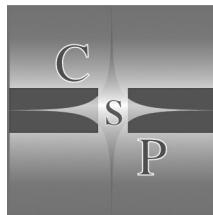


Astronomy and Astrophysics
in Spain (1850-1914)

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By

Pedro Ruiz-Castell



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LIST OF ABBREVIATIONS

Abbreviations have been used exclusively in footnotes when dealing with primary sources from the following archives:

- OAUV Archivo Histórico del Observatorio Astronómico de la
 Universidad de Valencia.
- ANF Archives Nationales de France.
- OAM Archivo del Observatorio Astronómico de Madrid.

CHAPTER ONE

STRUCTURE AND METHODOLOGY

1.1. Structure

The second half of the nineteenth and the beginning of the twentieth century was a time of major change in Spain. In the particular case of the development of science, these changes are very well illustrated in the field of astronomy and astrophysics. The current text aims to explain how these branches of scientific knowledge progressed in Spain during this period. It is divided into two main parts: the first deals with the observatories, institutions, and the scientific community of the period; the second examines the total solar eclipses observed from Spain in the early twentieth century, particularly those of 1900 and 1905. Consequently, the first part takes a more traditional history-of-science approach to present a general overview of the institutional situation in Spain as regards to astronomy and astrophysics during the second half of the nineteenth and the early twentieth century. The second part, however, steps outside the history of the institutions and applies the lessons learned in the first part to the study of specific issues related to the observation of these solar eclipses. It explores the high points of astronomical and astrophysical activity in Spain at the moments of the total solar eclipses of 1900 and 1905.

This separation into two different parts escapes from the typical chronological structure to which many historians are attached. It provides a way for the historian to look at the institutional history through the study of the activity during these solar eclipses. At the same time, it highlights some of the limitations of that more traditional way of doing history and explores new aspects which might help to better understand the processes studied in this work. In sum, it provides a different point of view for more ambitious generalisations and abstractions. What gave rise to the developments in astronomy in Spain during the late nineteenth and early twentieth centuries? Why did astronomy become relevant to Spain? The

study of the total solar eclipses of 1900 and 1905 helps to clarify these and other issues, such as the formation of a Spanish astronomical community during that period.

The first part not only deals with the general Spanish context of the second half of the nineteenth century, exploring several social, political, economic, and cultural aspects, but also provides some insights into the situation of astronomy in Spain during that period. An overview of the evolution of astronomy during the second half of the nineteenth century in the country is presented through the developments at the Observatory of Madrid, the main Spanish astronomical institution of the period, and looking at some members of the Spanish astronomical community that was formed during these years. Moreover, the progress of astronomy in Spain during the early twentieth century had the support of several other institutions. Specifically, the institutionalisation of astronomy in Spain during these years had two interesting allies: religious orders and universities. This implied a very heterogeneous scientific community devoted to astronomy, as it will be shown.

The second part of this book explores the state of astronomy in Spain during the late nineteenth and early twentieth century through the study of two particular eclipses whose path of totality crossed Spain in 1900 and 1905. To contextualise these astronomical events, attention is paid to the growth of popular and amateur astronomy during the period studied, as well as to the importance of solar eclipses in the development of solar physics and the rise of astrophysics. The scientific activity developed during the total solar eclipses of 1900 and 1905 is analysed in the subsequent chapters, with some previous eclipses (such as that of 1860) as background, and a comparative analysis of foreign and national programmes and methods of observation is attempted. Consequently, the text not only deals with the organisation and work of the first Spanish official eclipse expedition since the development of astrophysics and with the research pursued by foreign astronomers who visited Spain to observe the solar eclipses of 1900 and 1905, but also explores some social and cultural dimensions surrounding scientific enterprises such as eclipse expeditions. Finally, the study of the solar eclipses of 1912 and 1914 allows an analysis of the situation in which astronomy was left in Spain after the total eclipses of 1900 and 1905 through. When compared with the state of astronomy during the second half of the nineteenth century, one appreciates the qualitative step taken in astronomical research and initiatives in the country.

1.2. Methodology

This book focuses on the astronomers and institutions of Spain in the late nineteenth and early twentieth centuries. This includes not only Spanish individuals and institutions, but also foreign eclipse expeditions sent to Spain to observe the solar eclipses of 1900 and 1905. Of these, more attention is paid to the British and French expeditions because of the numbers of astronomers from these countries who went to Spain to observe the two eclipses. In fact, France and Great Britain were for Spain the two most influential European countries in terms of scientific research, at both the institutional and the amateur level, by the early twentieth century. That is why many of the bibliographical sources, particularly primary sources, cited in this book are French and British publications. Several archives and libraries in these two countries were visited in order to obtain information, including the Archives Nationales de France, the archives of the Observatory of Paris, the Bodleian Library, the archives of the Museum of the History of Science at Oxford, and the British Library. This made possible the systematic study of the main astronomical and astrophysical journals of the period. The following technical periodicals in the field of astronomy and astrophysics were consulted for this book:

