

A place of pilgrimage— the Coimbra Physics Museum

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Most physicists look back to Galileo and Newton as the founders of their subject, but their ideas took time to diffuse throughout Europe during the century of the Enlightenment. Portugal, a country that was rich and powerful at that time, was closely in touch with the most important centres of scientific culture, and followed the trend towards the establishment of physics as an academic discipline

So when the Marquis of Pombal (1699–1782) (Fig. 1), the authoritative prime minister who directed the reconstruction of Lisbon after the earthquake of 1755, reformed the University of Coimbra, studies in Natural Philosophy were considered indispensable. So was a “Cabinet” of physical instruments and demonstrations. Today it is the Physics Museum of the university, and it may be visited either personally or virtually (<http://www.fis.uc.pt/museu/index.htm>). This unique museum exhibits include a wide variety of scientific instruments of the 18th and early 19th centuries.

We describe here the work of some Portuguese scientists of that time, and the inception of the new Faculty of Philosophy with its Physics Cabinet.

Influences from abroad

After a long life Newton died in 1727, having enjoyed the recognition of his contemporaries, including the Portuguese who were in London at the time. Some of them knew Newton personally, through his Presidency of the Royal Society.

The adoption of Newtonian Philosophy in Portugal benefited much from the emigration to England in 1721 of Jacob de Castro Sarmiento (c. 1691 – 1762). A Jew pursued by the Inquisition, he had studied Medicine at the University of Coimbra. He belonged to the group of the so-called “*estrangeirados*” (“foreigners”). These were Portuguese who emigrated due to religious, political or intellectual persecution. Sarmiento became Fellow of the Royal Society in 1730. He translated



▲ Fig. 1: Marquis of Pombal, the Portuguese Prime Minister from 1750 to 1777.

in Portuguese one of Newton’s works on tides. “*Theorica verdadeira das mares, conforme à Filosofia do incomparável cavalheiro Isaac Newton*,” published in London in 1737 (“True

theory of tides, following the Philosophy of the incomparable Gentleman Isaac Newton”) is the first Portuguese translation of Newton’s works. Coimbra has an English microscope, made by Culpeper and dated 1731, that was donated by Sarmiento (Fig. 2).

Another “foreigner” who exerted a notable influence on the Portuguese development in the 18th century was John Hyacinth of Magellan (1722 – 1790) who studied at the Monastery of Santa Cruz, in Coimbra. (He was a remote relative of the navigator Magellan). After having left Portugal in 1756, he lived in France, before taking up residence in London in 1764. Renouncing Portugal, he declared that he did not want to live under a government that was not assuring personal freedom. In England he collaborated and maintained correspondence with the most famous European scientists of his time, such as James Watt. He promoted English scientific instruments made in England throughout the continent. His reputation extended from Lisbon to S. Petersburg, and even to the United States. Magellan was member or corresponding member of various scientific academies and societies, including those of Lisbon, Brussels, Paris, S. Petersburg, Berlin, Philadelphia, Haarlem, and London. He also collaborated with the Portuguese crown, sending collections of instruments of Astronomy, Physics, Navigation, and other subjects, whose construction he had supervised. The Cabinet of Physics in Coimbra benefited from his inside knowledge of the best builders of English instruments. There he sent a set of Physics and Astronomy instruments, some incorporating improvements made by him. The most important piece is the Atwood machine that is still displayed (Fig. 3). There is also a splendid pendulum clock.



▲ Fig. 2: The microscope made in London by Edward Culpeper in 1731, and offered to the University of Coimbra by Jacob de Castro Sarmiento.



▲ Fig. 3: The Atwood Machine sent from London by John Magellan.

The teaching of science before the 1772 reform

The first half of the 18th century was marked in Portugal by a significant advance of science, in particular astronomy. Under King D. João V (1689–1750), who ordered the construction of the baroque Library of the University of Coimbra, new astronomical instruments were acquired. This king had a fondness for the exact sciences, expressed in his financial support of the creation of a Cabinet of Experimental Physics at the House of Necessidades, occupied by the Oratorians. S. Felipe Neri had founded, in Rome, in 1565, the Congregation of Oratorians, which had always taken an interest in the religious and literary education of young people. In Portugal, it settled in downtown Lisbon, in 1667, at the House of Espírito Santo and subsequently moved to the Hospice of Our Lady of Necessidades

(nowadays the Ministry for Foreign Affairs). The Marquis of Pombal initially accepted the pedagogical work of the priests of Oratorio, as a partial replacement of the Jesuits he had expelled in 1767. Later he accused them of teaching pernicious doctrines, and the classes at the House of Necessidades were closed. They reopened in 1777, when the king D. José I (1714 – 1777) died and Pombal fell from power.

