

Chapter 2

The Cuban “Exception”: The Development of an Advanced Scientific System in an Underdeveloped Country

Angelo Baracca

This island is a paradise. Cuba. If I am lost, look for me in Andalusia or in Cuba.

(Federico Garcia Lorca)

Cubanity does not lie in showy touristic attractions, but in an ineffable underground tenderness, a being-not-being, the waving of the breeze, a certain lack of definition, a mixture of the earthly and the stellar. The most solid Cuban tradition may be looking forward to the future. Few peoples of America have been as determined to leap into the future so violently, with a shock of premonition. That is why there is a certain convergence of the generations. We are all marching towards a goal, somewhat distant and uncertain. This vagueness is convenient, it enriches us because it is limitless. Cuban means possibility, fantasy, fever for the future. We need to spread this character throughout the world.

(José Lezama Lima)

Given that man has come in order to live, education has to prepare for living In the school it must be learned how to handle the powers of struggles in a lifetime. They should not be called schools, but workshops. And the quill should be used in the afternoons, while in the mornings, the hoe.

(José Martí)

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2.1 Physics in a Difficult Environment

2.1.1 *Cuban Exceptionalism*

Science, education, politics, social development and economics are today considered to be highly interdependent. Although none of these factors can exist alone, they have nevertheless often been considered in isolation from each other or studies of their interactions have been confined to the consideration of more or less local contexts. When it comes to studying the history of physics in Cuba, however, it is inconceivable to separate scientific developments from their social, political, and cultural contexts. As this volume shows, the history of physics in Cuba cannot just focus on local contexts since it is closely entangled with global history, from colonialism to the Cold War.

In this sense, also the history of Cuban physics displays the features of international entanglement, sometimes visible and sometimes latent, of other aspects of Cuban history, from music to politics. Cuba is a strip of land covering less than a thousandth of the earth's surface and counting roughly two-thousandths of the world's population. Yet few places or peoples in the world can boast a comparable capacity to excite strong passions and emotions and also to exert cultural influence in every field, permeating—at times explicitly, more often in hidden, indirect or even unconscious ways—styles, tastes and trends. Cuba is a melting pot of ethnic and cultural influences from three continents and civilizations. Over the course of the century this shaped and strengthened a peculiar kind of national and cultural consciousness. Starting with the *Grupo Renovación*, Cuban music was spread worldwide by musicians like Argeliers León (1918–1991) and Harold Gramatges (1918–2008) and by celebrated performers like Benny Moré (1919–1963), the Trío Matamoros and Enrique Jorrín (the inventor of the *cha-cha-cha*). It was in the 1930s that Joséito Fernández (1908–1979) composed the world-famous song *Guantanamera* (which the North American composer Pete Seeger (born in 1919) adapted to verses by José Martí in the 1960s). In 1959 the victory of the Revolution on the small island of Cuba (which at the time had only six million inhabitants) introduced a clamorous rupture in the delicate world balance that had come into being at the end of the Korean War and that characterized the Cold War decades. Not only in the context of Latin American political emancipation but also in many other fields, Cuba played a disproportionately large role compared to its size.

In this volume only the history since the beginning of the nineteenth century will be considered, when Cuba was still under Spanish colonial dominion. Here some of the interdependence of science with economy and politics becomes obvious for the first time, when, for instance, the sugar industry exported more and more to the United States and, as a consequence, the *azucareros* sought for new scientific methods of sugar production. In this situation Cuba gradually detached itself from Spain and turned to the large and expansive northern neighbor. When by the end of the nineteenth century Cuba declared its independence from Spain it was rear-covered by Washington. This national liberation quickly entailed a new dependence—now it was the United States that dictated laws and economic measures. These first decades

of the twentieth century were characterized by a radicalization that was not confined to the field of politics but also affected developments in education, science, economy and social politics. This radicalization, together with the consolidation of a middle class benefitting from new economic opportunities beyond the sugar industry, led to the birth of revolutionary movements. The outbreak of the revolution of 1958 was the result of economic stagnation, a deficit in education politics, intellectual criticism and political struggles.

Over the course of the last five centuries Cuba constituted an *exception*, an *atypical case* lying outside of traditional classifications taking national histories as their paradigm. We must underlie that our use of terms such as “exception,” “exceptionalism” referred to Cuba does not imply any value judgment, nor reflect special sympathies, but correspond to concrete differences in his history and cultural and social reality with respect to any other (not only Latin American) country. The history of Cuba also constituted an exception in comparison with that of the other Spanish colonies in Latin America and the Caribbean. In a world that has become, since the Spanish expansion and colonial rule, increasingly globalized (Gruzinski 2004), Cuba has played a central role in many different aspects. It has served and continues to serve as a focal lens in particular for the cultural and intellectual processes accompanying globalization. In fact in Cuba people, customs, cultures, religious beliefs and even knowledge was mixed, giving way to synergisms that thus provided the basis for the concept of “transculturation” coined by Cuban sociologist Fernando Ortíz (1881–1969).

Ortíz developed the concept of ‘transculturation’ in 1941 to account for the interpretation of Spanish and African cultural influences in Cuban national identity that acknowledged the ongoing influence of the customs, traditions, and cultures of all those partaking in scenarios of cross-cultural contact and exchange. Ortíz insisted on the reciprocal influence that various groups have on each other in the creation of a new national identity (see e.g. Millington 2005). As Ortíz writes:

because this process does not consist exclusively in acquiring another culture,¹ [...] rather, the process also necessarily implies the loss or uprooting of an original culture, which could be termed a partial deculturation, as well as the consequent creation of new cultural phenomena which could be described in terms of a neoculturation. (Ortíz 1995 [1947], 102–103)

This concept reflects the international situation of Cuba coming out of a long history of colonial and imperial domination and later inspired concepts such as Creolization (Otto 2007), *mestizaje* and Postcolonialism (Shih and Lionnet 2011), relevant also to current references in history of science (Anderson 2009).

The aim of the volume is to show that Cuba’s *exceptionality* is not limited to such broader cultural questions, but instead comprises also knowledge, the natural sciences, and in particular physics. The articles collected in this volume show the rich history of Cuba’s *exceptionality* regarding scientific developments. We shall limit ourselves to the field of physics, in which styles of work, methodological approaches and conceptual contents have undergone substantial homologation all over the world by now. Still, we feel that the reader will recognize some quite decidedly characteristic

¹ This is what the Anglo-American word ‘acculturation’ actually means.

features in Cuban physics, as part of an international science. Physics as practiced in Cuba has displayed an exceptional plasticity in its capability to adapt to an often improvised technological infrastructure, in its ability to respond to specific social and economic needs, but also in its openness towards diverse traditions and schools of research and, not the least, in its inventiveness of ways to integrate physics into the concert of a variety of disciplines without an agenda of hegemony.

Some examples may help to capture the spirit of this plasticity. At the end of the 1960s, shortly after the revolution, Cuban physicists combined advanced nuclear technology of Russian provenance with a new silicium technology introduced by French physicists in summer schools to advance in the field of microelectronics.² In more recent years, Cuban physicists improvised means for exploring the newly discovered phenomenon of superconductivity at high temperatures for ceramic materials and developed a new advanced research activity in this field.³ The heavy burden imposed by the lack of funding and equipment due to the isolation of the country after the breakdown of the Soviet empire has been taken by Cuban physicists as a challenge to tackle new problems “under conditions of high tropicality” such as the collective behavior of ants or the movement of sand,⁴ relying on modest material means and uncommon inventiveness.

There is another exceptional feature in the relation to science and society in Cuba. The percentage of university graduates and physicians in the Cuban population and the overall level of their scientific training have no equals among other underdeveloped countries (Hoffmann 2004, 166–168).⁵ The country boasts considerable technical-scientific potential: there is a mid-level technician for every 8 workers, a university graduate for every 15; there are over 160 centers of scientific research, and 1.05 technologists and researchers for every 1000 economically active inhabitants (the latter amounts to 5.5 million): in 2011, 4,618 full-time researchers and 58,700 professors in higher education.⁶ These indicators are comparable to those in many highly developed nations and there are branches of knowledge, such as biotechnology, whose development in Cuba is well known beyond its borders.

To sum up, the interest of Cuba for science lies in the fact that it represents an exceptional, and perhaps unique, case of *development of an advanced scientific system in a developing country*, and what is more one with an extremely small population and economy. This is all the more exceptional if we add that this development has taken place in a few decades, as the case of physics treated in this volume demonstrates. Physics in Cuba was for a long time a rather marginal discipline in the Cuban scientific community and still today physicists are only a small part of it. Nevertheless, physics always acted as a backbone of intellectual life and has provided many other sciences with scholars, methods and scientific approaches that were important for the further development of Cuban sciences such as medicine,

² See the chapters by Baracca, Fajer and Rodríguez, and by Cernogora in this volume.

³ See the chapter by Arés Muzio and Altshuler in this volume.

⁴ See the chapter by Sotolongo Costa in this volume. See also the homepage of Ernesto Altshuler: <http://www.complexperiments.net/EAltshuler/HomeAlt.htm>. Accessed October 18, 2013.

⁵ See the chapter by de Melo Pereira and Sánchez Colina in this volume.

⁶ <http://www.one.cu>

biotechnology, or the nanosciences. Physics is a good example to study this process also in an international context, as this science is highly dependent on the an international communication of research results, on well-equipped laboratories with instruments made in different countries and on the exchange of well-trained experts. We therefore consider the importance of the history of physics in Cuba as a case study of science in an international context. This volume illustrates ways in which international flows of scientific knowledge and an international political situations and the “local” scientific and political circumstances interacted.

Science in Cuba has represented, since the beginning of the nineteenth century, time and again, a field of emancipation from colonial and imperial submission. Even more, throughout the Cuban history of the late nineteenth and twentieth centuries important figures as Félix Varela (1788–1853), José Martí (1853–1895), Enrique José Varona (1849–1933) or Manuel Gran (1893–1962) were conscious of the fact that political independence had to be accompanied by an autonomous development of scientific education and research. While Simón Bolívar (1783–1830) still relied on Enlightenment ideas of education, considering it as an individual form of liberation (Briggs 2010, 99–106), José Martí was inspired by US-American and British models. He envisaged education as a crucial factor in the formation of the Cuban nation, independent from Spanish and US educational systems (Quiroz 2006). In Martí’s perspective Cuba could achieve real independence only when the necessary skills were developed to overhaul the economic, political, social and technical underdevelopment inherited from the Spanish colonial regime.

The situation of the sciences in Cuba before the Revolution of 1959 depended on social and political conditions that inhibited the technological and scientific evolution of the country. The majority of the Cuban economic and political elites as well as foreign powers exploited the island and had no interest in any kind of autonomous development. This situation lasted over the times of Spanish colonial and US-American imperial domination, during which an elite of sugar producers impeded a real advancement of the society, especially that of science (Bravo 2001). However, the take-off of Cuban sciences after the Revolution would not have been possible without a minimal scientific infrastructure and trained personal. These achievements were the result of the development of a middle class and also a working class interested in the economic advancement of the country.

The social and economic circumstances fostered technological and scientific development, even against the will of the Spanish colonial regime. Looking for practical solutions, a cooperation between entrepreneurs and technicians established an international network and became a sort of a backbone of intellectual life on the island, as is shown by José Altshuler and Angelo Baracca,⁷ before playing an important role in the industrial development from 1963 on.⁸

Studies of the history of physics in Cuba and its an international contexts are still in their infancy. This volume brings together, as a first step toward a more comprehensive account, some pioneering work also directly involving Cuban scholars, as well as interviews with protagonists, resulting in first attempts at a systematic

⁷ See the chapter by Altshuler and Baracca in this volume.

⁸ See the chapter by Baracca, Fajer and Rodríguez in this volume.

treatment of entire historical periods before and after the revolution. This material is complemented by recollections and reflections from both the inside and the outside, from Cuban physicists and their foreign collaborators, and also by glimpses into the conditions and impact of scientific work and communication in Cuba.

