Chapter 8
Physics at the University of Oriente

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8.1 Introduction

This chapter will complement the information given in the previous chapter by Baracca, Fajer and Ródriguez on the development of physics in Cuba from 1959 to the present. Attention will focus here on the onset and development of physics teaching and research carried out at the University of Oriente, located in Santiago de Cuba, generally regarded as the second most important city of the country from an economical, social and cultural point of view. Its Physics School was formally established in 1970, replacing the physics chair that has existed since the founding of the university in 1947.

8.2 Initial Steps (1947–1961)

The inauguration of the University of Oriente on 10 October 1947 was reported in the Cuban press as "a transcendental event in the history of Cuban education […] with a most promising start […]" (*Diario de Cuba* 1947). Its foundation took place after countless efforts over two decades by various independent social organizations, made up of professionals, traders and industrialists with a long-term vision for development, in particular the Society for Higher Education in Oriente and the

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Executive Council for the University of Oriente, one of whose most active members was the prestigious physics teacher, Roberto Soto del Rey (1913–1995). The establishment of the new institution was especially welcomed by the lower income middle class families of the former province of Oriente, since it gave their offspring the chance to access higher education, something that was beyond their means when their sole option before 1947 was the University of Havana. The local socioeconomic and historical context as well as the popular backing and energy of the new educational center added to the fact that its original staff included several well-known Spanish intellectuals exiled in Cuba after their involvement in the Spanish Civil War on the Republican side made the University of Oriente a popular and progressive institution.

It may be said that upon its foundation, the university incorporated the best of the national pedagogical tradition, as expressed by the eminent Spanish-born professor, Francisco Prat, in an interview with a local newspaper (*Sierra Maestra* 1982). According to him, "The University of Oriente was born with the purpose of renewing teaching in Cuba."

From the very beginning, the Engineering Faculty at the university offered a degree course in industrial chemical engineering, which included higher physics in its study plan for its first course. This subject was taught by Roberto Soto del Rey, who became the founding head of the first physics chair (Consejo Directivo de la UO 1947).

The working style of the university's newly created physics chair echoed the basic principles put forward by the best of the Cuban pedagogical tradition developed between the final decade of the eighteenth century and the first third of the nineteenth century. It was inspired by the Cuban philosopher and teacher, Father José Agustín Caballero, who fought for "the teaching in Cuba of Copernican Physics and that of the Englishman Newton; he wanted experimental and applied physics as a support for young people to help national development" (Augustín Caballero et al. 1944). Inspiration came also from Caballero's disciple, priest and philosopher Félix Varela, whose confidence in the principle that "knowledge can be arrived at from experience and reason, led him to inaugurate [in Cuba] the teaching of physics and chemistry through laboratory experiments" (*Granma* 1997). All this supports the assertion by Spanish-born professor Francisco Prat that "the University of Oriente was born with the purpose of renewing teaching in Cuba" (*Sierra Maestra* 1982).

Soto del Rey was a faithful follower of the above ideas, especially those propounded by Varela about "experience and reason," and had always been a devout follower of Cartesian rationalism and Galilean experimentalism. At the university, he pioneered activities aimed at establishing international contacts with prestigious scientific and academic institutions. He was the first professor at the university to benefit from sabbatical years in the early 1950s,[1] which he spent at the Sorbonne

[1] According to a letter to Soto del Rey, dated 26 February l952 and signed by Ernesto Pujals Fernández, Secretary General of the University of Oriente, the University Board had decided on 30 January "to send two professors abroad every year to carry out special graduate studies" and chose him to be "the first one to enjoy the benefit of this decision."

and other European centers of higher education in search of a deeper understanding of relativity and quantum theories, statistical physics and tensor calculus. At the same time, he managed to have close social contact with local professionals, businessmen and industrialists who kept him informed of current technological and economical developments. He also profited from having been a student of Manuel Gran, his outstanding physics teacher at the University of Havana where he had done a degree course in physical-mathematical sciences from 1934 to 1939.

Soon after the creation of the university, Soto del Rey began to set up the first undergraduate physics laboratories, while in other university areas a well-stocked mechanical workshop and pilot plant were set up to help provide the students with solid practical training. According to Prat, they would "try to make the university a technological center dedicated to applied sciences, since right from the beginning emphasis was placed on chemical engineering studies, with the set up of the laboratories as soon as a budget was available" (*Sierra Maestra* 1982).

