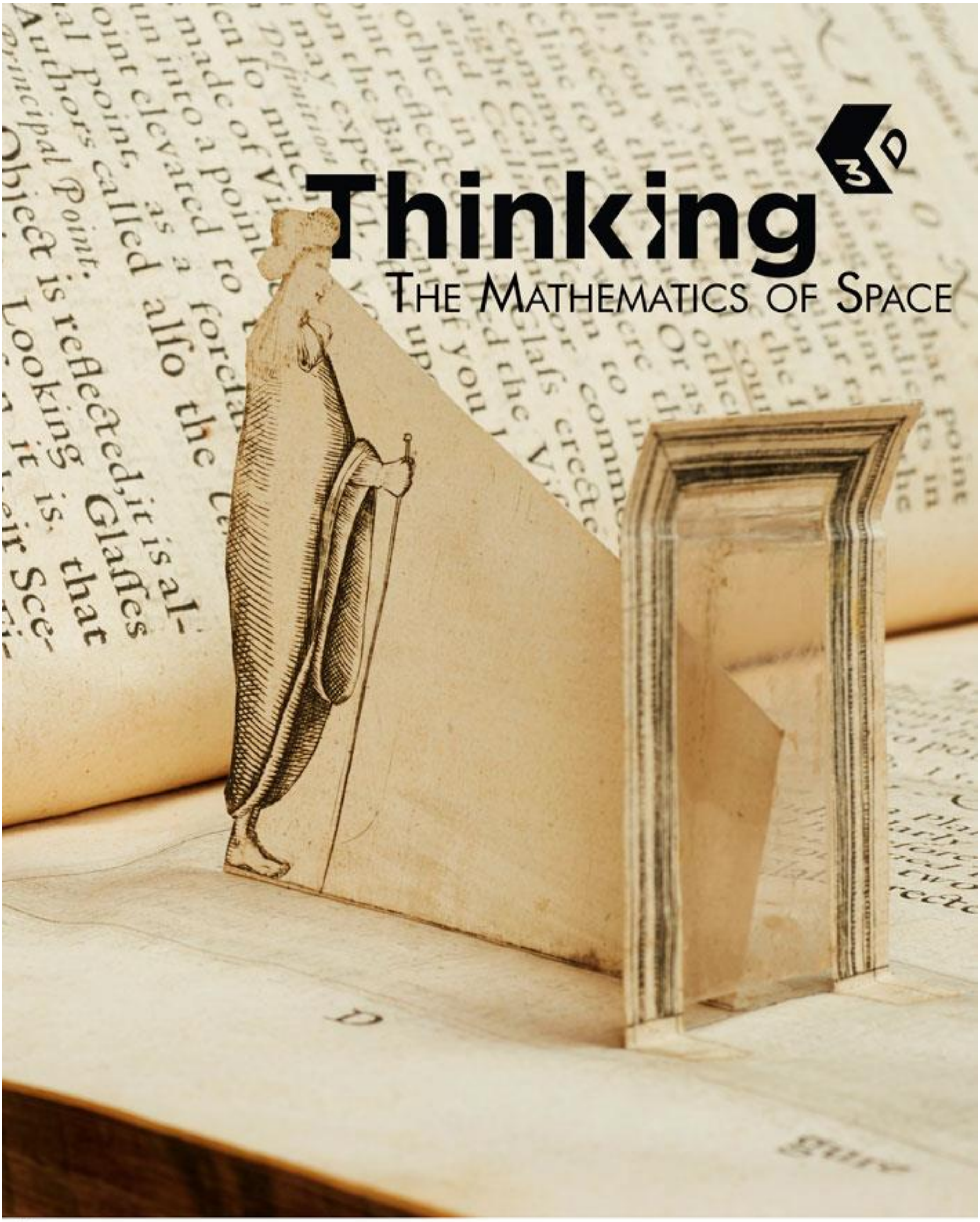
Thinking 3D

The Mathematics of Space



Exhibition open from

20 February to 26 April 2019

Christ Church Upper Library

Thinking 3D: The Mathematics of Space

Geometry was at the core for understanding a wide range of scientific issues in the early modern period. Christ Church Library houses spectacular collections of early printed books, manuscripts and instruments focused on mathematics and astronomy. The library and scientific tools of polymath Charles Boyle, 4th Earl of Orrery, bequeathed to the institution in 1731, is the largest and best known of these. However, equally important at least, are a respectable number of little-studied manuscripts by Early Modern Oxford mathematicians, such as David Gregory and Charles Scarburgh, and an impressive number of richly annotated rare editions of fundamental treatises on geometry and the study of perspective scattered among the Orrery and other Christ Church collections.