- *Astrophysical Journal*, volumes 1 (1895) to 50 (1919).¹
- *Monthly Notices of the Royal Astronomical Society*, volumes 53 (1892) to 73 (1913).²
- *Astronomical Journal*, volumes 1 (1849) to 50 (1944).³
- *Astronomische Nachrichten*, volumes 121 (1889) to 210 (1920).
- *Publications of the Astronomical Society of the Pacific*, volumes 3 (1891) to 19 (1907).
- *Journal of the British Astronomical Association*, volumes 1 (1890–1891) to 30 (1919–1920).⁴

¹ Storrs B. Barrett (comp.), *The Astrophysical Journal: A General Index by authors and by subjects to volumes I to XXV (January 1895 to June 1907)* (Chicago: University of Chicago Press, 1908); Storrs B. Barrett (comp.), *The Astrophysical Journal: A General Index by authors and by subjects to volumes XXVI-L (July, 1907, to December, 1919)* (Chicago: University of Chicago, 1920).

² See: Royal Astronomical Society, *General Index to the Monthly Notices of the Royal Astronomical Society, volumes LIII to LXX, 1892–1910, together with General Index to Illustrations in the Memoirs, volumes I to LIX, and the Monthly Notices, volumes I to LXX, 1822–1910* (London: Burlington House, 1911)].

³ G. M. Clemence and Louise F. Jenkins, *General Index to the first fifty volumes 1849–1944* (New Haven, 1948).

- *The Observatory*, volumes 13 (1890) to 42 (1919).
- *L'Astronomie*, volumes 9 (1890) to 13 (1894); and the *Bulletin de la Société Astronomique de France*, which absorbed *L'Astronomie* in 1895, volumes 1 (1887) to 24 (1910).

Other astronomical publications, such as the Russian *Astronomicheskii Zhurnal*, did not appear until later, in this case in the early 1920s. Other important journals dealing specifically with astrophysics, like the German *Zeitschrift für Astrophysik* and the French *Annales d'Astrophysique*, were published for the first time in the 1930s (in these two cases, 1930 and 1938, respectively). Some British and French general scientific periodicals, such as the *Proceedings of the Royal Society of London*, *Science*, *Nature*, *Knowledge*, *Annales du Bureau des Longitudes*, and the *Comptes Rendus de l'Académie des Sciences*, have also been methodically consulted. Finally, most of the Spanish primary sources cited in this book, including manuscripts, periodicals, and newspapers (such as *El Imparcial*, *El Heraldo de Madrid*, *El Liberal*, *El Mundo Científico*, *Memorias del Observatorio del Ebro*, *Boletín de la Sociedad Astronómica de Barcelona*, *Razón y Fe*, and *Ibérica*), have been obtained not only from the Spanish Biblioteca Nacional but also from the library of the National Museum of Science and Technology of Madrid and the archives of the Astronomical Observatory of the University of Valencia, the Observatory of Madrid, and the Ebro Observatory.

⁴ Volumes 1 to 18 can be searched with F. W. Levander, *General Index to the Journal of the British Astronomical Association, volumes I.-XVIII* (Edinburgh: Neill and Co., 1909).

Part I

The development of astronomy in Spain: institutions and individuals

CHAPTER TWO

SPAIN IN THE NINETEENTH CENTURY

2.1. Astronomy and the State

Greenwich, Paris, Pulkovo ... National astronomical observatories such as those of England, France, and Russia were established during the seventeenth and eighteenth centuries to investigate navigational and geodetic problems. Navigation was strongly linked to power. It implied not only military authority, but also territorial and economic resources. Several authors, such as William McNeill and Fernand Braudel, have pointed out the relationships between “technological” knowledge, the improvement of oceanic navigation and military techniques, and the growth of national economies.⁵ These relationships have been identified as the basis for the development of Western civilisation.⁶ Aware of its importance, the most powerful countries supported and financed astronomy during these years. Practical astronomy was to play a significant role in the development of both European imperialistic policies and oceanic commerce. This agenda was familiar to Spain, a country particularly interested in looking after the important market and font of resources that its American colonies provided. Evidence of this may be

⁵ See for instance: William McNeill, *The Pursuit of Power: Technology, Armed Force, and Society since A.D. 1000* (Oxford: Basil Blackwell, 1983); and Fernand Braudel, *Capitalism and Material Life* (London: Weidenfeld & Nicolson, 1973). McNeill points out the significant relationships between technology, armed force, and society, while Braudel underlines the importance of the conquest of high seas for modern Europe’s world supremacy.