In 1951, a project was drawn up for the organization of the School of Sciences and the degree courses in the natural sciences and chemical physics within the Faculty of Sciences and Engineering. In 1956, the School of Sciences was changed into the Faculty of Natural Sciences which offered, among other degree courses, one in physical-mathematical sciences and another in chemical-physical sciences. These attracted very few students, to the extent that the only student to enroll in the former, transferred to the latter in her third course.

As far as the undergraduate courses in engineering and the sciences were concerned, this was a stage of definition and establishment of the institution's characteristic pedagogical approach. The sciences were given an applied profile, to the extent that the idea arose to offer a degree course in industrial physics, similar to the one on industrial chemistry—including industrial research—that already existed at the university. While this idea did not come to fruition, the movement—led by Soto del Rey—to avoid privatization of the university did succeed.[2]

8.3 The Period 1961–1967

Soon after the Cuban Revolution in 1959, Soto del Rey became active in implementing an in-depth curricular and organizational reform of the university, firstly as a member of the Statutory Assembly that was created at his educational center, and later as a representative of the university in the National Council of Universities created by the new government. During the early 1960s, he exchanged ideas and proposals with his Italian counterparts, and at the same time initiated official contact with Soviet educational authorities to promote collaboration for the development of

[2] Soto del Rey resigned from the staff and the Board of Directors of the university in protest of the approval of a proposal to privatize the university presented by the Rector to the Board on February 1, 1948. His tough critical stance strengthened the strong movement against privatizing, which was finally defeated.

national scientific activities. He visited the Soviet Union, Poland, Bulgaria and other Eastern European countries with the goal to obtain technical and scientific support from their higher education institutions (Soto 2000, 33).

Needless to say, an academic entity begins to achieve its characteristic personality when it is not absolutely dependent on externally generated knowledge and its carriers (curriculums, textbooks, equipment, etc.), and arrives at a stage in which it can generate these so that it can contribute, however modestly, to the preservation and generation of culture. In line with this ideal, a textbook entitled "Surface Tension and Liquid Solutions," was produced by Soto del Rey and Luis Aguilar Salcedo. "With this work—they stated in their prologue—the Physics Department begins publication of the physics course taught to engineering students at the Universidad de Oriente" (Soto del Rey and Aguilar Salcedo 1961, 1). It was followed by successive volumes on mechanics, hydrodynamics and wave motion.

The above-mentioned work bore witness to the particular personality of the university's Physics Department. They were purposely written so that the exposition of a new subject started with short paragraphs, apparently isolated from one another. These were followed by higher level texts that finally became book chapters where the most general approaches were dealt with. The style of writing was terse, giving just the information required for a clear grasp of fundamental concepts. This was characteristic of Soto del Rey's teaching style, which combined rationality with synthesis and began with a description of his many experiences whose results were generalized to arrive at theoretical conclusions through rigorous mathematics, while always striving to point out any practical applications derived from general principles that came up in the process.

At the time, the staff of the Physics Department was strongly linked to the teaching of high school physics, despite the requirements of their regular duties at the university. Soto del Rey and Aguilar were active physics teachers at the Santiago de Cuba secondary education institute, which enabled them to exert considerable influence on the rest of its teaching staff and on the mass of its high school students.

Soto del Rey had a strong belief in the motivational and cultural impact of the history of science on the training of students. A permanent exhibition of old instruments and equipment on the premises of the Physics Department and a mini portrait gallery of famous physicists along the corridor leading to the laboratories, helped Soto del Rey to create an intellectual atmosphere that was attractive to both students and visitors.

At this stage, sight was not lost of the understanding that scientific research combined with international academic exchange were essential to the progress of higher educational institutions. Accordingly, in May 1962, the Dean of the Faculty of Sciences, José Fernández Bertrán, paid a visit to East Germany and signed a collaboration agreement with Dresden Technical University (Treaty 1962). He also reported the results of his search for further collaboration possibilities with various Italian institutions and physicists in nuclear and solid state physics, and remarked that this "might contribute to the planning of physical research in Cuba" (Fernández Bertrán 1962).

Following Fernández Bertrán's visit to Italy, two Italian specialists arrived at the university: the nuclear physicist Piero Basso and Mario Chirco, an electrical engineer with a good command of physics and mathematics, who stayed several years in Santiago de Cuba.