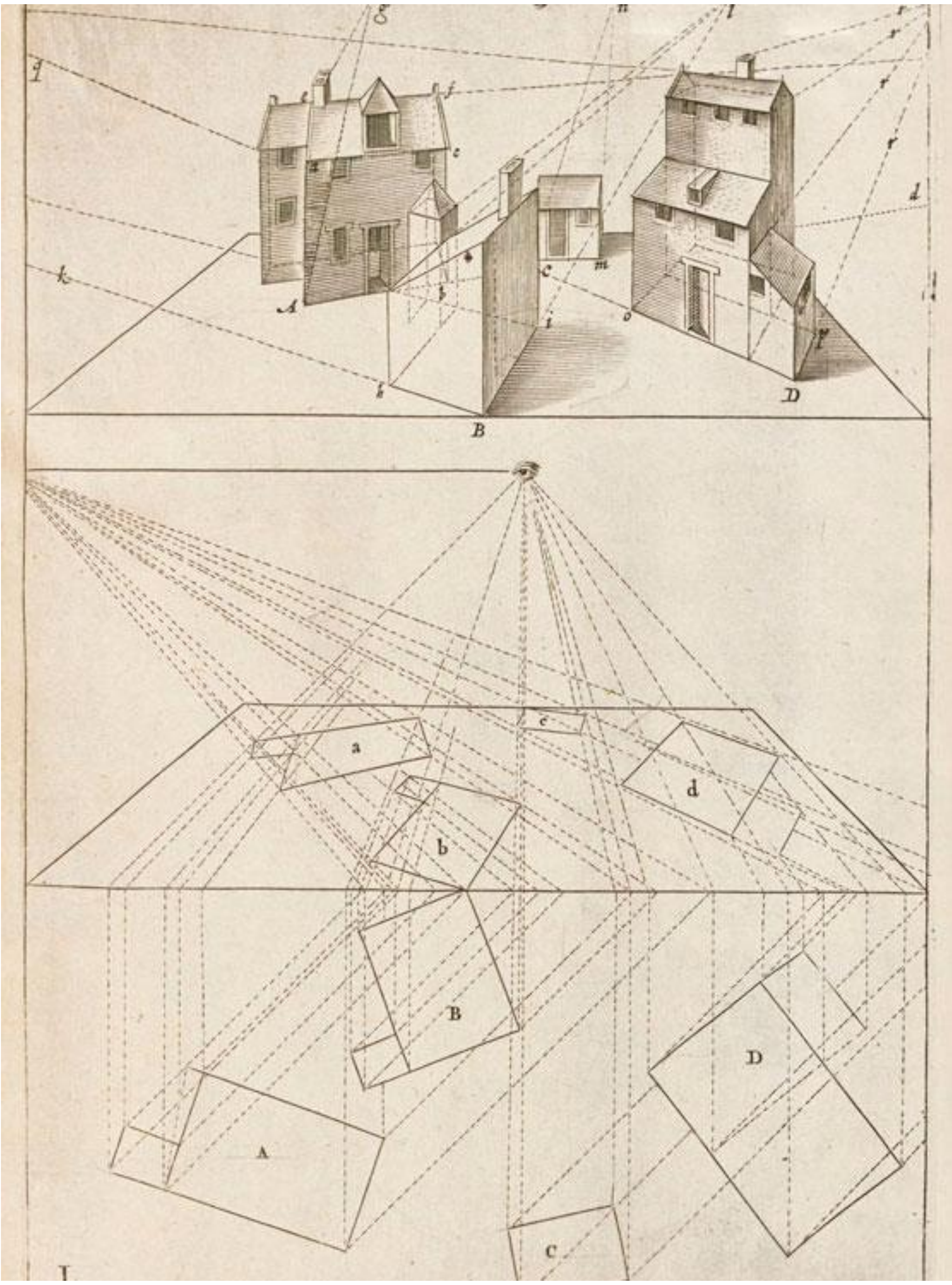
With the new translations of Euclid into Latin starting in the 12th century, theoretical geometry entered the university curriculum and from that moment on, the religious and speculative dimensions of this discipline have never ceased to attract mathematicians, philosophers and artists alike. Geometrical proportion and symmetry allowed a glimpse into the realm of transcendental beauty, while phenomena of vision were approached using the points, lines, shapes and other data of geometry to elicit mental constructions. Whether sculpting a statue, painting a picture, designing a building, or navigating the skies or the seas, visual information became encoded into a variety of geometrically organised graphs, grids and matrices. During the Early Modern period, several remarkable generations of scientists, artists, humanists, engineers and craftsmen started looking at the world in a new way, converting perceived reality into mathematical space.

The Mathematics of Space at Christ Church is part of the "Thinking 3D" series of events, coordinated by Daryl Green (Magdalen College, Oxford University) and Laura Moretti (University of St Andrews), organised in the UK during 2018-2019. This is a project focused on the development of techniques and technologies used to communicate three-dimensional forms in two-dimensional media. In this context, starting with the Renaissance, thinking about vision involved more than applying Euclidean rules to fixed objects and spaces. In art, to quote Leon Battista Alberti, this translated into a new, somewhat mesmerising, 'logic of likeness', which, in turn, developed into the study of perspective, an exciting, novel technique for processing visual information by means of geometric construction. Treated this way, three-dimensional forms appeared to represent natural objects far more realistically than had any previous depictions, and yet, they did so by creating illusions of reality. Such technical manipulations involved a great deal of deception, but also contributed to the technology of relational numeracy and analysis woven deep into the fabric of astronomy.

This exhibition, curated by Cristina Neagu, aims to highlight the role of the college in teaching geometry and astronomy at Oxford during the 17th and 18th centuries. Thematically, it will mainly focus on exploring the impact of Euclid, Archimedes and Serenus on both art and early modern geometry. Also on show in the Upper Library will be treatises on the study of perspective by Luca Pacioli, Jean François Nicéron, Joseph Moxon and Albrecht Dürer, as well as relevant works by early modern mathematicians like Nicolaus Copernicus, Johannes Kepler and Galileo Galilei, together with manuscripts of mathematical treatises by David Gregory and Charles Scarburgh. On display will also be a pair of heliocentric and Ptolemaic orreries, two spectacular sets of terrestrial and celestial globes, and globes of the Moon, Mercury, Venus and Mars, glossing on how the skies were perceived and mapped, and how much developments in the geometry of vision contributed to make this possible.

The Mathematics of Space, will open with a talk by Peter Grimwood on the orrery and the geometry of heaven. The talk looks at ways that philosophers and astronomers have attempted to organise and measure the universe that surrounds us, and the questions they attempted to answer. Questions that troubled them were "how big are the moon and the planets?", "how far away are they?" and "how can we make sense of the complex motions of the planets?". Various concepts are explained, and the role of orreries in allowing complex systems to be easily understood is demonstrated with a range of planetary models.

The Library would like to thank David Pierce Jones without whose support and encouragement this exhibition would not have been possible.



Contents

Thinking 3D in the Ancient World: The Reception of Euclid

Pacioli's *Elements* of Euclid (1509)

"Euclidis Megarensis philosophi acutissimi mathematicorumq[ue] omnium sine controuersia principis op[er]a [...]” (Venice: Paganino Paganini, 1509).

