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Angelo Baracca
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The History of Physics in Cuba

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Preface

Knowledge in the modern world is shared globally. Different knowledge communities in science, technology, economy, politics, and public opinion are becoming ever more entangled. This process has also affected the history of science, which is more and more becoming part of a global history of knowledge and ever less focused on specific disciplines or specific countries. Rather, it becomes clear that the history of scientific disciplines or national developments can only be understood as part of processes of knowledge exchanges and transformations, often over long time periods and large distances. Against this background, we consider this volume on the history of physics in Cuba, covering a period of more than 200 years, as a contribution to the study of the globalization of knowledge in history (Renn 2012).

With European colonial expansion, new forms of knowledge exchange were also created, partly destroying former regional networks. Cuba was a strategic center in the Caribbean and directly connected to all parts of the Spanish colonial empire. Havana became a colonial metropolis, communicating to all other cities in the Iberian world. The island of Cuba was also closely related to the non-Spanish colonies of the Caribbean. The relationships established during the colonial period persisted even after the independence of the Spanish-American nations. During the nineteenth century, commercial, cultural and political contacts to the United States increased considerably under Spanish colonial rule.

The early history of science in Cuba was closely connected to the history of its role as a colonial metropolis. The intellectual and political climate on the island was shaped by a continuous exchange with other parts of the Americas and with Europe. In Cuba, a rich and cosmopolitan aristocracy belonged to a worldwide exchange network transgressing the imperial frontiers.

The Cuban aristocracy relied on the so-called sugar-capitalism, a conjunction of capitalism, slavery and advanced technologies. But Cuba's impressive technological advance in the nineteenth century was not accompanied by an equally strong development in the educational and academic system, since such developments were opposed by Spanish colonial rule. Nevertheless, the worldwide diffusion of scientific knowledge in the eighteenth century and the ideals of the Enlightenment

associated with it also affected Cuba. A constant migration of young Cubans to Europe and the United States, as well as the economic and social development of the island over the course of the nineteenth century also created new possibilities for the production and dissemination of knowledge.

These global connections persisted even after Cuba, beginning in the mid-nineteenth century and more strongly after its independence in 1898, became increasingly dependent, both politically and economically, on the United States. However, Cuba was never completely dominated by these influences and succeeded in maintaining intellectual networks outside their spheres. As a result, Cuba was open to the appropriation of global cultural and intellectual developments and in turn was able to disseminate its own achievements worldwide. The idea behind this volume on the history of physics in Cuba is to contribute to the reconstruction of this global entanglement of knowledge.

In this sense, the volume is a pioneering step toward providing a detailed account of global entanglements in the history of science by focusing on the global relatedness of one discipline in one country. Especially after the Cuban revolution of 1959, connections to the USSR and the Eastern European countries formed the basis for a co-evolutionary process that involved both local advances and the generous foreign support of physics research in Cuba.

During the last years, an anachronistic situation has evolved that weighs heavily on the future development of science in Cuba in a globalizing world. The United States' politics of blockade continues to represent a major obstacle: two major laws passed during the last two decades effectively restrain commerce and the exchange of information between Cuba and other countries. Meanwhile, the Internet and open access to scientific information have become an ever more crucial condition for the development of science. One of the starting points for our interest in the development of Cuban science was in fact the encounter between one of us (JR) and Professor Fidel Castro Díaz-Balart on the occasion of the conference on "The Role of Science in the Information Society" (RSIS) held in Geneva from 10–12 December 2003 in support of the role of open access. Consequently, the Cuban Society of Physics, headed at that time by Professor Oswaldo de Melo, became one of the first institutions on the American continent to sign the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities (http://openaccess.mpg.de/286432/Berlin-Declaration). The complex political and technological history of the establishment and usage of the new media in Cuba has itself now become an active subject of research, undertaken by scholars such as Bert Hoffmann (2004, 2012).

This volume appears in the context of a process of rethinking Cuban history in a global environment. Until very recently, the linear development from colonial and imperial subjugation to the *Revolución* competed with a rather marginal historiography that regarded these periods in their own right and not just as episodes in a one-dimensional historical account. New interpretations now commonly emphasize the autonomy of Cuba—at least for the time after the revolution. Here, the need for Soviet aid from the 1960s on, for instance, is contrasted with autonomy in both internal development and foreign policy. These studies emphasize the uniqueness of Cuba, supposedly impermeable to penetrative influences from the outside. Global

history, in contrast, would demand the location of Cuba in a global environment that is defined neither by its hermetic confinement, nor by exclusive bilateral relations with Spain, the United States or the Soviet Union, but rather by multilateral entanglements. These different viewpoints promise to trigger interesting discussions about the relation between local and global epistemic traditions.

As the only participants in this project who are mere observers of the Cuban history of physics, we would like to express our gratitude and respect for all those who in past years have not only made this history, but also engaged in its writing. We consider it a privilege to have been able to work with our co-editor, Angelo Baracca, in bringing this volume together. He has not only initiated it and created the basis for its realization, but over many years has himself also been actively involved in Cuban physics, as a passionate participant-observer, so to speak. Since we do not share his first-hand experiences, our role was rather, together with Lindy Divarci, to act as midwives in helping to turn the available materials into a book. Nevertheless, also for us, the histories of Cuba and of Cuban physics have become a passion that we will continue to pursue.