D. Jose I had been attending Physics demonstration sessions at the house. A contemporary author recounts:

The Hospice of Necessidades was provided with various instruments, in part by the generosity of His Majesty who has founded that house, in part by his incomparable Son and in part by the very Congregation. The cabinet where these instruments were kept was the delightful theatre where Father Teodoro entertained His Majesty King D. Jose and his court with the innocent and admirable spectacles of Nature and where the same king D. Jose with his attendance and sharp observation frequently honoured the physical experiments done by Father Teodoro and even with his royal hands many times manipulated the machines, trying curiously the phenomena which were expounded.

So the Physics cabinet not only served to support the Physics lessons but also to entertain and instruct the king: modern researchers please note.

The first volume of “Philosophical Recreation or Dialogue on Natural Philosophy”, by Teodoro de Almeida (1722 – 1804) (Fig. 4), appeared in 1751. While it was not a textbook, its author was a pioneer in the development of scientific culture in Portugal and Spain. He was strongly attacked by conservative figures, in particular some Jesuits, who accused him of heresy. In some domains, his pedagogical and scientific activity between 1745 and 1760 anticipated by a quarter of a century the reform of teaching that occurred in Coimbra in 1772.



▲ Fig. 4 Teodoro de Almeida, a forerunner of Physics in Portugal.

Physics in Coimbra—such as Musschenbroeck, s’Gravesand, Desaguliers and Nollet—were fundamental references to Almeida.

The whereabouts of the instruments utilized by Almeida in his lessons is unknown. The same is true of the apparatus of the astronomical observatory existing at the same school, which was equipped and used by João Chevalier (a Portuguese Oratorian priest who, as an exile, was not only a founding member of the Royal Academy of Belgium, in Brussels, but also became its elected president).

Under Pombal all those who did not bend before state power were threatened. A victim of persecution, Teodoro de Almeida was obliged to flee. In France he corresponded with António Ribeiro Sanches, a Portuguese medical doctor of Jewish origin who became doctor to Catherine II at the Russian court and was one of the inspirers of Pombal’s reformation of sciences. Despite being abroad, Almeida still exerted a strong influence on Portuguese culture. After his return he published in 1784

“Physical-mathematical letters from Theodosio to Eugénio...” as a complement to the “Recreation”. He was one of the founders of the Royal Academy of Sciences in Lisbon, in 1780.

Pombal’s reformation of science studies

The 18th century saw a fierce controversy between Oratorians and Jesuits, the former considered to be modernisers, in opposition to the traditional attitudes of the Jesuits. But the tragic fate of the Oratorians was similar to that of Jesuits. Intellectuals not considered conducive to the implementation of a new scientific and pedagogical culture were to be eradicated, and this extended, paradoxically, to the main antagonists of Aristotelian thought. After much persecution the House of Necessidades was closed down.

This coincided with a project to create in Lisbon the College of Nobles, aiming at the education of aristocrats. The college, founded in 1761 but started up five years later, was part of Pombal’s project of education reform. In spite of political patronage to the foundation of the College of Nobles and of the hire of an Italian professor, Giovanni Dalla Bella (1730–1823), from Padova, and the creation of a Cabinet for Experimental Physics, the project was unsuccessful. All of the equipment was transferred in 1773 to Coimbra to equip the new Cabinet in what was then a Jesuit College (Fig. 5). Dalla Bella also moved to Coimbra.



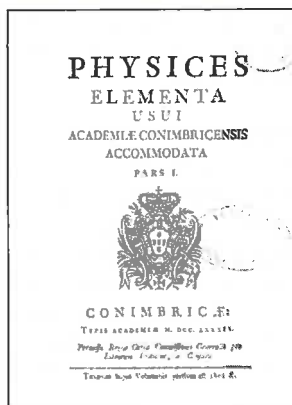
▲ Fig. 5: The “Colégio de Jesus”, where the Physics Cabinet of the University of Coimbra was installed in 1772. Nowadays is the place of the Physics Museum and the Natural History Museum.

Already in 1772 the School of Philosophy of the University of Coimbra had been created, so the Cabinet found a natural home there. The new school of Philosophy complemented a new school of Mathematics, with students attending both. The value and modernity of the Cabinet was recognized (it was said to be bigger than that in the University of Padova) as one of the most relevant accomplishments of Pombal’s reformation of the University.

