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Contents

Abdus Salam Receiving the Premi Internacional Catalunya

As announced in the previous issue of this newsletter, Abdus Salam, Director of the International Centre for Theoretical Physics and President of the Third World Academy of Sciences, received the Premi Internacional Catalunya (Catalonia International Prize) in Barcelona on 29 May. On this occasion, he was also received by H.M. Juan Carlos King of Spain at the Royal Palace in Madrid.

The Prize consists of a work of art — a sculpture symbolizing the Mediterranean by Eduard Arranz Bravo — and the amount of US$ 100,000, and is awarded by the Catalonia Regional Government through the Catalan Institute for Mediterranean Studies. Abdus Salam received the Prize for the following reasons:

King Juan Carlos receiving Professor Abdus Salam.

First — *For the decisive contribution Prof. Abdus Salam has made to contemporary science, namely the creation and development of the unified theory of electromagnetic and weak forces together with Glashow and Weinberg. This discovery earned him the Nobel Prize in Physics in 1979. It is one of the great theoretical advances in the field of physics since Isaac Newton. Electromagnetic force is responsible for virtually all chemical and biological phenomena, in addition to having an essential role in modern technology. Weak interaction is responsible for beta radioactive disintegration and has a basic function in nuclear fusion processes that are the energy source of the sun and the stars. Salam's great scientific contribution consists of having reduced these two forces into one, the electromagnetic and weak nuclear force, unifying both pre-existing theories.*

Second — *For the great humanistic and ecological concern of Professor Abdus Salam, who has strongly opposed the*

arms race and the use of nuclear weapons and worked literally without respite to solve the problems of the Third World, such as the advance of deserts or the lack of cultural and scientific information. His concern for the latter issue led him to create the International Centre for Theoretical Physics (ICTP) in Trieste in 1964, under the auspices of the United Nations and the Italian Government. Until now he has been director of the institute, which received 5,000 professors and postgraduates just in 1989; most of these people came from the Third World. In Trieste they have a chance to do what is impossible in their countries of origin: broaden their knowledge and devote their time to research. Professor Salam's entire personal fortune belongs to the ICTP, which will also be the recipient of the amount granted by the "Premi Internacional Catalunya".

Third — *For Professor Salam's ties to the Mediterranean through the International Centre for Theoretical Physics in Trieste, facing the Adriatic sea. Due to his contribution, the Mediterranean is one of the main centers of scientific training for the Third World.*

The Selection Committee for the Prize includes the Advisory Council of the ICEM, presided by the Honorable President of the Generalitat, Jordi Pujol, and includes Ricard Bofill, Abdelwahab Bouhdiba, Julio Caro Baroja, Georges Duby, Tahar Ben Jelloun, Hugues de Jouvenel, Fernando Lázaro Carreter, Andreu Mas-Colell, Predrag Matvejevic, Federico Mayor Zaragoza, Joaquim Molas, Edgar Morin, Simon Nora, Joan Oró, Amos Oz, Karl R. Popper, Baltazar Porcel, Hugh Thomas and Antonino Zichichi.

European Parliament

A delegation of about twenty-five Members of the European Parliament headed by Willy De Clercq visited the International Centre for Theoretical Physics in Trieste on Wednesday 27 June 1990. After the welcome address of Abdus Salam, Director of ICTP and President of the Third World Academy of Sciences (TWAS), the delegation was thoroughly briefed on both institutions by Prof. L. Bertocchi, Deputy Director of ICTP, and Prof. M.H.A. Hassan, Executive Secretary of TWAS.

Professor Abdus Salam addressing the Members of the European Parliament. On his left, Mr. Willy De Clercq, Chairman of the Committee on External Economic Relations of the European Parliament. On his right, Mr. G. Rossetti, Member of the European Parliament, from Trieste. On the far right, Prof. L. Bertocchi, Deputy Director of the ICTP, and, on the far left, Prof. M.H.A. Hassan, Executive Secretary of the Third World Academy of Sciences.

Willy De Clercq — a Belgian Minister of State and President of the Committee on External Economic Relations of the European Parliament — expressed his admiration for the achievements of Abdus Salam and his collaborators and stated that since the time for East-West tension is over, Europe is now re-activating its dossier on North-South relations. The European Parliament is conscious of its responsibilities in this respect and is prepared to consider concrete proposals.

In his reply, Abdus Salam recalled that he had chaired at the ICTP a Conference on East-West Co-operation in Science in March and that, for increasing this role, the Centre would need an additional US$ 3m. He also requested that the ICTP training programme for experimentalists from developing countries, presently limited to Italian laboratories, be extended to all European countries. After a brief discussion, the delegation was given an opportunity to meet with the scientists of the Centre.

The visit had been prepared during a meeting with G. Rossetti, Member of the European Parliament, on 5 June.

Just Published

Unification of Fundamental Forces— The First of the 1988 Dirac Memorial Lectures, Cambridge University Press, 1990, 160 pages.

Cambridge University Press has just published "Unification of Fundamental Forces — The 1988 Dirac Memorial Lectures" by Abdus Salam, Director of the International Centre for Theoretical Physics and President of the Third World Academy of Sciences in Trieste.

The annual lectures in honor of P.A.M. Dirac at Cambridge University are always anticipated as exciting sources of insight into the works and thoughts of this century's most influential physicists. This volume features an expanded version of the third Dirac Memorial Lecture, presented by Abdus Salam, as well as two previously unpublished lectures by Paul Dirac and Werner Heisenberg. Presented to general audiences, these lectures are largely non-technical and easily accessible to all those interested in the development of modern physics.

The Unification of Fundamental Forces

Salam's theme is the development of

physics as the discovery of fundamental unifications. Beginning with Galileo, who with his telescope demonstrated the universality of physics by proving that the laws of shadow making were the same on the moon as on the Earth, Salam reviews Newton's unification of terrestrial and celestial gravity, Faraday and Ampere's unification of electricity and magnetism, Maxwell's unification of electromagnetism and optics, and Einstein's unification of space and time.

The majority of Salam's talk is devoted to a wonderfully lucid overview of today's Standard Model of particle physics, including a close look at Dirac's equation for elementary entities, as well as his own contributions to the unification of the electromagnetic and weak forces. In conclusion, he looks beyond the Standard Model at the notion of supersymmetry, the search for particles even more elementary than quarks and leptons, the unification of the strong and electroweak forces, and the recent convergence of particle physics with early universe cosmology. Finally, he speculates as to whether superstrings might be the key to the greatest unification of all—the unification of gravity and the other fundamental forces by the Theory of Everything.

It is important to add that in this lecture, Salam,—whose ability as a scientist is equaled by his ability to explain complex subjects with clarity, simplicity, and eloquence—has contributed one of the most readable and stimulating summaries of particle physics ever achieved.

physics ever achieved.

History Unfolding

Delivered in 1968 at the International Centre for Theoretical Physics at Trieste during an historic lecture series entitled *From a Life of Physics*, Werner Heisenberg's "Theory, Criticism, and a Philosophy," and Paul Dirac's "Methods in Theoretical Physics," offer rare glimpses into the personalities of these founders of quantum physics. Reviewing their own lives in physics, they also provide unique insights into the methodologies and philosophies of their contemporaries, including Bohr, Einstein, Schrödinger, and Pauli. Their firsthand accounts of some of the most significant breakthroughs in physics provide remarkable opportunities to review the history of physics as it unfolded.

Diploma Course at ICTP

The ICTP announces the institution of a one-year training programme in high-energy physics, condensed matter physics and mathematics open to young promising graduates in physics and nationals mainly from developing countries. The programme is expected to start with academic year 1991-1992 and will lead to a Diploma.

The main topics in each of the three fields will include:

High energy physics: quantum field theory; particle physics; cosmology; selected advanced topics;

Condensed matter physics: solid state physics; statistical mechanics; many-body theory; selected advanced topics;

Mathematics: analysis; algebra; differential geometry; topology; selected advanced topics.

Request for Participation Forms have been circulated in the mailing list and are available upon request to the ICTP.

The Human Condition

Courtesy of
The Economist, May 26, 1990.

Moses made the first recorded attempt; Plato, Rousseau and Marx had shots at it. The United Nations Development Programme had high standards to match in trying, as it does in a new report, to define and measure "human development".

As philosophy, the UNDP's short definition will do: "Human development is a process of enlarging people's choices." As measurement, however, its sums leave much to be desired, because the measuring instruments are faulty where they are not lacking altogether.

For the choices the UNDP deems critical—a long and healthy life, education, access to resources— figures, of a kind, are available and capable of refinement. But there are no figures at all for the social achievements that are rightly said to be just as important for the quality of life: political freedom, human rights, individual self-respect. The UNDP intends to redo its assessment each year, and to widen the scope as it works out how.

For several decades the best way of ranking nations by their economic success has been to look them up in the tables of the World Bank's annual *World Development Report*, which provides figures for each country's gross national product per head, and for the rate at which that is changing. The UNDP team, under a Pakistani economic guru, Mr Mahboub ul Haq, offers the World Bankers some healthy competition. Its *Human Development Report 1990* unveils a new "human development index" (HDI).