Berlin, Germany

Jürgen Renn
Helge Wendt

References

Hoffmann, Bert. 2004. *The politics of the Internet in Third World development. Challenges in contrasting regimes with case studies of Costa Rica and Cuba*. New York: Routledge.

Hoffmann, Bert. 2012. Civil society in the digital age: How the Internet changes state-society relations in authoritarian regimes. The case of Cuba. In *Civil society activism under authoritarian rule. A comparative perspective*, ed. Francesco Cavatorta, 219–244. New York: Routledge.

Renn, Jürgen (ed.). 2012. *The globalization of knowledge in history*. Studies 1: Max Planck Research Library in the History and Development of Knowledge. Berlin: Edition Open Access.

Contents

About the Contributors

Diego de Jesús Alamino Ortega received a degree in physics in 1975 and a Ph.D. in physics in 1994 from the University of Havana. He was Professor of Physics and Professor of Philosophy at the Pedagogical University of Matanzas, a founding member of the Cuban Society of Physics, a member of the Cuban Society of Science History and Technology, the Cultural Society "José Martí" and the International History, Philosophy and Science Teaching Group. He has developed courses and attended events on the history of science in Cuba, Argentina, Mexico, Brazil and England. He was awarded with a Distinction for his services to Cuban education.

Marcelo Alonso graduated in physicomathematical sciences from the University of Havana in 1942; he later took postgraduate courses in theoretical and nuclear physics at Yale University. After working as a high school teacher on his return to Cuba, he became a member of the Department of Theoretical Physics of the University of Havana in 1949, and was appointed its chairman in 1957. In 1960, he moved abroad to serve as the director of science and technology for the Organization of American States, and took up residence in the United States serving as Professor at Georgetown University Graduate School and Florida Tech. Having held many significant posts in the academic world and at international organizations, he visited the University of Havana and other Cuban research institutions twice in 2000, and established friendly relations with local colleagues. Professor Alonso was author or coauthor of several physics textbooks, including one on atomic physics and another one which became a standard textbook used in many universities around the world. He passed away in Florida on November 11, 2005 aged 84.

Ernesto Altshuler was trained as a physicist at the University of Havana, where he also obtained his Ph.D. in 1994. He has worked scientifically on magnetic materials, transport in high temperature superconductors, vortex and granular avalanches, granular flows, collective behavior of social insects and bacterial dynamics in microfluidic devices – where the experimental approach has always dominated. While his scientific work has been strongly based in Cuba, he has collaborated with teams at the Texas Center for Superconductivity, The University of Oslo, and the

ESPCI (Paris), among others. His work in science popularization includes many papers in journals and magazines, and a science book on human vision for kids (*Through the Eyes*, 1993). He is currently Full Professor at the Physics Faculty, University of Havana, and Editor of the *Cuban Journal of Physics*.

José Altshuler received the electrical engineer's degree from the University of Havana in 1953, and the Dr.Sc. degree from the Czechoslovak Academy of Sciences in 1974. He is the author or coauthor of numerous papers and several books on subjects related mainly to the engineering sciences, higher education, and the history of science and technology. He served as both Professor of Electrical Engineering and as Vice-Rector at the University of Havana, and has also served as President of the National Space Commission and as Vice-President of the Cuban Academy of Sciences, of which he is an Honorary Academician. Professor Altshuler is currently President of the Cuban Society for the History of Science and Technology.

Oscar Arés Muzio was Professor at the Faculty of Physics of the Havana University for 35 years. He received his Ph.D. from the same university in 1985, in an issue related to permanent magnets. He has been a visiting scholar at several universities and research institutes in Russia, Italy, Germany and Mexico. His research interests have focused on material science (magnetics, superconductors, colossal magneto resistance, semiconductors, etc.) and devices for applications (magnetic, superconductors (SQUIDs), solar cells and solar thermal collectors). For many years he was head of the Laboratory of Magnetism and Superconductivity at the University of Havana and was co-author in obtaining the first high temperature superconductor made in Cuba. He was for many years a member of the Permanent Court of physical doctoral defenses in Cuba. For his scientific activities, he was awarded with the medal Carlos J. Finlay by the Cuban government.

Olimpia Arias de Fuentes is Senior Researcher at the Institute of Materials Science and Technology and Associate Professor at the Physics Faculty of the University of Havana. She graduated as a physicist at the University of Havana where she also obtained her PhD. Her current research area focuses on electrochemical sensors and biosensors and the necessary instrumentation for their environmental and biomedical application. She has also undertaken studies on the history of science and gender thematic in Cuba, published numerous papers in scientific journals and proceedings and presented many research contributions at diverse international congresses. She has given talks at universities in Italy, Germany, Chile, Mexico and Uruguay and has been a Visiting Professor at the University of Rome "La Sapienza." She is full member of the Third World Organization of Women in Science (TWOWS), the Cuban Commission of Women in Sciences, the Cuban Chemical Society and founder of the Cuban Physical Society where she was a staff member during the years 1978–1985. She was among the authors to be awarded with one of the Annual Prizes of the Cuban Academy of Sciences in 2001. She was also awarded with "The Distinction for the Cuban Education" given by the Cuban Minister of Higher Education and "The Medal José Tey" given by the Cuban Republic Government, both for her contribution to education in Cuba.