The promoters of the new teaching system condemned the “miserable” Jesuit teaching system. Its stagnant tradition included the prohibition of the works of Galileo, Descartes, and Newton from the College of Arts of Coimbra, according to a determination of the Dean of that college in 1746.

The new syllabus of Experimental Physics was in line with that of the best European schools. The *Physices Elementa*, in three volumes (1789/1790), written in Latin by Dalla Bella, was one of the first works arising from the Reformation of the University (Fig. 6: the digital version is in <http://www.fis.uc.pt/museu/dbella/dallabellaindex.html>).

The transformation of the educational system was to lead Portugal out of its isolation from the scientific development of the rest of Europe. The role of D. Francisco de Lemos, Brazilian-born assistant bishop of Coimbra, was crucial. A protégé of Pombal, he had studied Canon Law at the University. In 1770 he was



◀ Fig. 6: The “Physices Elementa” of the Italian Giovanni Dalla Bella.

appointed Rector and two years later Reformer of the University of Coimbra. In his “General Report on the Status of the University” Francisco de Lemos clearly expressed the need for a modern course of Philosophy, in order to keep up with international trends and be able to contribute to new knowledge.

The Reformer expressed very clearly his opinion on the influence the university should have in the country’s development. According to him, the study of the sciences should contribute to a better knowledge of natural wealth, bringing new resources to industry and trade. The experimental teaching should bring the development of new arts and factories. In the above mentioned Report, he wrote:

If His Majesty... promotes these ideas, the establishment of Natural Philosophy will be perfect and therefore the Kingdom and the Landlords will manifest the richness which was deposited by Nature; and therefore industry will have large material to exercise; and therefore new branches of trade will be formed; and therefore new arts, new manufactures and new factories will be created; and the existent ones will be perfected.

It was imperative to invest in the area of Natural Philosophy. The examples of the other states must be followed. Besides Dalla Bella, the Italian Domingos Vandelli was hired as teacher at the new Philosophy School. Pombal travelled to Coimbra to supervise the reformation of the university, to which new buildings and equipment were given. An Astronomical Observatory and a Chemical Laboratory were established, together with the creation of the Cabinet of Experimental Physics at the Philosophy School.

The University’s Statutes of 1772 stated that:

...students should not only observe the execution of the experiments with which the truths, known until the present moment are demonstrated, but also acquire the habit of making them with the sagacity and skill required of the Explorers of Nature.

The Cabinet was to show the purpose of Experimental Physics, its origin and its progress, and the experimental method.

The Physics Cabinet was equipped with six hundred items. Most were made in Portugal but many were ordered from manufacturers of international repute—George Adams, Benjamin Martin, John Dollond, Edward Nairne, Edward Culpeper, Francis Watkins, James Champnes, etc. Each instrument had a specific conception consistent with the syllabus of Dalla Bella as laid out in *Physices Elementa*. Between the foundation of the Physics Cabinet and the approval of Dalla Bella’s book, the adopted textbook and guide to the construction of the Cabinet was Musschenbroek’s *Introductio ad philosophiam naturalem*. Dalla Bella’s book followed that of Musschenbroeck in many respects.

Unfortunately the glow of the enlightenment in the second half of the 18th century soon faded in Portugal, and the 19th century was a period of decline. But that is another story...

A visit to Coimbra

The Physics Museum of the University of Coimbra, whose premises are in the original building of the Physics Cabinet, impresses the visitor with not only the scientific but also the artistic value of its objects. The building, originally the College of Jesus, was reconstructed from 1773 to 1777. Just in front of it there is a building originally projected to be a Chemical Laboratory—probably the first building in the world which was constructed for such a purpose.

The Physics Museum shows a permanent exhibition of scientific and didactic instruments from the 18th and 19th centuries in two rooms and an old lecture theatre, which maintains its original atmosphere. In one of the rooms is a recreation of the Physics Cabinet of the late eighteenth century, showing some instruments which are unique (Fig. 7). In the second room, many instruments from the 19th century, mainly from the first quarter,

▶ Fig. 7: The Chinese magnet of the Physics Cabinet consists of a large block of lodestone weighing 12 kg. Its precise origin is unknown, although tradition says that it came from China as a gift from the Chinese Emperor to the Portuguese King D. João V.



complete the exhibition. The collection should be a place of pilgrimage for the modern European physicist.

Although the latter part of the 19th century is today seen as a period of decline from such glorious beginnings, Coimbra continued to acquire state-of-the-art instruments from abroad. A few years ago, the European Physical Society sponsored a visit by experts to help identify those items and encourage their conservation. This has now been accomplished, and visitors can also view the later collection, in the reserves, by appointment.

Further reading

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