The Mathematics and Physics Departments were organically incorporated into the Basic School for Technology and Sciences, created in 1966. In addition to its regular staff, the Physics Department at times counted on the temporary collaboration of qualified teachers, like Suárez Soto and Olivares, and the Salvadorian, Ricardo Arrieta Salazar, who had come from California and upon his return trip to the United States, met a tragic fate at the hands of the Salvadorian dictatorship of the time.

8.4 The Physics School at the University of Oriente

8.4.1 Formation of the School (1967–1970)

Since 1965, two commissions had been created at the university to analyze the best ways to train physicists and mathematicians and to solve teaching problems at the institution. These were led by Luis Oliva and Miguel Matute, respectively.[3] However, they did not prosper because at the time it was thought that the University of Havana was capable of training all the physicists and mathematicians needed by the country. In conversations with F.D. Kochanov, a Soviet specialist who was working as a consultant on the teaching of general physics at the University of Havana, it was agreed that apart from elaborating proposals for the best possible teaching methods in physics, it was important for the development of the country to promote a closer link between physics and industry, especially mining and some other industries. This led to the creation of a degree course in physical engineering within the Faculty of Technology, in which printed matter elaborated by Kochanov dealing with industrial applications and possibilities of physical science were used as text and guidance material and contributed to the consolidation of a favorable environment for the further development of physics at the university.

In 1967–1968, Jorge González Alonso and Homero Fuentes González (who had obtained their physics degrees at a German institute of higher education and at the University of Havana, respectively) joined the staff of the Physics Department, which was then under great strain because of the insufficient number of teachers taking care of the relatively large number of undergraduate physics students (González and Fuentes 1968). The staff members had little time to engage in research projects, and to take or give graduate courses. This state of affairs became increasingly acute because of the sudden increase of students in engineering, agricultural, medical and pedagogical degree courses. To provide an emergency

[3] Interviews undertaken by Miguel Matute and Ramón Pomés.

solution to this problem in the absence of previously organized degree courses for the specialized training of physicists, a "student assistant" movement took place at the university (and at all other Cuban higher education centers as well), to voluntarily engage the advanced students in the teaching of physics to students enrolled in lower-level courses. The proposed procedure was to:

Create a group, taken from most highly qualified second and third year students of the engineering or chemistry degree courses, with the purpose of training them as physicists.

Engage this group of students to simultaneously dedicate themselves to the teaching of general physics to students of various degree courses, and to the setting-up of student laboratories, where the existing teaching staff could tutor with the help of foreign technical assistance.

Accordingly, in 1967 authorization was requested from the Ministry of Education to implement a special plan to train 20 physical engineers who were to graduate in 1971 "with the purpose of solving technological problems and to engage in the physical analysis of minerals" (*Sierra Maestra* 1968). This in fact amounted to the first step in the formation of the Physics School, the goals of the plan being to provide the personnel needed for academic work and to train an initial nucleus of physical engineers who would work on various branches of applied physics at the university and in industry. These engineers would be capable of doing useful research work and introduce the results of advanced physical research into technology.[4]

This was, in effect, a plan for training industrial physicists. J. González and H. Fuentes, in collaboration with Soto del Rey and Aguilar Salcedo designed the pertinent curriculum to include such subjects as electrotechnology, basic electronics and industrial electronics (González and Fuentes 1968). The Ministry of Education not only agreed with the proposal, but also added that the university had "the possibility of developing scientific research work in various branches for it counted on specialists of international scientific stature (such as José Fernández Bertrán) who could lead the way to graduate research work of national interest."[5]

In 1967, 20 years after the foundation of the university, the first steps were taken to create its Physics School, which finally acquired official status in March 1970, and on December 8th of the same year, produced its first 19 graduates in physical engineering. Their graduation took place one course in advance, for the academic semesters had been compressed in time and the vacation period was cancelled by mutual agreement between students and staff, who made a special effort for the purpose. Still, the idea of training such physicists at the university was subject to much criticism, both from outside and from within. It was necessary to repeatedly explain and defend the concept that there was a real need to train on a regular basis physicists capable of performing well within a matrix of non-physics professionals,

[4] A plan for the training of physicists at the university. (Undated document, probably written by the end of 1967 or the beginning of 1968.)