For each of 130 countries with a population of more than 1m, the index combines purchasing power, life expectancy and literacy. The next page sets out the numbers. Sri Lankans have an official GNP of $400 per head, but purchasing power of more than $2,000 per head because goods are cheap; their life expectancy is 71 years; 87% of them are literate. That gives them an HDI-rank of 83. Brazilians (GNP per head of $2,020) have purchasing power of $4,300, can expect to live 65 years, and 78% of them are literate. They get an HDI-rank of 80. Saudi Arabia (GNP per head of $6,200) scores purchasing power of $8,320, life expectancy of 64 years and 55% of literacy, for an HDI-rank of 64. That order reverses the conventional ranking by GNP per head.

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Subjectively revealing

The strength of the HDI is in reminding those who cannot see beyond the end of their statistics that there is more to life than GNP. Its big weakness, inevitably, is that it is subjective. The implicit weighting of purchasing power, life expectancy and literacy is arbitrary. Because the index is intended to measure the absence of deprivation, it gives no credit for income growth beyond an "adequate" income level of just under $5,000 (see the notes to the table). This helps to explain some peculiar results.

How many would agree, for instance,

	Life expectancy at birth (years) '87	Adult literacy rate (%) '85	Real GDP/head (PPP-adj'd) '87 $	HDI	Rank by GNP/head	Rank by HDI
Niger	45	14	452	0.116	20	1
Mali	45	17	543	0.143	15	2
Burkina Faso	48	14	500	0.150	13	3
Sierra Leone	42	30	480	0.150	27	4
Chad	46	26	400	0.157	4	5
Guinea	43	29	500	0.162	31	6
Somalia	46	12	1,000	0.200	23	7
Mauritania	47	17	840	0.208	40	8
Afghanistan	42	24	1,000	0.212	17	9
Benin	47	27	665	0.224	28	10
Burundi	50	35	450	0.235	18	11
Bhutan	49	25	700	0.236	3	12
Mozambique	47	39	500	0.239	10	13
Malawi	48	42	476	0.250	7	14
Sudan	51	23	750	0.255	32	15
C. African R.	46	41	591	0.258	29	16
Nepal	52	26	722	0.273	8	17
Senegal	47	28	1,068	0.274	43	18
Ethiopia	42	66	454	0.282	1	19
Zaire	53	62	220	0.294	5	20
Rwanda	49	47	571	0.304	26	21
Angola	45	41	1,000	0.304	58	22
Bangladesh	52	33	883	0.318	6	23
Nigeria	51	43	668	0.322	36	24
Yemen Arab R.	52	25	1,250	0.328	47	25
Liberia	55	35	696	0.333	42	26
Togo	54	41	670	0.337	24	27
Uganda	52	58	511	0.354	21	28
Haiti	55	38	775	0.356	34	29
Ghana	55	54	481	0.360	37	30
Yemen PDR	52	42	1,000	0.369	39	31
Côte d'Ivoire	53	42	1,123	0.393	52	32
Congo	49	63	756	0.395	59	33
Namibia	56	30	1,500	0.404	60	34
Tanzania	54	75	405	0.413	12	35
Pakistan	58	30	1,585	0.423	33	36
India	59	43	1,053	0.439	25	37
Madagascar	54	68	634	0.440	14	38
Papua N. Guinea	55	45	1,843	0.471	50	39
Kampuchea D.	49	75	1,000	0.471	2	40
Cameroon	52	61	1,381	0.474	64	41
Kenya	59	60	794	0.481	30	42
Zambia	54	76	717	0.481	19	43
Morocco	62	34	1,761	0.489	48	44
Egypt	62	45	1,357	0.501	49	45
Laos	49	84	1,000	0.506	9	46
Gabon	52	62	2,068	0.525	93	47
Oman	57	30	7,750	0.535	104	48
Bolivia	54	75	1,380	0.548	44	49
Burma	61	79	752	0.561	11	50
Honduras	65	59	1,119	0.563	53	51
Zimbabwe	59	74	1,184	0.576	45	52
Lesotho	57	73	1,585	0.580	35	53
Indonesia	57	74	1,660	0.591	41	54
Guatemala	63	55	1,957	0.592	63	55
Vietnam	62	80	1,000	0.608	16	56
Algeria	63	50	2,633	0.609	91	57
Botswana	59	71	2,496	0.646	69	58
El Salvador	64	72	1,733	0.651	56	59
Tunisia	66	55	2,741	0.657	70	60
Iran	66	51	3,300	0.660	97	61
Syria	66	60	3,250	0.691	79	62
Dominican R.	67	78	1,750	0.699	51	63
Saudi Arabia	64	55	8,320	0.702	107	64
Philippines	64	86	1,878	0.714	46	65
China	70	69	2,124	0.716	22	66
Libya	62	66	7,250	0.719	103	67
South Africa	61	70	4,981	0.731	82	68
Lebanon	68	78	2,250	0.735	78	69
Mongolia	64	90	2,000	0.737	57	70
Nicaragua	64	88	2,209	0.743	54	71
Turkey	65	74	3,781	0.751	71	72
Jordan	67	75	3,161	0.752	76	73
Peru	63	85	3,129	0.753	74	74
Ecuador	66	83	2,687	0.758	68	75
Iraq	65	89	2,400	0.759	96	76
U. Arab Emirates	71	60	12,191	0.782	127	77
Thailand	66	91	2,576	0.783	55	78
Paraguay	67	88	2,603	0.784	65	79
Brazil	65	78	4,307	0.784	85	80
Mauritius	69	83	2,617	0.788	75	81
North Korea	70	90	2,000	0.789	67	82
Sri Lanka	71	87	2,053	0.789	38	83
Albania	72	85	2,000	0.790	61	84
Malaysia	70	74	3,849	0.800	80	85
Colombia	65	88	3,524	0.801	72	86
Jamaica	74	82	2,506	0.824	62	87
Kuwait	73	70	13,843	0.839	122	88
Venezuela	70	87	4,306	0.861	95	89
Romania	71	96	3,000	0.863	84	90
Mexico	69	90	4,624	0.876	81	91
Cuba	74	96	2,500	0.877	66	92
Panama	72	89	4,009	0.883	88	93
Trinidad & Tob.	71	96	3,664	0.885	100	94
Portugal	74	85	5,597	0.899	94	95
Singapore	73	86	12,790	0.899	110	96
South Korea	70	95	4,832	0.903	92	97
Poland	72	98	4,000	0.910	83	98
Argentina	71	96	4,647	0.910	89	99
Yugoslavia	72	92	5,000	0.913	90	100
Hungary	71	98	4,500	0.915	87	101
Uruguay	71	95	5,063	0.916	86	102
Costa Rica	75	93	3,760	0.916	77	103
Bulgaria	72	93	4,750	0.918	99	104
USSR	70	99	6,000	0.920	101	105
Czechoslovakia	72	98	7,750	0.931	102	106
Chile	72	98	4,862	0.931	73	107
Hong Kong	76	88	13,906	0.936	111	108
Greece	76	93	5,500	0.949	98	109
East Germany	74	99	8,000	0.953	115	110
Israel	76	95	9,182	0.957	108	111
USA	76	96	17,615	0.961	129	112
Austria	74	99	12,386	0.961	118	113
Ireland	74	99	8,566	0.961	106	114
Spain	77	95	8,989	0.965	105	115
Belgium	75	99	13,140	0.966	116	116
Italy	76	97	10,682	0.966	112	117
New Zealand	75	99	10,541	0.966	109	118
West Germany	75	99	14,730	0.967	120	119
Finland	75	99	12,795	0.967	121	120
Britain	76	99	12,270	0.970	113	121
Denmark	76	99	15,119	0.971	123	122
France	76	99	13,961	0.974	119	123
Australia	76	99	11,782	0.978	114	124
Norway	77	99	15,940	0.983	128	125
Canada	77	99	16,375	0.983	124	126
Holland	77	99	12,661	0.984	117	127
Switzerland	77	99	15,403	0.986	130	128
Sweden	77	99	13,780	0.987	125	129
Japan	78	99	13,135	0.996	126	130

The table ranks the countries in ascending order of their score on the human-development index. The UNDP's researchers combined the first three columns in each part of the table-showing life expectancy, adult literacy and purchasing power to deduce the index shown in the fourth column. For each indicator, a "minimum" value and a "desirable" value had to be specified. Minimum values were set equal to the lowest actually observed in 1987: 42 years for life expectancy (as in Afghanistan, Ethiopia and Sierra Leone), 12% for adult literacy (as in Somalia) and $220 for purchasing power (as in Zaire). Desirable values were set at 78 years for life expectancy (as in Japan), 100% for adult literacy, and $4,861 for purchasing power (this is the average official poverty line for nine industrial countries, adjusted for purchasing-power parity). One further complication: to reflect "diminishing returns in the conversion of income into the fulfilment of human needs", logarithms rather than absolute values of purchasing power were used. With these minimum and desirable values fixing the end-points, and with the interval between them set equal to one, the countries could be located on each scale. A simple average of the three readings then yields the HDI. The last two columns in each part of the table show the ranking by unadjusted GNP per person and the ranking by HDI, respectively.

that Singapore (line 96) deserves to be ranked three places lower than Argentina, or the United States (112) no fewer than 18 places lower than top-placed Japan (and three lower than Spain)? Oddities become absurdities in the case of the communist and newly ex-communist countries, whose underlying GNP figures are worthless. Hands up everybody who thinks that North Korea (82) has reached a higher plane of development than Brazil, or the Soviet Union (105) than Portugal.

