

Crawford Collection



Royal
Observatory
Library

The Crawford Collection of books and manuscripts held at the Royal Observatory, Edinburgh is one of the most extensive and valuable astronomical collections in the world. The collection represents a broad history of astronomy spanning the 13th to the 19th century alongside its supporting subjects of physics, mathematics and optics.

It was given as a gift to the nation by James Ludovic Lindsay, 26th Earl of Crawford (formerly Lord Lindsay) when he learned that Scotland's modest Royal Observatory, on Calton Hill in the centre of Edinburgh, was under threat of closure. He agreed to donate the entire contents of his own observatory, including its exceptional library, after agreement with the British government. In 1896 the whole collection was moved to the new purpose built Royal Observatory.

Some examples from the collection are described below.

Jordanus Nemorarius [1225-1260]: De ratione ponderum. (c. 1290)

The Ponderum is considered to be one of the most important works in the history of mechanics (the branch of the physical sciences that is concerned with the study of the effects of forces on static or moving bodies). A discussion of the medieval science of weights, the Ponderum was written in France and bequeathed to the Sorbonne in 1271.

Jordanus was a contemporary of Fibonacci, and together they were the dominant mathematicians of the first half of the 13th century.

Alhazen [965-1040]: De aspectibus. (c. 1250)

Originally written in Arabic around 1000 this 'book of optics' was translated into Latin editions around

1250, probably in Spain.

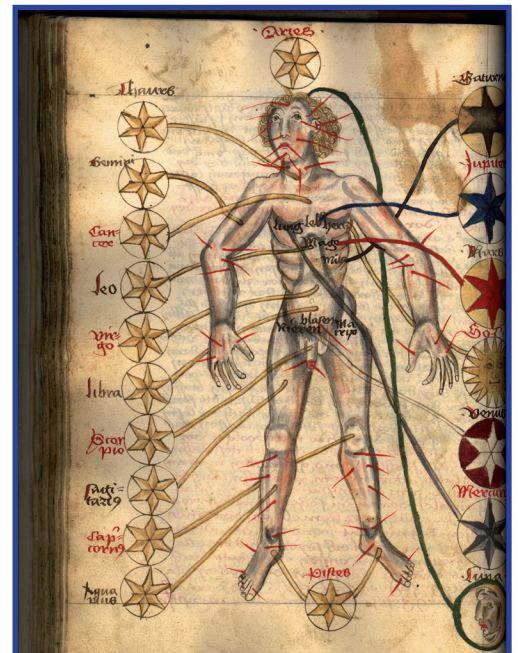
De aspectibus contradicts the theory of vision held by Ptolemy, Euclid and Aristotle in which objects are seen by rays of light emanating from the eyes. According to Alhazen, the rays originate in the object of vision and not in the eye, a hypothesis which was based on his theory that all objects reflected light in every direction. He demonstrated that light travels in a straight line.

He discovered the laws of refraction, and speculated on the physical nature of light whilst investigating the magnification produced by lenses and atmospheric refraction. His work has earned him renown as the 'father of modern Optics'.

[Anon.]: Planetenbuch: gottes huld umberal. (Germany, 1450) 'Book of fate'/'Planet book'

The main body of the book consists of poetry in the form of rhyming couplets with a coloured roundel on each page portraying one of the signs of the zodiac or a series of animals and birds. An image of a poet holding a scroll bears the text 'Rub the book and it will tell you whatever you want to ask it' [translated from the old German].

Astronomy and astrology were closely linked in the middle ages. The positions of the planets, alongside the more obvious effects of the Sun and the Moon, were thought to influence people and their daily lives in a variety of ways. 'Planet books' such as this



The 'zodiac man'

one claim that cosmic forces not only define man's character but also determine his fate.

[Anon.]: Henach sagt es von den newn Cometen ... (Germany, c. 1450)

The 'zodiac man' was an illustration which could be found in many of these types of manuscript. Every sign of the zodiac was considered to rule a part of the human body: Sagittarius ruled the thighs, Aries the head, Pisces the feet, and so on.

Physicians would consult patients' astrological charts when considering diagnosis, treatment and prognosis of many ailments. Depending on



Tycho Brahe: *Astronomiæ Instauratæ Mechanica*

which house of the zodiac the patient was born under, treatment would be given after looking into any possible consequences of astronomical events. Particular attention was given to the Moon: and a full or new moon would influence any decisions over recommended remedies such as blood-letting, purging, steam baths and, cupping.

Johannes Regiomontanus [1436-1476]: *Calendarium Latinum*. (Venice, 1476)

The calendar is printed in red and black with eclipse diagrams in black and yellow and is a good example of Regiomontanus' printed books dealing with calendar reform.

In 1476, Pope Sixtus IV invited the astronomer to Rome to amend and reform the ecclesiastical calendar and rectify the errors in the calculation of the date of Easter. Books such as these began the transition to the new, reformed Gregorian calendar. (Calendar change was not achieved

until 1582 under Pope Gregory XIII (pope from 1572 to 1585). In Scotland, this was adopted in 1600, moving New Year's day to 1st Jan but it took England more than 150 years to conform, and did not make the change from Julian to Gregorian calendar until 1752).

Nicholas Copernicus [1473-1543]: *De Revolutionibus Orbium Coelestium*. (1st edition) (Nuremberg, 1543) 'On the revolution of the heavenly bodies'

One of the Crawford Collection's prize pieces, this book was formerly owned and richly annotated by another famous astronomer - Erasmus Reinhold (1511-1553). Reinhold was senior astronomer at the University of Wittenberg in 1543 when the book was published.