[5] Report to the Ministry of Education's Vice Minister for Higher Education on the physical engineering degree course.

especially in view of the fact that in the Eastern part of the country, institutions did not invite physicists to join their staff; a newly trained professional in this field would have to prove himself by fruitfully linking physics to different areas. In short, it was claimed that the new professional would be something like a "physics cat," always capable of landing on its 4 ft, from whatever position it was flung.

At the time, several government officials and members of the teaching staff came to the defense of the new degree course, among them, the engineer Miguel Torres, first in his role as Dean of the Faculty of Technology and then later as Vice Rector; Luis Estévez, José Borges and Rosina Hing, members of the staff of the Mathematics Department; and the engineers Miguel Matute and Arístides Berenguer from the Electrical Engineering School, who also belonged to the staff of the Special Plan for Physics Engineering. Valery Smirnov, from the Leningrad State University, had a marked influence on the conception of the new degree course, on the modernization and extension of the undergraduate laboratories and on the actual training of the first generation of students. Johann Monecke, staff member of the Dresden Technical University, taught a model course in quantum mechanics in 1969.

After one academic course following the inauguration of the Physics School, the Mathematics School was inaugurated with a similar conception and also with the active participation of its students. Later on, the Biology School was created, which, in addition to the Chemistry School, completed the basic organizational structure for the fundamental sciences at the University of Oriente.

8.4.2 Consolidation of the School (1970–1976)

The foundation and organization of the Physics School in March 1970, together with the first and only graduation of physical engineers (at the time) in the following December, define the end of one stage and the beginning of the next, which now had the well-earned right to develop physics in the province of Oriente.

As soon as the Physics School had been officially established, it was decided that it would specialize in physical methods of analysis. Jorge González Alonso and Homero Fuentes were appointed Director and Vice Director, respectively, and the following five departments were created: Nuclear Physics, Optics and Spectroscopy, X-Ray Physics and Metals, General and Theoretical Physics, and Electronic Physics, headed by Luis Pérez Tamayo, Miguel Catasús Portuondo, Manuel García Ramos, Luis Aguilar Salcedo, and Carlos Cabal Mirabal, respectively. Following the Soviet educational pattern, the first three departments were supposed to offer specialized training to the students and engage them in applied research in their respective fields, while the task of the last two was to take care of the basic education of the physics and other students, and to cooperate with other departments.

Apart from Aguilar, the heads of the other departments were still students. Moreover, since the organization of the university was still in a state of flux, a few months later, in August 1970, the formerly appointed Director of the Physics School, the graduate Jorge González Alonso was promoted to Vice Dean of the Faculty of

Sciences, and Homero Fuentes and Carlos Cabal were appointed Director and Vice Director of the School, respectively. Before the end of the same year, another shift took place when Cabal became Director of the School (until 1973) in place of Fuentes, who had been appointed as Vice Dean of the Faculty of Sciences.

The School was considerably strengthened when the first 19 graduates in physical engineering joined its teaching staff. These included González, Fuentes, Soto del Rey and Aguilar Salcedo, plus other recently graduated physicists from the University of Havana. On the other hand, its scientific level was considerably enhanced thanks to the periodic working visits of a number of staff members from the Leningrad University (Smirnov, Petrov, Niementz, Braun, Lavzovsky, Borodin, Molchanov and Zanadvorov). Their collaboration at this stage (it extended up to 1976) was crucial for the launching of applied scientific research, which initially was certainly not at an advanced level, but did confirm the need for the further development of physics work at the university and its importance in the provincial vicinity.

Further development of the Physics School called for strong international ties, including visits by the staff members—either short or long-term—to appropriate institutions abroad. Accordingly, between 1971 and 1972 around ten members of the school staff visited Leningrad University and the technical universities in Dresden and Stockholm to become acquainted with their teaching methods, taking short special courses or taking up graduate courses leading to a doctoral degree. In 1970, Matute visited Italy for 6 months.[6] In September 1971, Homero Fuentes and Carlos Cabal traveled to East Germany and the USSR to establish or strengthen formal agreements with the Dresden Technical University and the Leningrad University, which was visited again in 1972 by Luis Aguilar and Miguel Catasús. French specialists, headed by Henry Pezerat, gave graduate courses on materials characterization in 1970, while from 1971 to 1972 some physics graduates (G. Lucambio and L. Méndez) took summer school courses from French professors at the University of Havana.