Still, development buffs will study promotion and relegation in the HDI league with interest. Among the more surprising promotions is that of India (37). By raw GNP per head, only 24 countries are poorer. On the HDI, India moves in front of another 12.

Most Arab nations, with high incomes but also high death-rates and low literacy, are relegated en bloc by the HDI. Several social-democratic countries in and around Latin America—such as Costa Rica (103), Uruguay (102) and Jamaica (87)—win promotion; so do some "progressive" Asian countries such as Sri Lanka and Thailand (78). Bravely, the UNDP opines that this may have something to do with freedom, even with democracy. Unfortunately the best of all Latin American performers has been Chile (107)—not exactly free or democratic in recent years.

Wishful thinking aside, the report has little to say about why some countries have been so much better than others at translating growth in GNP into "development"; more guidance on policy is promised for next time. Not long ago, the UNDP might have argued that growth hardly matters, but attitudes have changed. Growth is good, it now affirms. What is needed is more of the right sort of public spending, especially on primary education and health and less of the wrong sort—e.g., on armies.

The UNDP adds to the literature on military waste with figures on soldiers in relation to teachers. In the rich world, Japan's armed forces enlist 25 people for every 100 employed in teaching. In the United States there are as many soldiers as teachers. In the big West European countries with conscription the armed forces are usually slightly larger than the teaching profession. Britain, with no conscription, has 62 soldiers per 100 teachers.

In the Third World, the most over-militarised countries tend to be neighbours scared of each other, with the smaller neighbour having proportionately the larger armed forces. Poor Somalia has 525 soldiers per 100 teachers, because larger Ethiopia has 494. Iraq has 428, because larger Iran has 112. Syria has 320, Jordan 245, Israel only 191—but then every adult Israeli is a soldier, and most of them talk like teachers too.

In Pakistan's 154 soldiers per 100 teachers face India's 28 per 100—and, partly in consequence, India's adult-literacy rate is 43% to Pakistan's 30%. Yet people do learn to read, even with big armies. Nicaragua (88% literate) had 326 soldiers per 100 teachers when these figures were gathered, in 1988; it has many fewer since this year's elections. Thanks to financial support from the United States, El Salvador still has its 183 soldiers per 100 teachers, and a 72% adult-literacy rate.

One of the HDI's brightest stars is Costa Rica. It is a small country with no more than middling purchasing power, but life expectancy fully up to rich-country standards. It has no army, so nought soldiers per teacher—and 93% adult literacy.

Votes for fewer women

That women generally get a raw deal is scarcely a surprise. That the deal is getting slightly less raw is encouraging. In every single country women have been catching up with men in literacy, and in the proportion enrolled in primary education. That may, in the long run, help to close the status gap; but not unless women get more of a share in power. If parliaments are where power lies, that is happening slowly if at all.

Women hold more than one seat in five in the parliaments of only 16 countries. Four of them are Nordic: Denmark's is the least feminist, with 29% of female members. The other dozen are ten members of Comecon, plus China and North Korea. It seems that one way to have women in parliament is not to hold proper elections. As democracy spreads in Eastern Europe, watch the statutory women fade off the parliamentary scene.

In 20 parliaments women hold between 10% and 20% of seats. Nine of these assemblies are chosen by reasonably democratic processes. The democratic parliament with the highest female enrolment (after those four Nordics) is that of Trinidad and Tobago, with 16.6%; closely followed by West Germany, New Zealand and, yes, Switzerland on 14%. Women account for 9.9% of Canada's parliament, for 6.3% of Britain's and 5.3% of the American Congress.

Doing without elections does not necessarily bring in the women. There is not one woman in the parliaments of five Arab states, a record matched among democracies only by Papua New Guinea.

Mastering the Fine Art of Writing Reports for Nonscientists

by Thomas L. Warren

Being a good scientist has always meant staying abreast of new technological advancements, keeping up with the literature in one's field, and knowing when to call on the expertise of others. These days, more than ever before, it also means doing a lot of writing: in peer-reviewed journals, a prerequisite for advancement in one's career; and in grant proposals, a necessity of research life for many scientists.

In addition to writing scientific papers and applications for funding, today's researchers are also frequently called on to provide written communications to nonscientists: accountants, public relations officers, personnel directors, and the like. For many researchers, reports to nonspecialists are more difficult to write than the most daunting grant application, because in communicating to people outside the field a scientist has to adapt his or her writing style to readers' needs and level of expertise.

If you're the kind of person who finds this kind of writing an insufferable chore, you may find yourself wasting valuable research time by agonizing over these interdepartmental communications. You write, rewrite—and your report still comes back from the reader with questions, or,worse, goes forward unread.

The unread report is not just a waste of time; it is a threat to your organization, and even to your research itself. Accountants will review your budget request whether or not you help them by writing clearly and directly, anticipating their need for information—and your budget may not be approved if your request is unclear. Your organization's publicist will not do an effective job of getting the word out about your research if your reports are ambiguous and full of jargon.

A reader will tend to put a report aside if it is written with no thought to his or her need for information. Undoubtedly, you yourself have encountered this problem with some of the interdepartmental communications you have read. While perusing a report from the accounting department, for example, you may have wondered, "What impact will the 10 percent drop in accounts receivable have on my research?" It is important to bear in mind, however, that your communications to the accountants may be just as incomprehensible to them as their papers are to you. To circumvent this problem it is useful to give some thought to your readers before you begin to write.

to write.

Reader Analysis

Your readers turn to reports (or any written material, for that matter) with a need for specific information. The task for you, the writer, is to determine what the needed information is and to provide it in the most helpful way possible.

For starters, find out who has to read what you write. Once you have a name or job title, ask yourself three questions:

• **What does my reader need to know?** Many communication situations are problem-centered. The reader's task is to determine whether your equipment is cost-effective, or to let the public know about recent discoveries. The status quo will change once that person has received your report. If you have done your job, then new equipment will arrive, or the public will support the research effort. On the other hand, a poorly written report could mean no new equipment or a loss of public support.

To determine the content of your report, it may be helpful to think through the communication situation you are faced with, and to consider what your reader will use your information for, before you sit down to write. Are you writing from a proactive or reactive standpoint—that is, are you initiating communication or responding? If proactive, then what are the key pieces of information your reader needs to grant your request? If reactive, why does the reader want your information?

Like many writers in other fields, scientists often are consumed with interest in their own disciplines and tend to tell their readers more than they need to know. Rarely will an auditor want you to tell all you know about lipoprotein. Rather, you may be expected to write a memo explaining how a particular expenditure applies to your research into lipoproteins and fat-soluble vitamins.

• **How can I help my reader to understand?** As you know, cost accounting has its own vocabulary and theory, which can be as arcane as those of biophysics—and just as incomprehensible to anyone outside the field. When you write a report to be read by nonspecialists, your readers usually have little knowledge of your field, so you have to help them understand the material.

you have to help them understand the material.

What if, when asked to provide a statement about the purpose of a recent study you were doing, you produced the following:

"The purpose of the study reported here was the establishment of an unsophisticated in vitro system, based on measurement of the rate of release of growth hormone from isolated fragments of anterior pituitary from rats, which could provide a suitable technique for further elucidation of the mechanisms by which regulation of the growth hormone secretory process in the cells of the anterior pituitary may be achieved."

This paragraph is perfectly appropriate for a peer-reviewed journal—and, in fact, it actually appeared in a journal article. But it misses the mark as a communication to a nonspecialist. In a paragraph like this, what do you assume your reader knows about the work? Does he or she actually know the technical terms (*in vitro*, *posterior*, *pituitary*, *growth hormone secretory*, and so on)? How can a lay reader respond, except to ask for an explanation? Will you have the time—or the will—to write it?

Helping your reader to understand means defining terms, providing analogies, giving examples from outside the lab, simplifying concepts, and clarifying graphs and tables.

No one is asking that you oversimplify to the point of distorting what you mean. Just be aware that, although your reader may know the meaning of individual words in your reports, the combinations may be mysterious. Researchers in animal science know what "heavy beef heart mitochondria protein" is, but who else does? Many readers will wonder whether the "heavy" modifies "beef" or "heart" or "protein" or what.

No matter how clear the concepts are to you, you are not the reader, and your terms may be completely meaningless to that person. When communication fails, frequently the problem is that the writer failed to help the reader understand the message.

• **What do I want my reader to do with the information?** When you consider what action you expect from your reader, you also have to consider what persuasive elements to use. For

your reader, you also have to consider what persuasive elements to use. For example, the most important persuasive element is your credibility as a scientist. This credibility certainly carries the day when you are discussing scientific issues. But what content of your report is nonscientific—such as a request for additional staff? In cases like this, you need other approaches.