The political situation that still persists in Cuba makes it difficult to write a history that is free from political implications, as historical accounts not influenced by current political and ideological situations are hardly achievable. The result is unavoidably a kind of political history, and may be biased by a lack of distance to historical events that are still closely connected with the present.

2.2 Contradictions and Developments of Cuban Economy, Culture and Science in Late Colonial Times

Though poor in precious natural resources, especially metallic minerals, and with the exception of sugar lacking important processing industries, Cuba was a precious source of added value for goods thanks to its strategic geographical position, which gave it a trade advantage as juncture for commerce between Latin America and Europe and as time went on also with the United States. At the same time, there seemed to be little motivation for technical and practical innovations.

In the mid-eighteenth century the 250-year-old Spanish colonial domination in America was weakened by wars in Europe and North America. The political authority that before seemed to be prevailing was shattered by unforeseeable events. The situation in the Caribbean changed after independence of the 13 British colonies in 1776, the French Revolution of 1789 and the subsequent independence of Haiti as well as the Napoleonic occupation of Spain that led to the independence of Argentina in 1810–1816, Paraguay in 1811, Venezuela in 1811–1819 (in the context of the ‘Gran Colombia’, which in 1830 was divided into Ecuador, Venezuela and Colombia), Chile in 1818, Peru in 1821 (which Bolivia separated from in 1825) and Mexico in 1821–1823.

Cuba did not free itself from Spanish colonial dominion until 1898, when after the Spanish-American War the Iberian colonial power had to hand over Puerto Rico, Cuba and the Philippines to the new emerging imperial power. Thus, during the nineteenth century Cuba remained a Spanish colony and had to master the challenges to site itself between the colonial dependence and the newly emerged independent nations, mostly with United States.

2.2.1 Sugar and Tobacco in the Nineteenth Century

Cuba’s economy relied mostly on a sugar monoculture. After the Haitian revolution of 1791 and the breakdown of its sugar production, the Cuban sugar economy was given a decisive boost. The threat of a similar social revolution (Ferrer 2005, 67–83)

reinforced the determination of the Cuban Creole elite⁹ to remain faithful to the Spanish crown. In this way, the colonial regime survived in Cuba, even when during the nineteenth century the dependence on the US-markets of sugar and from US-sugar companies increased.

The already mentioned Cuban sociologist Fernando Ortíz has considered tobacco to be the hero in Cuban society, while sugar is the villain (Ortíz 1940). Tobacco was grown mainly in the western part of the country, where it created a middle class. On the contrary, sugar was grown in the rest of the island and created two classes of people: masters and slaves (Reinert 2007). Tobacco farming developed a demand for specialized individual skills and the division of labor, since the market price depended on the pickers’ and handlers’ ability (an expert sorter can distinguish between 70 and 80 different types of tobacco). The sugar crop, instead, was based on a mass of slaves and on the brute strength needed to cut the cane with a machete. Tobacco, says Ortíz:

is wealth and intelligence, and mainly domestic capital; sugar is poverty and ignorance, and foreign capital. In Cuba’s history sugar represents Spanish absolutism, tobacco the liberation of the native population. Sugar has always been sustained by foreign intervention. [...] Sugar has always preferred slave hands, tobacco free men. Sugar imported blacks with force, tobacco fostered the voluntary immigration of white men. (Ortiz 1995 [1947], 65)

Cuba possessed a world advantage for both crops. Its tobacco was one of the few cases of “brand-name” products in the third world. It is interesting in this context to consider the thesis of Reinert, according to which the predominance of sugar in the Cuban economy was a cause of its underdevelopment. Indeed, as we shall see, though technological development was greater in sugar refining than in cigar production, cigar producers were consistently richer than sugar producers (here the author traces a parallel, in a certain sense reversed, with the situation of the United States after 1930, which boasted the highest level of efficiency in the world both in agriculture and industry, but farmers stayed poor while industrialists got rich).

In effect, in the first decades of the 1800s competition from other Caribbean islands that had increased their sugar production, along with the introduction of the sugar beet in Europe¹⁰ and the British campaign for the elimination of the African slave trade (Adderley 2006; Brown 2006), that Spain was forced to cease in 1821 (Blackburn 1988), caused great changes in the structure of the Cuban sugar industry. Albeit the slave-economy, the owners of sugar mills invested in technological innovations (Scott 1985, 27–28; Zeuske 2012, 39, 104), including the introduction of steam-powered machinery and the first railroad. The number of *ingenios*¹¹

⁹ Creole is the term given to offspring of white immigrants born in Cuba.

¹⁰ For the interrelation of the global sugar market and the technological change in Cuban sugar production, see Tomich (2005).

¹¹ The term *ingenio* indicates the former colonial companies for processing cane to extract sugar and its byproducts. Previously there had been the *trapiche*, which produced on a smaller scale. For an overview over the principal Cuban *ingenios*, see Cantero et al. (2005).

multiplied rapidly (from roughly 1,000 in 1827 to 2,000 in 1860). This economic boom of what has been called “sugar-capitalism” (McNeill 2010, 295) or “capitalism of humans,” i.e. capitalism of slavery (Zeuske 2012, 35) constituted a factor that further delayed the formation of a national consciousness antagonistic to Spanish dominion, in contrast with what happened in the rest of Latin America.

Three developments polarized the Cuban situation even further, feeding a sort of vicious circle. Economic prosperity, linked to the single-crop sugar economy, fostered strong resistance to any possibility of eliminating slavery; on the contrary, the demand for slaves and the consequent illegal traffic from Africa grew. The result was that towards the middle of the 1800s the ratio between the white population and the population of African origin (made up of roughly 2/3 slaves and 1/3 free men) was reversed (de la Sagra 1842; Scott 1985). This circumstance worked to worsen fears of revolts, like in Haiti at the end of the eighteenth century or in Jamaica along the 1830s (Ferrer 1999). From the 1840s on, a high amount of Chinese came to Cuba by the coolie trade. Even if only a little number of them stayed in Cuba after in 1874 the trade was resolved, the Chinese impact in cultural life in Cuba was for a long time remarkable (López 2004).

Because of the unstable situation related to slavery and forced work, the Creole elite had an interest to strengthen the ties with Spanish colonial power. At the same time, the goal of many of those Cubans who wanted to put an end to Spanish domination was translated into a desire to be annexed to the United States, which embodied the ideal of a free modern country.

2.2.2 The Role of Sugar in Making Cuba Dependent on the US for Its Modernization

It is relevant to make some general observations at this point about how deeply the sugar economy conditioned and determined Cuba’s entire history, economy and society. Sugar was not only the most important export good of Cuba, but also a motor for modernizing the country’s technology, even when socially and politically this meant that Cuban social structure should remain backward as has been partly shown before. At the end of the nineteenth century the US-companies bought the majority of Cuban sugar production but invested in new forms of production. The Cuban economy was ever more oriented towards the United States, which absorbed the majority of Cuban exports (about 17 % in 1840, 86 % in 1895); US capital invested in Cuba also increased. This was also one reason why the *ingenios* sugar producers yielded to the greater productive capacity of the *centrales*.

Thus, US economic penetration of Cuba had been growing from the start of the century. Already in 1826 the volume of Cuban trade with the U.S. was almost three times greater than its trade with Spain. (Ramón de la Sagra 1831, 200–205). This was

the reflection of a growing presence of North American capital in the Cuban economy, which led to the ownership and control of vast parts of its productive structure. As an authority like Fernando Ortíz emphatically claims:

in 1850 this country's trade with the United States exceeded that with the Spanish metropolis and the United States definitively assumed its natural geographical condition of buyer for nearby Cuban products, but also its privilege as economic metropolis. Already in 1881 the United States Consul General in Havana officially wrote that Cuba was economically dependent on the United States, even if politically it was still held by Spain. (Ortíz 1995 [1947], 64)

2.2.3 *Technological Developments During the Nineteenth Century*

In this context it may come as a surprise that in the course of the nineteenth century Cuba experienced the introduction of advanced innovative technologies very early on, earlier not only than the mother country but also than other, more developed countries. This, in fact, constitutes another aspect of Cuban exceptionality. Examples are the introduction of the steam engine in the *trapiche*¹² as early as 1817, the first railroad for transporting goods between Havana and the village of Güines (46 km) in 1837, and the precocious development of advanced communication technology (Blaquier 2009; Baracca 2009).

The Cuban railway developed parallel to the sugar industry and telephone lines followed the train tracks (Blaquier 2009). The first railway was important to transport sugar and possibly also slaves (Zeuske 2012), as well as to explore remote parts of the island. Miquel Biada i Bunyol, who had a close relationship with the governor Miguel Tacón y Rosique (1755–1855), promoted the first railway in a Spanish territory that was inaugurated in 1837. He after this success returned to Catalonia, where he promoted the first European Spanish railroad from Mataró to Barcelona. Another migrant to Cuba was Antonio López y López, who promoted maritime steamship connections from Cuba to Spain (McDonogh 2009, 64). Such technical development on the island depended largely on Spanish investments. But its realization was more easily possible in the Cuban political environment, where the Creole elite was open to support such projects. They afterwards expanded the railway network in the Middle and Western parts of the island, while in the Eastern regions much less effort was made (Santamaría García and García Álvarez 2004, 170–172).

The telegraph played an important role during the Ten Years' War (1868–1878), when the interception of dispatches allowed the revolutionaries to avoid early arrest of the leaders of the revolt, while during its military intervention of 1898 the United

¹² The *trapiche* were colonial sugar plants for processing sugarcane.

States made early experiments with techniques for cutting underwater cables to isolate the Spanish army (Pruna Goodgall 2005, 227). It is therefore understandable that the Island felt the need for advanced scientific knowledge, modern higher education and new technical engineering competence only much later. Cuba's need for the development of railways, communication and information technologies, and the fight against tropical diseases is evident. It may also be supposed that Spain's scientific and technological backwardness and its pre-capitalistic, purely exploitative attitude towards its colonies created a further obstacle to Cuba's scientific development, at the same time as it contributed to the decline of Spain itself.

Also other infrastructures were renewed during the nineteenth century. The entire military defense system was reinforced in order to prevent an invasion as in 1762, when the British navy could have taken quite easily the harbor of Havana and occupied the town. Besides the buildings and the armaments the geographical knowledge of the Cuban island and the surrounding waters were improved, for instance by the cartography project of José de Valcourt undertook between 1821 and 1830. The map was the basis to build further defense fortification at the rim of the island as well as on surrounding islands (Nadal 1989, 329–356).

To these can be added the preliminary experiments on the telephone carried out in 1849 by the Italian Antonio Meucci in the *Teatro Tacón* of Havana (Ortíz 1940; Catania 1994, 2004; Altshuler and Díaz Martín 1999, 2004), the start-up of the first public telephone service in Havana in 1882 (González Royo 2004) and the first public illumination systems (Altshuler and González 1997). Cuba had also been a shipbuilding power; indeed, until the Battle of Trafalgar (1805) the most powerful Spanish ships were built in Havana.

2.2.4 Education and Intellectual Life in Cuba in the Nineteenth Century

In the nineteenth century, a contradictory situation arose which characterized Cuban society. Important technological advances were made, but were not reflected in the educational and the intellectual life of the country. The growth of more specific scientific disciplines, in particular chemistry, physics and engineering, remained slow, though they had made significant progress in other Central American countries. This contradiction can be explained on the basis of the peculiar Cuban colonial status we have discussed (Baracca 2009). The growth of the economy and commercial exchanges, in fact, boosted the need of advanced communication systems and production technologies. As we shall also see below, the progress made in Cuba in the field of medicine since the beginning of the nineteenth century, was greater than that of other colonies, and comparable to the level of medical knowledge and practice in more developed countries. In contrast to these noteworthy developments in technical progress, as well as in the medical and applied natural sciences, the

Spanish colonial rule and the fears of the Creole elite strongly opposed and prevented comparable progress in education and basic sciences.