Up until 1976, 40 physicists had obtained their physics degree at the university,[7] some of them in nuclear physics (that year the Physics School had about 50 students). The main research subjects up to 1976 were those mentioned in (Pérez Rojas et al. 1976). Though the Department of Optics and Spectroscopy took the main load of thesis tutoring, the Department of Nuclear Physics began to catch up. Spectroscopy research developed in connection with the nickel industry in Oriente, with the application of atomic emission and absorption techniques, following two working lines: one on the plant product (M. Catasús), and another one on lateritic minerals (J. Ricardo). Work on X-ray analysis and metals dealt mainly with phase transformations.

In 1968, when Soto del Rey began teaching physics to first year medicine students, he arrived at the conclusion that the subject should be taught differently to correspond to the interests of his students. This led him to develop medical physics as a new subject. In the end, this was so successful that members of the

[6] Interviews granted by Miguel Matute and Ramón Pomés.

[7] Graduates Register, General Secretariat of the university.

teaching staff asked to take the new subject as a graduate course. It was later introduced as a standard course within the biology curriculum. As a by-product, in 1988 Soto del Rey published a four-volume textbook entitled *Introduction to Biophysics* (Soto del Rey 1968). This corresponded with his former view that given the national priorities, especially those particular to the province of Oriente, physics students should be trained in two main areas: technical and biological physics, as he called it. This idea preceded his involvement in the actual teaching of students of medicine and biology.

From 1976 to 1977, the first physicists graduates of the OU returned to Cuba after taking part in specialized and doctoral courses abroad. Margarita Cobas Aranda (optics) and Ramón Pomés Hernández (X ray crystallography) were the first to successfully defend their doctorates at Leningrad University. This made the Physics School of the University of Oriente the country's pioneer institution in the field of optics and spectroscopy. The achievements in the development of nuclear physics and X-rays and metals were not trivial, in both the experimental and the applied context.

8.5 A Period of Development (1976–1985)

When the Ministry of Higher Education was created in 1976, the Physics School and its Department for Electronic Physics was officially dissolved, while the other departments were absorbed into the Faculty of Physical, Chemical and Mathematical Sciences. In 1980, these were transferred to the newly created Faculty of Physics and Mathematics, whose first dean was Carlos Cabal Mirabal, who had obtained his doctoral degree from Leningrad University.

In addition to the international academic exchanges, especially with East Germany and the USSR, the improved qualifications of the staff trained abroad meant that training offered to physics students progressively improved. By 1985, the faculty included eight physicists with a doctoral degree (or candidate degree, as it was called at the time), one of whom had obtained this at the university, while 14 physicists out of 35 staff members had attained the rank of senior or auxiliary professor.

In 1983, some thirteen years after the creation of specialized studies in physics, the Laboratory for Physical Methods of Analysis summarized its main achievements: application of neutron techniques to the determination of the humidity of Cuban soils; determination of the structure of sucrose crystals experimentally grown in orbit during the 1980 Soviet-Cuban space flight (experiment Zona;[8]) determination of the composition of national minerals for inclusion in the 1:100,000 Cuban geological map; publication of more than a hundred scientific papers in national and international specialized journals; and participation in more than 80 scientific gatherings (ten of them of international nature) in the USSR, East Germany, The

[8] See the chapter by Ernesto Altshuler et al. on the Cuban technophysical experiments in space.

Netherlands and Canada. To this, it may be added that staff members of the Physics School were awarded prizes for their scientific work: in the 250th Anniversary of the USSR Academy of Sciences contest (R. Pomés, third place) and the Leningrad State University for Young Scientists Contest (Carlos Cabal, second place/1979, and first place/1980) (Project UCT 1983).

Several scientific monographs, textbooks and handbooks were published by members of the physics staff, among them: *Methods for the Determination of Gold in Minerals* (Cobas Aranda 1980), *NMR Studies of Paramagnetic Electrolytic Solutions* (Cabal Mirabal and Chizhik 1982), *Collection of Solved Problems in Physics* (Parera et al. 1984), *Electronic Methods in Experimental Physics* (Méndez Perez 1986), and *Introduction to Biophysics* (Soto del Rey 1988).

From 1980 to 1988, the Physics School strongly engaged in vocational guidance work for hundreds of senior high school students throughout the Eastern region of the country, which included its active support in the organization of Olympics for physics, chemistry and mathematics. Training courses were organized for high school physics teachers, and about a dozen popular scientific articles were published in national, provincial and university periodicals. Programs dealing with the relevance and possibilities of physics in the Cuban social context were also produced for TV.