You can appeal to your reader through logic. To be most effective, organize your presentation as a logical arrangement of the facts that lead to the inevitable conclusion that you need help or money. The problem here is what form of logic to use. Does your reader agree that the most logical thing to do is hire more people? From a science

standpoint, the request may be completely logical. But what about from a larger, organizational point of view? Increasing your budget for staff salaries could mean reducing funding for other work.

To determine the best approach, you will have to know your reader. What in your qualifications will he or she consider important? What kind of logical appeal will work? It all comes back to providing the information in a form that the reader can easily understand.

Thomas L. Warren is a director of the Technical Writing Program and coordinator of graduate studies in English at Oklahoma State University. He has published many articles on technical communication, spoken to many diverse groups on effective communication, and written a self-help course in report writing for the American Management Association.

Communication Tips for the Scientist

by Ricki Lewis

Nontechnical professionals who frequently read scientists' reports offer the following suggestions for researchers needing to get their messages across clearly:

1. Know Your Audience

The purpose of a paper should determine its style and organization. Nancy Thornton, who teaches writing effectiveness to word-weary scientists at some 20 institutions in upstate New York, suggests that researchers ponder their report's destination before sitting down to write.

"Is it a progress report for a manager? If so, what will the manager do with it? Will he or she send it on to someone else, and how will that affect the language to be used?" asks Thornton, whose clients include scientists at Sterling Winthrop, General Electric, the New York State Department of Environmental Conservation, and numerous small technical firms. Well-written in-house reports often start with journalism's "five Ws"—who, what, where, when, why—"so that the reader can focus on where [the paper] is headed," she says.

Care must be taken in describing scientific work to public relations professionals so as to avoid premature trumpeting of a "breakthrough." Press releases often require much back-and-forth between scientist and writer, with a go-between sometimes called in to "translate." "We use people who once were practicing scientists, or technical writers," says one public relations person whose accounts cover such diverse fields as monoclonal antibodies, lasers, and polymers.

But many other public information specialists lack such technical expertise. "The majority of people working with institutions such as medical centers do not have science backgrounds," says Laura Feragen, manager of media relations at Pennsylvania Hospital in Philadelphia. "I studied English and social studies, but I've been in health care reporting for 11 years," she says, adding that in positions like hers, "you have to learn not to be intimidated by words thrown at you." Garret DeYoung, a freelance writer who has edited such publications as *High Technology* and *Photonics Spectra* and written for the Illinois Institute of Technology, agrees. "Scientists should write clearly, assume that the [reader] is intelligent, explain things when asked, yet at the same time not be condescending," he says.

2. Organize

"Is there a clear introduction, experimental section, results, conclusions, and recommendations? A table helps where there is a paragraph of solid data or a comparison of two or three methods. Find which organizational format will work the best," suggests Thornton. Adds Jim Magee, a patent attorney at the General Electric Research and Development Center in Schenectady, N.Y., "What problem are you trying to solve, and what did you do to solve it?" See the big picture—and make sure the reader does, too.

3. Polish

It may help to edit the editors. "In writing for government agencies, it's not uncommon for 25 people to edit a scientific paper. By the time it gets back to the poor scientist, he doesn't know where to start. The larger structure is lost," says Thornton. The same too-many-cooks problem arises for textbook authors, whose work is often reviewed by multiple readers. The solution to the information overload—a consensus reviewer to derive one list of recommendations.

Finally, put the paper aside for a day or two. Let others read it. Read it aloud.

4. Be Aware Of Your Discipline's Writing Quirks

Thornton, who has helped thousands of scientists improve their writing skills, has noted interesting trends. "Electrical engineers and pharmacologists are too tight," she says. "They write with a telegram style. At the other extreme, computer scientists tend to be too wordy. Chemists write in short paragraphs, maybe because they are so used to representing things as formulae."

Potential clients often expect Thornton to whip their employees writing into Pulitzer form in just an hour or two. Perhaps this is because the secret to good writing is to make the paper read as if composing it were effortless.

But any scientist who writes frequently—be it in-house reports, journal articles, or grant proposals—knows how tough it is. Says Thornton, "People don't realize it takes a long time and a lot of work to master clear and effective writing."

Ricki Lewis teaches biology at the State University of New York, Albany.

Visits to ICTP

Brazilian Ambassador

On 10 May, His Excellency Mr. Carlos Alberto Leite Barbosa, Ambassador of Brazil to Italy had a brief visit of the Centre. He was received by the Deputy Director, Prof. L. Bertocchi, and Prof. H. Cerdeira, Staff Associate of

the ICTP for Condensed Matter Physics, from UNICAMP, Campinas, Brazil.

A. Gromiko (USSR)

Prof. Anatoly Gromiko, Director of the African Studies Section of the USSR Academy of Science, was invited to the ICTP within the framework of the programme "Science, High Technology and Development". He delivered a lecture entitled "New Thinking in a Nuclear Age" on 13 May.

S.K. Chopra (India)

Dr. S.K. Chopra, Adviser in the Planning Commission of the Government of India, came to the Centre on 18 May. He was received by the Director Abdus Salam and met scientists and other members of the ICTP Staff.

Minister J. Brunetti (Italy)

On 21 May, Minister J. Brunetti (Ms.) was received at the ICTP by Professor Abdus Salam. Minister Brunetti is the Director General of the General Directorate for Cooperation to Development of the Ministry of Foreign Affairs which finances, among others, the programmes of External Activities and of Training in Italian Laboratories. A meeting with all ICTP officials followed.

J.L. de Segovia (Spain)

Prof. José L. de Segovia, President of the International Union for Vacuum Science, Technique and Applications, met Prof. Abdus Salam on 22 May to discuss on closer cooperation between IUVSTA and ICTP. IUVSTA has set up two new committees, the Co-Ordinated Activities Committees, chaired by Dr. A. Zalar from Yugoslavia, and the Developing Countries Committee, chaired by Dr. P. Barna from Hungary.

R. Matera (Argentina)

Dr. R. Matera, Secretary for Science and Technology of Argentina, had a meeting with ICTP scientists and officials on 24 May. Possibilities of further collaboration between the ICTP and Argentina were discussed.

Italian Geographers

Prof. G. Valussi of the Institute of Economic Geography of the University of Trieste, organized on 28 May a visit to the ICTP for forty university professors from all over Italy participating in the yearly inter-university geographical excursion. This year, they have had the opportunity to visit the Trieste scientific institutions.

Czech Minister

On 28 May, the Deputy Director of the ICTP, Prof. L. Bertocchi, received Mr. Ján Pisút, First Deputy Minister of Education, Youth and Sport of the Slovak Socialist Republic, and Ms. Alena Brunovská, Director of the Department of Science of the same Ministry.

Sixth Argentine Congress of Meteorology

The Argentine Center of Meteorologists is organizing the 6th Argentine Congress of Meteorology that will be held in Buenos Aires in November 1991. Papers are welcome in all aspects of meteorology and meteorology-related fields.

More information about abstract and deadlines will be published soon. Also, information can be obtained by writing to: Centro Argentino de Meteorólogos, Pabellon II, Ciudad Universitaria, 1428 Buenos Aires, Argentina.

Hot Papers

From "The Scientist", April 2 and May 14, 1990;
From "The Scientist", April 2 and May 14, 1990;

The articles listed below, all less than two years old, have received a substantially greater number of citations than others of the same type and vintage, according to data from *The Science Citation Index* of the Institute for Scientific Information, Philadelphia. Why have these research reports become such stand-outs? A comment following each reference, supplied to *The Scientist* by one of the authors, attempts to provide an answer.

THEORETICAL PHYSICS

S. Coleman, "Why there is nothing rather than something: a theory of the cosmological constant," *Nuclear Physics B, 310, 643-68, 12 December 1988.*

Sidney Coleman (Harvard University, Cambridge, Mass.): "The cosmological constant is a quantity that appears in Einstein's gravitational field equations. It can be thought of as the energy density of the ground state of quantum field theory, empty space. Experiment gives an upper bound on the constant (consistent with it vanishing altogether). Rough theoretical estimates predict a value several dozen orders of magnitude greater than the experimental upper bound. This is possibly the worst prediction in 20th-century physics and has been an embarrassment for many years.

"My paper extended earlier work by Hawking and Linde to offer a novel theory of the vanishing of the cosmological constant. The theory was (and is) highly speculative and I am not sure why it has received so much more attention than its predecessors did. It might be because it opens the possibility (till unrealized) of computing other constants of nature. However, it might be just that high-energy theorists currently have a lot of time on their hands, a situation that will probably persist until the next generation of accelerators comes on line."

SUPERCONDUCTIVITY

M.A. Subramanian, C.C. Torardi, J. Gopalakrishnan, P.L. Gai, et al., "Bulk superconductivity up to 122°K in the Tl-Pb-Sr-Ca-Cu-O system," *Science*, 242, 249-52, 14 October 1988.