⁶ See: J. R. McNeill and William H. McNeill, *Las redes humanas. Una historia global del mundo* (Barcelona: Crítica, 2004); and Samuel P. Huntington, *El choque de las civilizaciones y la reconfiguración del orden mundial* (Barcelona: Paidós, 1997), pp. 54–63.

seen in the publication of astronomical ephemerides in the *Almanaque Náutico* of the Naval Observatory of San Fernando from 1791.⁷

The Royal Observatory of Cadiz, originally conceived by the Spaniard Jorge Juan y Santacilia (1713–1773), was founded in 1753.⁸ In 1735 Jorge Juan, together with the Spaniard Antonio de Ulloa y García de La Torre (1716–1795), had participated in the expedition to Peru led by the Frenchman Charles Marie de la Condamine (1701–1774) to measure an arc of the meridian at the equator. On his return in 1744 he devoted himself to the reorganisation of the Spanish Navy. Once appointed Captain of the *Compañía de Guardiamarinas* (Royal Marine Guards) in 1751, Jorge Juan promoted the establishment of an astronomical observatory. The Observatory was created as an annexe to the Royal Marine Guards Academy with the purpose of teaching astronomy to future naval officers. In 1798 it moved next to the island of León. The Observatory became independent from the Academy six years later and in 1814 changed its name to Real Observatorio de San Fernando.⁹

For political and economic reasons, and in the absence of mature institutional frameworks, navies encouraged and supported the development of astronomy all over eighteenth-century Europe. The equation “economic power = military power” would remain valid during the nineteenth century.¹⁰ In Spain, astronomy was developed during the eighteenth and early nineteenth centuries partly as a result of the needs, stimulus, and protection of the Navy. Nevertheless, by the end of the

⁷ See the *Almanaque náutico y efemerides astronómicas para el año ... calculadas de orden de S.M. para el Observatorio Real de Cádiz* (Madrid: En la Imprenta Real, 1791–1959); 168 volumes.

⁸ For a complete history of the Observatorio de la Marina de San Fernando, currently known as the Real Instituto y Observatorio de la Armada, see: A. Lafuente and M. Sellés, *El Observatorio de Cádiz (1753–1831)* (Madrid: Ministerio de Defensa, 1988); and Francisco José González González, *El Observatorio de San Fernando (1831–1924)* (Madrid: Ministerio de Defensa, 1992). On the scientific instruments of the observatory, see: Francisco José González González, *Instrumentos científicos del Observatorio de San Fernando (siglos XVIII, XIX y XX)* (Madrid: Instituto de Historia y Cultura Naval, Ministerio de Defensa, 1995).

⁹ The island of León was renamed the city of San Fernando in 1813. The change of name, made by the liberal courts who met on this island in 1813, was probably in honour of the Spanish king Fernando VII.

¹⁰ See: Paul Kennedy, *Auge y caída de las grandes potencias* (Barcelona: Plaza & Janés, 1994).

eighteenth century new attitudes in favour of a more theoretical and speculative astronomy were developing within the country. Good examples are the attempts of educational reforms to promote astronomy in Seville and Valencia and the foundation of a Royal Observatory in Madrid, in charge of cartographic activities and astronomical research.¹¹

The economic problems and political instabilities of nineteenth-century Spain, however, proved to be enormous obstacles to the consolidation of such projects. There is no doubt about the connections between the State and the progress of astronomy during the seventeenth, eighteenth, and early nineteenth centuries. In Spain, these links seem to have been particularly significant. In fact, any attempt to study the evolution of astronomy during the nineteenth century has to take these into account. Some of the most relevant aspects of the social, economic, and cultural development of Spain during the nineteenth century are now considered.

2.2. Nineteenth-century Spain

By the end of the eighteenth century, Spain had a reasonably significant role in the world as a country with moderate power. However, Spain had to begin the nineteenth century relegated to a second order. The Battle of Trafalgar (21 October 1805) confirmed the superiority of the British Navy and the decline of the Spanish *Armada*. The Napoleonic invasion of 1808 heralded a century of political instability. The Spanish Empire also began to disintegrate with the new century. The events of 1808 in Spain created on the other side of the Atlantic a crisis of political legitimacy and power. The process of independence in Chile started in 1810—although it did not finish until 1823. Argentina claimed independence from Spain in 1816, five years before the independence of Mexico, Central America (Guatemala, Honduras, Nicaragua, El Salvador, and Costa Rica), Peru, Venezuela, and Ecuador. By 1824 the conclusive loss of the South American colonies had been formalised.¹²

¹¹ See: Manuel A. Sellés, 'Astronomía y navegación', in Manuel Sellés, José Luis Peset, and Antonio Lafuente (comps.), *Carlos III y la ciencia de la Ilustración* (Madrid: Alianza, 1988); pp. 81–98.