One of the most widely-known and influential early Latin versions of Euclid’s treatise was Luca Pacioli’s (1445-1517). He based his work on a 13th-century translation by Johannes Campanus (1220-1296).

Pacioli was an eminent mathematician and author of several important works in the field, among which is *Divina Proportione* (on display; see OR.1.17). He collaborated with Leonardo da Vinci and Piero della Francesca, and may have been Albrecht Dürer’s tutor in the secrets of perspective. The impact of their meeting in 1506 appears to have fired Dürer's mathematical ambitions, as in 1507 he mentions purchasing Bartolomeo Zamberti's Latin translation of Euclid's *Elements*. Dürer's copy with his monogram and annotations is now kept at the Herzog August Bibliothek Wolfenbüttel.

Like Dürer's own copy of Euclid, the volume on display has copious manuscript ink notes throughout, mostly in the margins, alongside printed diagrams.

Shelfmark: ON.2.16

Euclid’s Elements (1533)

“Eukleidou stoicheiōn bibl. 15. ek tōn Theōnos synousiōn […]” (Basle: Johann Herwages, 1533).

The *Elements* is one of the most influential works in the history of mathematics. It served as the main textbook for teaching geometry from the time of its first publication in 1482 in Venice, until the early 20th century. Space (both bi- and three-dimensional) is introduced as an abstraction of physical space. Euclid’s innovation was to build geometry as a science by starting from a few very basic properties (postulates - or axioms) abstracted from the physical world.

The volume on display is the first printed version of Euclid's *Elements* in Greek, edited by Simon Grynaeus (1493-1541). Christ Church Library houses two copies of this valuable edition. The volume selected for the exhibition is particularly interesting as there are extensive ink notes throughout, mostly in the margins alongside printed diagrams. Current research on this item is trying to establish the hand. To increase the possibilities of debate on this topic, this copy will be soon available in digital form on the Library website.

Shelfmark: ZO.5.2

Euclid's *Elements* printed in Arabic (1594)

Kitāb Taḥarrī Usūl al-Ūqīdas [...]"; parallel title and imprint in Latin: "Euclidis Elementorum geometricorum libri tredecim [...]" (Rome: Typographia Medicea, 1594).

This is the first printed Arabic version of Euclid's *Elements*. It was based on an earlier 1260 manuscript by Nasīr al-dīn al-Tūsī (1201-1274), a well-known Persian astronomer and mathematician. He is noted for writing the first major work on pure trigonometry as well as for his commentaries on Greek authors. Although Euclid's work had survived the medieval period in Arabic translations, which would be re-translated during the Renaissance, the text was not printed in Arabic until the end of the 16th-century, in Rome. It was produced at the Medici Press, which was established by Ferdinand de Medici and given a monopoly on 'foreign printing' by Pope Gregory XIII. Printing Arabic with moveable type was a technological challenge and this work is one of the first Arabic-language books printed in Europe.

The copy at Christ Church is part of the John Morris bequest and contains medieval Latin manuscript fragments used as binding waste.

Shelfmark: MB.2.2

Clavius' Latin edition of Euclid's *Elements* (1607)

"Euclidis elementorum libri XV. [...] Auctore Christophoro Clauio Bambergensi è Societate Iesu [...]", 2 volumes (Frankfurt: Nicolaus Hoffmann, 1607).

Although Christopher Clavius (1538-1612) produced little original mathematics of his own, he did more than any other German scholar of the 16th century to promote a knowledge of mathematics. He was a gifted teacher and writer of textbooks, producing a version of Euclid's *Elements* in 1574, which contains ideas of his own. Clavius also designed scientific instruments. Among these were sundials, a quadrant for use in surveying and an instrument to measure fractions of angles. Apart from this, Clavius is perhaps best known for his work on the reform of the calendar.

There were many Latin editions of Euclid's *Elements* published before the first issue of Clavius' version appeared in 1574. Before Pacioli's version (on display; see ON.2.16) was issued in 1509, the very first Latin complete printed edition was produced in 1482, also in Venice, by Erhard Ratdolt. He was an early innovator in the printing of scientific diagrams and his edition contains the earliest known printed mathematical diagrams, which he crafted himself.

The volume on display is part of the Orrery bequest and is listed in "A catalogue of the library of Charles late Earl of Orrery" (Library Records 22).

Shelfmark: OP.5.19-20

Scarburgh's "*English Euclide*" (1705)

"The English Euclide: being the first six elements of geometry [...] translated out of the Greek, with annotations […], by Edmund Scarburgh [...]" (Oxford: Sheldonian Theatre, 1705).

This English edition of Euclid's *Elements* was published by Edmund Scarburgh from the material left to him for this purpose by his father, Sir Charles Scarburgh (or Scarborough) (1616 - 1694). The latter was educated at St Paul's School, Gonville and Caius College, Cambridge (BA, 1637, MA, 1640) and Merton College, Oxford (MD, 1646). While at Oxford he was a student of William Harvey and in turn became to Christopher Wren. He was an original fellow of the Royal Society and a fellow of the Royal College of Physicians, as the author of a treatise on anatomy, *Syllabus Musculorum*, which was used for many years as a textbook.

Although important for the study of geometry during the early modern period, the Scarburgh edition is neither complete, nor the first translation of Euclid's *Elements* into English. In 1570 England became one of the few countries to publish Euclid in the vernacular before the Latin edition.

Scarburgh's "English Euclide" at Christ Church is listed in "A catalogue of the library of Charles late Earl of Orrery" (Library Records 22), and contains extensive marginal annotations in ink throughout, plus an enclosure (on display) with notes by the same 18th-century hand

Shelfmark: OP.1.2

Thinking 3D in Art: The Geometry of Perspective

Albrecht Dürer's *Treatise on Geometry* (1535)

"Albertus Durerus [...] institutionum geometricarum libris [...] (Paris: Christian Wechel, 1535).