Mas Subramanian (E.I. Du Pont de Nemours and Co., Wilmington, Del.): "This is the first paper to report superconductivity in the system Tl-Pb-Sr-Ca-Cu-O with transition temperatures up to 122°K. It also reported the precise structural and compositional information of the 122°K superconductor derived from high resolution microscopic and single crystal X-ray diffraction investigations.

"This paper attracted much attention

because high-temperature superconductors with transition temperatures as high as 125°K were known in the system Tl-Ba-Ca-Cu-O but not in the Tl-Sr-Ca-Cu-O system. The work demonstrated how one could stabilize new superconductors by appropriate chemical substitution. It is now recognized that such substitutions not only favor the phase stability, but also may alter the electronic structure, which may induce superconductivity."

Articles Alert

From "The Scientist", April 2, April 30, and May 14, 1990;

The Scientist has asked a group of experts to comment periodically upon recent articles that they have found noteworthy. Their selections, presented herein every issue, are neither endorsements of content nor the result of systematic searching. Rather, the list represents personal choices of articles the columnists believe the scientific community as a whole may also find interesting. Reprints of any articles cited here may be ordered through The Genuine Article, 3501 Market St., Philadelphia, Pa. 19104, or by telephoning (215) 386-4399.

PHYSICS

by Frank A. Wilczeck, School of Natural Sciences, Institute for Advanced Study, Princeton, N.J., USA.

• Measurements of the Z boson's lifetime give decisive information as to the possible existence of new species of light neutrinos, in addition to the three known ones (electron, muon, τ lepton). Even though the neutrinos themselves are essentially undetectable, by comparing the actual Z decay rate to the decay rate from "known causes," one might see an indirect signal of their existence. Recent results strongly indicate that the three known neutrinos exhaust the list. This result is important to cosmology because the number of neutrino species affects the rate of expansion of the early universe, which is an ingredient in the calculation of element abundance in big-bang nucleosynthesis. (In addition to the text, there are more than three pages of authors' names, which must be some sort of record.)

D. Decamp, B. Deschizeaux, J.-P. Lees, M.-N. Minard, et al., "A precise determination of the number of families with light neutrinos and of the Z boson partial widths," *Physics Letters B*, **235**, 399-411, 1 February 1990. (Laboratoire de Physique des Particules, Annecy-le-Vieux, France; et al.)

• Quantum numbers used to be quantized. Lately, it is increasingly common to find numbers, once thought of as sacrosanct quantum numbers, indeed breaking into fractions. This is particularly common in two-dimensional condensed matter systems, in which fractional electric charge, and even fractional quantum statistics, have become central to the Hall effect theory. These are widely speculated to play a role in spin orderings (chiral spin states) and in high temperature (anyon) superconductivity.

S.P. Benz, M.S. Rzchowski, M. Tinkham, C.J. Lobb, "Fractional giant Shapiro steps and spatially correlated phase motion in 2D Josephson arrays," *Physical Review Letters*, **64**, 693-6, 5 February 1990. (Harvard University, Cambridge, Mass.)

• The burgeoning state of the art in scanning microscopy is well-summarized.

R. Pool, "The children of the STM," *Science*, **247**, 634-6, 9 February 1990. (AAAS, Washington, D.C.)

• How can a paper that opens, "A functioning human brain is a lump of warm wet matter of inordinate complexity," be resisted? It tackles, head-on, some of the classic "problems" of philosophy and psychology, by taking the point of view—the only defensible one, in my opinion—that until proved otherwise we should assume the laws of physics are adequate to describe all aspects of reality. It also isolates some of the key facts that really do need explaining. The paper makes a genuine contribution in a domain where the air is often both "thin and hot."

M.J. Donald, "Quantum theory and the brain," *Proceedings of the Royal Society of London*, **A427**, 43-93, 8 January 1990. (University of Cambridge, England)

• Precision measurements of the Z boson lifetime has generated considerable excitement recently. The Z boson lifetime, which gives information about the number of different neutrino species, is a value of great interest in cosmology. A complete survey of the situation *prior* to these measurements provides a self-contained, elementary but masterly, account of the relevant cosmology.

D. Denegri, B. Sadoulet, M. Spiro, "The number of neutrino species," *Reviews of Modern Physics*, **62**, 1-42, January 1990. (CERN, Geneva; Centre d'Etudes Nucléaires de Saclay, Gif-sur-Yvette, France; University of California, Berkeley)

• Strange and wonderful things are happening at the center of our galaxy. There is impressive evidence that a massive (greater than 10^6 solar masses) black hole lives there; bathed in an inrushing whirlpool of inpouring gas, exerting hug gravitational fields on nearby objects. Observations, and some of the ingenious techniques used, are described.

C. Townes, R. Genzel, "What is happening at the center of our galaxy?" *Scientific American*, **262**, 46-55, April 1990. (University of California, Berkeley; Max Planck Institute, Mainz, W.Ger.)

• A classic (and continually refined) chapter of mathematical physics deals with proof of the stability of matter: why it doesn't all collapse in a heap (not obvious, because there are singular attractive forces!). A masterly and quite accessible recent survey of this deep and delicate subject, by one of the main contributors to the field, is given.

E.H. Lieb, "The stability of matter: from atoms to stars," *Bulletin of the American Mathematical Society*, **22**, 1-49, January 1990. (Princeton

. University, N.J.)

• Fundamental physical theory is dominated at present by ideas of symmetry and gauge invariance. Roughly speaking, gauge invariance means that the laws of physics are most simply expressed (specifically, are *local*) in terms of variables that form a highly redundant description of the physical world. Most stated equations, therefore, consist of the relationships between arbitrary names. It is a real challenge, then, to extract their physical meaning. In this context, it often becomes difficult even for experts to relay their findings. A profound analysis is presented.

M. Henneaux, C. Teitelboim, J. Zanelli, "Gauge invariance and degree of freedom count," *Nuclear Physics*, **B332**, 169-88, 26 February 1990. (Centro de Estudios Científicos de Santiago, Chile; Université Libre de Bruxelles, Belgium; University of Texas, Austin; Universidad de Chile, Santiago)

• Two leaders in theoretical physics have presented an accessible, up-to-date summary of the current state of turbulence—quite an outstanding challenge in description alone.

U. Frisch, S.A. Orszag, "Turbulence: challenges for theory and experiment," *Physics Today*, **43**, 24-32, January 1990. (Observatoire de Nice, France: Princeton University, N.J.)

PHYSICS

by Sokrates T. Pantelides, IBM Research Division, Thomas J. Watson Research Center, Yorktown Heights, N.Y.

• The fractional quantum Hall effect was described theoretically some time ago, but its relationship to the integer Hall effect has been rather elusive. A new theory by Jain, Kivelson, and Trivedi bridges the gap. The theory was motivated by unpublished experimental data, reported by Engel, Wei, Tsui, and Shayegan, at the Eighth International Conference on Electronic Properties of Two-Dimensional Systems, held in Grenoble, France, in 1989.

J.K. Jain, S.A. Kivelson, N. Trivedi, "Scaling theory of the fractional quantum Hall effect," *Physical Review Letters*, **64**, 1297-1300, 12 March 1990. (State University of New York, Stony Brook; University of California, Los Angeles)

• For many years, III-V semiconductors and alloys proved to yield a plethora of innovative transistors. Nowadays, mixing Ge in Si, by either molecular beam epitaxy (MBE) or chemical vapor deposition (CVD), is making possible comparable Si-based devices, featuring a controllable negative differential resistance in the collector current. A recent paper reports a SiGe resonant tunneling hot-carrier transistor. Don't ever count Si out!

S.S. Rhee, G.K. Chang, T.K. Carns, K.L. Wang, "SiGe resonant tunnelling hot-carrier transistor," *Applied Physics Letters*, **56**, 1061-3, 12 March 1990. (University of California, Los Angeles)

• The debate on Fermi-level pinning at semiconductor-metal interfaces has focused so much on interface and defect states that hydrogenation is an obvious desirable probe. It's happening—the experimental results are intriguing—but understanding is still elusive.

Y.Q. Jia, G.G. Qin, "Effects of hydrogen on Al/*p*-Si Schottky barrier diodes," *Applied Physics Letters*, **56**, 641-3, 12 February 1990. (Peking University, Beijing; Academia Sinica, Shenyang, China)

• Measured hyperfine parameters have often led to unambiguous identification of defects in semiconductors. A new report shows that first-principles calculations of hyperfine parameters is now possible and can unambiguously resolve ambiguities!

C.G. Van de Walle, "Structural identification of hydrogen and muonium centers in silicon: first-principles calculations of hyperfine parameters," *Physical Review Letters*, **64**, 669-72, 5 February 1990. (North American Phillips Corporation, Briarcliff Manor, N.Y.)

• There seems to be no end to new probes of individual atoms. A recent paper reports that femtosecond pulses can be used to "push" molecules in a molecular crystal along selected paths in the lattice, very much as one pushes a child on a swing.

A.M. Weiner, D.E. Leaird, G.P. Wiederrecht, K.A. Nelson, "Femtosecond pulse sequences used for optical manipulation of molecular motion," *Science*, **247**, 1317-19, 16 March 1990. (Bell Communications Research, Red Bank, N.J.; Massachusetts Institute of Technology, Cambridge)

Activities at ICTP May-June 1990

Title: SPRING SCHOOL ON STRING THEORY AND QUANTUM GRAVITY AND WORKSHOP ON STRING THEORY, 23 April - 4 May 1990.