¹² For a more complete understanding of the processes of independence in Latin American countries, see: Leslie Bethel (ed.), *The Cambridge History of Latin America. Volume III, From independence to c.1870* (Cambridge: Cambridge University Press, 1985); and John Lynch, *Las revoluciones hispanoamericanas 1808–1826* (Barcelona: Ariel, 1980).

During these years a sense of national decline and of inferiority alongside European philosophical and scientific progress was felt amongst the Spanish intellectual elites. For many of them the roots of the problem were found in the enormous pressure that the Catholic Church had exerted in the country. Nonetheless, the central years of the century brought new changes. From the 1850s the gap between Spain and Europe was seen by contemporary Spaniards not only as an intellectual problem or a lag in culture, but also as an economic fact¹³—even when during these years foreign trade experienced a vigorous growth in general terms.¹⁴ From 1858 to 1863 the government led by General Leopoldo O'Donnell y Jornis (1809–1867) pursued a *policy of prestige* based on the imperialistic expansion of Spain. Again, the aim to control new lands was strongly linked to economic interests. Although less important than the campaigns of the most powerful European countries, military expeditions were organised to places such as Morocco and Mexico. They did not create the basis of any new Empire, but encouraged and promoted Spanish national identity.¹⁵

It was in this new context that the elite began to revisit the problems of the country from new points of view. The freedom of thought brought about by the *Glorious Revolution* of 1868 encouraged it even more. One of the most characteristic examples is the public debate that developed during the 1860s and 1870s into the well-known *polémica* about Spanish science—a debate centred on whether there existed a scientific tradition in modern Spain.¹⁶ On the one hand, public figures such as José Echegaray y Eizaguirre (1832–1916), Gumersindo de Azcárate (1840–1917), Manuel de la Revilla y Morera (1846–1881), and José del Perojo y Figueras (1850–1908) denied the existence of such a scientific tradition in the country.¹⁷ Their arguments, again, identified the roots of the problem with

¹³ See: Raymond Carr, *Spain 1808–1939* (Oxford: Clarendon Press, 1966).

¹⁴ Albert Carreras and Xavier Tafunell, *Historia económica de la España contemporánea* (Barcelona: Crítica, 2003).

¹⁵ José Álvarez Junco, 'La conformación de una identidad', in José María Jover Zamora (dir.), *Historia de España Menéndez Pidal. Tomo XXXVI, La época de la Restauración (1875–1902). Volumen II, Civilización y cultura* (Madrid: Espasa Calpe, 2002); pp. 5–45.

¹⁶ See for instance: Enrique García Camarero and Ernesto García Camarero, *La polémica de la ciencia española* (Madrid: Alianza, 1970).

¹⁷ Their approach was, however, slightly disparate, as they were strongly influenced by different philosophical schools. Gumersindo de Azcárate, for instance, was a recognised *krausist*, while Manuel de la Revilla and José del Perojo were well known for their neo-kantian ideas.

the political and religious intolerance of, and the oppression by, the Church and the State. Others, such as Felipe Picatoste y Rodríguez (1834–1892) and Marcelino Menéndez y Pelayo (1856–1912), claimed that a nationalistic approach to the problem was needed and underlined the importance of Spanish scientific activity during the sixteenth and seventeenth centuries.¹⁸ The discussion was, however, part of a broader ideological and political debate. Even when it dealt explicitly with scientific details, the public debate was infused with more general arguments about freedom of thought and the roles of the Catholic Church and the State in the country.

The *polémica* took different shapes and forms. A good example is the debate precipitated by the Spanish translation of the *History of the Conflicts between Religion and Science*¹⁹ of 1876. The prologue, written by Nicolás Salmerón Alonso (1838–1908), exposed the incompatibility of Catholic faith with cultural and scientific progress.²⁰ The powerful neo-Catholic movement, however, reacted immediately, and replies to the text were published during the late 1870s, the 1880s, and into the 1890s.²¹ A similar debate emerged in Spain during this period around Darwinist ideas. But as Glick has pointed out, those on both sides of the debate defended postures whose origins and objectives were far removed from the scientific problem itself.²² A glance at some of the names associated with this public discussion confirms this observation. Echegaray, who taught mathematics and physics at the Engineering School of Madrid, was a well-known politician and a famous playwright. Azcárate, Professor of Law at the Universidad Central of Madrid, was also an active politician. Revilla was a recognised writer, like Perojo and Picatoste, who were also distinguished politicians. Menéndez y Pelayo was a prestigious philologist and historian. Salmerón was another prominent politician, President of the Spanish First

¹⁸ See the main work of Marcelino Menéndez y Pelayo, *Historia de los heterodoxos españoles* (México: Porrúa, 1995) [First edition: Madrid, 1882].

