PHYSICS IN POLAND

More By Reason Than By Force

Jozef Spalek from the Institute of Physics, Jagiellonian University, Cracow, places the evolution of physics in Poland in perspective.

The Assembly Hall of Jagiellonian University's Collegium Maius.

A MODEST HISTORY

Compared to the Polish school of mathematics, associated with the names such as W. Sierpiński, S. Banach, K. Kuratowski, S. Ulam, S. Lukasiewicz, A. Tarski, and H. Steinhaus, our achievements in physics are much more modest. This is so even though the tradition of science had its roots in the liberal arts when the Cracow Academy (now the Jagiellonian University) was established in 1364 by Casimir the Great. This is where Nicolas Copernicus studied in 1491-5 (but never graduated), and where air was liquefied in 1883 for the first time by Wróblewski and Olszewski.

The history of Polish science in the 19th and early 20th centuries reflects our tragic history for during this period one had to be abroad to carry out science successfully. The period is highlighted by Marie Curie (who always signed her name as Maria Sklodowska-Curie), and by Marian Smoluchowski, the main champion of atomic theory after the death of his mentor, Ludwig Boltzmann, and a creator of Brownian motion theory which is in some ways more general than Einstein's theory. We can also add Wojciech Rubmowicz, who discovered selection rules in optical transitions within the Bohr-Sommerfeld theory of the atom.

The post-World War II period is essentially marked by people who were both scientists and organizers of our scientific structures, notably:

– Leopold Infeld, first Director of the Institute of Theoretical Physics at Warsaw University, whose work with Albert Einstein gave rise to Born-Infeld non-linear electrodynamics and co-authorship of the much-appreciated book *Evolution of Physics*;

– Marian Miesowicz who discovered liquid crystals while working for his habilitation in the 1930s at the Academy of Mining and Metallurgy in Cracow;

– Wlodzimierz Trzebiatowski, the organizer of the Institute of Low Temperatures and Structural Research in Wroclaw, who led the first group to study magnetism in actinides.

Among others who also helped reorganize and redirect physics from the ground up after World War II one should mention Marian Danysz and Jerzy Pniewski, from Warsaw University, who discovered nuclei with hyperons and then helped to establish the Nuclear Research Centre in Otwock near Warsaw. Organization of the Institute of Nuclear Physics in Cracow was carried out by Jerzy Niewodniczański, a Professor at Jagiellonian University and the discoverer of forbidden optical transitions in the spectra of stars. The famous "Warsaw school" of semiconductor physics owes its existence principally to Leonard Sosnowki, Professor at Warsaw University and the organizer of Warsaw's Institute of Physics of the Polish Academy of Sciences.

Several conclusions can be drawn from the history of the post-war period. First, Polish physics was brought back to life. However, an emphasis on nuclear research, motivated more by ideology than anything else, overshadowed the development of "small" physics involving, for example, condensed matter and quantum optics and biophysics and medical physics, in particular. The second factor which haunts us now was the relaxation of strict selection standards when promoting young people. Their absence often led to a suppression of diversity in border areas through the predominance of large projects that were sometimes created solely to ensure the survival of large, specialized institutes.

AN EVOLVING COMMUNITY

The physics community comprises more than 35000 people (of which only half are now active) in a nation of 38 million inhabitants (the ratio is about half that for the Federal Republic of Germany before unification). Some 75% are school teachers, about 13% scientists, and fewer than 10% are in industry and the research institutes attached to ministries. By comparison, about 50% of physicists in the USA and Germany work in industry or in industry-related research. However, numbers are changing drastically because many young physicists are entering the computer business or being employed as specialists in a vast programme of computerization involving banks, insurance companies, hotels, travel