Organizers: Profs. M. Green (Queen Mary College, London, UK), H. Verlinde (Princeton University, USA), S. Randjbar-Daemi (ICTP) and E. Sezgin (ICTP), in co-operation with the International School for Advanced Studies (SISSA, Trieste, Italy) and the Italian Institute for Nuclear Physics (INFN).

Lectures: *(Spring School)* Topological aspects of conformal field theory and 2-d gravity. Baryon violation at finite temperature. Integrable lattice models and quantum groups. Recent developments in 2d gravity. 2d gravity and matrix models. Self-duality and N=2 string magic. Integrable lattice models and quantum groups. Quantum string magic. Integrable lattice models and quantum groups. Quantum cosmology.

(Workshop) Conformal field theory, triality and the monster. Extrinsic geometry of non-critical strings. Renormalization group flows in generalized Toda field theories. Critical exponents of 1-dim, models from finite-size effects in conformal field theories. Quasi-exactly-solvable quantal problems: 1 dim. analogue of rational conformal field theories. Algebraic structure of integrable hierarchies in bilinear form. Self-duality and N=2 string magic. A model of interacting strings and the Hagedorn transition. One-loop quantum gravity effects in superstrings. Chern-Simons theory and geometric

regularization. Quantum group tensor products and fusion rule multiplicities. Toda theory and W-algebra from a WZNW point of view. Heterotic solitons. Matrix models and string theory: supersymmetry and non-ambiguous solutions. Classical r-matrix and exchange algebra WZNW and Toda theories. On 2-d gravity in the formalism of conformal field theory. Non-universality of 3 d Dirac determinant. The quantum Ising chain with a general defect. Fusion of braiding matrices for W-algebras and Boltzmann weights of integrable lattice models. Some non-perturbative aspects of the relationship between LG and CY σ models. Spectra and symmetries of Gepner models compared to Calabi-Yau compactifications. Symmetry breaking in conformal theories of 4 dim. superstring. C-theorem and spectral representation. The 2-d effective supergravity and the super WZNW model. Three short stories on non-critical strings. The Aharanov Bohm effect without gauge fields. Gravitation and multiloop superstring amplitudes. The covariant path integral representation of the off-shell string amplitudes. W∞ gravity.

The School and Workshop were attended by 154 lecturers and participants (33 from developing countries).

Title: SPRING COLLEGE IN CONDENSED MATTER ON: PHYSICS OF LOW-DIMENSIONAL SEMICONDUCTOR STRUCTURES, 23 April - 15 June 1990.

SEMICONDUCTOR STRUCTURES, 23 April - 15 June 1990.

Organizing Committee: Profs. N.H. March (Chairman, University of Oxford, UK), P.N. Butcher (University of Warwick, UK), G. Chiarotti (II Università di Roma, Italy), P. Fulde (Max-Planck-Institut für Festkörperforschung, Stuttgart, Federal Republic of Germany), F. García-Moliner (Instituto de Ciencia de Materiales, Madrid, Spain), F. Gautier (Université Louis Pasteur, Strasbourg, France), I.M. Khalatnikov (Landau Institute for Theoretical Physics, Moscow, USSR), S. Lundqvist (Chalmers University of Technology, Göteborg, Sweden), Chi Wei Lung (Institute of Metal Research, Shenyang, P.R. China), K. Singwi (Northwestern University, Evanston, USA) and M.P. Tosi (Università di Trieste and ICTP, Trieste, Italy).

Course Directors: G.H. Döhler (Universität Erlangen-Nurnberg, Federal Republic of Germany) and M. Tomak (Middle East Technical University, Ankara, Turkey).

Co-operation of the International Centre for Science; co-sponsorship of the Italian Direzione Generale per la Cooperazione allo Sviluppo (Ministry of Foreign Affairs, Rome, Italy).

Lectures: Quantum wells and superlattices - an overview. Fabrication of low-dimensional structures. Electronic structure (including many-body effects and band offsets). Electron transport. Phonons. Unconventional structures and materials. Quantum Hall effect. Optical properties. Theory of fluctuation surface states in metal-insulator-semiconductor structures. Spin effects and other recent developments in the fractional quantum Hall effect. Quantum Hall effect (theory). Quantum wires and quantum dots. Electrons in superlattices. Phonon emission, absorption and reflection from a two-dimensional electron gas. Band structure engineering (including heterojunction bipolar transistors and HEMTs). Electron transport in small systems. Weak localization (theory and experiments). Metallic superlattices. Tunneling. Quasi-one dimensional charge density wave systems. Infrared photoconductivity of 2D electron systems. Tunneling in asymmetric GaAs/AlAs double-barrier structures. Unusual magnetoresistance of quasi-2D semiconducting La_2CuO_4. Polaronic transport in quasi-2D semiconductors. Magnetic order of quasi-2D semiconducting La_2CuO_4. Magnetotransport and scattering experiments in heterostructures in the integer quantum Hall regime. Quantum transport in ultrasmall devices. Quantum adiabatic electron transport in ballistic conductors. Force balance equation: a contribution to understanding electron transport. The effects of spin orbit coupling on the Landau levels in the tilted magnetic field. The problem of the Green functions for the fractional quantum Hall effect. Two-dimensional electron crystals. Electron properties of low-dimensional organic conductors. Low-frequency dynamics of a 2D electron gas in strong magnetic fields. Collective excitations in 2D electron systems.

Unusual magnetoresistance of quasi-2D semiconducting La_2CuO_4. Polaronic transport in quasi-2D semiconductors.

Group Seminars: Intersubband transitions in 2D-systems. Comments on the theory of the integer quantum Hall effect. A new cheap commercial MBE system for research. Renormalized effective-mass in semiconductor barriers. Electronic structure and conduction properties of polymers. Impurity spectroscopy of 3D and 2D systems. Diffusive excitation energy transport in quasi-one-dimensional structures. Effect of finite temperature and Landau level broadening on the quantum Hall conductance. Exact diagonalization of one-electron Green function for a 2DEG in a magnetic field. Capacitance measuring technique as applied to heterojunction studies. A new method (ATM) to calculate the electron and hole subbands of semiconductor hetero-structures. Calculation of energy bands using quantum mechanical impedance. Transmission properties of 1D disordered systems. Calculation of energy bands using quantum mechanics impedance. Calculation of binding energies of excitonic molecules in spherical quantum wells. Self-consistent electronic structure of a quantum pillar. Growth of semiconductors with MBE. Magneto plasmons in a layered system. The properties and anomalous damping of edge magnetoplasmons in a bounded quantum Hall electronic system. Low temperature mobility in Si-Ge_xSi_{1-x}. Impurity centres in III-V compound semiconductors. Fluctuations and the IQHE. Coupling between intersubband and cyclotron modes in quantum wells with tilted valleys. Nonparabolic and nonisotopic 3D-electrons in a magnetic field. Deep level transient spectroscopy of Si doped with Pd centres. Electronic band-structure and excitonic effects in GaAs δ-doped n-i-p-i structures. Influences of a parallel magnetic field on localization of disordered 2D-electrons in $GaAs/Al_xGa_{1-x}As$ heterostructures. SQUID magnetic measurement of L.B.$MnSt_2$ films. Resonant Zener tunnelling in quantum wells. Effect of magnetic field on quantum tunnelling. Contact electrification of polymers by metals. a-Se/n-Si heterojunctions. Effect of inhomogeneity of an elastic medium

IQHE. Coupling between intersubband

on the phonon relaxation mechanism of 2D carriers. Constraints of the charge correlation function of 2D-quantum systems. Influence of the electron-phonon interaction on the coherent transport in mesoscopic systems. On the relevance of the Chern-Simons action for the description of the Q.H.E. Landau levels and cyclotron masses in $GaAs/Al_xGa_{1-x}As$ quantum wells. Time-dependent tunnelling in a transverse magnetic field. Determination of junction parameters of $GaAs/Al_xGa_{1-x}As$ heterojunction by IV and CV techniques. Application of resonant tunneling effects in future quantum functional devices. A MBE in-line slow positron beam defect analysing system. Electron transport phenomena in potential channel structures having discontinuities in lateral dimension. Charge carrier transport, recombination and trapping in Q1D conducting polymers. DX center in $Al_xGa_{1-x}As$ and GaAs. Probing of epitaxial layer interfaces by persistent photo-conductivity. Theory of Quantum Hall Effects in lattice systems. Free-carrier absorption in Q2D and Q1D electron gas. Time dependent quantum tunneling applied to semiconductor hetero-structures. Fabrication of 2D-$MnSt_2$ films. Laser and nonlinear optical parameters of Q.W. heterostructures.

The College was attended by 133 lecturers and participants (46 from developing countries).

Title: FIRST ICFA SCHOOL ON BEAM DYNAMICS AND [illegible] BEAM DYNAMICS AND ENGINEERING OF SYNCHROTRON LIGHT SOURCES, 7 - 18 May 1990.