¹⁹ John William Draper, *History of the Conflict Between Religion and Science* (London: H. S. King, 1875). The book was translated into Spanish by the astronomer and meteorologist Augusto T. Arcimis Werle as *Historia de los conflictos entre la religión y la ciencia* (Madrid: Imprenta de Aribau y C^a, 1876).

²⁰ For a brief introduction to the conflicts between science and religion in nineteenth-century Spain, see: Francisco Pelayo López, 'Ciencia y religión en España durante el siglo XIX', *Asclepio*, 40 (1988), 187–207.

²¹ Enrique Menéndez Ureña and José Manuel Vázquez-Romero, 'El pensamiento y las ideas', in Jover Zamora (dir.), *Historia de España Menéndez Pidal. Tomo XXXVI. Volumen II* (Madrid, 2002); pp. 125–176.

²² Thomas F. Glick, *Darwin en España* (Barcelona: Península, 1982).

Republic in 1873. This indicates how easily the debates set up around scientific topics moved into a more general arena.

At the same time, as Sala Catalá has pointed out for the particular case of biology, many of those who in the late 1860s began to develop new ideas in Spain on scientific methodology relegated the practice of science to a secondary role because it was seen as an activity subject to rationally constructed philosophical deductions.²³ As a consequence of the terms in which the public discussion was set up, he argues, no experimental biology was practised in the country. Philosophical, political, and educational issues were considered, in many cases, more important. Indeed, public discussions about science, common in nineteenth-century Europe, were greatly politicised in Spain, obviating any examination of how scientific activity had to be pursued. Consequently, many of these debates have to be understood as part of a more general battle between “two Spains”: the modern versus the traditional, the progressive against the conservative.

Two of the aspects traditionally linked to the progress of science in nineteenth-century European countries are economic and industrial developments. In Spain, the early years of this century were characterised by the loss of the American colonies and, as a consequence, the increasing debt of the State.²⁴ However, no government reformed the inequitable and unproductive Spanish taxation system, under which the burden of tax rested much more heavily on the poor. During this period the State was dependent on loans and did not have sufficient means to promote a process of modernisation in a backward economy.²⁵ The first decades of nineteenth-century Spain saw a strong economic contraction. Nevertheless, a slow and gradual recovery, in terms of industrial and urban development, began in 1840. As Nadal has argued, between 1830 and 1840 a process of industrialisation was initiated in the country, more or less at the same time as in other countries such as Belgium, France,

²³ José Sala Catalá, ‘Ciencia biológica y polémica de la ciencia en la España de la Restauración’, in José Manuel Sánchez Ron (ed.), *Ciencia y sociedad en España: de la Ilustración a la Guerra Civil* (Madrid: El Arquero-CSIC, 1988), pp. 157–177.

²⁴ Josep Fontana, *La quiebra de la monarquía absoluta* (Barcelona: Ariel, 1971).

²⁵ Raymond Carr, *Modern Spain 1875–1980* (Oxford: Oxford University Press, 1980).

Germany, Austria, Russia, and Sweden.²⁶ Steam-powered machines were introduced in the cotton industry during the 1840s, a railway system began to be constructed during the 1850s, gasworks for urban and domestic lighting were set up during the 1860s, and both non-industrial manufacture and industrial production began to co-exist in the food, textile, and metallurgical sectors.²⁷

The permanent political crisis that shook Spain during the first two-thirds of the nineteenth century, dominated by successive military *coups d'état*, severely hampered attempts to lead the country along the pathway of economic modernisation. These projects, introduced mainly by the Progressive Party, aimed to create and consolidate the political and institutional bases for an industrial and technologically advanced society. As Tortella has summarised:

The most notable of these were the legislative program of the Progressive Biennium (1854–1856) and the executive and legislative of the Glorious Revolution (1868–1874). These efforts were not wholly fruitless, and not all nineteenth-century Spain stagnated: Catalonia, and especially Barcelona, underwent considerable industrialization; land reform was carried out; a railroad network was built; improvements were made in the educational system; monetary, banking, and fiscal reforms were implemented; yearly budgets were duly prepared and enacted into law; some manufacturing industries developed and some older industries were partially modernized.²⁸

Despite the slow modernisation of the country, the process of growth set in motion during the mid-nineteenth century gained momentum as the century progressed and finally rapidly accelerated in the twentieth century.²⁹ This process was catalysed by the political stability created by the restoration of the monarchy in the last quarter of the century.

²⁶ Jordi Nadal, *El fracaso de la Revolución industrial en España, 1814–1913* (Barcelona: Ariel, 1975).