Indeed, the most advanced sectors of Cuban intellectuality (and some progressive sector of the church) expressed the need of a scientific renovation: the priest Félix Varela (1787–1853), under the enlightened and progressive direction of Bishop Juan José Díaz de Espada (1756–1832), introduced as early as in 1817 modern contents of physics. However, the Spanish royal power in the motherland strongly opposed and prevented the further and full development of a modern education system, until the end of the colonial Spanish rule in 1900. During the second half of the nineteenth century, progressive and conservative circles could not agree on the question of how much education was required. While the Spanish conservatives rejected the initiatives of progressive Creoles, freed blacks and anarchist organizations, these latter groups tried to establish an educational infrastructure in partial opposition to the colonial institutions (Casanovas Codina 1998).

Earlier, at the beginning of the nineteenth century, the Catholic priest, Félix Varela who is said to have first taught Cubans to think, carried on educational work of fundamental importance, introducing the innovating spirit of the enlightenment in Cuba, as we shall see in the first contributions to this collection. Elected in 1822 as a representative to the Spanish Cortes, he voted in favor of partial autonomy from Spain and during his stay in Spain, wrote an influential treatise in favor of the abolition of slavery (Los restos del padre Varela 1955). With the restoration of absolutism under Fernando VII in 1823 he was forced to seek refuge in the United States and came to the conclusion that full independence was the only solution. Varela shared the destiny of exile with other intellectuals of this time, as José María Heredia (1803–1839), the first great Cuban poet.

After such promising innovation, Varela's fellows tried to develop his premises. All throughout the nineteenth century Creole elites in Cuba practiced a deeply rooted racism, which also had an impact on the educational system. For the entire first half of the nineteenth century there was no universal school system and where schools did exist they were limited to elementary education. The literacy rate was very low: only about 19 % of the white population knew how to read and write and hardly 2 % of colored people were literate (Melcón Beltrán 1989). In 1857 the first governmental *Escuela Normal*, or primary school, was founded, but in general education remained or was given back into the hands of religious orders (Melcón Beltrán 1989, 282). In the second half of the century provincial secondary schools (*de Segunda Enseñanza*) were created, but they had almost no funding. And while despite the commitment of its teaching staff the University of Havana languished in the indifference of the metropolis, several private colleges were born. In the countryside and among the colored population education was almost nonexistent. At the same time, the melting pot of ethnic groups and influences from all over the world (there were thousands of Chinese immigrants and French immigrants from Haiti and Louisiana) created fertile terrain for lively cultural manifestations. The periodical press flourished and a varied literature illustrated the features, figures and problems that characterized the island.

2.2.5 *Academy of Science and Medicine*

In contrast with the languishing situation of the education system and of the basic sciences, in the fields of medicine and natural sciences, during the course of the nineteenth century Cuba boasted renowned practitioners who made decisive contributions to the problems of a tropical country.¹³ Here we will name only the most authoritative of these (García Blanco 2002; Pruna Goodgall 2006), some of them studied for some years in Europe. Many were pupils of Félix Varela at the San Carols Seminar and all belonged to the progressive part of Cuban society. In 1803 the physician Tomás Romay (1764–1849) introduced the anti-smallpox vaccine. The naturalist Felipe Poey (1799–1891), who in the last years of his life abandoned his religious faith to embrace evolutionary theories, (Pruna Goodgall 1999), documented Cuban fauna and in 1877 founded the Sociedad Antropológica (Anthropological Society). After completing a PhD in Paris, Alvaro Reynoso (1827–1888) carried out fundamental research applying physiological chemistry to agriculture, and proposed a scientific system based on the physics and chemistry of soils for the cultivation of sugarcane. (Fernández Prieto 2005). In 1878 the researcher and physician Carlos J. Finlay (1833–1915) formulated the “theory of the mosquito” as carrier of yellow fever, coming up against the opposition of doctors internationally and in the United States (with highly unedifying outcomes, as we shall see later on). Carlos de la Torre (1858–1950) made important paleontological discoveries. In light of these scientific developments, in 1861 Queen Isabella II finally authorized the founding of the *Real Academia de Ciencias Médicas, Físicas y Naturales de La Habana* (The Royal Academy of Medical, Physical and Natural Sciences of Havana) (Pruna Goodgall 1994, 2001, 2003, 2006), which had in vain been proposed as early as 1826 by a series of scholars led by Tomás Romay and Nicolás José Gutiérrez (1800–1890) as we have already noted.

2.2.6 *Liberation Movements*

The international situation of the nineteenth century inspired the intellectual development in Cuba. Young Cubans who studied in France brought their acquired knowledge back to the Cuban sugar industry. The political ideals of Europe circulated among the progressive circles on the Island. In this way, Cuba became part of the international networks of intellectual life and could react immediately to scientific and political changes in Europe and the US. North American culture and lifestyle, the British abolitionist movement and gender equality in the North of the United States had its influences also on Cuban intellectual and political life. The more liberal developments led the Cuban Creole elite identify more and more with the slave-owning aristocracy in the US South.¹⁴ Cuba remained a radically sexist

¹³ Some cooperation with distinguished scientific centers was established, see García Gonzáles (2010).

¹⁴ How useful a comparative view on Cuban and southern US slavery policies is revealed in Bergad et al. (1995).

and male chauvinist society, where women were not allowed to attend university, though women of color were objects of their white masters' sexual desire and the colored population entirely marginalized (Lamore 1980). The nineteenth-century masterpiece of Cuban literature, *Cecilia Valdés*, illustrates this situation very effectively. Its author, Cirilo Villaverde (1812–1894), accused of anti-Spanish conspiracy, spent most of his life in exile in New York. Here in 1869 his wife, Emilia Casanova (1832–1897), founded the first patriotic association for women. Freedom-loving and anti-racist sentiments were in fact deeply rooted among Cuban emigrants in the United States, whose most authoritative representative was undoubtedly José Martí.

The Cuban national liberation movement was shaped by both internal and external factors that determined its particular nature: the growing level of Spanish colonial exploitation, the ever growing problem of slavery (that lasted to 1886) and the patriotic sentiment that had grown up among some of the landholders, especially in the center-east of the country. Another part of the Creole social and economic elite remained faithful to Spain, although they occupied most important posts in the fields of administration and army (Kuethe 1986). After many months of preparation a revolt broke out in 1868, when a civil war in the mother country had temporarily overturned the monarchy, causing an earthquake in Cuba as well and giving the impression of a decline of the European powers (the defeat of the French in Mexico; the Spanish defeat in Santo Domingo in 1865; the rebellion in Puerto Rico in 1868). Though both slaves and free blacks joined the rebels in the Ten Years' War (1868–1878), the question of the abolition of slavery remained open, as their participation strengthened the rebels' fear of an uprising (Scott 1985).

The years following the war saw the expansion of strongly capitalist elements in Cuba, along with a process of concentration of production. The Cuban economy was ever more oriented towards the United States, which absorbed the majority of Cuban exports (about 17 % in 1840, 86 % in 1895); US capital invested in Cuba also increased. Meanwhile, patriotic sentiments and national consciousness continued to grow and, under the influence of Martí, prepared the decisive insurrection.

2.3 Cuba Between Independence, US-Interventions and Dictatorial Regimes in the First Half of the Twentieth Century

2.3.1 The War of Liberation and Independence and the US Rule

After the outbreak of the 1895 War of Liberation from Spain, which also awakened strong passions in Europe with many young men volunteering to fight for the Cubans, the twofold military intervention of the United States in 1898 against Spain in Cuba and in the Philippines brought an end to Spanish colonial rule, and actually marked the beginning of the foreign politics of intervention in the world. Inside the

US, while the black North American community held contradictory feelings towards Cuba—racial solidarity vied with benefits deriving from participation in the war as soldiers of the United States—the majority of the population was divided between those favoring annexation, “English-style” forms of government, and independence. The military intervention was perceived as a final step to reunite the country after the divisions caused by its Civil War; its expansion westwards was resumed and participation in the imperial race with the European powers began.

With regard to the influence, or the interference, of the United States with the countries of Latin America, we should remember that as far back as 1823 President Monroe had resolutely affirmed the principle of U.S. hegemony over the entire continent (“The Monroe Doctrine”), thereby excluding any further attempts on the part of European powers to colonize the Americas, or even merely to interfere in the politics of the newly independent states of central and south America (Foner 2004). In 1845 John O’Sullivan coined the expression “manifest destiny”, which was to become an important part of US national ideology. In 1904 the Monroe Doctrine was reaffirmed and the “Roosevelt Corollary” was added, sanctioning the right of the United States to intervene militarily to restore order in the countries of the western hemisphere.

On January 1st 1899, the US occupation of Cuba officially began with General John Brooke (1838–1926); the peace treaty of Paris (December 10, 1898) between the USA and Spain excluded Cuban (as well as Philippine) representatives. The island was thus dominated by a neo-colonial regime, which had a profound influence on internal social developments. This situation, barely differing from Spanish domination, evidently frustrated the dynamics of development of a Cuban middle class, as well as of the popular movements that had led to the War of Liberation. This was true also for the intellectual and scientific milieus.

Brooke appointed some white Cubans, who had lived in exile in the US, to head the four main government departments (Interior; Finances; Justice and Education; Agriculture, Trade and Industry), while the economy of the island remained in US hands. To isolate the veterans of the Liberation Army (largely men of color), among other reasons, no Cuban army was created, but only a police force. This was to be a source of great difficulty for the future Republic.

The military government of Leonard Wood (1860–1927), which followed Brooke’s government in December 1899, was favorable to annexation. It adopted the model of racial segregation that the US Supreme Court had legalized in 1896, effectively making Cuba a practicing laboratory for US hegemony by trying out new forms of political and economic neo-colonial dependence—the “informal” and “benevolent” empire—with both direct and indirect forms of interference (Zeuske and Zeuske 1998). The military government maintained Spanish law, administration and bureaucracy, while favoring the white elite and concentrating all economic affairs in US hands. The circulation of the US Dollar was promoted and investment of capital coming from the US was encouraged. In this way ties between the United States and sectors of the Creole bourgeoisie were strengthened, causing profound transformations and heightened tensions in the political, cultural and racial identity of the occupied country.

Foreseeing an all inclusive submission of the island’s interests to those of the US, the first Cuban government promoted an education campaign, conceived as a way to make the Cuban population conform to US values and standards. The war had destroyed the majority of school buildings and the few teachers still employed were extremely poor. The school system was reorganized on the US model and the teaching of English and US history was promoted. In the framework of the effort to favor the values of the US system, a significant initiative was taken by Wood: in the summer of 1900, 1,273 Cuban teachers were sent to Harvard University (amounting to over half of the entire corps of elementary schoolteachers, a majority of them women). In reality, what the Cuban schoolteachers, especially the women, gained from the US tradition of liberty insights that reinforced their desire for independence.¹⁵

2.3.2 *The Period of Enrique José Varona*

The Ministry of Education and Fine Arts was assigned to the authoritative Cuban intellectual and educator, Enrique José Varona (1849–1933). He had been a deputy to the Spanish *Cortes* and a collaborator of José Martí and can be characterized as anticlerical, favoring gradual reforms and supporting a practical, objective and scientific approach to education. He, as José Martí, Andrés Poey Aguirre or José Varela,¹⁶ was a positivist, supporting thus the development of science and technologies in order to industrialize the country (Pruna Goodgall 2005, 172–177). Varona introduced a reform of secular education founded on the supremacy of public over private schools and inspired by modern pedagogical ideas. Varona was well aware that without radical social change and the start of a process of industrialization, the objective of scientific-technical development was an illusion. In a letter of 15th October 1900 he wrote to the Cuban doctor and anthropologist Luis Montané:¹⁷

You want to know the spirit that guided me when I undertook the reform of our education institutions. [...] I will be clear about this as you merit it to be, and open hearted. [...] I acted in the spirit of legal defense of the people of Cuba; a defense within its possibilities and in the field of the possible [...] When France was aware of its defeat against Germany, it renewed its military organization copying on the German example. We have to compete in the field of industries and in the field of sciences with the North Americans. And if we want to avoid to be completely erased of this field we have to educate us as the Americans do... [I] will transfer the fight to the only battlefield where we can fight. We are dealing with a social phenomenon and the consequences of an ineludible law. The only way to avoid the possible dangers of these consequences is to become part of the conditions producing this phenomenon.