Organizers: Profs. E. Keil (CERN, Geneva, Switzerland), A.W. Chao (SSC, Berkeley, USA) and M. Puglisi (Sincrotrone, Trieste, Italy), with the assistance of the ICFA Panel on Beam Dynamics, and in co-operation with the International Centre for Science (ICS, Trieste, Italy), the International Committee for Future Accelerators (ICFA) and the Sincrotrone Trieste (Trieste, Italy).

Lectures: Single particle dynamics. Synchrotron light. Introduction to Ms-DOS. Magnets. Collective effects. Ion trapping and ion clearing in Elettra. Radio frequency. Vacuum design. Vibration effects and orbit stabilization in synchrotron radiation sources. Compact courses. Insertion devices. Instrumentation and controls.

The School was attended by 60 lecturers and participants (2 from developing countries).

Title: COLLEGE ON RECENT DEVELOPMENTS AND APPLICATIONS IN MATHEMATICS AND COMPUTER SCIENCE, 7 May - 1 June 1990.

Organizers: Profs. R.F. Churchhouse (University of Cardiff, UK), V.K. Samaranayake (University of Colombo, Sri Lanka), K.T. Shah (University of Trieste and ICTP) and P. Zanella (CERN, Geneva, Switzerland).

Lectures: Colouring and Knot polynomials. Applied mathematics and the environment. Randomly- and uniformly- distributed point sets. Product integration rules. N-completeness and the travelling salesman problem. Fractals. Graph theory. Random number generators. Solving ordinary differential equations. Number theory. Graphics supercomputing. Desktop publishing. Parallel solution of ordinary differential equations. Computer network at ICTP. Software for geometrical computations. Hitting probabilities of DLA clusters. Julia sets. Burnside problems. Bounded rationality in repeated decision problems. Diophantine equations. Neural computing. Transportation problems. GO. Introduction to algebraic coding [illegible] GO. Introduction to algebraic coding theory. Algebraic coding theory, some recent developments. Algebraic computation. Multigrid methods. Continuous system simulation environment: modeller-PC. Bifurcations. Supercomputers. Generalized Boolean algebras. Mathematical models for SP well loggins. Hausdorff-Kuratowski hierarchy of w-regular languages. Design of integrated geographic informative systems. Graph theory (calculation of chromatic polynomials).

The College was attended by 87 lecturers and participants (25 from developing countries).

Title: COLLEGE ON ATMOSPHERIC BOUNDARY LAYER PHYSICS: I - MODELLING OF THE ATMOSPHERIC FLOW FIELDS, 21 May - 1 June 1990.

Organizers: Profs. A. Barros (University of Buenos Aires, Argentina), D.P. Lalas (Wayne State University, Detroit, USA) and C.F. Ratto (University of Genoa, Italy). Local co-ordinator: Prof. G. Furlan (University of Trieste and ICTP). Co-sponsorship of the International Centre for Science (ICS, Trieste, Italy), Direzione Generale per la Cooperazione allo Sviluppo (Ministry of Foreign Affairs, Rome, Italy) and Kuwait Foundation for the Advancement of Sciences.

Lectures: Introduction to the ABL structure and concepts. Introduction to wind turbine siting. Modelling the vertical ABL structure. Turbulence in the ABL. Diurnal variation of the ABL and horizontal non-homogeneous ABL. Response of neutral boundary layer to change of roughness. Wind turbine siting. ABL numerical models. ABL in-situ ground based measurements. Measures and evaluations of ABL parameters. ABL measurements aloft. Flow driven by surface differential heating. Introduction to mesoscale models and their use. The UB/NMC model. Flow driven by surface differential heating. Estimation of wind energy potential. Wind field reconstruction techniques. Evolution of mass-consistent models: from NOABL to AIOLOS and WINDS. Limited area atmospheric flow modelling. Coupling a mass-consistent model with a non-[illegible] mass-consistent model with a non-stationary one-dimensional model. Lagrangian modelling of pollution. WINDS. A mass-consistent model coupled with a one-dimensional model. The Jackson-Hunt Theory. An introduction to MS-Micro/2: its structure and use. Wakes. Statistical analysis of extreme wind speeds. An introduction to AVENUE: its structure and use. AVENUE. Engineering applications of statistical analysis of wind data bases. An introduction to the WASP model: its structure and use. WASP.

The first part of the College was attended by 99 lecturers and participants

(31 from developing countries).

Title: COLLEGE ON ATMOSPHERIC BOUNDARY LAYER PHYSICS: II - AIR POLLUTION MODELLING FOR ENVIRONMENTAL IMPACT ASSESSMENT, 4 - 15 June 1990.

Organizers: Profs. A. Mancini (University of Catania, Italy), M.P. Singh (Indian Institute of Technology, Delhi, India) and Dr. T. Tirabassi (FISBAT-CNR, Bologna, Italy). Local co-ordinator: Prof. G. Furlan (University of Trieste and ICTP). Co-sponsorship of the International Centre for Science (ICS, Trieste, Italy), Direzione Generale per la Cooperazione allo Sviluppo (Ministry of Foreign Affairs, Rome, Italy) and Kuwait Foundation for the Advancement of Sciences.

Lectures: Dispersion in the atmospheric boundary layer. Concentrations, fluctuations in the atmosphere. The European Space Agency's programmes for observing the earth and its environment. The estimation of air pollution diffusion. The removal of particulate matter from the atmosphere. Air pollution probability density function. Pollution meteorology and atmospheric removal processes. An overview of air pollution modelling. Dispersion and deposition into the atmosphere — a case study: the Chernobyl accident. Use of convective scaling models to calculate dispersion from tall stacks in urban areas. Stochastic models for real-time forecast and control of air pollution episodes. Modelling the transport and diffusion of pollutants using puff models. Particle diffusion models. Application of puff models to emergency preparedness systems at EDF. Diffusion from continuous sources near the ground: similarity theory of the convective boundary layer. Modelling of accidental releases, of hazardous materials, relevant physical process: laboratory and field experiment. Diffusion from continuous sources near the ground: similarity theory of the atmospheric surface layer. Atmospheric dispersion modelling in planning and management: an overview. Diffusion of puffs near the ground: general framework and vertical diffusion. Modelling of accidental releases, of hazardous materials: source-term models. Diffusion of puffs near the ground: similarity theory for the influence of windshear on horizontal diffusion. Modelling of accidental releases, of hazardous materials: atmospheric dispersion models for neutrally and negatively buoyant materials. Long-range models evaluation using Chernobyl data. An easy way to use an analytical air pollution model. Theoretical background of acoustic and electromagnetic remote sensing of the atmosphere. The DIMULA diffusion model. Applications of atmospheric remote sensing techniques to air pollution and environment quality assessment. Monitoring stations for air quality control. Dispersion model for toxic and inflammable chemicals: some case studies. Operational atmospheric dispersion models.

The second part of the College was attended by 98 lecturers and participants (35 from developing countries).

Title: MINIWORKSHOP ON QUANTUM CHAOS, 4 June - 6 July 1990.

Organizers: Profs. G. Casati (University of Milan, Italy), H.A. Cerdeira (UNICAMP, Campinas, Brazil, and ICTP) and R. Ramaswamy (Jawaharial Nehru University, New Delhi, India).

Lectures: Resonances from periodic orbits. Self-similarity in quantum dynamics—a quantum KAM theory. Localization phenomena in the vibrational dynamics of small polyatomic molecules. Excited hydrogen atoms: properties, production and behaviour in a static electric field. Anderson localization. Classical structures in the quantized Baker transformation. Semiclassical theory of strongly perturbed Coulomb systems. Proposed experiments in the context of quantum chaos. Far-infrared photovoltaic effects in AlGaAs heterostructures: progress towards new experiments in quantum chaos. Semiclassical quantization: methods and applications. Phase space quantum (semiclassical) mechanics. Hydrogen and other Rydberg atoms in strong low- and mid-frequency electric fields. Time-dependent systems. Quantum chaos: statistical relaxation in discrete spectrum. Some topics from random matrices. The classical/quantum correspondence for few-electron systems: the helium atom revisited. Quantization of localized chaos. Dissipative quantum systems. Irreversibility, dissipation and quantum chaos. Semiclassical quantization of multi-dimensional systems. Wave chaos in singular quantum billiard. The configurational quantum cat map. Circular ensembles and quantum chaos. Some studies on the coupled quartic oscillators. Quantum theory of single events. Phase space structure of multidimensional systems: bottlenecks and transport. Hydrogen atoms in strong high-frequency fields. Selberg trace formulae. Random-matrix models for fluctuations in microscopic and mesoscopic systems. Numerical methods. Quantization of maps. Classical and quantum chaotic scattering. Classical mixing and quantum level statistics. Are GOE fluctuations intimations of classical chaos? Quantum measurement theory and experiments.

The Miniworkshop was attended by 95 lecturers and participants (18 from developing countries).

Title: ADRIATICO RESEARCH CONFERENCE ON QUANTUM CHAOS, 5 - 8 June 1990.