This is the first Latin edition of Albrecht Dürer's (1471-1528) treatise on geometry, *Underweysung der Messung*. The ground-breaking German original was published in Nuremberg in 1525, but it was this translation by the humanist Joachim Camerarius that brought the work to the attention of the whole of Europe. The text synthesises the internal structure and principles of Euclid's *Elements* with the various classical and contemporary sources available. Dürer's treatise begins with Euclidean principles and spreads into a diverse set of geometrical applications, such as column design, sundials, calligraphy, the modelling of polyhedra, and perspective.

When we compare the way Dürer implemented his perspective theories in his own practice, we find that he generally seems to use the technique of constructing forms on pre-foreshortened planes. The page on display (with the flap open) is an example of constructing a cube in perspective.

The work which perhaps best illustrates this technique is Dürer's *St Jerome in His Study* of 1514. Using a radically off-centre view-point, the artist openly engages in extremes of transformation of space.

The volume on display is part of the Henry Aldrich bequest.

Shelfmark: AF.4.13(2)

Analysis of the perspective in Albrecht Dürer's *St Jerome in His Study*.

V = vanishing point
Z1 / Z2 = viewing distance

Albrecht Dürer's *Treatise on Geometry* (1605)

"Alberti Dureri Institutionum geometricarum libri quatuor [...]" (Arnheim: Jan Jansz: 1605).

This is a later Latin edition of Dürer's *Underweysung der Messung*. The contents and illustrations remained largely the same as in the 1535 edition of Camerarius' translation. The copy at Christ Church however lacks the flaps extending two of the illustrations. Thus, the images end up being incomplete and the argument stated in the text does not reflect in the woodcut accompanying it.

Unlike the Latin, the German second, posthumous edition published in 1538 makes ample use of the autograph corrections in Dürer's extraordinary personal copy (located at the Bayerische Staatsbibliothek in Munich). The volume includes the artist's prolific notes, marked directly in the margins, bound together as separate pages, or contained on small scraps of paper glued onto the pages they reference. They attest to Dürer's prolonged and passionate engagement with the treatise even after its initial publication. For exemplification, see photo of additional content inserted into Diagram 50 (Book I, 24), and reprinted as Diagram 51 in the 1538 edition.

The illustration in the volume on display shows a perspective device being used to depict a lute.

Shelfmark: ZO.2.9

Nicéron's *Thaumaturgus Opticus* (1646)

"R.P. Ioannis Francisci Niceronis Parisini, ex Ord. Minim. Thaumaturgus opticus, seu Admiranda optices, per radium directum [...]" (Paris: François Langlois, 1646).

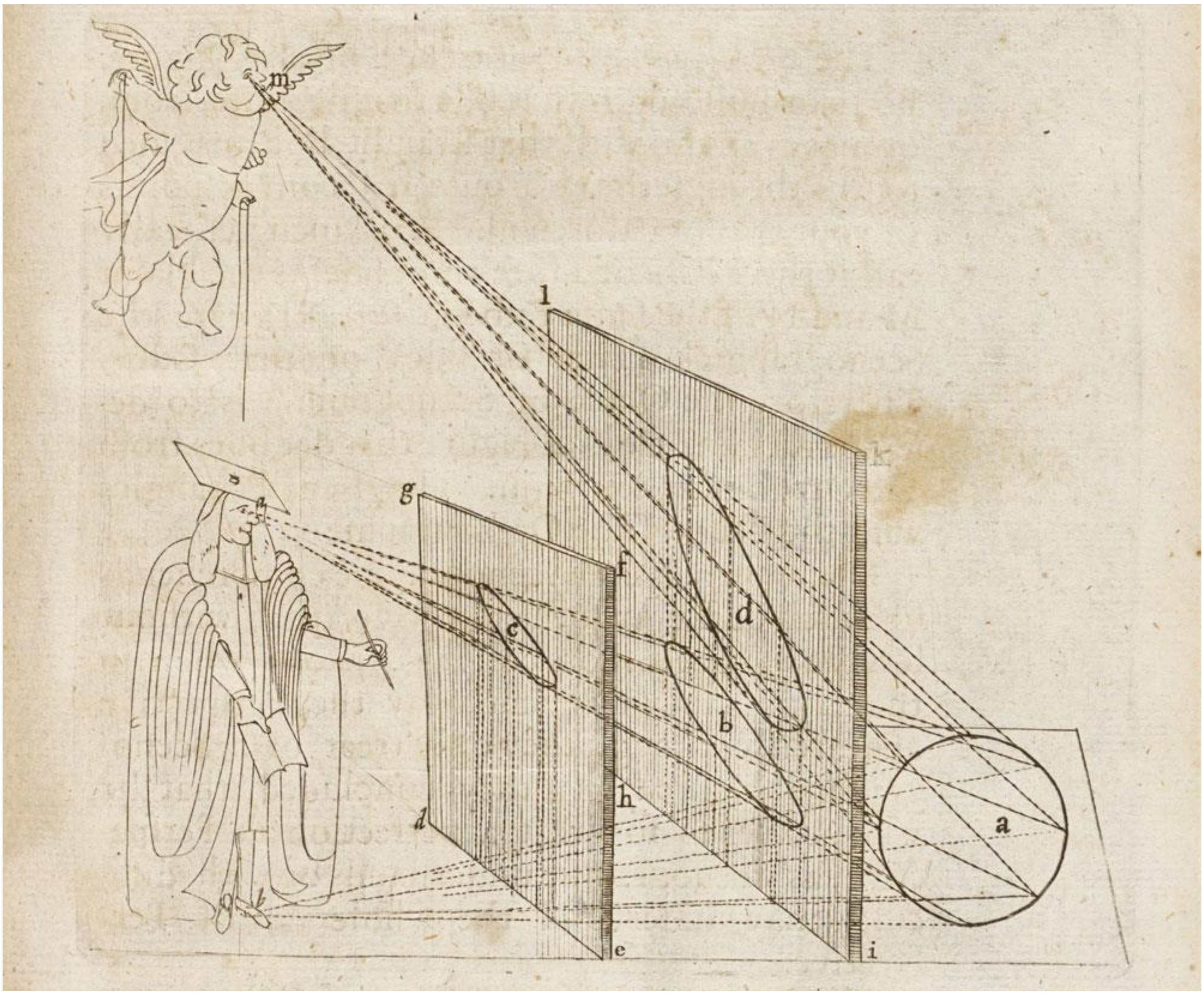
During the 16th- and 17th-centuries, anamorphotic images were very much in vogue. They appeared in paintings (such as Holbein's *Ambassadors*), prints and theoretical treatises (such as the volume on display). The classic phase of anamorphosis occurred in France and Italy during the 1630s and 1640s. The theorist at the centre of all this was Jean François Nicéron (1613-1646).