This reveals Varona’s great interest in the creation of technical careers in the University of Havana, though unfortunately he did not increase the teaching of basic

¹⁵ For the different opinions on Cuban independence, see Zeuske and Zeuske (1998, 419–425).

¹⁶ See the chapter by Altshuler and Baracca in this volume.

¹⁷ Our thanks go to José Altshuler for bringing this quote to our attention.

sciences, such as mathematics and physics.¹⁸ This view of technological progress being, to some degree, independent from support by an advanced scientific system, was, at the time, widely spread even among developed countries. Even in the US a culture of inventors (like Edison) still prevailed at the turn of the century, while the integration of science in technical innovation processes in Germany played an important role in fostering the “Second Industrial Revolution” (Baracca et al. 1979). In Britain this situation that was observed with concern, giving rise to a widespread warning for the backwardness of industry, science and higher education (Lloyd-Jones and Lewis 1998). Crucial turning points in this situation were the First World War, the Great Depression, the New Deal and the Second World War.

2.3.3 US-Exploitation of Cuban Sciences

The US goal to gain and maintain control dominated the scientific climate of Cuba of the early twentieth century. As a specific example, in the question of whether mosquitoes—as the Cuban physician Carlos J. Finlay had discovered—or bacteria were the cause of yellow fever, the head of the US Army medical services, George M. Sternberg (1838–1915), who strenuously opposed the “mosquito theory,” in 1899 sent a medical commission to Cuba.¹⁹ A member of this commission, Jesse Lazear (1866–1900), in agreement with his superior, Walter Reed (1851–1902), tested Finlay’s thesis by allowing himself to be bitten by a mosquito provided by Finlay and died as a result of the experiment. Using Lazear’s observations, Reed then published a work in which he credited himself with the discovery of the transmission of yellow fever. After some years the scientific community finally recognized the expropriation of the scientific discovery and Finlay was nominated for the Nobel Prize (Access to the Archives of the Nobel Foundation has revealed that Finlay was proposed for the Nobel Prize seven times before his death in 1915; the world congresses of medical history of 1935, 1954 and 1956 recognized Finlay’s absolute, unquestionable priority). This episode illustrates how US governmental institutions influenced control over Cuban scientific research.

2.3.4 Between Republic, Autocratic Rule and Scientific Advancement

The range of positions that developed inside the country, with a majority in favor of independence and a growing awareness of the repressive nature of United States “humanitarian” domination, made it clear that the solution of annexation would be possible only if imposed by force. Washington therefore handled in order to leave

¹⁸ See the chapter by Altshuler and Baracca in this volume.

¹⁹ On this controversy, see Cirillo (2004).

substantial instruments of control in its own hands, imposing in 1901 the insertion into the new republican constitution of notorious *Enmienda Platt* (contemporaneously with the Spooner Amendment for the Philippines), insuring the United States a veto on Cuba's foreign, military and economic policy, as well as the right of military intervention to preserve the Island's independence and government stability. This Amendment had a devastating effect on Cuba's political development and set the stage for three US military interventions (in 1906–1909, 1912 and 1917–1923), but it was also used by various Cuban authoritarian governments as a scarecrow against adversaries (the interventions were partly demanded by the Cuban governments themselves, amongst internal uprisings). Its influence was still felt even after its abrogation in 1934.

In this framework the Republic was inaugurated on May 20, 1902, opening an extremely tormented and contradictory period which was to last almost half century. Despite the extremely serious problems the newborn Republic had to face, the United States gave priority to strengthening its system of dominion, the “Cuban experiment,” which was to serve as a model for other countries. The immigration of whites from Spain was encouraged in order to reproduce the model of racial segregation that existed in the US South²⁰ (blacks were not allowed into fashionable public places), exasperating social contradictions (the living conditions of the majority of farm workers were miserable). At the same time, thousands of US citizens invaded the Island, flooding it with dollars, the country was obliged to open up to US products, thereby thwarting the possibility of development of other industrial sectors, and Cuban economy was ever more monopolized by the production and exportation of this single crop, sugar (36 % in 1900, 92 % in 1920: in the end Cuba was producing 28 % of the world's cane sugar; the US purchased over 50 % of Cuban sugar). The penetration of US financial capital (in the 1930s Cuba received more US capital than any other Latin America country) nourished a Cuban sugar-producing oligarchy which served as an internal prop for neo-colonial domination and which, referring to the *Enmienda Platt*, used this domination as a weapon of blackmail to solve its own contradictions.

While the political situation of the Republic continued to worsen, the presidency of Woodrow Wilson practiced between 1911 and 1916, behind the screen of a formally non-expansionist program, a kind of neo-colonialism different from European-style occupation, stepping up the politics of intervention in the Caribbean (Mexico, 1914; Nicaragua, 1912–1925; Haiti, 1915–1934; the Dominican Republic, 1916–1930). In 1917 the marines once again landed in Santiago de Cuba, mainly to preventively protect the US plantations from the spread of liberal insurrections.

A fleeting economic miracle during the First World War, due the rising to stars of the price of sugar, was followed in 1920 by an economic and financial collapse, while Cuba become a paradise of lavish business affairs for North American bankers,

²⁰ Actually, the profound changes in the island's social fabric created by US neo-colonial policy led to a form of discrimination different from the segregation existing in the United States, whose formal inspiration was a concept of “racial democracy” sanctioned by the Constitution in which discrimination derived from the “color line.”

entrepreneurs and speculators. The growth of social discontent and turmoil offered Wilson the opportunity for a political rather than a military intervention, dispatching in the island General Crowder as “proconsul” to insure the interests of US bankers.

In this climate, discontent and protests reflected the growing intolerance in respect to US interference and led to the maturation of a new national consciousness. Even if Cuba remained an essentially agricultural country (in 1931 nearly 50 % of its four Million inhabitants worked in agronomy) torn by social contradictions and with a high illiteracy rate of nearly 40 % of the population and higher still among the colored population in 1919, the country’s physiognomy and social composition was undergoing profound transformations. A sector of working class in production and services was growing and acquiring consciousness. The transformations comprised urbanization, the spread of the telephone (Altshuler and Díaz Martín 2004), completion of railway lines, public electric lighting (Altshuler and González 1997), tramways, radio broadcasting and the first airborne communications. The automobile, the radio, the cinema and advertising increased the penetration of United States culture and values into every aspect of Cuban life and reinforced racial discrimination.

The presidency of Gerardo Machado (1871–1939), elected in 1924, as it suffocated revolts and attempted coups, degenerated (with Crowder’s favor) into a ferocious dictatorship inspired by Mussolini’s fascism. The dictatorship also led to radicalization of the opposition movement. The University of Havana was the seat of the *Directorio Estudiantil*, a radical association directed by Antonio Guiteras (1906–1935). Banned by Machado in 1927, the *Directorio* reformed as a secret association, but then splintered into groups with different tendencies. Right-wing associations also arose, while in 1925 a group of anarchists, socialists and communists founded the *Confederación Nacional Obrera de Cuba* (CNOC) and, inspired by the Russian Revolution, the Communist party was born in 1925 led by Carlos Baliño (1848–1926) and Julio Antonio Mella (1903–1929). Many of its exponents were Spaniards and Jews of East European origin (a novelty in Cuba’s ethnic mix). In 1929 Mella, who was in exile in Mexico, was assassinated according to Machado’s orders.

The depression that followed the 1929 crack struck Cuba violently. Economic crisis provoked a radicalization of grassroots protest movements and in 1931 there was an attempted general strike with insurrectional overtones, in which Antonio Guiteras took a prominent part. In 1933, when his hope for a new United States intervention was not met, Machado was forced to resign.

2.3.5 The Intertwinement of Social, Intellectual and Political Growth

In these decades, mentality and the intellectual life in Cuban society underwent deep changes. A new generation of young people took the place of the veterans of the Liberation Army who until then had been the animating force behind social

unrest. Sections of the working and middle classes, colored people (Bronfman 2004, 106) and above all students and intellectuals introduced a more radical interpretation of the national problem, based on a reformulation of the inheritance of José Martí and of the *Mambises*,²¹ which was heavily influenced by the revolutions in Russia and Mexico. The University of Havana became the center of student protest, which grew more radical under the leadership of Julio Antonio Mella. This combination of nationalistic and revolutionary goals led to demonstrations and rebellion. Furthermore, between 1923 and 1925 a number of influential groups were founded, such as the *Federación de los Estudiantes Universitarios* (FEU), the *Asociación de Veteranos y Patriotas*, the first feminist groups and the Cuban Communist Party. The *Junta de Renovación Nacional*, whose head was Fernando Ortíz, launched a Manifesto of Intellectuals for the reform of civil society and the fulfillment of the ideals of the Revolution.

However, the tormented social climate hindered the kind of commitment required by scientific work, and at universities political struggles overshadowed even educational activity. Intellectuals mainly focused on the construction of a national identity and became organized in groups (Zeuske and Zeuske 1998, 426–427), many of whom were soon banned by the authorities (Bronfman 2004). At the same time the new nationalism boosted the foundation of national scientific associations such as the Cuban Society of engineers, to mention only one closely related to the subject of physics (Funes Monzote 2004, 286–292).

The 1920s were years of heavily social turmoil, but also intellectually vital for the years to come. The social ferment gave birth to an intellectual renaissance in politics, in cultural production and scientific research. In 1921 Varona gave his speech on “*El imperialismo yanqué en Cuba*” at the *Academia de Ciencias*. The great writer and musicologist Alejo Carpentier (1904–1980), who had been jailed by Machado in 1927, fled to France (a hazardous escape, using the passport of the French poet, Robert Denos); he returned to Cuba in 1939, emigrated to Venezuela in 1945, and returned to the Island in 1959, the year of the triumph of the Revolution. After his early training in the school of Lombroso, Fernando Ortíz (1881–1969) set out to search for the originality and essential traits of Afro-Cuban culture (Los Negros Brujos, 1916; Catauro de Cubanismos, 1923; Glosario de Afronegrismos, 1924). He founded and directed several reviews and invited Federico García Lorca (1898–1936) to lecture in Cuba. At the same time, science teaching at the University of Havana was modernized by the mathematician Pablo Miquel (1887–1944) and the physicist Manuel Gran.²² In 1927 another important scientific institution was founded called the Finlay Institute, whose first task it was to instruct the future clerks of sanitary administration and later on developed departments treating tropical diseases with vaccination (Pruna Goodgall 2005, 224–227).

²¹ The term *mambises* refers to the guerrilla Cuban independence soldiers who fought against Spain in the Ten Years War (1868–1878) and War of Independence (1895–1898).

²² See the chapters by Altshuler and Baracca and by Altshuler in this volume.

2.3.6 *The Establishment of Batista's Regime and the Consolidation of the Revolutionary Movement*

The times when revolutionary movements worked mostly underground followed a phase of uncontrollable revolutionary furor, which was exploited by a group of low-level non-commissioned army officers—unusual in Latin American *golpes*—to stage a mutiny, the “Sergeants’ Revolt,” on September 4, 1933. The radical movement saw this as an opportunity to intervene, in particular the student organizations, which were divided between moderates and revolutionaries but were in fact dominated by Guiteras, who became the most influential figure in a short-lived radical government that nationalized the electricity company and several United States-owned sugar companies.

It was in the context of this increasing chaos that Fulgencio Batista (1901–1973), the most astute of the military officers, was able to exploit the situation: in 1934, maneuvering with the US ambassador, Sumner Welles (1892–1961), he took advantage of the worsening of the crisis to gain popular favor and place the liberal Mendieta as head of government. The United States strengthened the position of the new president by abolishing the *Enmienda Platt* and signing a new treaty, which kept the military base at Guantanamo in its possession. Yet the protest movement did not die down, culminating in the bloody repression of the premature general strike of March and the elimination in an ambush of Guiteras’s group, which was preparing an expedition to launch a revolution in the east of the country.