This volume is the first edition where Copernicus puts forth the idea that the Earth and other planets revolve around the Sun – a heliocentric arrangement of the Solar System.

Tycho Brahe [1546-1601]: *Astronomiæ Instauratæ Mechanica*. (Nuremberg, 1602)

In this book Tycho describes his instruments and the observatory, Uraniborg on the island of Hven; a biography giving an account of some his discoveries about the Sun and

Moon; observations of planets and comets and, an accurate catalogue of the positions of a thousand stars.

When the funding ran out for maintaining Hven, Tycho was invited to Prague by the emperor Rudolph II. In 1601, he was joined by Johannes Kepler. Tycho was not convinced by the heliocentric system, or the assertion made by Copernicus that the Earth was spinning, and firmly believed until he died that the Earth was static.

Johannes Kepler [1571-1630]: *Harmonice mundi*. (Linz, 1619) 'Harmony of the world'

Here Kepler asserts his 3rd law of planetary motion, which established a relationship between the distance from the Sun to the planets and, the time it takes to complete an orbit.

Kepler composed music to describe this planetary motion and believed that each planet's orbit made its own music. These 'musical orbits' convey Kepler's vision of a 'harmony of the spheres' and the scores are set down in the book.

Kepler believed that Copernicus was correct in his heliocentric vision of the universe – but asserted that the orbits of planets were not circular, as Copernicus had stated, but elliptical.

Galileo Galilei [1564-1642]: *Sidereus Nuncius*. (Venice, 1610)

Galileo was also a believer in the Copernican system and, in this book he describes his observations made, for the first time, through a telescope. His confidence in the heliocentric system gained credence as he recorded views of the Moon, the Milky Way and the moons of Jupiter which he could plainly see were orbiting around the planet. Galileo came to the attention of the Inquisition and was advised that he could write about the Copernican theory as long



Nicholas Copernicus: *De Revolutionibus*

as he treated it as a mathematical hypothesis. Later publications led to his house-arrest.

**Isaac Newton [1642-1727]:
Philosophiæ Naturalis Principia
Mathematica. (1st edition)
(London, 1687)**

The Principia can be regarded as one of the most important and influential books ever published. Newton demonstrated mathematically that the same physical laws (laws of universal gravitation) apply throughout the Universe.

After modifying Kepler's 3rd law of planetary motion, Newton's inverse square law for gravitational force unified celestial and terrestrial physics and laid the foundations of modern astrophysics.

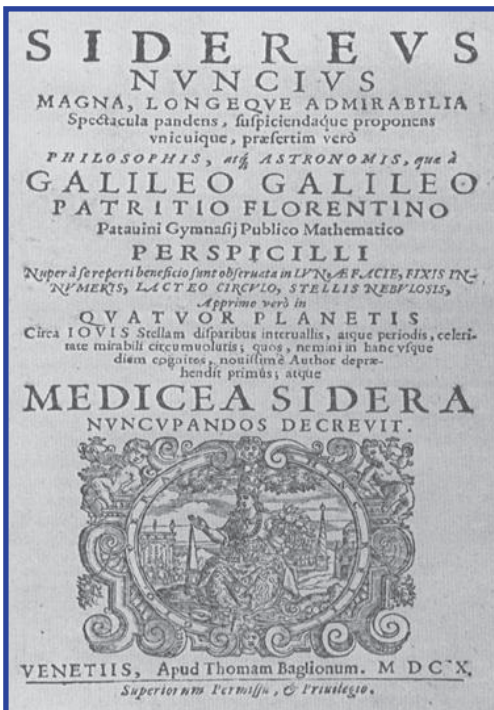
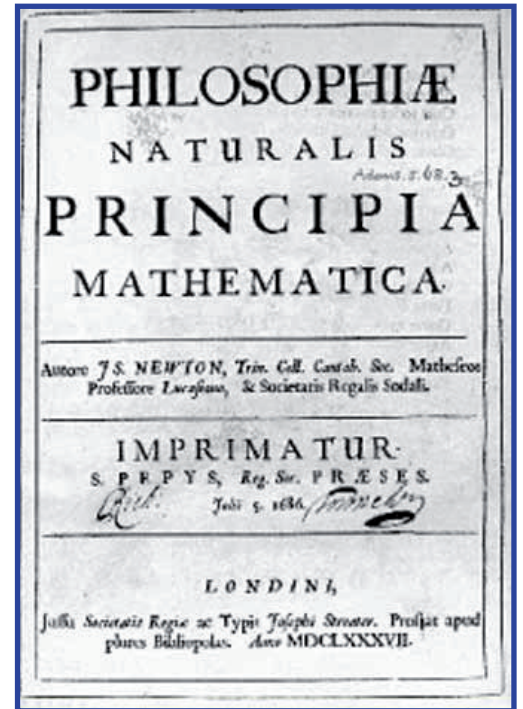
**Edmond Halley [1656-1742]:
Synopsis of the astronomy of
comets. (London, 1705)**

Halley showed that the comet of 1682 moved in a slightly extended elliptical orbit and could be identified as the

earlier comet that had also appeared in 1532 and 1607.

Basing his predictions and calculations on Newtonian dynamics, Halley predicted that the same comet would return again in 76 years and, in 1758, long after his death, the comet's reappearance confirmed his prediction.

Halley's comet was last seen in 1985-86, so it won't appear again until 2061.



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