The second part of Nicéron's *Thaumaturgus* is dedicated to a comprehensive treatment of anamorphotic images and varieties of 'artificial magic'. He describes how anamorfic images may be projected using a grid where the perspective has been distorted, gives mathematical instructions for the design on surfaces which are pyramidal or conical, and images designed to be viewed in cylindrical or conical mirrors.

The image on display, taking into account Albrecht Dürer's method as illustrated by the examples selected; see AF.4.13(2) and ZO.2.9) is a demonstration of Nicéron's means of approach for his anamorphotic wall painting of *St John the Evangelist*. Note that the left-hand side of the upper diagram continues at the right of the lower.

The volume at Christ Church is part of the Orrery bequest and is listed in "A catalogue of the library of Charles late Earl of Orrery" (Library records 22).

Shelfmark: OR.1.10



Moxon's *Practical Perspective* (1670)

"Practical perspective; or Perspective made easie : Teaching by the opticks, how to delineate all bodies, buildings, or landskips [...]" (London: Printed by Joseph Moxon, 1670).

This is the first edition of Moxon's treatise on perspective, with the famous mica pop-up doorway illustrating the observer looking though the picture plane.

Joseph Moxon (1627-1691) was an English mathematician and printer specialising in scientific books. He produced the first English language dictionary devoted to mathematics, and the first detailed instructional manual for printers. He is, however, better known as a globe and mathematical instruments maker, also specialising in the printing of maps and charts, and in the production of globes. Terrestrial and celestial globe pairs were used to teach astronomy cartography and navigation.

The volume on display is part of the Orrery bequest and is listed in "A catalogue of the library of Charles late Earl of Orrery" (Library Records 22).

Shelfmark: OR.2.9

Thinking 3D in Astronomy: Suns, Planets and Platonic Solids

Pacioli's *Divina proportione* (1509)

“Diuina proportione : opera a tutti glingegni perspicaci e curiosi necessaria oue ciascun studioso di philosophia: prospectiua pictura sculpura [...]” (Venice: Paganino Paganini, 1509).

This is the first edition of Luca Pacioli's (1445-1517) influential treatise on the golden ratio. Pacioli commissioned three manuscripts of the treatise by different scribes. He gave the first copy to the Duke of Milan, Ludovico il Moro; this manuscript is now preserved in Switzerland at the Bibliothèque de Genève. A second copy was donated to Galeazzo da Sanseverino and now rests at the Biblioteca Ambrosiana in Milan. The third, which is now untraced, was given to Pier Soderini, the Gonfaloniere of Florence. The text discuses the golden ratio from a mathematical perspective (closely following Euclid's *Elements*) and explores its applications to various arts. It also contains a discourse on the regular and semiregular polyhedra, as well as a discussion of the use of geometric perspective by painters.

The book contains numerous illustrations, starting with twenty-three capital letters drawn with a ruler and compass by Pacioli, followed by some sixty woodcuts after drawings by Leonardo da Vinci. The illustrations Leonardo provided portrayed geometrical bodies both in their solid form and skeletal manner, in such a way as to display their complete configuration in space. Pacioli seems to have been behind the construction of regular bodies and their derivatives in three-dimensional form in a variety of materials including wood and crystal.

The page on display shows a truncated dodecahedron in skeletal form.

Shelfmark: OR.1.17

Copernicus’ *De revolutionibus orbium coelestium* (1543)

“Nicolai Copernici Torinensis De revolutionibus orbium cœlestium libri VI [...]” (Nuremberg, Johannes Petrejus, 1543)

This is the first edition of the influential work which first proposed the heliocentric theory of the Earth and the other planets moving around the Sun. Copernicus’ (1473-1543) model offered a radical alternative theory to Ptolemy’s long accepted geocentric model. Copernicus argued that eight spheres, around the motionless Sun at the centre, made up the universe: one for each the six known planets, an outermost sphere of fixed stars, and one for the Moon around the Earth.

142 woodcuts displaying geometrical diagrams and letter characters were commissioned to illustrate, and clarify, the complexity of Copernicus' thesis. Only 6 of these woodcuts were used twice.

The volume on display is from Robert Burton's (1577-1640) library. It is an imperfect copy, lacking the preliminary gathering and gathering a; gatherings b-c are mutilated at the head with loss of text. Burton's markings suggest this damage occurred before he acquired the book in 1607.

Shelfmark: f.1.3

Kepler’s *Mysterium Cosmographicum* (1596)

“Prodromus dissertationum cosmographicarum,: continens mysterium cosmographicum, de admirabili proportione orbium coelestium […]”(Tübingen: Georg Gruppenbach, 1596).

This is the first edition of Johannes Kepler’s (1571-1630) major astronomical work. It proposes a geometrical plan of the universe, illustrated on the page displayed. Kepler reasoned that the paths of the six known planets around the Sun could be described by the solid 3D shapes of spheres which enclose the particular polyhedrons (tetrahedron, cube, octahedron, dodecahedron, icosahedron) known as the five Platonic solids.