Major Classical Universities and Polytechniques

Place	Institution	Physics institute	Staff *
Katowice	Silesian Univ.	Institute of Physics	71
Cracow	University of Mining & Metallurgy	Faculty of Physics & Nuclear Techniques	96
	Jagiellonian Univ.	Institute of Physics	176
		Astronomical Observatory	22
Lódź	Lódź Univ.	Divisions of Physics	79
	Lódź Polytechnic	Institute of Physics	64
Lublin	Marie Curie-Sklodowska Univ.	Institute of Physics	76
Poznań	A. Mickiewicz Univ.	Institute of Physics	177
Toruń	Nicholas Copernicus Univ.	Institute of Physics	88
Warsaw	Warsaw Polytechnic	Institute of Physics	86
	Warsaw Univ.	Institute of Experimental Physics	124
		Institute of Theoretical Physics	57
		Astronomical Observatory	14
		Institute of Geophysics	15
		Division of Mathematical Methods	15
		Heavy-Ion Laboratory	20
Wroclaw	Wroclaw Polytechnic	Institute of Physics	98
	Wroclaw Univ.	Institute of Experimental Physics	55
		Institute of Theoretical Physics	44
		Astronomical Institute	19

Poland has 11 classical universities,19 polytechniques, 8 pedagogical universities, and 10 universities of agriculture that teach physics. * Academic staff (1992/3)

Major Research Institutes in Physics

Place	Affiliation	Institute	Scientific staff *
Cracow	NAEA	Institute of Nuclear Physics	256
Poznań	PAS	Institute of Molecular Physics	78
Warsaw	PAS	Institute of Physics	160
	NAEA	Institute of Nuclear Chemistry & Technology	98
	ministry	Institute of Electronic Materials Technology	103
	ministry	Institute of Electronic Technology	86
	PAS	Space Research Centre	50
	PAS	Astronomical Centre	49
	PAS	High Pressure Research Centre	40
	ministry	Institute of Plasma Synthesis & Microsynthesis	35
	ministry	Institute of Applied Optics	21
Warsaw-Otwock	NAEA	Institute of Atomic Energy	193
	NAEA	Institute of Nuclear Studies	176
Wroclaw	PAS	Institute of Low Temperature & Structural Studies	123

NAEA: National Atomic Energy Agency; PAS: Polish Academy of Sciences. * Total scientific staff (1992/3)

Jagiellonian University's Institute of Physics.

agencies, *etc.* (where they usually earn much more than full professors at the best universities).

The economic situation naturally affects the physics community. Newly formed enterprises appear at a remarkable rate, but almost all are launched in the anticipation of quick profits, that is, without any strategic planning, particularly in R&D. Life seems very disturbing, especially if one considers Poland's technological future. However, 45 years of neglect shows up acutely and there is no way to create a sound, long-term technological (and scientific) policy when the fundamental structures in banking, telecommunications and the like are missing, and where the work force is highly demoralised. The government's priority is the essential transformation of the production sector for without an efficient economy, health, education and social security are doomed; the need for an unavoidable austerity for the rest of the century is largely ignored by the public at large.

A SOUND EDUCATION SYSTEM

Physics can be studied at the 5-year MSc level at 10 classical universities, 7 technical universities (polytechnics educating mainly technical physicists), and in a few pedagogical universities (mainly involved in the training of future school teachers). PhDs are awarded at several research institutes and universities (see list) either by pursuing graduate studies or through research while on a teaching assistantship for a maximum of 8 years. In the late-1980s, about 1000 students received master's degrees in physics each year and some 20% went on to receive a PhD (this is a factor of 2-3 times less than in the USA, Germany and France). Over the last few years, student numbers have fluctuated strongly, but the general trend is positive.

Undergraduate education in physics is concentrated mainly at the classical universities (which have no engineering schools). The first three years comprise general education involving 240 hours of mathematical analysis, 240 hours of general physics, 2 semesters of information theory, 1 semester of classical electrodynamics, atomic physics, and introductory wave mechanics, 2 semesters of classical mechanics, and 1st and 2nd year student labs. The remaining two years (4 semesters) are devoted to advanced and specialized courses. Undergraduate studies end with the master's thesis and the MSc degree. From my own experience in Poland, the UK, and the USA, I would say that our best universities (Warsaw and Cracow) offer comparable, and maybe even more advanced, undergraduate programmes than elsewhere.