The masses and workers’ movement (foundation of the *Unión Revolucionaria Comunista* and of the *Confederación de Trabajadores de Cuba*, CTC in 1939) renewed with a combativeness brought new challenges to an already enfeebled political and social system.

As a response, the military organization was strengthened, obviously with the approval of the United States, and became a parallel power directed at guaranteeing internal stability. The same process was happening in other countries of the region, reflecting an international climate favorable to the rise of fascist regimes in Europe. Batista ably manipulated the seven short-lived civil governments that followed one another from 1934 to 1940, and in the end won the 1940 elections.

The economic boom that occurred during the Second World War gave Batista’s social-democratic government of 1940–1944 a certain degree of popularity. The war consolidated the integration of the American continent and its economic mechanisms under the North American shield: between 1942 and 1947, Cuba sold the whole of the *zafra*s to the United States.

As it was the case after World War I the crisis had only been postponed. The workers’ movement maintained a position of strength in the post-war situation, when the electoral victory of the *Partido Auténtico* (*Partido Revolucionario Cubano*, not to be confused with the Communist party) awoke great hope in 1944. However, the wartime economic recovery had not eliminated contradictions existing between the dependent position of the sugar companies, the various sectors of the internal bourgeoisie and pressures coming from the lower classes.

In Cuba as elsewhere, the development of the Cold War translated into an offensive against the Communist and workers’ movement. The moderate spirit, the subservience

to oligarchic and imperialistic interests, the rampant corruption, the nepotism and the proliferation of gangster bands aggravated the institutional crisis. Popular pressure demanded greater national sovereignty and the restitution of the US military bases of San Antonio de los Baños and San Julián. But the 1948 law that lowered the sugar quotas included a clause that instituted United States retaliation against countries that denied “fair and impartial” treatment to its citizens, trade, navigation or industry. Between 1950 and 1952 military agreements were signed that placed Cuban armed forces under the control of North American missions.

In the 1950s once again the Cuban bourgeoisie showed its inability to carry out a process of national independence autonomously, a limit it was to pay dearly for in the choices imposed after 1959 with the victory of the Revolution. Only the FEU made some feeble attempts at resistance to Batista’s coup, but they were destined to failure because of a lack of arms. In fact, at first the *golpe* was rather favorably welcomed, even by the Communist Party. But Batista’s politics became more and more repressive and anti-working class, and showed to be completely dependent on United States interests. Batista enlarged the rights of North American military personnel, broke off diplomatic relations with the Soviet Union and, with the support of the CIA, created the *Buro Represivo de Actividades Comunistas* (BRAC). Meanwhile, the balance of trade continued to worsen and the policy of public and urban works increased public debt without improving economic conditions. In fact, the traditional parties became Batista’s accomplices, taking part in the governments or the elections of 1954 and 1958.

The revolutionary movement created new organizations, such as *Acción Revolucionaria Oriental*, directed by Frank País, and García Bárcena’s *Movimiento Nacional Revolucionario* (Ibarra 1998, 157–160). In Havana the young lawyer Fidel Castro (born in 1926) presented a denunciation of Batista and published a manifesto calling for mobilization; he attracted a group of young people identified as the *Juventud del Centenario de Martí*, who prepared themselves for armed struggle. In this way the assault on the *Cuartel Moncada* in Santiago de Cuba of 26th July 1953 was conceived. Though it was a failure in military terms, it represented a point of no return. Fidel transformed the trial that followed into a denunciation of the regime (*La historia me absolverá*). From prison he launched the *Movimiento Revolucionario 26 de Julio*, and after he was released thanks to popular pressure and exiled to Mexico he prepared for the invasion of the Island. In 1954 the FEU also took up the struggle, under the presidency of José Antonio Echeverría, creating the *Directorio Revolucionario* as its armed branch. On 31st August 1956, Fidel Castro and Echeverría signed the *Carta de México* and on 2nd December, 82 combatants led by Castro landed from an overloaded *Granma* yacht in the Eastern Province.

2.3.7 Social Conditions, Cultural Ferments and Modernization in Science

Meanwhile, Cuba was becoming a more complex society. In 1953 the population reached 5,829,000 inhabitants, of whom 23.6 % were still illiterate. Urban concentration grew. In the towns 51.6 % of the population lived in masonry houses and

37.2 % in palm-leaf houses; in the countryside the relative proportions were 2.5 % and 78.2 %. Agriculture remained the main occupation for men, and services for women, who represented only 17.1 % of the economically active population. Nevertheless, in spite of its explosive contradictions and social inequalities and the discrimination against blacks, Cuba was not properly underdeveloped: in the 1950s the average pro-capita income was the second highest in Latin America and the country ranked among the first five on the basis of other socio-economic indicators. The standards of healthcare were among the best on the continent, not very far behind those of the United States and Canada. As regards the number of doctors in proportion to the population, Cuba ranked 11th world-over and third in Latin America, although the situation was decidedly worse in the rural areas and especially in the Eastern Province.

The younger generations gave birth to a lively cultural revival: the Grupo Orígenes produced writers of the caliber of Lezama Lima (1910–1976), Cintio Vitier (1921–2009) and Eliseo Diego (1920–1994), and of the playwright Virgilio Piñera (1912–1979). In the visual arts, Wilfredo Lam (1902–1982), of mixed Chinese and Afro–Cuban origin, was a world-renowned interpreter of symbolism and surrealism, also showing Cubist influence. Cuban music was spread by musicians like Argeliers León (1918–1991) and Harold Gramatges (1918–2008) and by celebrated performers like Benny Moré, the Trío Matamoros and Enrique Jorrín (the inventor of the cha-cha-cha). It was in the 1930s that Joseíto Fernández (1908–1979) composed the world-famous song Guantanamera (which the North American composer Pete Seeger adapted to verses by José Martí in the 1960s).

A group of intellectuals that included Rubén Martínez Villena (1899–1934), Mirta Aguirre (1912–1980), Juan Marinello (1898–1977), José Antonio Portuondo (1911–1996), Julio le Reverend and Carlos Rafael Rodríguez (1913–1997) spread Marxist ideas in Cuba. A fresh approach to historical studies was given by Ramiro Guerra (1880–1970), whose *Manual de Historia de Cuba* was published in 1938, and by Emilio Roig de Leuchsenring (1889–1964).

Fernando Ortíz's production flourished: besides the already cited *Contrapunteo Cubano del Tabaco y del Azúcar* (Ortíz 1940) he published *La Africanía de la Música Folklórica de Cuba* (1940), and *Los Instrumentos de la Musica Afrocubana* (1952–55). Nor can we ignore the birth of the writer Italo Calvino, whose parents were Italians working at the *Estación Experimental Agronómica* of Santiago de las Vegas.

When in 1950 the government approved a law on private universities, the Universidad de Oriente (Eastern University) (Méndez Pérez et.al. 2012, 33–36) had already been founded in Santiago de Cuba²³ and the Università Marta Abreu in Santa Clara. In the 1950s scientific studies were updated, even if the only employment possible for graduates that remained was secondary school teaching.²⁴

The Batista regime promoted sectors of investigation in physics and searched after international cooperation, as in nuclear physics. In the framework of the Atoms for Peace campaign, a program to foster the civil use of nuclear power and to build

²³ See the chapter by Méndez Pérez and Cabal in this volume.

²⁴ See the chapter by Altshuler in this volume.

a nuclear power plant was initiated by the US-government. The only physicist who knew nuclear physics in Cuba, Marcelo Alonso (1921–2005) contacted colleagues in the Netherlands and in Germany in order to evaluate potential cooperation with European institutions and firms (Politisches Archiv Auswärtiges Amt). In this field, the pre-revolutionary years laid a foundation on which later research and cooperation with Soviet and Eastern Europe research units could be built on.

Meanwhile, the crisis of the Cuban system deepened on every level. United States foreign investments were gradually redirected towards oil and industry, with the result that Cuba fell from its place as first investment market for North American capital to second in 1940 and third in 1956, after Venezuela and Brazil. And though sugar exportations were declining, Cuban industry did not take off in other sectors. In 1954, 63.2 % were quite small enterprises employing less than 10 workers, while the rest of these enterprises hired 25 employees.

While sugar was in the late nineteenth century an economic motor for innovation and technical advancement at the island, it now retarded any introduction of new technologies and further mechanization in sugar production processes. The azucarero-oligarchy, in straight collaboration with the changing dictatorships and bearing in mind the US-interests in Cuba, preferred to employ the cheap main d’oeuvre of impoverished land-workers instead of investing in costly machines. By doing so, unemployment rates were quite low—at least in times of harvest—and no social riots were to be feared. The producers of sugar did not have the capital to buy any machines. Consequently, hardly any technical innovations were known in Cuba for this period, neither by importing machines nor by developing them inside the country (Edquist 1985, 79–82).

2.4 Revolution, Modernization and Political and Economic Changes Between 1960 and 1990

2.4.1 A Revolution That Broke All Moulds

One can be critical of or radically contrary to the Cuban Revolution and its ardent supporters but one can hardly deny the originality of this event and its developments. For half a century it has defied all analyses and predictions, representing yet again Cuba’s “exceptionality,” for better or worse, to remain impartial (if for not other, the disproportion between the smallness of this country, and its worldwide influence). As Mark T. Berger underlines, the particularity of post-revolutionary Cuba was not that it would have been a Soviet satellite state close to the US, but that despite being a close ally of the USSR it continued to pursue its own politics, as can be seen in Nicaragua, Guatemala or even Angola (Berger 2004). Another example would be Cuba’s relation to China after the revolution that troubled the Cuban-Soviet relationship for some years (Ying-Hsiang 1973). The limited independence

to act on its own count in international politics was also a schema recognizable in the field of physics, as will be shown later.

Legions of journalists, intellectuals, writers and revolutionaries immediately precipitated to this small island (Gott 2004). Among them were Jean-Paul Sartre (Sartre 1961), Simone de Beauvoir (1908–1986), Leo Huberman (1903–1968) and Paul Sweezy (1910–2004) (Huberman and Sweezy 1960) and Charles Wright Mills (1916–1962). Indeed, Mills' last work was on Cuba (Mills 1960); in it, while denouncing the United States' ignorance of history, including the history of its own imperialism, he stressed that one of the challenges the Revolution would have to face was the lack of well-qualified people. The consequences of this problem on the choices made as regards physics are discussed in some of the essays included in this *volume*.

Ernest Hemingway (1899–1961) lived in Cuba for 20 years (he wrote *The Old Man and the Sea* there), where he met both Fidel and Che. From its very dawning, the Cuban Revolution challenged all interpretations and attempts to trace (or reduce) it to existing ideologies or movements. This evasive character in all likelihood was neither a special gift of the Cuban revolutionaries nor a sign of sophisticated political analysis. On the contrary, the Revolution's first steps seem rather uncertain, pragmatic and at times unclear: one should recall the very young age of the leaders at the beginning of the *guerrilla*: Castro 29, Ché 28, Raul 25, Camilo Cienfuegos 24 (3 years more in 1960). But it is probably these very uncertainties, this character so difficult to fit into traditional classifications, which contributed to disorient the great powers and above all the imperial logic of the United States, still under the influence of McCarthyism. It is likely that the United States made some of the most serious mistakes in its history towards this "object of desire," moved as it was by arrogance and a sense of pride that had been hurt by this small Caribbean David.