The above scientific and educational work, which only emerged in the 1970s, had a beneficial influence not only on the quality of undergraduate teaching, but also on the development of graduate training (previously nonexistent) through the implementation of PhD-level studies as well various graduate courses and training programs. As early as 1979, the National Commission for the Peaceful Use of Atomic Energy deemed the school's Department of Nuclear Physics mature enough to entrust it with the national leadership of a PNUD project entitled "Introduction of Nuclear Techniques in the Country's Economy" (Project PNUD 1979). All of this contributed to the standing of the Physics School within the national physics community, to the extent that in 1985 the Cuban Physics Society held its Third Symposium not in Havana, but at the University of Oriente.

8.6 A Transitional Period (1985–1993)

At the beginning of the 1980s, an emigration wave of experienced staff members from the Physics School developed and grew with time. It originated from certain policy decisions at the national level, such as (a) the creation of a physics department for technical sciences that was attached to the creation in 1985 of the Julio Antonio Mella Higher Polytechnic Institute; (b) the elimination beginning in 1982 of specializations from the curricula; (c) the close-down between 1985 and 1986 of applied nuclear physics research by the Executive Secretariat of Nuclear Matters (SEAN), added to the impossibility of obtaining the financial resources and equipment for the two projects mentioned above. Consequently 17 senior staff members left the university for other institutions, with the result that the number of PhDs and

professors (senior and auxiliary) was reduced to four and five, respectively, and the staff vacancies had to be covered by either inexperienced physics graduates or by graduates trained in other fields. By 1993, few of the original staff remained, especially after the retirement of Soto del Rey and Aguilar Salcedo and the passing of Arturo Guzmán, one of the first graduates of physical engineering, who was just finishing his doctoral thesis work on magnetic relaxation in rare earth paramagnetic systems.

Generally speaking, while the situation described above certainly brought about a decline in the scientific and academic standards as well as the philosophy that defined the early rise of the Physics School, the new staff managed from 1986–1987 to initiate the recovery of the school's former standards of excellence on new research lines established in place of those eliminated in 1982. After the purchase in 1987 of a suitable electron microscope, some of the remaining members of the former staff specialized in materials sciences and related techniques, while others dedicated themselves to the automation of experiments and computational physics, which were later combined for application in biophysics, medical physics and biotechnology specialties. A working group dedicated to nuclear magnetic resonance (NMR) was created in 1981, which from 1987 to 1990 bore its first relevant results that were to define the future path of this field.

A multidisciplinary Medical Physics Group, created in 1987, began its activities by establishing a successful partnership with the "Conrado Benítez" Oncology Hospital of Santiago de Cuba. It expanded to become the National Institute for Oncology and Radiobiology, carrying out automation and simulation tasks, and radio isotopic test calculations with computerized renographs. For the practical results it achieved with the digital photoplethysmograph UOangio-0, in collaboration with the "Saturnino Lora" hospital of Santiago de Cuba and the National Institute of Angiology and Cardiovascular Surgery, the Medical Physics Group was awarded a Prize for Scientific Merit. The results also had a high economic impact. In addition, the NMR Group was elected the most distinguished collective of the university for establishing a methodology for polymerization kinetics evaluation of hemoglobin in patients with drepanocytic anemia, and for producing an important preliminary study on the classification of lymphadenopathy useful for the quantification of breast cancer.

Project 35–26–7 NMR was started in December 1987, thus fulfilling a direct request from the country's leadership to develop technology in Cuba for the manufacture of nuclear magnetic resonance imaging equipment for medical purposes. This was necessary since it was impossible to acquire ready-made equipment of this kind for the country's public health system from abroad, especially since at the time the commercial firms involved were required to obtain a license from the US government to sell their products to Cuba. Initially the project was undertaken by five graduate physicists (only one of them with a PhD degree) and several students in the final year of their degree courses; they worked with a few engineers, whose goal was to calculate, design, set up, characterize, validate, register and apply to patients their NMR imaging equipment. The first machine went into regular operation in early 1991, at the beginning of the

extremely difficult period the country endured after losing more than 80 % of its foreign trade with the former socialist countries in Europe. Despite these setbacks, three units for full body imaging were prepared in record time, together with several relaxometers and NMR magnetometers. A stable multidisciplinary collective was thus created that included physicists, engineers, chemists and computer scientists with a high professional standard recognized at national and international levels. The project was able to attract some valuable international cooperation, especially from the Institute of Physics of the University of Sao Paul, led by the late Horacio Carlos Panepucchi.