²⁷ Miguel Artola, 'La burguesía revolucionaria (1808–1874)' in Miguel Artola (dir.), *Historia de España* (Madrid: Alianza Editorial, 1990).

²⁸ Gabriel Tortella, *The Development of Modern Spain. An Economic History of the Nineteenth and Twentieth Centuries* (Cambridge, Mass., and London: Harvard University Press, 2000).

²⁹ *Ibid.*

2.3. Restoration Spain and the end of century crisis

The restoration of the monarchy was proclaimed in December of 1874, after the *pronunciamiento* (military insurrection) of Arsenio Martínez Campos (1831–1900) in Sagunto (Valencia). The coronation of the King Alfonso XII (1857–1885) took place in January 1875. The political system of Restoration Spain, conceived by Antonio Cánovas del Castillo (1828–1897), was based on two main parties governing alternately, under the conservative constitution of 1876. As suggested above, the years of Restoration Spain benefited from previously created conditions for an incipient process of modernisation. During the late nineteenth century the political panorama was modified and economic change occurred on a noticeable scale. Nevertheless, the weight of tradition and the extreme rigidity of the institutional framework held back the evolution of the country and, compared with progress in other European countries, the total change was small. Spain on the whole remained largely agrarian, traditional, and backward.³⁰ Changes in the social and institutional structure, such as fiscal and administrative reorganisation, liberalisation of the economy, and educational reform, were achieved, but the process was not consolidated. Economic historians have identified the reason for the failure of the process as the lack of preparation in the country for the assimilation of such a process of modernisation.

The slow and unbalanced process of modernisation was one of the many factors that contributed to the Spanish end-of-century crisis. The historian Jover Zamora has identified the years 1885–1887 as the starting point for this critical period.³¹ The beginnings of the crisis have been linked to the death of Alfonso XII in 1885 and the subsequent regency of María Cristina of Habsburg. This period was characterised by a sense of pessimism, largely a consequence of ongoing calamities such as epidemics, floods, wars, mutinies, civil disorders, etc. It was also related to factors present in other European countries, such as the agrarian crisis and the insecurity of the middle classes brought on by the emergence of an organised working class. The economic crisis of the late 1880s in Europe

³⁰ For an introductory and general overview of the different processes of industrialisation all over Europe, see: Sydney Pollard, *La conquista pacífica. La industrialización de Europa 1760–1970* (Zaragoza: Prensas Universitarias de Zaragoza, 1991).

³¹ José María Jover Zamora, 'Aspectos de la civilización española en la crisis de fin de siglo', in Jover Zamora (dir.), *Historia de España Menéndez Pidal. Tomo XXXVI. Volumen II* (Madrid, 2002), pp. 747–784.

meant that confidence in the development of science and technology faltered somewhat. It was clear by then that the rise of capitalism had created dreadful problems and exacerbated the misery in which working classes lived.

The crucial point of this period in Spain was the year 1898. The military defeat of that year, in which the United States of America shamed the Spanish Navy and the last overseas colonies (Cuba, Puerto Rico, and the Philippine Islands) were lost was seen as evidence that the country was in terminal decline. If the declaration of war against Spain by the United States engendered a wave of patriotic feeling,³² the *Disaster* of 1898 troubled the national conscience.³³ Many writers focused on the situation of the country and its position in history. Criticism from the *regenerationist* movement, a legacy of nineteenth-century Spanish liberal ideas, was particularly strong. The aims of regeneration spread throughout various sectors of Spanish society, through the press, universities, and the Parliament.

The turn of the century saw the spread throughout Spain of a very heterogeneous *regenerationist* movement. It developed many different branches, representing particular interests and philosophical theories.³⁴ There were also *pseudo-regenerationists* within the existing political system, interested in exploiting the popularity of the movement for political ends, and other sectors, such as the socialist party and the anarchists, who called for a complete rupture from the political system. The latter groups, however, were relatively weak and their influence was restricted to local, rather than national, spheres.

³² Sebastian Balfour, 'War, nationalism and the masses in Spain, 1898–1936', in Edward Acton and Ismael Saz (eds.), *La transición a la política de masas* (Valencia: Universitat de València, 2001), pp. 75–91.

³³ Juan Pablo Fusi and Jordi Palafox, *España: 1808–1996. El desafío de la modernidad* (Madrid: Espasa Calpe, 1997).

³⁴ See: Pedro Cerezo Galán, 'El pensamiento filosófico—El 98: la generación trágica', in José María Jover Zamora (dir.), *Historia de España Menéndez Pidal. Tomo XXXIX, La edad de plata de la cultura española (1898–1936). Volumen I, Identidad, Pensamiento y Vida. Hispanidad* (Madrid: Espasa Calpe, 1993); pp. 133–152; and Pedro Cerezo Galán, *El mal del siglo. El conflicto entre Ilustración y Romanticismo en la crisis finisecular del siglo XIX* (Madrid: Biblioteca Nueva, 2003).