The leaders of early post-revolutionary tried to position Cuba internationally into a context that would not determine a priori the ideological ally. But it became clear very quickly that the new regime was refuted by the US-government and that Moscow was akin willing to spend support. Although, it is difficult (and is neither the job nor the purpose of this presentation) to discern clearly how much there was of shrewdness or deliberate calculation in the events of the Cuban Revolution, how much improvisation or more probably pragmatism and intuition, how much luck or destiny, and how much in the end depended on mistakes made by others, as Richard Gott (2004) has stated, from whom we borrow some of the following observations. This is not a merely theoretical question, because the playing-out of the various positions and judgments, with all their consequent misunderstandings and rigidities, in only a few months decided Cuba's choices regarding internal affairs and its international position for the next half century. In this context it is interesting to learn the ideas professed by Fidel Castro at the dawn of the Revolution, as received by an educated United States population when, in April 1959, he accepted an invitation to speak at a conference in Washington. On purpose to avoid any occasion of a meeting, President Eisenhower had left the capital for a game of golf in South Carolina.

Castro gave a speech at Princeton University on the subject “The United States and the Revolutionary Spirit”:

He first addressed existing theories of revolution, noting that the Cuban experience had shattered three myths. First, that ‘a revolution could be successful even if the mass of people are not starving.’ Second, that revolutionary forces ‘could defeat regular military forces;’ and third, that a revolution ‘could succeed against modern arms.’ Guerrilla tactics aside, Castro attributed the success of the Cuban Revolution to the widespread ‘fear and hatred of Batista’s secret police,’ and to the fact that the rebels ‘had not preached class war,’ thereby gaining ‘95 per cent support’ from the population.

A student journalist noted that Castro promised “he would lead the country to economic and cultural progress without sacrificing individual freedoms.” Castro also was reported to have said that democracy was “the most beautiful political and social idea.” The latter remark was greeted with a standing ovation. *Long Island Newsday* reported that the Premier had claimed in his address that he

expected and would allow minority parties to develop ‘in opposition to his regime’, and that while there were ‘no plans to nationalize any lands,’ his government would ‘expropriate legally’ any ‘idle or unproductive lands.’ (Bogenschild 1998)

The first years after the revolution were owing to favorable circumstances where decisions made by the new government, as a minimum wage for sugarcane cutters, a decrease in electricity and telephone rates, rents and the cost of medicines, the creation of new jobs and an increase in the salaries of low-level public workers, while the pay of high-level bureaucrats, judges and members of the government was lowered. This met with the inaptitude by the old pro-US-bourgeois to reinstall its powers.

What proved to be the decisive turning point in Cuba-United States relations was the agrarian reform of 17th May 1959 (Benjamin 1990, 179–181). It was not in fact a radical reform, but the essential point is that it was impossible for Cuba to carry out a real reform without encroaching on the interests of the large imperialist corporations. Economists arrived from other Latin American countries and from East Europe, as Michal Kalecki (1899–1970) from Poland, or the French Marxist economist, Charles Bettelheim (1913–2006) (Hamilton 1992, 36–54). The final goal was ambitious indeed: to develop an industrial economy. It was Ernesto Guevara who promoted the ambitious project of turning Cuba from a prevalently agricultural country into an industrialized one through a process of accelerated industrialization that would start with heavy industry came up against objective difficulties, such as the country’s economic isolation and its backwardness (Boughton 1974).

The revolutionary government was strongly committed to developing basic and scientific-technical education. The whole country was swept by a wind of change and enthusiasm. In 1961 a widespread campaign mobilized 100,000 teachers to eliminate illiteracy (some of them were brutally murdered by counter-revolutionary bands still present in the island) (Abendroth 2009). A campaign of on-going adult education was also undertaken, along with a program to develop an advanced school system open to one and all, which had no equal in Latin America. On 20th December

1959 the first *Reforma Integral de la Enseñanza* was promulgated (Wylie 2010, 82). Sixty-nine army barracks were transformed into schools, over three thousand new schools were built in the first year and about seven thousand teachers were trained, so that three hundred thousand children could attend school. The doors to secondary and university education were opened to workers, including farm workers.²⁵ In 1961 the *Consejo Nacional de Cultura* was founded to foster cultural development, along with the *Escuela Nacional de Arte*, ENA (its buildings in west Havana, audaciously designed by outstanding architects, are well worth a visit),²⁶ while a widespread network of art schools was built all over the country. That same year the *Ley de Nacionalización de la Enseñanza* was promulgated, putting an end to private profit-making schools. Immediate measures to improve and extend healthcare to the entire population were also taken (Wylie 2010, 83).

In 1960 Fidel Castro explicitly affirmed that “The future of our country must necessarily be a future of men of science”,²⁷ while Ernesto “Ché” Guevara even foresaw the future importance of solid-state electronic devices. As regards university, the urgent need to update the old system and introduce a modern spirit of scientific research fostered probing discussions involving directors, professors and students. The result was the University Reform of 1962, which was to prove a fundamental stimulus. But even as early as 1960 there were spontaneous experiments to reform the Engineering School of the University of Havana by introducing new programs of study, despite the difficulties caused by the lack of well-prepared staff. The students themselves made up for this lack by giving lessons to students in lower years; this work on the part of the *alumnos ayudantes* went on for years. These processes are described in detail in this volume as regards the field of physics. In 1960 the first six students left to study engineering in Moscow, thanks to Ché Guevara’s personal involvement, to be followed by physics students soon after. Their return as graduates in 1966 made it possible to establish a stable professional teaching staff and the curriculum of the School of Physics of the University of Havana.

2.4.2 *In Search of New Allies*

The reactions inside the United States against the Cuban Revolution grew at all levels, independently from the nature of the measures it adopted, but based on the

²⁵ See the interview with Melquades de Dios Leyva in this volume.

²⁶ The project for the Escuelas, conceived of by the Ministry of Culture to host 1,500 students from Latin America, Asia and Africa, was entrusted to the Cuban architect, Ricardo Porro, who called his colleague Roberto Gottardi and his Italian friend Vittorio Garatti to collaborate. It soon became clear that the plan was beyond the island’s concrete possibilities, and in fact in the following years there was a gradual waning of the extraordinary enthusiasm that had taken hold of architects, workers, teachers and students in the initial phases of planning and construction. See Loomis (1999), Daley (2000), Craven (2002), chap. 2 and Giani (2007).

²⁷ Speech given on January, 15 1960 by Fidel Castro. See Torres Yribar (2011).

real or presumed Communist leanings. The first counter-revolutionary group (*La Rosa Blanca*) inside US territory was formed with the complicity of the CIA and the FBI, and the sabotage actions grew (through US air raids in October 1959 which sabotaged the sugar mills) up to the unsuccessful military invasion on 17 April 1961 at the Bay of Pigs.

The obstinate intensification of clandestine actions to create unrest in Cuba and overturn the regime (“Operation Mongoose”), with the enforcement in January 1962 of the expulsion of Cuba from the Organization of American States (a decision that was not revoked until June 2009, see below), objectively pushed the country to increase links with the Soviet Union and converged with Khrushchev’s plan to deploy nuclear missiles (Bain 2008). Nikita S. Khrushchev (1894–1971) obtained from US President John F. Kennedy (1917–1963) the promise not to attack Cuba and to withdraw US-American nuclear missiles from Turkey and Italy, before the head of the Kremlin agreed to abandon his plans (George 2013).

The already big problems the country had to face were further aggravated by the fact that many entrepreneurs, technicians, economists professors or intellectuals left the Island after 1959 (Gott 2004). The international crisis had nearly no influence on an animated intellectual and artistic life: the Cuban cinema was born, new writers became worldwide known and the new Cuban music met internationally with success. Efforts were also focused on publishing and cultural diffusion and growth. In 1962 the *Editorial Nacional Cubana* was created, and in 1967 the *Instituto Cubano del Libro*. The result was that while in 1958 the country produced only about a million books, in 1967 production had grown to eight million and to 35 million in 1975. Meanwhile, innovative activity in the fields of healthcare and education went on apace. The 1962 University Reform greatly stimulated higher education, the level improved enormously and study materials were brought up to date. The start-up of scientific research necessitated the creation of scientific institutions and the formation of researchers. In fact, many of the most important research institutes that the country has today were founded in the 1960s. And most science, engineering and research programs were introduced in universities in those years (Núñez Jover et al. 2008).

Cuba’s cultural ferment continued to exercise its fascination all over the world. The articles in this volume reconstruct the singular presence in the University of Havana’s School of Physics of physicists and technicians from many western countries, who held courses in modern physics, equipped workshops and laboratories and started the first scientific projects. During the same decade some of Cuba’s other main research institutes were born. Among them figures the newly founded *Accademia Cubana de Ciencias*, under whose aegis a series of projects and new institutions were developed, as it was the norm in Soviet Union, where the Academy hold the monopoly for research (Domínguez 1979, 397). The universities were able to consolidate stable teaching staff and curricula. By the end of the decade there was a critical mass of graduates prepared to carry out scientific research, thanks also to the return of Cubans who had left to study in the Soviet Union and other socialist countries, while collaboration with these countries was consolidated.

2.4.3 The Sharp Turn of Cuba's Economy and Politics at the End of the 1960s

As we have remarked, a change of the early revolutionary Cuban (Guevara's) economic and political program was underway since 1963, but the critical turn was accomplished in the last 1960s. Guevara had recently disappeared, and the echoes of his denouncement of the Soviet and the Chinese models burnt out, when Moscow's tanks crushed the "Prague Spring", on 21th August 1968. Castro's denunciation of the Czech reformers took everybody by surprise.

The rigid bipolar equilibrium of the Cold War drastically limited space for autonomy in the countries that chose to remain in the Soviet Block. It seems like a twist of fate that Cuba debunked its non-aligned international role while the world was undergoing shocks that seemed to confirm those previous perspectives: the North Vietnamese "Tet Offensive" of January 1968 fed the crisis that was sweeping the United States, with the massive movement against the War in Vietnam, and the assassinations of Martin Luther King (1929–1968) in April and Robert Kennedy (1925–1968) in June, and in September Mexico City was bathed in the blood of *Plaza de la Tres Culturas* massacre; while the "French May", and its international extensions, challenged the hegemony of the orthodox Communist parties in the western left—flying as its own icon the image of "Ché", next to that of Mao Tse-tung.

The peculiarity of Cuba's position can probably be better appreciated taking into consideration the endemic instability that was to run over Latin America, characterized by coups and bloody military regimes, which increased segregation and social inequalities. Anyway, even if Cuba had entered the Soviet orbit, it still showed the originality of its choices in the international arena. Castro kept a space of autonomous action, taking decisions and positions that disoriented the big powers and interfered with their plans. In 1975 he surprised both Moscow and Washington by returning into the African arena, which Ché and his guerrillas had left suddenly 10 years before. Castro's decision to intervene militarily to support the MPLA in the defense of Luanda in 1975 was so resolute that he sidestepped the reservations of Brezhnev, who at that time was aiming at a substantial rapprochement with the United States. The venturesome (reckless?) Cuban expedition, without any Soviet logistical support, allowed Agostinho Neto (1922–1979) to route the assault on the capital and proclaim the independence of Angola. Further Cuban reinforcements convinced South Africa to withdraw from Angola, and the symbolic value of the defeat by a largely black army was one of the triggers of the Soweto revolt in June 1976. Once more images of Ché were hoisted next to those of Malcom X and Mao Tse-tung.

Cuba's intervention in Africa continued in the form of aid, medicines and teachers to many countries, besides another military intervention in Ethiopia. Cuba regained great prestige in the anti-colonialist milieus, and in September 1979 hosted Conference of the Non-Aligned Movement. In the 1970s, Cuba continued to be a sort of Mecca of Afro-Cuban culture. Performers like Sidney Poitier (born in 1927),

Harry Belafonte (born in 1927), and the South African singer Miriam Makeba (1932–2008) arrived.

Following the terrorist attack of October 6, 1976, in which 73 persons lost their lives, including Cuba’s entire fencing team, in 1977 Jimmy Carter’s administration opened a phase of (although contrasted) rapprochement between the two countries. Some concrete initiatives were taken (opening *Interest’s Sections*, travel and remittances), but this opening tottered after the success of the Sandinists in Nicaragua in 1979, and was closed when Reagan’s victory in the 1981 elections led to a strengthening of the embargo against Cuba and intensification of acts of sabotage.