Angelo Baracca received his Ph.D. in physics in 1968 from the University of Florence, Italy, where he is currently Professor of Physics. He has collaborated with universities and research centres in France, the United Kingdom, Spain, and Germany, and is now collaborating closely with the University of Havana in Cuba. He is actively engaged in the movements for peace and disarmament and has devoted himself professionally to the study of nuclear technology – both civil and military – its structure and history. Besides several textbooks of physics, he has published many papers and books. Besides teaching and research activities in many fields such as high-energy physics, statistical mechanics, and the foundations of quantum mechanics, his interests concentrate on the history and social responsibility of science.

Duccio Basosi is Researcher in History of International Relations at the Ca' Foscari University of Venice since 2009. He obtained his Ph.D. in History of International Relations from the University of Florence in 2004. From 2002 to 2009, he has been a scholar at the Machiavelli center for Cold War Studies, a consortium of historians from seven Italian universities. He specializes in international relations from the 1960s to the 1990s, with a focus on US foreign policy, Cuban foreign policy, and international political economy. He co-edited the collection of essays (with A. Lorini), *Cuba in the World, the World in Cuba. Essays on Cuban History, Politics, and Culture* (Firenze, 2009). His monograph, *Il governo del dollaro. Interdipendenza economica e potere statunitense negli anni di Richard Nixon, 1969–1973* (Florence, 2006), was awarded the "Premio SISSCO Opera Prima" by the Italian Society for the Study of Contemporary History in 2007.

Carlos A. Cabal Mirabal was a co-founder in 1971 of Cuba's second school of physics at the University of Oriente, which he directed for several years. He was also the founder Dean of the Faculty of Mathematics and Physics (1980–1989) and Founder Director of the Medical Biophysics Centre (1989–2005) at the Oriente University in Santiago de Cuba. He defended his Ph.D. thesis in magnetic resonance at the University of Leningrad (1980). He has been Full Professor at the Oriente University for 40 years, Full Professor at Havana University for the last 5 years and is Honorary Professor at the La Plata National University, Argentina. Currently, he is Head of the Images Group at the Center for Genetic Engineering and Biotechnology and continues to work in the field of MR, in particular, in molecular imaging. In 2010 he received the Cuban National Prize for Physics. He is a member of the International Union of Pure and Applied Physics (Magnetism Commission) and merit member of the Cuban Academy of Sciences.

Ocatvio Calzadilla Amaya is Full Professor at Havana University, Department of General Physics. He received his Ph.D. in physics and mathematics at Havana University in 1994. Since 1972, he has served as Professor of general physics and training laboratory. He has authored books for physics education. His research interests are the materials science. His research first focused on the preparation of semiconductor materials by vapor phase transport in closed ampule using the melt method. At the present time, he is working on the growth of semiconductor

thin films using the chemical bath deposition method and electrochemical method. He has published several scientific articles about the growth and characterization of materials.

Manuel Cardona is Founding Director Emeritus at the Max Planck Institute for Solid State Research in Stuttgart and Honorary Professor at the Universities of Stuttgart and Konstanz. He is also Adjunct Professor at Arizona State University. He received a *licenciado en ciencias* degree at the University of Barcelona in 1955, a Dr. of Sciences degree at the University of Madrid in 1958 and a Ph.D. at Harvard University in 1958. He has been awarded 11 honorary doctorates (Barcelona, Madrid, Valencia, La Laguna, Rome, Sherbrooke (Canada), Toulouse, Regensburg, Thessaloniki, CINVESTAV (Mexico), and Brno (Czech Republic)). He is a member of the National Academy of Sciences of the USA, that of Mexico and the Royal Society of Canada. He has received the 1988 Principe de Asturias Prize (Spain). He has authored or co-authored 1,300 refereed articles which have attained the *h* number of 98. He is the author or co-author of about 15 books and textbooks. He has supervised a large number of Latin-American students, having spent 3 months at the University of Buenos Aires (June–August 1965) shortly before the military revolution of General Onganía, whose effects in the academic life of the Continent he helped to palliate. His field of endeavor is solid state physics.

Jacqueline Cernogora graduated in physics at the Faculty of Sciences of Paris University. She then joined the GPS *Groupe de Physique des Solides* (Solid state physics group) in 1960, first studying the photoconductivity of germanium doped with deep-level dopant, (third level thesis in 1962), later studying disordered semiconductors by means of radiative recombination. The first study of highly doped germanium gave rise to her Ph.D. in 1968. Later studies were concerned with amorphous chalcogenides, semi-magnetic semi-conductors, porous silicon and amorphous carbon, each of which gave rise to various publications. In 1962, she joined the Centre National de la Recherche Scientifique (CNRS) as Research Attaché and went on to become Program Director there in 1968. She was part of the French-Cuban Committee during the early 1970s.

