed to: Patricia Maiolo, Laboratorio di Didattica delle Scienze, Dipartimento di Fisica – Università "La Sapienza", P.le Aldo Moro, 2 – 00185 Roma, Italy.

Schola Ludus Science and Public

The Project Schola Ludus, The School for our Common Future is an open project including all fields of human knowledge from phenomenological to basic theoretical levels, in a widely co-ordinated co-operation of scientists, teachers, students and public. Having started with a small successful interactive exhibition we propose to open a pilot hands-on science centre in Bratislava in approximately 10 years. In the science centre the picture of nature, culture and society would be portrayed by up-to-date science knowledge in an understandable interactive and multimedial way. Besides this a new concept of education would be created. – Our main goal is harmony between nature and mankind:

To understand nature. To help to change the bad prospects of life on Earth in the future with an untraditional joining of scientific fields. To see the "invisible", to foresee, and to stress individual, common and social problems simultaneously.

Science as a living part of national culture. Manyfold mutual communications among nations, cultures, science and the public. We hope to stimulate the ethical dimension of environmental feeling.

Pleasure through learning, connecting knowledge and fun. Through intuition and one's own experience awakening surprise and curiosity, profiting fully from all men's gift. The project Schola Ludus intends to contribute to this type of education by creating a real base for serious study.

We suggest to divide the program into the following sections:

1. The Gate to Knowledge including phenomena understandable by sensory perception chosen so as to introduce the successive creation of basic universal concepts (for example the unit, movement, symmetry, borders etc.)
2. The Path into the Inner Structure of Matter bringing to life the principles of nature, key natural laws, detection and investigation (laws of conservation, quantum theory,...)
3. The Variety of the World presented through a set of educational projects from special fields of science and technology underlining their mutual relationship (dynamics of biological systems, brain, etc.)
4. The Spiral of Knowledge, conceptions and misconceptions, rational cores of obsolete theories, acceptance of theories by scientific community and the public.

In the sessions we suppose to provide brainstorming. Demonstrations are welcome. The participants are encouraged to take part in a "science show" for public. Significant phenomena and processes should be illustrated using simple, inspiring demonstrations stressing the connections between the natural principles, technology, philosophy, culture and everyday lives. The conference will be held in **Bratislava**, the capital of the Slovak Republic in **January 1994**.

Conference addresses: Chairman: RNDr. K. Teplanova, CSc. Faculty of Mathematics and Physics, Comenius University, Mlynska dolina F2, 84215 Bratislava, SQ, fax: 427 725 882, phone: 427 720 003. Secretary: Dipl. Ing. J. Reguli, CSc, Faculty of Chemical Technology, Slovak Technical University, Kollarovo nam., 81237 Bratislava, Slovak Republic.

GENERAL INFORMATION

GIREP COMMITTEE

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FEES

The accounting year runs from January 1 to January 1, Fees paid after September in any year will be credited on the following year, unless the applicant specifies otherwise. – The current fee (1992) is 10 £st, preferably paid into one of the two London accounts or, if that is not possible, the equivalent of 10 £st in the currencies and into the accounts indicated application for (or renewal of) membership, with members paying their own bank charges and mailing costs. It is possible and advisable, in order to reduce bank expenses, to pay several years together in advance. – In cases of real difficulty of payment, please contact the Secretary who is ready to advise whether special arrangements can be made.

London accounts:

a) GIRO: Fees in £st should be made out to "Brian Davies re GIREP" GIRO Account n° 53 889 4806. This number must be quoted and the money sent to GIROBANK, c/o The Post Office, Eccleston Street BO LONDON SW11 9LS, UK. At the same time, please send a note to the Treasurer confirming how much money you sent and when and for what years. b) Non GIRO: made out to "GIREP ACCOUNT N° 90301248" and sent to the Treasurer.

Italian Account: Equivalent of 10 £st can be paid, in Italian Lire only, made out to "Marisa Michelini" and sent to: Dr Marisa Michelini, Istituto di Fisica dell'Università, via Campi 213/A, 41100 Modena, Italy.

APPLICATIONS AND NEW MEMBERS

Applicants for membership should, please require the Application Form from the Treasurer.

INQUIRIES – CHANGES OF ADDRESS

Please, address inquiries concerning fees to the Treasurer. Other inquiries may be addressed to the Secretary or to any other member of the Committee. Please, send notice of changes of address to the Secretary.

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