During the first years of the twentieth century almost all sectors of Spanish society adopted a *regenerationist* mentality which involved rejecting the situation of contemporary Spain and putting faith in the future of the country.³⁵ In general terms, *regenerationists* wished for a nationwide programme of public works to create the infrastructure needed for a modern economy. The programme should include measures to promote agricultural productivity, decentralise the State, and invest in education, and proposals to increase the networks of communication and distribution (more railways) and to reform the judicial and electoral systems.³⁶ The modernisation of Spain was understood in terms of the French, British, and German models, and the intervention of the State in the economy was seen as crucial to revitalise the country.³⁷ This initiative, known in Spain as *européisation*, sprang from the new social and cultural framework developed in Spain during the last quarter of the century.³⁸

The fact that the country did not collapse under the strain of economic problems during the difficult years after 1898 allowed the regime of the Restoration to survive.³⁹ *Regenerationism* strongly influenced the political life of the country during these years, but the concept was finally emptied of meaning, and the word was absorbed by and included as part of the established political system. Almost every critic of the corrupt constitutional monarchy, unrepresentative of the great interests of the nation, assumed the title of *regenerator*. But the protest movements failed

³⁵ Carlos Seco Serrano, 'Las ideologías políticas', in Jover Zamora (dir.), *Historia de España Menéndez Pidal. Tomo XXXIX. Volumen I* (Madrid, 1993); pp. 319–467.

³⁶ Sebastian Balfour, *El fin del imperio español (1898–1923)* (Barcelona: Crítica, 1997).

³⁷ The importance of the State in the process of industrialisation has been studied in: A. Gerschenkron, *El atraso económico en su perspectiva histórica* (Ariel, Barcelona, 1968).

³⁸ Juan Pablo Fusi, *Un siglo de España: La cultura* (Madrid: Marcial Pons, 1999).

³⁹ Nonetheless, Spain found itself immersed in a slow and progressive process of weakening. This probably had more to do with the imbalance of the process of modernisation in Spain rather than with the *Disaster* itself. See for instance: Jordi Nadal and Albert Carreras (dirs. and coords.), *Pautas regionales de la industrialización española (siglos XIX y XX)* (Barcelona: Ariel, 1990). This lack of cohesion in late nineteenth- and early twentieth-century Spanish society could be understood as a particular and characteristic stage of an early economic and industrial development. See: Carr, *Modern Spain 1875–1980* (Oxford, 1980). For a study of the *centrifugal* forces of the period 1898–1909 which caused this weakness, see: Balfour, *El fin del imperio español (1898–1923)* (Barcelona, 1997).

either to overthrow, or to radically reform, the discredited political system. As Carr explained:

The protest movements were fissiparous, divided in tactics and as much rent by personal feuds as the “corrupt” parties they attacked. Secondly, the political system was more open and flexible than its critics admitted. Finally, apathy and the regionalist issue inhibited the creation of mass nationwide parties of protest.⁴⁰

Economic and regional interests on the one hand, and the rejection of an alliance with non-dynastic movements on the other, inhibited any alternative to the established political system. Traditional networks of social and ideological control continued in a country that was yet to be modernised, with high levels of illiteracy and underdeveloped transport systems.⁴¹ The political system was now more and more isolated from Spanish society, and its structural characteristics frustrated all efforts to renew it.

By the turn of the century, Spain was still not a modernised country. From the economic point of view, there was in Spain, from 1827 to 1902, an average increase over 215% in the cost of articles of prime necessity, while the augment in wages was 15%. Since 1902 the prices of bread and wine slightly decreased, but in the cost of other necessities was an average increase over 19%. Rents also raised enormously in most industrial centers.⁴² In contrast to most advanced European states, during the whole of the nineteenth century Spain’s population had grown very slowly, due to a relatively moderate birth rate and high mortality. Several factors contributed to this, among them poor sanitation, low agricultural productivity, chronic housing shortages, and an expensive and inadequate transportation network. One of the most interesting elements was widespread ignorance, in particular about the causes and transmission of illness. There is no doubting the relationship between literacy and economic development and productivity. The investment in human

⁴⁰ Carr, *Modern Spain 1875–1980* (Oxford, 1980).

⁴¹ Balfour, *El fin del imperio español (1898–1923)* (Barcelona, 1997).