Víctor Luis Fajer Avila defended his doctoral thesis in physics in 1993. He was elected in 1999 President of the Cuban Physical Society and at present is Vice-President of the Society. He has led and conceived the developing works of seven versions of automatic and digital polarimeters, denominated LASERPOL, of economic and scientific-technical importance. He has presented 90 publications and 4 patents. He has published several papers about physics in Cuba. In 1999 he received the "Carlos J. Finlay Medal" and was nominated Academician of the Cuban Academy of Sciences. He is Titular Researcher and Head of Department of the Center for Technological Applications and Nuclear Development (CEADEN) and Titular Senior Professor of the High Polytechnic Institute (IPSJAE), Havana.

Federico Falcon is a researcher at the Institute of Science and Technology of Materials of Havana University. He completed his Ph.D. thesis in 1986. His research areas are crystallization and crystal growth. He has published papers on related

subjects in various journals. In 2007, he obtained the medal "Serguei Koroliov" from the Cosmonautic Federation of Russia.

Roberto Fieschi obtained his degree in physics at the University of Pavia in Italy in 1950 and a Ph.D. in physics at the University of Leiden in the Netherlands in 1955. He was Professor of Physics at the University of Parma from 1965. From 1966 to 1972 he was Head of the Physics Institute, and from 1969 to 1976 Director of the National Research Council Laboratory MASPEC, overseeing its development. Professor Fieschi was a member of the CNR Physics Committee and Vice-President of the Technological Committee. In 1977, he was commended by the Ministry of Public Instruction and subsequently awarded a gold medal. He is also part of the National Council of the Union of Scientists for Disarmament (USPID). In 1997, Professor Fieschi was awarded the Laurea honoris causa in Materials Engineering by the University of Lecce. In the 1970s, he was a member of the Central Committee of the Partito Comunista Italiano. He is now Professor Emeritus at the University of Parma.

Juan E. Fuentes received his Ph.D. from Moscow State University, Solid State Faculty in 1975. Thereafter he has taught at the School of Physics and then at the Faculty of Physics of Havana University. At the same time he has been working in investigations in different branches of solid state physics. He is the author of articles on the growth and characterization of single crystals and films. He is currently working in the piezoceramics group and is interested in lead-free ceramics.

Federico García-Moliner founded the renowned Spanish research school in solid state physics, which reached a high international level. He was dedicated to teaching activities and played an important role in the formation of young scientists in many European countries. In addition, he played a key role in supporting scientists in developing countries, also in Latin America. He played an active role in the Pugwash Conferences on Science and World Matters. In 1992, he was awarded the *Premio Príncipe de Asturias de Investigación Científica y Técnica* for his contributions to solid-state physics.

Carlos R. Handy received his B.A., M.A., and Ph.D. degrees in theoretical physics from Columbia University in New York City. He was born in Havana, Cuba, in 1950, but raised in the United States. He is the grandson of the famous Blues composer, William C. Handy. Dr. Handy was a postdoctoral student at Los Alamos National Laboratory in the late 1970s. While there, he developed a strong interest in Moment Problem reformulations of Quantum operators, particularly for developing new computational methods in tackling singular perturbation/strong coupling problems. Based on his works in the mid to late 1980s, he is now recognized as a pioneer in the application of semi-definite programming related methods to quantum operators, anticipating these interests within the mathematics-optimization community by more than a decade. Simultaneously, through his appointments at Clark Atlanta University (1981–2005) and Texas Southern University (2005 to present), he was able to build internationally competitive research centers and departments in institutions dedicated to educating African Americans. He currently serves as the Chair of the Physics department at Texas Southern University in Houston, Texas.

Brian Hayes is Senior Writer for *American Scientist* magazine, where he writes a column called "Computing Science." He is also the author of *Infrastructure: A Field Guide to the Industrial Landscape* (W. W. Norton, 2005) and *Group Theory in the Bedroom, and Other Mathematical Diversions* (Hill and Wang, 2008). He is a former editor of both *American Scientist* and *Scientific American*.

Fabrizio Leccabue received a degree in chemistry in 1972 at the Chemistry Department of Parma University in Italy. From 1973 to 2007 he worked at the Institute MASPEC of Consiglio Nazionale delle Ricerche of Parma. He has coordinated national projects (Strategic Project/1997, Finalized Project/1997, ASI/2003), some European projects (Brite Euram Feasibility II/1992, HCM/1995, Alfa/1996, bilateral agreement between CNR and CSIC/2002, URSS Academy of Sciences/1984, MURST-British Council/1997) and international projects (CONACyT, Mexico/2002, University of La Habana, Cuba/2001). He has served on the management committee of European COST Action 514/1993 and 528. On materials of technological applications, he has developed collaborations between Italian companies (ST-Microelectronics, Alenia, Pirelli Pneumatici, Italcementi, Bormioli) and local companies (Vacuum Components & System, CAEN, ALSIM) devoted to the study of sensors, magnetically coupled mechanical systems, piezoelectrics, ferroelectrics, non-volatile memory (PZT, SBT), and hard (hexaferrites, intermetallic alloys) and soft (FeSiB based alloys) magnetic materials. In the last 10 years, he co-developed research on the preparation and characterization of ferroelectric thin film and oxides, obtained by pulsed laser ablation deposition and sol–gel processing, and amorphous, nano-/micro-crystalline magnetic materials using melt spinning. In this period, his scientific activities also included the design and construction of MOCVD reactors to prepare SiC film. He has co-authored more than 140 publications in international journals, given 185 scientific presentations at International Conferences and has supervised more than 35 degree theses, PhDs and fellowships.