In the years following the “Prague Spring” Cuba brought its economy into line with reassuring Soviet standards, thereby condemning itself for 30 years to dependency on sugar. Despite the failure in 1970 of the clearly overestimated objective of a sugar harvest (*zafra*) of 10 million tons), while the ideological and revolutionary ferment of the 1960s was reduced. Fidel Castro decided to nationalize all private companies in 1968 and a national party organization was installed that broadened its impact in any social activity. In 1975, the first Congress of the Cuban Communist Party was held.

In fact, thanks to substantial Soviet support the Cuban economy overcame the difficulties of the past. Between 1975 and 1985 it enjoyed an over-4 % growth rate, and for the population there began a period of prosperity. Some original aspects remained in the Cuban system, confirming it as an exception even within the Soviet system. Available resources were used not only to strengthen the armed forces, but also to develop schools and healthcare (Bain 2007), science and technology (Bethell 1993) and to give Cubans a higher standard of living and more available consumer goods. However, we cannot ignore critics like the writer Heriberto Padilla (1932–2000), who was segregated and then arrested in 1971, which provoked a position statement by legions of authoritative international intellectuals, including Sartre, Simone de Beauvoir, Octavio Paz (1914–1998), Carlos Fuentes (1928–2012), Vargas Llosa (born in 1936), García Márquez (born in 1927) and Julio Cortázar (1914–1984) (the last two subsequently withdrew their support of the letter).

Adhesion to the Communist Block entailed a growing reliance of Cuban agriculture on sugar cane, which was to have deep implications in the 1990s (Lorini and Basosi 2009). Nevertheless, although Cuba counted heavily on the exchange of “sugar-for-oil” and other goods with the Soviet Union, it never cut off trade with non-socialist countries. Though carried on at lower market prices for sugar, this supplied a certain quantity of strong currency and some margin of autonomous maneuver. The percentage of exportations towards non-socialist countries was 30.5 % in 1970, and the situation did not sensibly change even after 1972 when Cuba joined the COMECON market; in 1980 this percentage was 29 % (60 % of the 71 % of exportations towards socialist countries was with the Soviet Union).

With the Soviet Union’s economic support Cuban society progressed greatly and enjoyed a period of prosperity, as the state was able to satisfy the population’s basic needs and also to supply consumer goods. In the field of healthcare, while in 1958 there was only one rural hospital and 161 first-aid stations with 6,000 doctors (of whom

half left the country in 1959), in 1975 the country had 56 clinics, 118 dispensaries, 396 polyclinics and 10,000 doctors. Over the same period, average life expectancy rose from 55 to 70 years.

2.4.4 *The Crucial Leap in Education and Science*

Following the great commitment to schools and universities, the total number of students passed from 811,345 in 1958 to 3,051,060 in 1975 (on roughly 7 and 9.5 million inhabitants respectively). The spread of primary education grew by a factor of 2.7, middle and higher education by 6.1 and university education by 5.5. In the same period the number of students in higher education passed from 15,000 to 83,000.

In December 1968 the *Congreso Cultural de La Habana* brought together a numerous and vivacious international public that also included authoritative scientists, (mainly French and Italian physicists), who expressed relevant advices for the basic choices in the development of Cuban physics.²⁸ From a proposal launched on that occasion by French and Italian scientists was born the initiative of the *Escuelas de Verano* (summer schools), which from 1968 to 1973 brought to Cuba international specialists in every discipline, who introduced equipment, techniques and materials that gave a strong impetus to scientific research in Cuba.²⁹

The 1970s saw a first readjustment of the Cuban scientific system after the preparatory phase and the take-off in the 1960s. This represents record time for a small third-world country, an absolute exception. Cuba by now could count on a critical mass of scientists with a solid up-to-date formation and a network of research centers. This is certainly true in the field of physics. As the articles in this volume, advanced scientific sectors such as microelectronics were developed. Forms of cooperation and exchange with the most important centers of excellence in the Soviet Union and other socialist countries were consolidated (after first degrees were taken in these countries, advanced PhD studies began), but this did not mean that important instances of collaboration with the western world were interrupted (Reid-Henry 2010). The historical analysis developed in this book mentions several collaborations developed, mainly in the field of solid state devices and physics, with Canada, Spain and France, while the article by Leccabue documents the lasting and fruitful collaboration with Parma, Italy, which is still alive: it is relevant for the appreciation of Cuban peculiarity Leccabue's remark that an analysis with the Cuban colleagues showed that reliance on Soviet technology appeared too restrictive for the needs and perspectives of subsequent development of research in this field.

Anyway, the relevance of the strengthening of the collaboration with, and support by the Soviet Union and the Socialist countries could hardly be underestimated, such as it was the case for big international cooperation treaties, as for instance the

²⁸ See the chapter by Baracca, Fajer and Rodríguez in this volume.

²⁹ See the chapter by Cernogora in this volume.

participation of Cuba in the INTERKOSMOS program. This cooperation existed already since the mid-1960s but only in 1976 a formal institution having for aim the exploration of the outer space, depending on the Soviet Academy of Science was founded in cooperation of most of the Soviet allies states in Eastern Europe.³⁰

In general terms, as Jorge Núñez Jover states:

The existence of the science and technology policy has long come hand in hand with the notion that scientific advances fail to fully translate into the practical use of its results. So in the mid-1970s, evidence started to mount indicating that the practical use of scientific results to solve the problem of production and services was a matter of greater complexity. This brought about a number of changes in the science and technology policy establishing what has been called the ‘model of centralized direction’ (1977–1989), whose objective was to complete the efforts from the supply with a deliberate strategy to use scientific and technological results; this was called the ‘introduction of results.’ It was supposed to be achieved through a very centralized model relying on the identification of ‘research problems’ to direct research towards issues of high priority and the use of results in the fields of production and services. Although the use of results was emphasized, this staged was based on the same lineal concept towards scientific research as a triggering element in the relationship between science, technology and production.

Problems of concept were compounded by a very relevant practical circumstance. In parallel with the emphasis on science and the expectations that it would increase its contribution to development ran an implicit technological policy which was characterized by generalized imports of technology, quite frequently from the European socialist countries. They were characterized, *inter alia*, by being moderately modern technologies with low energy efficiency and environmentally aggressive. The tendency of assimilating, rather than producing, technologies and the frequent lack of interest to innovate shown by the entrepreneurial segment of the agents of technological change explain why the scientific development and the human potential achieved were not expressed in the expected practical results. This situation justifies the critical view that was formed around this issue throughout the 1980s, a discussion that was included in a broader debate on the praxis of the socialist transition in Cuba and, particularly, the economic efficiency of the country. (Núñez Jover et al. 2008)

2.5 Politico-economic Crisis and New Cooperations (1985–1999)

2.5.1 *Toward the Breakdown of the USSR*

The collapse of the Soviet Union without doubt caused traumatic change in Cuba. There had been a forewarning in 1983, when President Andropov had let the Cuban leaders know that the Soviet strategic guarantee, established in 1962, had not been operative for some time (Gott 2004; Purcell and Rothkopf 2000, 84). Cuba changed its military strategy, instituting a system of defense based on a “people’s war,” which was to play an important role in the following two decades. But Castro had more or less sensed what was coming and preceded Gorbachev by presenting a new

³⁰ For the history of Interkosmos and the role of the GDR, cf. Katharina Hein-Weingarten (2000), esp. 153–165.

economic program in February, 1986, that was called *Política de rectificación de errores* (politics correcting errors.). This program was far from the Soviet model and represented an explicit refusal of the reforms attempted by some socialist economies of Eastern Europe. The economic situation in Cuba at the mid-1980s became increasingly difficult as the fall in the international price of sugar had created an increasing dependence of Cuba on socialist countries' markets (Lorini and Basosi 2009). In contrast to previous years, in 1986 this market accounted for 85 % of Cuban exports, and that same year 98 % of the fuel. The nutrition was in huge parts assured by COMECON-countries from where 50 % of the calories and 57 % of the protein consumed in Cuba were imported (Tablada 2001, 39).

Also in its science and technology policy since the mid-1980s the country introduced relevant changes. The more pointed changes include the re-launching of university research, now with a more applied orientation, the definition of new priorities for scientific and technological development, comprising biosciences, biotechnology, pharmaceutical industry, high-tech medical equipment. The newly created productive scientific parks became true networks of integrated cooperation where research, creation of technologies, production and commercialization of products are part of a continuous process led by unique strategies, the enhancement of the Science and Technology Forum, a unique Cuban experience geared towards increasing social participation in the scientific and technological development and its applications. (Núñez Jover et al. 2008)³¹

These changes had important consequences in physics as well, leading to a probing process of critical revision of prior choices and serving as a stimulus for new applied sectors such as nuclear physics, including the project to build a nuclear power plant at Juraguá, near the bay of Cienfuegos, with Soviet aid (Blasier 1993).³²

In international affairs Cuba became involved in some political conflicts in Africa in 1988, after the attack launched by South Africa the previous year, sending 9,000 soldiers to complete a contingent of over 50,000 men (George 2005). As Castro observed, in relation to total population, this was equivalent to over a million US soldiers. Not only did Cuba save Dos Santos' government in Angola (which had succeeded that of Agostinho Neto) but it literally changed African history: as Nelson Mandela declared upon his visit to Havana in 1991, the defeat of the racist army at Cuito Cuanavale destroyed the myth of its invincibility and greatly contributed to the subsequent end of apartheid.

Even before this decisive intervention in Africa Castro had made another able move (Lorini and Basosi 2009) that restored Cuba's credibility in Latin America, despite the fact of being partly isolated by most of the military juntas governing in the Continent. In 1982 Mexico opened the "Latin American foreign debt crisis", which then spread to Brazil.³³ Loans from international financial organizations were subject to the "Washington consensus" and they imposed plans of adjustment based on privatization, economic deregulation, reductions in public expenditure and liber-

³¹ For development in biotechnology, see also Reid-Henry (2010, 28).

³² See the chapter by Baracca, Fajer and Rodríguez in this volume.

³³ Though the situation varied from one country to another, Latin American foreign debt had swollen from \$30 billion in 1970 to \$331 billion in 1982 and would reach \$410 billion in 1987.

alization of monetary flow. Castro made an astute move in March 1985, once again disorienting the politics of the great powers, by maintaining that the debt was too high to be repaid and had in fact already been abundantly paid to the rich North through neo-colonial exploitation (Castro 1989). This move had been carefully prepared by the Cuban leadership, which had already found an agreement for its own debt of \$2.9 billion (Lowenstein 1985). In August 1985 Havana hosted a large continent-wide meeting “against the debt”; though the ministerial delegations were limited to Ecuador, Argentina, Bolivia, Nicaragua and Panama, there were over a thousand delegates from NGOs, unions, religious groups, political parties and even businessmen. The headline in the *New York Times* was, “Cuba’s emergence, America’s myopia” (Szulc 1987).

After the fall of most dictatorships in the early 1980s political, diplomatic and trade relations were established first with Ecuador, then with Argentina, Uruguay and Brazil. As of 1989 there were only three Latin American countries that had not resumed relations with Cuba: Chile, Paraguay and Colombia.

Despite internal economic problems, Cuba has continued to send doctors and teachers to Africa and to Latin America, where it has undoubtedly played an active role, participating intelligently in the reawakening of this continent in the last 20 years and thereby continuing to represent an indispensable interlocutor, also as regards the United States. But, the Cuban diplomatic offensive in Africa and Latin America lost energy over the years because of the worsening of the economic crisis. As well, the trial and execution in 1989 of the Soviet-affiliated General Arnaldo Ochoa Sánchez, a hero of the wars in Africa, shows that the political situation inside Cuba became more and more difficult in regard to the influence the Soviet Union was allowed to take.