Organizing Committee: Profs. S. Lundqvist (Chairperson, Chalmers University of Technology, Göteborg, Sweden, and ICTP), H.A. Cerdeira (Chairperson, UNICAMP, Campinas, Brazil, and ICTP), A. Levi (International School for Advanced Studies, SISSA, Trieste, Italy), E. Tosatti (International School for Advanced Studies, SISSA, Trieste, Italy), M.P. Tosi (University of Trieste, Italy) and Yu Lu (Academia Sinica, Beijing, P.R. China, and ICTP).

Course Directors: Profs. G. Casati (University of Milan, Italy), H.A. Cerdeira (UNICAMP, Campinas, Brazil, and ICTP) and M.C. Gutzwiller (IBM Thomas J. Watson Research Center, Yorktown Heights, USA).

Co-sponsorship of IBM-Italy and the International School for Advanced Studies (SISSA, Trieste, Italy).

Lectures: Quantum chaos: fact or fiction? A rule for quantizing chaos?

Excited hydrogen atoms in strong microwave fields: experiments vs. theories. Recent advances in the semiclassical theory of chaotic systems. Bound, quasi-bound, and resonant quantum states: statistics and parametric motion. New aspects of quantum chaos. Quantum remnants of periodic orbits in the ergodic region of the kicked rotor. Rydberg atoms in external magnetic, electric and microwave fields. Quasi energy Eigen values and Eigenfunctions of a series of time periodic Hamiltonians. Indicators of quantum chaos based on Eigenvector statistics. Separatrix states in the kicked quantum rotor. Riemann's zeta-function and the semiclassical theory of spectral rigidity. Quantum signature of a family of periodic orbit in a Hamiltonian system. On the dequantization map. The auto-correlation function—an indicator of quantum chaos. Quantum effects in chaotic Josephson junctions. Resonances from periodic orbits. Fluctuations in the hydrogen in microwave system. From localization to delocalization. Effect of noise on Hamiltonian systems with 1.5 degrees of freedom. Chaos in ion-solid-interactions. Quantum chaos in the IBFM and IBFFM nuclear models. Quantum deformation of the Arnold cat map as a K-system. Maslov indices and periodic orbits. Deformed GOE for systems with a few degrees of freedom in the chaotic regime. Random dynamics in the quantized shifted standard map. Stability of quantum motion in regular and chaotic states. Dyson's Coulomb gas model as a rigorous consequence of level dynamics. Molecular spectra and random matrix theory. Semiclassical structures of trace formulas. Irregular time-dependant scattering of electrons: cross-sections.

The Conference was attended by 57 lecturers and participants (6 from developing countries).

Title: TRIESTE CONFERENCE ON TOPOLOGICAL METHODS IN QUANTUM FIELD THEORY, 11 - 15 June 1990.

Organizers: Profs. W. Nahm (Physikalische Institut, Bonn, Federal Republic of Germany), S. Randjbar-Daemi (Iran/ICTP) and E. Witten (Princeton University, USA).

Lectures: The self-dual Yang-Mills equations and its descendants. Exact solutions to models of two-dimensional quantum gravity. Introduction to quantum field theory associated with moduli problems. Covariant W-gravity. On the loop equation in 2d gravity. On stable bundles and the formula of E. Verlinde. Exact solutions to models of two-dimensional quantum gravity. Modular invariance in conformal QFT2. The modular geometry of 2D gravity. Geometrical aspects of quantum field theory. Exact solutions to models of two-dimensional quantum gravity. Solving the strongly coupled 2D gravity in the conformal gauge. Solvable lattice models. The critical exponent for strings in dimension 0. A connection between 2D gravity and 4D topological quantum gravity. Universal W-algebras in quantum field theory. Strings in less than one dimension and KdV flows. Attempt to understand anomalies intuitively. Statistics in three-dimensional QFT and connections with quantum group theory. Integrability and conformal invariance. Strings in critical dimensions.

The Conference was attended by 155 lecturers and participants (17 from developing countries).

Spring college in condensed matter on: Physics of low-dimensional semiconductor structures, 23 April - 15 June 1990.

College on recent developments and applications in mathematics and computer science, 7 May - 1 June 1990.

Activities at ICTP in 1990-91

1990	
Adriatico Research Conference on Quantum fluctuations in mesoscopic and macroscopic systems	3 - 6 July
Adriatico Research Conference on "Physics of strongly correlated systems"	10 - 13 July
Symposium on Frontiers in condensed matter physics	11 - 13 August
Adriatico Research Conference on Defects in HCP crystals	14 - 17 August
6th Trieste IUPAP Semiconductor Symposium on "Hydrogen and semiconductors: Bulk and surface properties"	27 - 31 August
Working party on electrochemistry - Condensed matter aspects	27 August - 7 September
International conference on medical physics	3 - 7 September
College on medical physics	10 - 28 September
School on qualitative aspects and applications of nonlinear evolution equations	10 September - 5 October
College on neurophysics: "Neural correlates of behaviour, development, plasticity and memory"	1 - 19 October
College on "The design of real time control systems"	1 - 26 October
Workshop on atmospheric limited area modelling	15 October - 3 November
Third autumn course on mathematical ecology	29 October - 16 November
Workshop on earthquake sources and regional lithospheric structures from seismic wave data	19 - 30 November
Workshop on composite materials	26 November - 7 December
Experimental workshop on high-temperature superconductors and related materials (advanced activities)	26 November - 14 December
First International School on Computer network analysis and management	3 - 14 December
1991	
Second college on theoretical and experimental radiopropagation physics	7 January - 1 February
Fifth international workshop on computational condensed matter physics	16 - 18 January
Winter college on "Multilevel techniques in computational physics (Physics and computations with multiple scales of lengths)	21 January - 1 February
Second training college on physics and characterization of laser and optical fibres	21 January - 15 February
Second ICTP-INFN course on basic VLSI design techniques	4 February - 1 March

Experimental workshop on high temperature superconductors and related materials (basic activities)	11 February - 1 March
Winter college on ultrafast phenomena	18 February - 8 March
Workshop on mathematical physics and geometry	4 - 15 March
ICTP-WMO international technical conference on long-range weather forecasting research	8 - 12 April
Spring school and workshop on superstrings	8 - 19 April
Course on "Oceanography of semienclosed seas"	15 April - 4 May
Fifth workshop on perspectives in nuclear physics at intermediate energies	6 - 10 May
Spring college in materials science on "Nucleation, growth and segregation in materials science and engineering"	6 May - 7 June
Interface of high energy and condensed matter physics (joint conference with condensed matter group)	13 - 17 May
Third ICFA school on instrumentation in elementary particle physics	13 - 31 May
Structural and phase stability of alloys (Adriatico Research Conference)	21 - 24 May
Spring school on plasma physics	27 May - 21 June
Second school on non-accelerator particle astrophysics	3 - 14 June
Working party on initiation and growth of cracks in materials	3 - 14 June
Working party on simulation of materials degradation	3 - 14 June
Physics of inhomogeneous materials (Adriatico Research Conference)	11 - 14 June
Miniworkshop on nonlinearity: fractals, pattern formation	11 June - 5 July
Topics in quantum field theory and applications	17 June - 5 July
Research workshop in condensed matter, atomic and molecular physics	17 June - 27 September
Summer school in high energy physics and cosmology	24 June - 26 July
International conference on complex systems: fractals, spin glasses and neural networks	2 - 6 July
Miniworkshop on strongly correlated electron systems	8 July - 2 August
Strongly correlated electron systems (Adriatico Research Conference)	16 - 19 July
Course on functional integration and its applications	19 - 30 August
College on singularity theory	19 August - 6 September
Working party in condensed matter	2 - 13 September
Workshop on materials science and physics of non-conventional energy sources	2 - 20 September
Functional integration and its applications (Adriatico Research Conference)	3 - 6 September
School on dynamical systems	9 - 27 September
Sixth college on microprocessors: technology and applications in physics	23 September - 25 October
Conference on recent developments in the phenomenology of particle physics	30 September - 4 October
Workshop on soil physics	30 September - 25 October
Workshop on upper-medium-lower atmosphere	October-November
Workshop on stochastic and deterministic models	7 - 11 October
Second international workshop on radon monitoring in radioprotection and earth science	7 - 18 October
Training college on the applications of synchrotron radiation	14 October - 8 November
Workshop on climate and global change	28 October - 1 November
Third workshop on telematics	28 October - 15 November
Workshop on climate and global change	28 October - 1 November
Third workshop on telematics	28 October - 15 November
Experimental workshop on high temperature superconductors and related materials (advanced activities)	4.– 22 November
Remote sensing applications in earth sciences	11 November - 6 December
School on materials for electronics: growth, properties, and applications	18 November - 6 December
Workshop on non-linear dynamics and earthquake prediction	25 November - 13 December

For information and applications to courses, kindly write to the Scientific Programme Office.

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EDITORIAL NOTE - *News from ICTP* is not an official document of the International Centre for Theoretical Physics. Its purpose is to keep scientists informed on past and future activities at the Centre and initiatives in their home countries. Suggestions and criticisms should be addressed to Dr. A.M. Hamende, Scientific Information Officer.