Irving A. Lerch received his Ph.D. in biological and medical physics in 1969 at Chicago University. His research focused on radiation metrology, low-energy X-ray spectroscopy, radiation biophysics and biomedical statistics. In 1973, he was program officer at the Division of Life Sciences in the Department of Research and Isotopes at the International Atomic Energy Agency (IAEA) in Vienna, with developmental projects in East-Central Europe, the Middle East, Africa and Asia. From 1976 to 1992, he headed the Department of Radiation Oncology Physics of New York University. He has served on numerous national and international boards and committees. From 1992 through 2003 he served as Director of International Affairs for the American Physical Society at the American Center for Physics in College Park, Maryland. He has been consultant to the IAEA and UNESCO.

Jorge Lodos received his Ph.D. in Chemistry from Kiev Food Polytechnic Institute, Ukraine, in 1979 and became D.Sc. at Havana University in 1999. He has held different positions in the sugar industry. He acted as Director of Cuban Sugar Industry Research Institute (ICINAZ) for 15 years where he was responsible for and

scientifically involved in experiments for the Cuba-USSR space flight in 1981. He is Associate Professor in the Faculty of Chemistry at Havana University. His research focuses on sugar and sugar by-products technology. He is the author of books, articles and patents on sugar technology and has received several national awards.

Werner Marx studied chemistry at the University of Bonn and prepared his diploma and doctoral thesis in physical chemistry, both dealing with atmospheric chemistry. In 1982, he joined the Central Information Service for the institutes of the Chemical Physical Technical Section of the Max Planck Society, located at the Max Planck Institute for Solid State Research in Stuttgart. This service provides assistance to access, explore and exploit the wealth of scientific information resources available worldwide. The target groups are researchers, librarians, administrators, and decision-makers of the Max Planck Society. Establishing impact data for research evaluation has become a major subject. His publications are focused on the possibilities and limitations when using and interpreting citation data. His special interests are the potential of databases for more comprehensive information demands and the application of bibliometrics to the history of science.

Osvaldo de Melo Pereira is Full Professor of the General Physics Department of the University of Havana. At this university, he received his Ph.D. in 1992 and also served as Dean of the Physics Faculty in the period 2001–2006. He was President of the Cuban Physical Society from 2005 to 2011. His research is mainly related to the preparation of semiconductor films and nanostructures as well as to optical and structural characterization techniques. He has published over 80 scientific papers, over 20 papers on the popularization of science, and has edited three books. He has received awards from the Cuban Academy of Science in 1999, 2004, 2007 and 2013. De Melo has been Visiting Professor of the Centro de Investigaciones y Estudios Avanzados (Mexico) and the Universidad Autónoma de Madrid (Spain), was IOP fellow (2006–2011), and a senior member of the IEEE. He has led a number of international projects and has chaired several international meetings.

Luis M. Méndez Pérez received a degree in physics in 1971 and M.Sc. in higher education in 2005 at Universidad de Oriente, Cuba. He took postgraduate courses on nuclear physics at San Petersburg State University, Russia, from 1972 to 1976. He is a Professor of General Physics, of History of Physics and also of History of Philosophy at Universidad de Oriente, Cuba. He is a member of the Cuban Society of physics, of the Cuban Society of History of Science and Technology. He has been a Visiting Professor at Eduardo Mondlane University, Mozambique, at the ISCED of Uige, Angola and at the Physical Institute of Sao Carlos, Sao Paulo University, Brazil. He was awarded with a number of distinctions and orders for his service to Cuban Education.

Jorge Núñez Jover has a Ph.D. in chemistry and is Director for Postgraduate Studies at the University of Havana (UH). He is the coordinator of the master's and doctoral programs on science, technology and society. He holds the chair in science, technology, society and innovation. He has published 10 books and over

100 papers. His research is in the areas of education, science, technology and society; postgraduate studies evaluation and accreditation, as well as university science policy. He is invited Professor in universities in Spain, Germany, Brazil, Mexico and other countries in Latin America and the Caribbean.

Isarelis Pérez Ones graduated in sociology in 1997, and also with a master's degree in science, technology and society (STS), at the University of Havana (UH). She is now an Assistant Professor there. She was a graduate student at Roskilde University, Denmark (2002–2003). In 2005, she trained in the Ph.D. program, 'Globelics Academy,' at the Technical University of Lisbon. She is finishing her Ph.D. on STS at the UH. Her main interests are related to the social studies of science and technology and gender and higher education. Her current work has focused on the role of universities in the national system of innovation.

Rosalind Reid is a journalist and university administrator. During her tenure as Editor of *American Scientist* magazine from 1992 to 2007, she visited several Latin American countries to promote international scientific networking and the visual communication of science. She serves on the Board of the Council for the Advancement of Science Writing and is currently Executive Director of the Institute for Applied Computational Science at Harvard University and Assistant Dean for External Programs at the Harvard School of Engineering and Applied Sciences.