Poland's basic educational system is largely based on pre-war values. By this I mean that the main emphasis is placed on formal skills in mathematics and on the theoretical consistency of given system of thought, *i.e.*, on sophistication factors. Much less effort is directed towards intuitive model building and the invention or ingenuity needed in solving problems. The system used to be a defense against the political invasion of our minds, and is expressed beautifully by the moto of Alma Mater Jagiellonicae: *"Plus ratio quam vis"* (more by reason than by force). As we gain confidence in our freedom we have to become more adaptable in an ever-changing society.

We are probably behind in developing in our students the proper physical intuition, although this is also true of most French, German and Italian universities. The development of an intuitive feeling for physics and of model building of our world requires a top-notch creative education and teachers of the highest quality. Such an education in creative thinking is built over generations, but we lack the necessary continuity since pre-technological thinking still flourishes through a rapidly strengthening trend towards a traditional upbringing. Research and academic physicists through well-established contacts with North America and the rest of Europe represent the *avant garde* in transforming our research and education systems.

Finally, some general remarks. The most prosperous societies of the future will be those with the majority of people properly educated in an interdisciplinary manner. The division into physics, chemistry, biology and even psychology may become obsolete

Jozef Spalek, on the left, with M.D. Mateev.

as the solving of complicated problems will involve all these disciplines to obtain holistic answers. For instance, is the brain merely an information system? Or is it a collective physical system, that reveals itself in an epileptic attack?

Physics is not only a strategically important discipline but also part of our culture, provided one can afford it. Its impact on technology in Poland is very limited today because we lack the link to industry (although the situation is changing, albeit slowly). On the other hand, if our advanced education system breaks down, the country will be reduced to providing physical labour to the affluent world. Help is needed to enhance links to industry as it was given to individuals for many years so that the best people could be promoted by cooperation schemes to create a self-sustaining mass of human excellence. Individually, as scientists, we would like to acknowledge the help and cooperation we received for all those years from colleagues abroad. We cannot afford loosing them now in this decade of our first-order transition.

This text is taken from *Physik in Polen – Herausforderung und Chance* published in *Phys. Bl.* **49** (1993) No. 6.

POLISH PHYSICAL SOCIETY

The Polish Physical Society, founded in 1919, operates from a Secretariat based at Warsaw University's Institute of Physics. It has some 1800 members; 13% teach physics in schools while the rest are mostly university academics and research scientists in institutes. Professors pay 80 kPZL (about 3.5 ECU) in fees, research scientists and teachers 40 kPZL, and students 20 kPZL. There are sections for teachers and optical physics and 18 branches. The Society's executive arm, called the Main Board, has 11 members with the Presidency generally alternating between universities and the institutes (Professor Henryk Szymczak, Director of the Institute of Physics of the Polish Academy of Sciences, is currently the President). The Society used to receive the bulk of its funding from the Polish Academy of Sciences at a time when membership numbered 3000-4000 (2500 in universities, 1200-1400 in institutes, and a few in industry). Support now also comes *via* grants from the Committee for Scientific Research (the KBN) for meetings and publishing activities. The latter include:
– *Acta Physica Polonica A & B* (original articles, monthly);
– *Reports on Mathematical Physics* (original articles, bimonthly);
– *Advances in Physics* (popular 30-40 page quarterly of reviews & news in Polish sent to members);
– *Delta* (popular 20-page bimonthly for school teachers and students in Polish edited by the physical, mathematical and astronomical societies).

Acta Physica Polonica now has 500-600 subscribers, down from 700-800 when the former Soviet Union took 150 subscriptions (something needs to be done about the sharp reduction in the number of exchanges). Unlike other scientific journals in the region, there is no marketing agreement with a western publisher (which tends to raise overseas cover prices considerably), but conference proceedings are published to maintain income as they can be produced to international standards and distributed for only ECU 6.3-7.2 per issue. The Editor aims to ensure that proceedings will not exceed the space assigned to original articles in all branches of physics, where the rejection rate is a stiff 30%.

The Society oriented its biennial general conference away from research to physics teachers a few years ago. The 500 or so participants hear plenary lecturers, display posters and attend an exhibition. The Society also helps organize several scientific meetings and schools (see p. 59) and arranges grants for students to attend international conferences, the funds coming from supporting institutions. A section to promote science in the media is being created.