A knowledge of these was essential for anyone who claimed competence in cosmology. Kepler's scheme of planetary orbits is founded upon the interrelationship of celestial bodies inscribed one inside the other, displayed like a piece of goldsmith’s art. Like Pacioli, who was keen to build the regular bodies represented in his *Divina proportione*, Kepler wanted to have the model of his cosmographical system constructed in metal.

Mysterium Cosmographicum was the first published work defending Nicolaus Copernicus’ (1473-1543) heliocentric system (on display; see f.1.3).

Shelfmark: OS.6.1

Galileo's *Macchie solari* (1655)

"Istoria e Dimostrationi intorno alle Macchie Solari e loro accidenti […]" (Bologna: Heredi Dozza, 1655)

Galileo Gallilei's (1564-1642) treatise on sunspots was originally published in 1613 and re-issued in the first collected edition of his works, "Opere di Galileo Galilei […]”, published 1655-56. Galileo wrote the treatise in the form of letters to Marcus Welser of Augsburg, arguing that sunspots appeared on the surface of the sun and were not tiny satellites of it. Based on observations of their motion, Galileo concluded that the sun rotated on a fixed axis. The work also includes Galileo's first written account of his observations of the phases of Venus and the mysteries of Saturn. His specific endorsement of the Copernican model foreshadowed many of his later theories and their political and religious consequences.

The text is accompanied by numerous woodcut diagrams and illustrations. The one on the page on display shows a perspectival analysis of the appearance of the sunspots. As a spot occupies the intervals PL, LD, DB etc., it will appear diminished in size according to RS, SO, OC etc. All this suggests that Galileo's graphic recording of sunspots was accomplished by the projection of telescopic images on a sheet of paper. A circle was drawn on the paper and the image was fitted to this circle. The means by which Galileo analysed the results of his observations relied upon his understanding of the theory of perspective.

Shelfmark: OR.4.28

David Gregory's *Institutionum astronomicarum* (1686)

"Institutionum astronomicarum partes tres in ususm iuventutis Accademiae Edinbugenae [...]

Autograph manuscript by David Gregory (1661-1708), astronomer and friend of Isaac Newton. He graduated from the University of Edinburgh in 1683 and was elected to the mathematical chair there. Gregory was the first professor who publicly lectured on the Newtonian philosophy. In 1691, he left Scotland, and through the combined influence of Newton and Flamsteed, in 1692, Gregory took the degrees of M.A. and M.D. at Oxford, and became master commoner of Balliol College. During the same year, he was also elected a Fellow of the Royal Society. One of his principal works, *Astronomiæ Physicæ et Geometricæ; Elementa*, was published, with a dedication to Prince George of Denmark, in Oxford in 1702. It was the first textbook composed on gravitational principles, and remodelling astronomy in conformity with physical theory.

The volume on display is an early treatise on astronomy written for the use of his students in Edinburgh. The text is accompanied by numerous exquisitely drawn plates, such as the one on display, illustrating the revolution of the earth around the Sun.

The manuscript was bequeathed to Christ Church Library with many other volumes by his son, David Gregory (1696-1767), first Professor of Modern History in the University of Oxford, and dean of Christ Church from 1756-1767). The whole manuscript will soon be available in digital form on the Library website.

Shelfmark: MS 133

Thinking 3D in Manuscripts: Teaching Geometry at Oxford

Serenus' *On the Section of a Cylinder* (1704)

Greek manuscript on *De sectione cylindri* ascribed to Serenus Antissensis (4th century AD). The text was copied from three codices held at the Royal Library in Paris for Henry Aldrich and placed by him at the disposal of Edmund Halley for his 1710 edition *Apollonii Pergaei conicorum libri octo et Sereni Antissensis De sectioni cylindri & coni libri duo.*

It seems likely that from the 7th-century, the two surviving works of Serenus and the commentary of Eutocius were bound with the *Conics* of Apollonious. Theodorus Metochita read them together early in the 14th-century. A Latin translation of Serenus' *De sectione cylindri* and *De sectione* coni was published by F. Commandinus at the end of his *Apollonü conicorum libri quatri* (Bologna, 1566). The Greek text was first published by E. Halley 1710. A definitive critical edition with Latin translation was published by E. Nizze, *Serenus von Antissa: Ueber den Schnitt des Cylinders* (Stralsund, 1860) and *Ueber den Schnitt des Kegels* (Stralsund, 1861); and there is also a French translation with introduction and notes by Paul Ver Eecke, *Serenus d'Antinoë Le livre De la section du cylinder e le livre De la section du cône* (Paris-Bruges, 1929).

The layout of the volume on display consists of three columns, mostly of 29-31 lines to the column, dedicated to the main text. The verso of the page is usually blank, except, occasionally, for geometrical drawings. Provenance: Henry Aldrich (1648-1710) bequest. The whole manuscript is available in digital form on the Library website.

Shelfmark: MS 85

David Gregory's *Notes on Isaac Newton's Principia* (England, 1695)

A consummate astronomer and mathematician, David Gregory (1661-1708) produced numerous manuscript treatises on fluxions, trigonometry, mechanics, and hydrostatics. This is a transcript of his *Notæ in Isaaci Newtoni Principia Philosophica*, composed about 1693, it is said at Newton's request. In 1714, a proposal for printing this work fell through.

This important mathematical manuscript has a rather long and convoluted history. A note written vertically near the fore-edge of the inside of the upper board and signed by David Gregory explains its origins: "This book was written by James Canarys Doctor in Divinity, first Parson of Selkirk in Scotland, afterwards Vicar of Abingdon in Berkshire in England, in the year MDCXCV. The Original was allow'd hm by the Author Dr Gregory, upon these conditions, that no body ever ^should^ use it without Dr Gregory's consent; and that the book should be returned to Dr Gregory in case Dr Canarys should dye first: which last happening the 4th of May 1698, this book was returned May 19th following, by the Lady Anne Areskine his relict." Gregory's status as a recognised expert on fluxions (i.e. derivatives in calculus) is demonstrated by the fact that an author on the subject, George Cheyne, sent a copy of his own *Fluxionum Methodus Inversa* (London, 1703) to Gregory with a letter of presentation.