For the development of the "Giromag" NMR relaxometer and a methodology for the characterization HBS polymerization process, the collective received a national prize in 1994 from the Cuban Academy of Sciences awarded the collective responsible for above mentioned project a National Prize in 1994, and another one in 1995 for their development of the "Giromag" tomograph. The "Giorgio Albieri in Memoriam First Prize" was awarded to the NMR Cuban group led by Cabal at the 5th International Conference on Applications of Physics in Medicine in Trieste in 1996. Other national and international prizes followed. The results obtained stand among the most complex and significant technoscientific achievements accomplished in the country. In association with the development of equipment and related technologies, new research directions in the field of molecular and cellular biophysics were introduced that had a strong impact on Cuban biotechnology and the medical-pharmaceutical industries.

Rooted in the above achievements, which include the multidisciplinary collective, a Center for Medical Biophysics was set up on new premises in Santiago de Cuba, duly equipped for biomedical R+D work. In his 1993 inaugural speech, President Fidel Castro put forward an idea that was to become one of the conceptual pillars of contemporary scientific activity in Cuba: "Some day science and the productions of science must move into first place in the country's economy. We have to develop the production of human intelligence. This must be our place in the world, because there will be no other."

These thoughts were taken into account by the university authorities, who addressed this new approach by introducing successive structural changes within the university. One of these was the creation of the Faculty of Natural and Mathematical Sciences, which included a physics department in charge of the degree course (*licenciatura en física*).

8.7 Rebirth of the Physics Department

Starting in 1993, the physics department was reorganized so that the optics and spectroscopy group was transformed into a collective—led by Jorge Ricardo—dedicated to fluorescence and laser applications. Working groups were created for theoretical physics (led by Raúl Riera and backed by the University of Havana's Physics Faculty), materials sciences (led by José Anglada), computational fluid dynamics (led by Rafael Mut, backed by the University of Barcelona), and

university physics didactics. Researchers in these groups worked on nanostructures, thermal and electric properties of ionic conductors, properties of ferroelectric materials and magnetic properties of soft magnetic materials. They also took part in the preparation of national programs for basic sciences, computational sciences and new materials, which were managed by the Ministry of Science, Technology and Environment (CITMA). Several national prizes and awards were won by members of these departments for the results of their work (among them, the Carlos J. Finlay and the Lázaro Peña orders awarded by the Council of State) and the Cabal was re-elected as a Senior Member of the Cuban Academy of Sciences for the period 2002–2006.

The Physics School continued to develop throughout the 1990s, despite the interruption in the previously close collaborative ties with the USSR and East European countries. The first "R. Soto del Rey In Memoriam" Physics Symposium held in 1997, was successfully revived in 2000 as an international conference attended by specialists from Brazil, Spain and other countries. Research and collaboration projects with Mexican, Brazilian, Spanish, and Venezuelan universities were later undertaken. By 2005, senior and auxiliary professors made up 80 % of the teaching staff, of which 60 % had a PhD and 67 % an MSc degree.

Fifty years after the foundation of the University of Oriente, its original physics chair had already developed into an academic complex which included a center for medical biophysics, a department for applied physics, and a physics department in charge of the degree courses in physics (awarded an "excellence certificate" in 2005 from the Ministry of Higher Education) and in physical engineering. More than 400 physicists, including some from African and Latin American countries, have graduated from the university in the five decades since its inauguration.

8.8 Conclusion

When the university was inaugurated in 1947, physics as a science was represented as a single basic subject in the chemical engineering curriculum. Later on, it was included in other engineering specializations and in agricultural and medical studies as well. Roberto Soto del Rey, head of the first physics chair, inspired the general orientation and further development of physics studies at the university. They experienced a very important turning point when a physical engineering degree course was established in 1967, especially since it supplied the country with a growing mass of well-trained specialists who were able to cover the teaching needs of higher education and applied research in important industrial sectors located in Eastern Cuba. Still, progress was not easy, due to serious difficulties that came at one time or another from radical changes in the university structure, migration of experienced specialists to other institutions and a limited material base available for experimental research. Still, professionals with a strong physics background who were trained at the university have been able to make important contributions to the educational, scientific, technical and economic development of the country, for which they have been amply recognized at the national level.

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