Jürgen Renn is Director at the Max Planck Institute for the History of Science in Berlin, as well as Honorary Professor for History of Science at both the Humboldt-Universität zu Berlin and the Freie Universität Berlin. He has taught at Boston University, at the ETH in Zurich and at the University of Tel Aviv. He has held visiting positions in Vienna, Bergamo, Pavia and at CalTech. He is a member of the Leopoldina as well as of further national and international scientific and editorial boards. His research looks at the structural changes in systems of knowledge. The aim is to develop a theoretical understanding of knowledge evolution, taking into account its epistemic, social and material dimensions. As groundwork for such a theoretical approach to the history of knowledge, he has been studying some of the great transformations of systems of physical knowledge, such as the origin of theoretical science in antiquity, the emergence of classical mechanics in the early modern period and the revolutions of modern physics in the early twentieth century.

Carlos Rodríguez Castellanos received his *Licenciado en Física* (1970) and his Master of Science (1975) at Havana University, and his Ph.D. in theoretical and mathematical Physics at the Joint Institute for Nuclear Research, Dubna, USSR, in 1981. His research has focused on applications of quantum statistical mechanics to condensed matter theory and materials science. He has made contributions to polaron theory, dielectric relaxation, quantum Hall effect, adsorption and diffusion in porous materials. He was Professor of Theoretical Physics (1984) and Emeritus Professor (2013), Dean of the Faculty of Physics (1984–1991), Vice Rector for Research (1991–1996) and Director of the Institute of Materials Science and Technology (1999–2008) at the University of Havana. He was President of the

Cuban Physical Society (1991–1994); President of the Jury of the XXII International Physics Olympiades (1991); and Member of the Commission "Physics for Development" of IUPAP (1996–9). In 2012, he was Emeritus member and Vice President of the Cuban Academy of Sciences.

María Sánchez Colina is currently Dean of the Physics Faculty at the University of Havana where in 1996 she received her Ph.D. Her research focuses on semiconductor lasers. She has been Visiting Professor at the Centro de Investigaciones y Estudios Avanzados (Mexico) and at the Universidad Autónoma de Madrid (Spain). She has edited two conference proceeding volumes and was editor of the *Cuban Journal of Physics* from 2002 to 2010. From 1998 to 2001, she was Chair of the Cuban Chapter of the Electron Devices Society (EDS –IEEE).

Oscar Sotolongo-Costa received his Ph.D. from Havana University and is Professor for theoretical physics and history and methodology of physics there. He lectures on the physics of complex systems and on different branches of theoretical physics. His research interests include fluid mechanics, statistical physics, dynamical systems, and he has published widely on these subjects. He is currently President of the "Henri Poincare" group of Complex Systems at Havana University.

Maria C. Tamargo is Professor of Chemistry at the City College of the City University of New York (CUNY), where she has been since 1993. Prior to that, she was a Member of Technical Staff at Bellcore and AT&T Bell Labs. Her research interests focus on semiconductor materials growth by molecular beam epitaxy with emphasis on exploring novel materials properties and device applications of wide band gap II-VI compounds. She has authored over 250 research papers and is the editor of *II-VI Semiconductor Materials and Their Applications* (2002, Taylor and Francis). During the years 2001 through 2007, she served as Dean of the Division of Science at City College. She is a fellow of the American Physical Society and an editor of the research journals *Physica Status Solidi c* and *Semiconductor Science and Technology*.

Carlos Trallero-Giner is Professor at the Department of Theoretical Physics at the University of Havana. He received a Ph.D. in theoretical physics and mathematics in 1980, and a doctor's degree in physics and mathematics in 1990 from the Ioffe Institute, San Petersburg/Russia. He has been a visiting scholar at several universities and research institutes in Germany, USA, Russia, Spain, Brazil, and other countries. He was awarded a Fellowship of the American Physical Society and Distinguished Professor by the Cuban Ministry of Higher Education. His research interests focus on condensed matter theory, light scattering in solids, semiconductors and low-dimensional structures, phonons and electron phonon interactions in nanostructures, optical properties, mathematical physics and chaos, and Bose-Einstein condensation. He has published over 200 scientific research papers.

Theodore Veltfort (1915–2008) was an electrical engineer by profession and volunteered with the Abraham Lincoln Brigade during the Spanish Civil War. In Cuba, he worked first for JUCEPLAN, under the leadership of Ernesto Guevara,

and then for 5 years at the University of Havana in the School of Physics, directed by Dr. José Altshuler.

Elena Vigil Santos received her B.Sc. and MAT degrees from Fairleigh Dickinson University, N.J. and her Ph.D. from Havana University (UH) in 1984. She teaches Solid State Physics as Professor or the Physics Faculty (UH). She engaged in III-V semiconductor physics and optoelectronic devices research for over 20 years. In the last 10 years she has studied materials and structures for new-concept solar cells. She designed and prepared the first experiment in which GaAs and AlGaAs epitaxial layers were grown in space during the Cuba-USSR space flight in 1981. She held different posts in Havana University: Research Vice-Director of the School of Physics (1970–1974) and Research Vice-Director of the Institute for Materials and Reagents (1985–1998). She is "member of merit" of the Cuban Academy of Science and member of the Latin American Regional Committee of the International Council of Science (ICSU).