The manuscript was bequeathed to Christ Church Library with many other volumes by his son, David Gregory (1696-1767), first Professor of Modern History in the University of Oxford, and dean of Christ Church from 1756-1767). The whole manuscript will soon be available in digital form on the Library website.

Shelfmark: MS 131

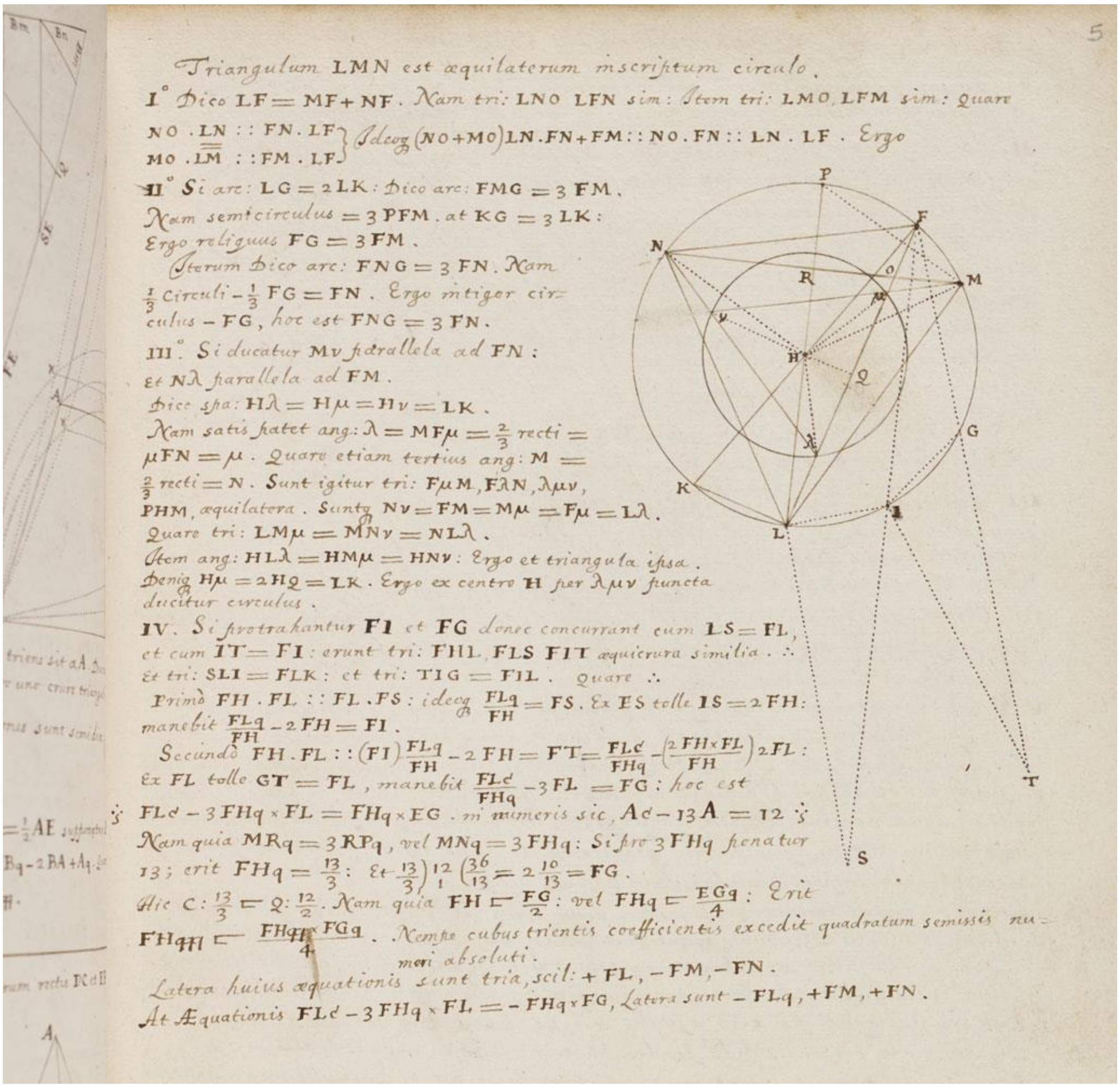
David Gregory's *Notebook covering 1696-1708* (Oxford)

This notebook dates from David Gregory's later years, when he was resident in Oxford. The manuscript's arrival in the Library is slightly unclear. W.G. Hiscock mentions that the manuscript was found in September 1935 in a cupboard of the Christ Church Library Manuscript Room and surmises that it passed to the author's son (himself Dean of Christ Church), and was left in the Deanery, being handed over to the library at some point after 1867, as it is not included in G.W. Kitchin's catalogue of Christ Church manuscripts published that year.

Interestingly, on page 151, Gregory mentions another mathematical work on display, MS 85: '8 Nov. 1705 I sent Elphinstons history of Scotland to the Dean of Christs Church to be (by the permission of a Secretary of State) exchanged with A Greek Copy of Serenus Antinsensis de sectione Coni et cylindri, which is now lying at M Pigualts merchant at Calais. I had returned to me December 14.' This must refer to the route taken by MS 85, in which Gregory's hand appears at the end, noting that it was 'transmissus' to England in 1706 – cf. page 180 (November 1706) where Gregory discusses an intended edition of Apollonius and Serenus, to be produced by him and Mr Halley, noting 'the Greek is from the Copy that the Dean of ChristChurch had from the French Kings Library in the summer 1706'.

The manuscript was bequeathed to Christ Church Library with many other volumes by his son, David Gregory (1696-1767), first Professor of Modern History in the University of Oxford, and dean of Christ Church from 1756-1767). The whole manuscript will soon be available in digital form on the Library website.