⁴² By the early twentieth century, the average salary of industrial workmen, miners, and artisans varied from 3 to 4 pesetas for a working day, while women got from 1 to 2.5 pesetas and children 1 peseta. Therefore, families spent from 75% to 90% of their incomes for necessary food. The cost of the absolute necessities of life was such that an unmarried man could not live on less than an average of 2.75 pesetas a day. See: Clarence Perkins, ‘The Social and Economic Problems of Modern Spain’, *Political Science Quarterly*, 27 (1912), 92-108.

resources was a great stimulus to economic innovation, both in the sense of inventiveness itself and other more subtle aspects related to a society's capacity to absorb and adopt appropriate technologies. In Tortella's words:

Poverty limits the potential for investment in education, and in turn the lack of education makes economic growth difficult, thereby perpetuating poverty. On the other hand ... a population that is poor and ill-informed in a country that is technologically backward has difficulty appreciating the importance of education, beginning with the ability to read.⁴³

In the Spanish case, poverty resulted not only from insufficient economic resources, but also from a historical inertia and lack of political pressure. Spain entered the modern era with an educational system insufficiently developed despite the late but serious efforts of the mid-nineteenth century. In other words, although the restoration of the Spanish monarchy meant political stability, it also reinforced the strong social power of the Catholic Church through the control of education.⁴⁴ Spain, by the beginning of the twentieth century, was still mainly an agrarian country where the Catholic Church had strong influence through its control of primary and secondary education. Despite a period during the last decades of the nineteenth century in which the Church lost some economic and political power, there emerged in the late nineteenth and early twentieth centuries what Pérez Díaz has described as

a strategy for recovering the lost ground and for a partial comeback to a position of influence. It [the Catholic Church] made a concerted effort to extend a network of primary schools through Castile; to revive the missions of the Old Regime with an emphasis on a sort of sentimental religion targeted on women; and to build up a network of secondary schools, Catholic newspapers and Catholic agrarian institutions and political parties.⁴⁵

⁴³ For a more detailed explanation, see: Tortella, *The Development of Modern Spain* (Cambridge, 2000).

⁴⁴ See: Antonio Viñao Frago, *Política y educación en los orígenes de la España contemporánea* (Madrid: Siglo XXI, 1982); and Manuel De Puentes Benítez, *Educación e ideología en la España contemporánea* (Madrid: Tecnos, 1999).

⁴⁵ Víctor Pérez Díaz, *Peasant Ethics and Religion: Towards a Theory of the 'Three Cultures'* (Madrid: Instituto Juan March, 1991); p. 15.

Publications such as *Razón y Fe* and *El Debate* are good examples of the influence that reactionary, fundamentalist, and anti-liberal positions exerted.⁴⁶ As Carr described it:

Every tension in Spanish society was refracted through the prism of the religious issue ... To liberals, the attempt to re-Catholicize Spain meant handing over the nation to “the irreconcilable enemy of modern institutions, the recognition of the forces of the past as the directing element in society”. To Catholics the Institute of Free Education was a step towards godless Spain; to anti-clericals Spain was already in danger of falling into the hands of Jesuits.⁴⁷

Nevertheless, liberal culture largely dominated the press, literature, and the arts during the second half of the nineteenth century in Spain.⁴⁸ The main philosophical schools were krausist and positivist,⁴⁹ and private, liberal, and secular institutions such as the krausist *Institución Libre de Enseñanza*, founded in 1876, spread throughout the country. As the century advanced, a public debate developed regarding the state of public education in Spain, including that of universities, and scientific research. Particularly interesting was the krausist approach, which conceived of a higher education system in which scientific research played a crucial role.⁵⁰ This rhetoric was echoed in the different Spanish governments of the period. The State became more and more interested in creating an appropriate educational system, and the different reforms promoted took

⁴⁶ Fusi, *Un siglo de España* (Madrid, 1999).

⁴⁷ Carr, *Modern Spain 1875–1980* (Oxford, 1980).

⁴⁸ Fusi and Palafox, *España: 1808–1996* (Madrid, 1997).

⁴⁹ Krausism was one of the most important intellectual movements in nineteenth-century Spain. Based on the ideas of the German philosopher Karl Christian Friedrich Krause (1781–1832), it was introduced into Spain by the jurist and philosopher Julián Sanz del Río (1814–1869). In their search for a more ethical and just social system, krausists played a crucial role in the social movement which led to the Revolution of 1868. See, for example: Juan José Gil Cremades, *Krausistas y liberales* (Madrid: Seminarios y Ediciones, 1975).

⁵⁰ However, some authors have argued that the pragmatic character of the philosophy of science derived from Krause did not support the pursuit of scientific research. This has been presented for the case of medicine by Montiel Llorente in ‘Las consecuencias de una elección para la Filosofía de la Medicina Española: Krause frente a Schelling’, in Elvira Arquiola and José Martínez Pérez (cords.), *Ciencia en Expansión: estudios sobre la difusión de las ideas científicas y médicas en España (siglos XVIII-XX)* (Madrid: Complutense, 1995).