2.5.2 The Deep Troubles of the ‘Periodo Especial.’ New Cooperations in a Changing World

In January 1990, faced with the global retrenchment of the Soviet Union, Fidel Castro spoke of the need for Cuba to enter a “special period in peacetime” (Gott 2004, 335–349). It was the official beginning of the most dramatic period for the Cuban economy since the *Revolución*. Technological supplies from the USSR came to a halt between 1989 and 1992, and the sudden lack of strategic raw materials and spare parts caused further economic problems in industry and transport. In 3 years imports plummeted by 72 % and exports by 67 %, the investment rate was 7 % down from 26 %, gross capital formation fell by 60 % and oil imports dropped by over 50 %. In 1993 the GDP was a startling 35 % lower than in 1989 (Núñez Jover et al. 2008). Annual sugar production sank from over 8 million tons to little more than 4, while the end of Soviet subsidies forced direct sales on international markets at very low prices. Even tobacco production halved (Lorini and Basosi 2009). Official Cuban statistics reported that in 1996 daily caloric intake was down 27 % compared to 1990 levels.

To the negative effects of the changes in east Europe was aggravated by the consequences of a process that from this time on was called globalization.³⁴ In a situation when the entanglement of the world's political and economic processes became obvious by the downfall of the seemingly clear cutting frontier between the West and the East, the United States strengthened the so-called *bloqueo* against Cuba by the Torricelli (1992) and Helms-Burton (1996) Acts. International financial institutions denied loans to Cuba, one of the few remaining communist regimes in the world. In these years, the CIA dedicated at least two detailed studies to Cuba, in 1991 and 1993:

the first one advanced the hypothesis that “the deterioration of the Cuban economy (would have) further undermined Castro’s legitimacy”, while the second spelled out clearly that there was “a better than even chance that Fidel Castro’s government would fall within the next few years.

Given these conditions, with a display of Cuban sense of humor, an economist of the Havana-based *Centro de Investigaciones de la Economía Mundial* observed some years later that, with virtually no access to foreign credit, the socialist island had undergone, during the *periodo especial*, the only true ‘classical’ economic adjustment: international prices had grown, the external deficit had soared, domestic consumption had been curtailed to offset the loss in purchasing power. (Lorini and Basosi 2009)

Certainly, this new global and internal situation required some important adjustments in Cuban politics. In 1993 the government reacted rapidly to take more radical economic measures. As regards international trade, possession and use of the US dollar were legalized, creating the rather paradoxical situation of the existence of a double currency, in order to try and stimulate foreign investment in public-private joint ventures, tourism and selected industries in which the Cuban state kept at least 51 % ownership. Instead of the traditional low technology sectors for export (sugar and tobacco), non-traditional sectors in which capacity had been developed in the past and which could attract foreign currency were promoted: high value-added service products such as international tourism, healthcare and education; and high-tech industrial sectors, especially biotech products, pharmaceuticals and medical equipment. At the same time, the export potential of traditional sectors was sustained, with a restructuration of the sugar agribusiness and promotion of the nickel industry (Moreno 1998).

As regards the domestic economy, there was a partial liberalization of small-scale enterprises, in particular restaurants, called *paladares* and rented rooms for foreign tourists, along with more limited businesses that do catering for the population in houses and streets (Corrales 2004). A program for the production of food for the population was developed, allowing farm cooperatives to sell surplus products to urban markets, the so called *agromercados* (Babb 2011). Taxes were introduced for the first time in over 40 years and they were heavy for private enterprises. Cuba continued its transformation to a service economy oriented towards activities aimed at fostering foreign trade, saving and reducing its dependency on fuel, and fully utilizing the Island’s skilled human resources. The outcome was a marked growth in the tertiary sector at the expense of the primary and secondary sectors.

³⁴ Some at this time spoke even of a reversed global situation, see Jatar-Hausman (1998/1999).

The transformations were profound: greater diversification of the economy was promoted, with more cultivable land farmed for crops other than sugar, like vegetables and soy. Small-scale organic farming was developed in urban gardens, the *organoponicos*, which covered a significant percentage of the country's food requirements (Paponnet-Cantat 2003). Half of the existing sugar refineries were closed, while nickel and cobalt mining doubled from 1993 to 1997, mainly in the form of public-private joint ventures with foreign countries (Navarro Vega 2013). Despite the economic bottleneck, huge investments were made in medical and pharmacological research 120 million dollars between 2005 and 2008 (Núñez Jover et al. 2008), allowing Cuba to become one of the world's most advanced countries in the field of biotechnology. The sudden lack of the energy supplies that had come from the Soviet Union created very serious problems, especially the interruption of electricity, with frequent long blackouts (*apagones*) (Pérez-López 1992). Deep drilling led to the discovery of substantial (though low-quality) oil deposits, while the production of natural gas grew from virtually zero to over 450 billion cubic meters from 1990 to 1999.

In 1994 the worst phase of the *periodo especial* was over, economic decline slowed and recovery began. (Núñez Jover et al. 2008). By 2004 the sum of products and services had registered a 46 % recovery from 1994 and the country enjoyed a balance of payments surplus. In 2005 the economy boasted a growth rate of 11.8 %, the highest since 1959, and it continued to grow in 2006. And this despite the hurricanes that devastated the Island in 2008, when the evacuation of a million people and the other measures that are always taken in Cuba avoided the hundreds of victims that such cataclysms regularly claim in the other countries of the region (including the United States).

This period can be considered to exemplify again the exceptionality of Cuba, as the increasing diversification of Cuban economy has not led to a collapse of the country. Although the egalitarian society of the 1960s and 1970s was deeply shaken by the creation of tangible economic differences between those who could access foreign currencies (through tourism and foreign remittances) and those who could not, the government has made an effort to keep up support the key sectors of health-care, education and social security. Even if the persistent shortage of medicines, products and basic equipment, paper, books and other materials for consumption undoubtedly lowered the general level of these services, Cuba has determinedly worked at preserving and in some cases even improving the features that distinguished its social model from the one prevailing in the rest of the world, especially in Latin America.

Midway through the 1990s, a report of the United Nations Economic Commission for Latin America and the Caribbean (CEPAL, from the Spanish acronym) stated that ‘given the size of the external shock, the policies of adjustment (in Cuba) has been relatively low [...] in comparison with other Latin American economies,’ attributing such an outcome to the ‘orientation toward solidarity’ of the Cuban social context. (Lorini and Basosi 2009)

UNICEF confirms that Cuba is the only country in Latin American or the Caribbean to have eliminated childhood malnutrition (UNICEF 2004). The infant mortality rate at birth is among the lowest in the world and continues to improve despite the economic crisis.

As far as international politics are concerned, Cuba has enormously strengthened its influence on the Latin American continent. In 1987 eight Latin American countries for the first time proposed Cuba's readmission to the Organization of American States (after its expulsion in 1962, cf. *supra*). The United States opposed the motion, but 2 years later was humiliated when the Latin American countries elected Cuba as non-permanent member of the U.N. Security Council. In the U.N. General Assembly's votes against the US blockade against Cuba the Latin American countries passed from abstaining to voting in favor, with the result that the total number of votes against the US jumped from 59 to 101 between 1992 and 1994. Left-leaning Latin American leaders have shown renewed interest in the Cuban Revolution. Venezuela, above all, has become Cuba's most important political and economic partner, while China has also given significant support to Cuba.

Finally, after 47 years the Organization of American States unanimously cancelled the U.S.-imposed resolution excluding Cuba from the continent's community structures during the 2009 summit in Honduras. While Hillary Clinton was forced to grin and bear it, the Honduran President Manuel Zelaya (who soon after, as if by historical nemesis, was overthrown in a coup not without United States' manipulation!) turned directly to Fidel Castro and, referring to his historic defense speech of 1953, pronounced: "I say to Commandeer Fidel Castro, today you have been absolved by history."

A time of reckoning has come as concerns Cuba's internal problems as well. In part these have become more critical because of the repercussions the world crisis has had on the domestic economy and the population's living conditions. But the passage of political leadership from Fidel, the historic leader now afflicted with health problems, to his brother Raul, at the same time as it granted substantial political continuity also awakened great hopes in the population. The commitment to carry out significant changes can no longer be postponed, but it is evidently difficult to carry out because of bureaucratic fossilization, international isolation and internal taboos in political debate in relation to repressive responses by the government.

2.5.3 Cultural Vitality, Higher Education and Low-Funded Universities

Few words are sufficient to recall the ongoing of Cuban cultural vitality, in spite of the crisis: the international success of Cuba's popular music (Pablo Milanés, Silvio Rodríguez, the Van Van, Charanga Habanera, etc.), Cuban ballet (Alicia Alonso, the *Escuela Cubana de Ballet*), the plastic and figurative arts, the *Havana Biennale d'Arte*, uninterrupted Cuban film production, the annual *Festival del Nuevo Cine Latinoamericano*, the good health of Cuban literature (both at home and abroad: besides by now historical figures like Dulce María Loynaz, Cintio Vitier, Eliseo Diego, Dora Alonso, and Lisandro Otero, is testified by names that include

Guillermo Cabrera Infante, Miguel Barnet, Roberto Fernández Retamar, Senel Paz, Pablo Armando Fernández, Reynaldo González, Leonardo Padura).

The effect of the crisis on scientific research has been particularly heavy. However, Cuba has managed to resist in this field as well, though paying a high price. The government has done everything possible to support the most important activities. On 18th January 2002 the then president Fidel Castro stated that “this country will live on intelligence and intellectual property”, which means that the political commitment to bet on knowledge, education and science remains firm. There has been far-reaching reorganization in many areas; inevitably, experimental research has been the most affected, while computer-driven research has been significantly boosted. The relations with non-socialist countries cultivated by Cuba in the first decade of the Revolution, which had never been completely suspended, have turned out to be very useful in this phase: many Cuban scientists (even if a certain number have left the country) take advantage of collaboration and exchanges with Spain, Mexico, Brazil and other countries. This reconfirms the high level reached by Cuban science on the international scene as well as the solidity of the results achieved before 1990.

Though the necessary reorganization has produced sacrifices and penalized important activities, it was done intelligently and in the end has even had some useful outcomes. Since the country has made every effort not to abandon its free education and healthcare systems, interdisciplinary projects have been intensified. The excellence of Cuba’s biotechnological and medical research and the importance of the results it has reached are known worldwide.³⁵ Naturally, the interruption of relations with the socialist countries has led to a worrying crisis in employment opportunities for university and polytechnic school graduates. Still, thousands of students from Latin American and other third-world countries study medicine or art in Cuba, something that would be impossible for them in their own native countries.

The new global situation of Cuban science alters thus between the excellence in some fields of study and research and difficulties that are not very different of those in other countries.

2.5.4 The Challenge of the Future in the Context of the World Crisis

This is not the place to discuss the present world economic crisis, and speculate on the place and the future of Cuba. Nevertheless at least a short remark seems necessary. Indeed, starting around 2010 the Cuban government has turned into reforms of the economic system, which are difficult to evaluate, but are changing at least the external aspects of Cuban life, but are deeply influencing also the mentality of the citizens. Anyone who visits Cuba now will remark at first glance the change in the

³⁵ See the chapter by Pérez Ones and Núñez Jover, republished in this volume.

urban panorama itself, people selling goods everywhere, small trades, but inexistent before 2010. On the one hand, the world economic crisis strikes also this country, even if in different ways from others. The American Administration does not show any sign of loosening the blockade to the Island, in contrast with the initial perspectives of the Obama presidency. On the other hand, the Cuban government has acknowledged (all the more in these conditions) the inefficiency of the “universal” State economy, and in particular the necessity of dramatically reducing the number of the State workers and bureaucracy personnel, an extremely painful choice. Among other economic reforms (commerce of apartments and cars, permission to expatriate, etc.), the permission of the *trabajo por cuenta propia* is the most visible at glance.

We think that it is impossible for everyone to give a well-advised evaluation of these economic measures, and even more of the general and political perspectives: too many times in the past quarter of century specialist have predicted nothing less than the collapse of the Cuban regime. Nevertheless we felt obliged at least to point out these changes, which could give a further turn to the situation that we have tried to discuss: Cuba could set aside one more surprise.

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