Shelfmark: MS 34



Scarburgh's *Archimedes* (1544)

"[Archimēdous tou Syrakousiou, Ta mechri nyn sōzomena, hapanta]. = Archimedis Syracusani philosophi ac geometrae excellentissimi opera [...]" (Basel: Thomas Gechauff, 1544).

The rediscovery, study and diffusion of Ancient Greek writings were essential characteristics of Renaissance mathematics. Within just a few decades, important works of Antiquity were printed. Thomas Gechauff's *editio princeps* of the Archimedean corpus is one such essential series of texts. The present edition includes Archimedes' works *On the sphere and the cylinder*, *On the measurement of the circle, On conoids and spheroids, On spirals, On the equilibrium of planes, The sand-reckoner*, and *On the quadrature of the parabola*. The manuscript from which the Greek text was printed (now in Nuremberg Stadtbibliothek), was acquired in Rome by the German humanist (and closest friend of Albrecht Dürer) Willibald Pirckheimer. The Latin translation printed in the present edition was a new one produced in the 1450s by Jacopo da Cremona. The circulated text was copied and corrected by figures such as Regiomontanus, whose amended version served as the source for the Latin text of the present edition.

The volume on display contains not only the rare 1544 edition of Archimedes' work, but also numerous manuscript notes, possibly by the Oxford mathematician Charles Scarburgh (whose 'English Euclide' is also on display; see OP.1.2) bound at the beginning and end of the printed text. The whole manuscript will soon be available in digital form on the Library website.

Shelfmark: OR.1.4

Thinking 3D and Mapping the Skies: Planetary Globes and Orreries

Globes

Terrestrial and celestial globes

The pair of terrestrial and celestial globes on display by the door to the Upper Library at Christ Church are by George Adams. They are in their original cases, signed by Adams as "Instrument Maker to His Majesty K G III". The set was purchased in the 1760s for the New Library, as it finally approached completion. The hexagonal cases do not have only a protective function, but also a didactic and symbolic role. On top of each case is a brass drum with a biblical inscription in Greek around its edge (Isaiah, 6.3). The top of each brass drum is engraved with an astronomical scene – the solar system on one, and the annual cycle of the sun and seasons on the other. These astronomical plates make the Christ Church pair of globes unique.

The globes on display (from a private collection) close to the central window in the Upper Library were published as 16" diameter globes in 1852 by Charles Copley of New York. Copley produced fine cast iron stands for these globes showing the strength of the American industrial revolution. At this time Smith & Son were producing pairs of 21" globes which were usually sold on mahogany stands. There are, however, some examples of 21" cast iron stands used by Smith, whose construction is so similar to Copley's design that it is likely that there could have been trading between these two globe makers. On display are Smith's cast stands, but in bronze, not iron, supporting Copley's award-winning globes (and Peter Grimwood's orreries).

Mercury

As far as we can ascertain, this is the first globe ever made of Mercury based on Antoniadi's map published in 1934. On display is an 8" globe (the correct scale to match the 21" Earth and 20" Venus globes).

Venus

On display is a 20" Venus globe to scale using Bianchini's gores from 1727, themselves based on his map of the same year, and extremely rarely made as a globe.

Mars

On display is a 12" Mars globe to scale. With greater magnification telescopes, several globes of Mars were produced during the 19th-century. This recreation is based on the globe made by Louis Niesten in 1892.This globe is very scarce. There are only 5 known surviving examples.

Moon

On display is a 6" Moon globe to scale. Serial production of Moon globes based on printed gores was initiated, in 1849, by the Austrian civil servant and globe maker, Josef Riedl von Leuenstern. Until the end of the 19th-century, very few lunar globes went into serial production.

Orreries

Ptolemaic Orrery

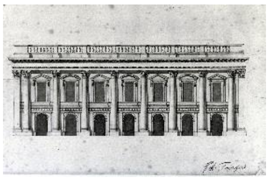
The Ptolemaic Orrery shows a system proposed by Tycho Brahe where the Earth is at the centre of the universe and the planets revolve around the Sun. The model includes a planisphere of the night sky. The Earth is a 2" globe, the moon is white jade and the sun is a hollow golden ball. The stars are silver alloy set in a blued steel plate.

Turning the handle shows:
Mercury and Venus orbiting the Sun
the sunlit portion of the Earth moving around and creating day and night, (enabling sunrise and sunset times to be read from the 24 hour dial)
the Sun orbiting the Earth
the Sun rising and falling each year, showing the seasons
the Moon orbiting the Earth
the phases of the Moon
the inclination of the Moon's orbit to the plane of the ecliptic
the movement of the nodes of the Moon's orbit (allowing lunar and solar eclipses to be predicted)
the date (the civil calendar)
the star map for the night sky at midnight for the date shown

Heliocentric Orrery

The heliocentric orrery shows the Sun, Moon and Earth and includes a rotating planispheric star map. The mechanism is contained within a 24" brass armillary sphere, and turning the handle demonstrates the following motions:
the Earth revolving on its axis, showing day and night
the Earth orbiting the Sun
the Earth's axis fixed in space, showing the seasons
the Moon orbiting the Earth
the rotation of the Moon, always showing the same face to the Earth
the inclination of the Moon's orbit to the plane of the ecliptic
the movement of the nodes of the Moon's orbit (allowing lunar and solar eclipses to be predicted)
the date (the civil calendar)
the star map for midnight on the date shown.

The earth sphere is a 3" globe, with 12 gores and two polar culottes applied to a wooden former. The globe (by Greaves and Thomas) is an accurate reproduction of an 1830 original. The moon is a white jade sphere, and the Sun is a gold-plated brass sphere. The star map is made from 24 carat gold stars fused into a circular disc of midnight blue glass.



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To see mathematical manuscripts and unique, richly annotated copies of seminal printed texts, as they become available on the website, please go to Christ Church Digital Library
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