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Abbreviations

ACC	Cuban Academy of Sciences
AENTA	Agency for Nuclear Energy and Advanced Technology
AID	Agency of Information for Development
ALASBIMN	Latin American Association of Biology and Nuclear Medicine Societies
APS	American Physical Society
BECICPA	Special Bureau for the Construction of Scientific Instruments with Adjunct Production (now CEDEIC)
BIOCEN	Center of Biopreparations
CAME	Argentina Confederation of Medium Enterprises
CBFM	Center for Biophysics and Medical Physics
CCE	"Ernesto Che Guevara" Electronic Component Complex
CEAC	Cuban Commission for Atomic Energy
CEADEN	Center for Studies Applied to Nuclear Development
CECT	State Committee for Science and Technology
CEDEIC	Development Center for Scientific Instruments and Equipment (originally BECICPA)
CENC	National Nuclear Energy Commission of Cuba
CENIAI	National Center of Automatic Exchange of Information
CENTIS	Isotope Center
CERN	European Organization for Nuclear Research
CID	Center for Digital Research
CIEN	Information Center for the Nuclear Sphere
CIES	The Solar Energy Research Center
CIGB	Center for Genetic Engineering and Biotechnology
CIME	Research Center for Microelectronics
CIMEQ	Center for Clinical and Surgical Research
CINVESTAV	Center of Investigation and Advanced Studies
CIPIMM	Institute for Research and Projects for the Mining-Metallurgical Industry

CITAMEL	Enterprise for Information Technologies and Advanced Telematic Services
CITMA	The Ministry of Science, Technology and Environment
CLAF	Latin American Center for Physics
CNEA	National Commission for the Civil Applications of Atomic Energy
CNIC	The National Center for Scientific Research
CNCT	National Council for Science and Technology
CNGC	National Commission for Scientific Degrees
CNRS	National Center for Scientific Research (France)
CNSN	National Center for Nuclear Safety
CPHR	Center for Radiation Protection and Hygiene
CSIC	The Spanish National Research Council
CUJAE	Ciudad Universitaria "José Antonio Echeverría"
CYTED	Ibero American Program of Science and Technology for Development
DNI	National Directory of Informatics
EF	School of Physics
ESI	Essential Science Indicators
FCT	The Science and Technology Forum
FCTN	Faculty of Nuclear Sciences and Technologies, University of Havana
FELASOFI	Latin-American Federation of Societies of Physics
FEU	University Students Federation
GET	Group for Electronics in Tourism
GDS	Semiconductor Devices Group
IAEA	International Atomic Energy Agency
ICID	Cuban Institute for Digital Research
ICIMAF	Institute for Cybernetics, Mathematics and Physics
ICM	Institute of Marine Sciences
ICINAZ	Cuban Institute for Sugar Research
ICO	International Commission for Optics
ICSU	International Council for Science
ICTP	International Center for Theoretical Physics, Trieste
IFN	Institute for Nuclear Physics
IGA	Institute for Geophysics and Astronomy
IILA	Italian Latin-American Institute
IMACC	The Mathematics, Cybernetics, and Computing Institute
IMRE	Institute of Materials Science and Technology
ININ	Institute for Nuclear Research
ININTEF	Institute for Fundamental Technical Research
INSAC	National Institute of Automated Systems and Computer Technologies
INSPEC	Web of Science, Essential Science Indicators
INST	Institute for Nuclear Science and Technology
INSTEC	Higher Institute for Applied Sciences and Technologies (until 2003, ISCTN)

IPHO	Organization for the International Physics Olympiads
IPVCE	Vocational Pre-university High School in Exact Sciences
ISCAB	Higher Institute of Intensive Livestock Farming Sciences
ISCAH	Higher Agricultural Sciences Institute of Havana
ISCTN	Higher Institute of Nuclear Sciences and Technologies (renamed INSTEC in 2003)
ISPEJV	Pedagogical Institute "Enrique José Varona"
ISPJAE	"José Antonio Echeverría" Higher Polytechnic Institute
ISPJAM	Higher Polytechnic Institute "Julio Antonio Mella"
ISCTN	Institute of Nuclear Sciences and Technologies, Havana
ITM	Military Technical Institute
IUCr	International Union of Crystallography
IUPAP	International Union of Pure and Applied Physics
JINR	Joint Institute for Nuclear Research
LACETEL	Central Laboratory of Telecommunications
LAGS	Laboratory of Synthetic Antigens
LIEES	Laboratory for Solid State Electronics Research
LRI	Industrial Radioisotope Laboratory
LTP	Planar Technology Laboratory
MASPEC	Special Materials for Electronics and Magnetism (now IMEM)
MES	Ministry of Higher Education
MIC	Ministry of Informatics and Communications
MINCOM	Ministry of Communications
MINED	Physics Department of the Ministry of Education
MINFAR	Ministry of the Revolutionary Armed Forces
MININT	Ministry of the Interior
MINJUS	Ministry of Justice
MINSAP	Institute of Oncology and Radiobiology of the Ministry of Public Health
MOCVD	Metalorganic Chemical Vapour Deposition
NED	National Endowment for Democracy
OTRI	Office for the Transfer of Research Results
PAHO	Pan-American Health Organization
PNUD	United Nations Development Programme
SCI	The Thomson Reuters Science Citation Index
SCUH	Superconductivity Laboratory, University of Havana
SEAN	Executive Secretariat for Nuclear Affairs
SIME	Ministry of Metallurgy and Electronics Industry
SLAFES	Latin-American Symposium of Solid State Physics
SUMA	Ultramicroanalytic System
SQUID	Superconducting Quantum Interference Devices
TWAS	Third World Academy of Sciences, Trieste
TWOWS	Third World Organization for Women in Science
UAI	International Astronomical Union
UCLV	"Marta Abreu" Las Villas University

UH	University of Havana
UJC	Union of Young Communists
UNAM	National and Autonomous University of Mexico
UNEAC	Cuban National Union of Writers and Artists
UNPD	United Nations Program for Development
UO	University of Oriente, in Santiago de Cuba
UPEC	Journalists' Union
USAID	United States Agency for International Development
UUCP	Unix-to-Unix Communication Protocol
VVER or WWER	Vodo-Vodyanoi Energetichesky Reactor (Water-Water Power Reactor)
WHO	World Health Organization
WoS	Web of Science

Introduction

Chapter 1
A Short Introduction to this Volume

Angelo Baracca, Jürgen Renn, and Helge Wendt

The history of physics in Cuba comprises two centuries of intensively interrelated processes in politics, society, science and worldwide communications. The evolution of physics as a discipline since the early nineteenth century may serve as a focal lens for studying the developments in Cuban society in a global context. At the eve of the 1959 Revolution, the new physics of the twentieth century was not widely known, nor taught, in Cuba and scientific research scarcely existed in its universities. It is only in the past half century that Cuba has built up an advanced scientific system.

To a broader public, the high level of Cuban science in biotechnologies, immunology and medicine is well known. But scientific development also took off very quickly in physics, achieving impressive results within the first 15 years after the Revolution. One may imagine that such a rapid take off and development was due exclusively to the far-reaching collaboration with—and support from—the USSR and other Socialist countries. It is true that this factor should not be underestimated. Hundreds of Cuban physicists graduated, specialized and worked in the prestigious scientific institutions of the USSR. Nevertheless, the contributions to this volume show that in the beginning many Western physicists also played a fundamental role. During various periods, they visited the newly founded School of Physics of the University of Havana and promoted initiatives in higher education and scientific research, such as the summer schools. Collaboration with the USSR and the Socialist countries grew gradually and assumed a significant role only from the 1970s on. Cuban physicists, however, never severed ties nor terminated their collaborations with Western colleagues and institutions, a circumstance that has played an important role.

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Another original aspect that must be considered in the scientific development in Cuba since the 1960s is that the strategies for this development were not simply copied or imported from more advanced countries. There was a lively debate within the Cuban scientific community (and with foreign Western advisers), inspired by the requirement that research should relate directly to the economic and social development of the country.

This volume presents the history of one scientific discipline in one country, from its origins in the early nineteenth century up to the present time. This task was facilitated by both the relatively short historical period of this development and the relatively limited size of the Cuban community of the physicists. Nevertheless, we hope to present a pioneering volume that depicts the development of a scientific community in an international context over a period of 200 years.

The Structure of the Volume

The contributions to the volume are organized in four parts. They are preceded with a personal introduction by Angelo Baracca to Cuban society with all of its complex and multifaceted aspects. This is an attempt to help the reader with little or no knowledge of Cuba to position the developments discussed in the volume within the lively historical and social reality. It is followed by a short critical bibliography compiled by Duccio Basosi that aims to suggest further reading for the non-specialist. A short biography of all of the authors who contributed to this volume is also included.

The first part of the volume includes several contributions that reconstruct the different stages of the history of physics in Cuba, from its beginnings in the late colonial era to the present. The first contribution by José Altshuler and Angelo Baracca gives an overview of the development from the late eighteenth century on. The second contribution by José Altshuler deals in more detail with the beginning of the systematic teaching of physics from the 1920s to the end of the 1950s. The third contribution by Angelo Baracca, Víctor Fajer and Carlos Rodríguez Castellanos treats the development of physics after 1959, covering the foundation of various institutions as well as international cooperation, mostly with countries of the former Eastern bloc. In their contribution, Carlos R. Handy and Carlos Trallero-Giner give a detailed overview of the achievements of Cuban physics after 1959, dealing with research as well as with education. The contribution by Luis M. Méndez Pérez and Carlos A. Cabal Mirabal describes how the University of Oriente in Santiago de Cuba, founded in 1947, became an important center of teaching and research in physics from the 1960s on. In his contribution, Diego de Jesús Alamino Ortega studies the training of physics teachers in Cuba from the colonial period on, with a focus on pedagogical efforts undertaken after the revolution. The paper by Isarelis Pérez Ones and Jorge Núñez Jover, reprinted from *Science and Public Policy,* discusses some of the political strategies of technological innovation and the development of physics in Cuba in the 1980s and 1990s.