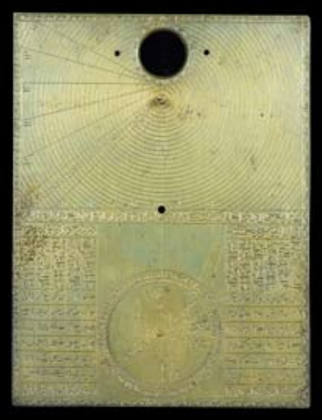
SUNDIAL AND QIBLA INDICATOR



Times of prayer and the sacred direction for praying – towards Mecca – are important elements of Islamic observance and the astronomical and geometrical challenges they present have given rise to a variety of ingenious instruments. This one combines a sundial and a 'Qibla indicator' (for direction). The horizontal pin-gnomon dial is on the upper section of the plate (see left-hand illustration) and would have indicated the time in 'Babylonian hours', i.e. counted from sunrise, but the hinged gnomon for casting the shadow is missing, as is the magnetic compass that was set in the circular hole. The lower section of the plate, though now incomplete, was used to find the Qibla, in combination with a table of geographical data on various places engraved on the reverse (see right). This Persian instrument is unsigned but dates from the eighteenth century.

Inventory no. 48472

Sundials

ROMAN PORTABLE SUNDIAL

A rare example of the tiny number of surviving portable sundials from the Roman era. There are two discs, the smaller turning in a central recess in the larger. This adjustment allows the instrument to be set for a range of latitudes, according to a scale on the larger disc marked 'XXX' - 'LX'. The curved piece which rotates above the smaller disc is a combined hour scale and gnomon (the part of a sundial that casts the shadow). This is set for date (solar declination) against a scale on the smaller disc, ranging from 'VIII K IAN' (=25th December) for the winter solstice to 'VIII K IVL' (=24th June) for the summer solstice in the Julian calendar. Once these adjustments have been made, the dial can be suspended vertically and turned until the shadow of the gnomon falls on the curved hour-scale, indicating the time. On the back of the large disc are engraved the latitudes, given in degrees, of 30 provinces of the Roman Empire. For nearly every province, the latitude cited is the mean of the range of latitudes given for that province by Ptolemy. The dial is thought to date from the 3rd century A.D. but the maker is not known.

Inventory no. 51358

Spherical Astrolabe

THE SPHERICAL ASTROLABE

Astrolabes generally present the stars and the path of the sun on a flat surface using a planispheric projection, in the manner of a map of the world. This is the only complete example of a spherical astrolabe, where the heavens retain the spherical form they are assumed to have in traditional astronomy. The solid sphere carries co-ordinate lines based on the horizon, while the bands that enclose it, forming a 'rete' or net, incorporate circles for the equator and the ecliptic (the path of the sun) and carry pointers for the positions of prominent stars.

The spherical astrolabe is used for the same set of astronomical calculations as the more common planispheric model but is less convenient to use and less robust. It is thought to be an Islamic invention and there are treatises on the instrument by an-Nairīzī (d. c.922) and al-Bīrūnī (973-1048).

The instrument is signed 'Work of Mūsa. Year 885 [= A.D. 1480/1]' and from the style of lettering and the system of numerals used, it is understood to have been made in Eastern Islam. The sphere is of brass with inscriptions and engraved lines damascened in silver, while the surrounding rete is of brass, laminated with silver on the ecliptic and equatorial circles and on the vertical quadrant; the suspension piece is of silver. The rete has pointers for 19 fixed stars, all named and all above the ecliptic, and the astrolabe can be adjusted for use in any latitude.

Inventory no. 49687

BROAD SHEET

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BROAD SHEET No.8

Museum of the History of Science

OXFORD in FLORENCE

THE 400TH ANNIVERSARY OF GALILEO'S TELESCOPIC DISCOVERIES

The Museum of the History of Science is lending some of its most famous instruments to a special exhibition to be held in Florence from 13 March till 30 August 2009, 'Galileo. Images of the Universe from Antiquity to the Telescope'. The instruments include unique items closely associated with the Museum, such as the 'spherical astrolabe' and the 'geared astrolabe'. We apologise that they will be gone during the summer months, when we have many visitors, but the anniversary of Galileo's work is an international event whose focus is properly located in Florence, and items from our international collection should contribute to the celebration. The exhibition is organised by the Fondazione Palazzo Strozzi and the Istituto e Museo di Storia della Scienza, is curated by Professor Paolo Galluzzi, and will be held in the Palazzo Strozzi (www.palazzostrozzi.org). This issue of Broadsheet deals with the instruments in Florence that are normally on display here. One side has instruments applied to astronomical calculations; on the other they are used as representations of the heavens.

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Geared Astrolabe

ASTROLABE WITH GEARED CALENDAR

This Persian astrolabe, made in Isfahan by Muhammad ibn Abī Bakr al Ibarī,in 1221/2, contains a geared calendar movement and is the oldest geared machine in existence in a complete state. One side is an astrolabe and is connected to the calendar by a train of gears. It illustrates an important stage in the development of the various complex astronomical machines from which the mechanical clock derives. The design is based on a text by al-Bīrūnī (973-1048), who explained how a special train of gearing might be used to show the revolutions of the sun and moon at their relative rates and to demonstrate the changing phase of the moon, phenomena of fundamental importance in the lunar calendar used in Islam.

The wheels have teeth shaped like equilateral triangles, recalling the teeth on the wheels in the Hellenistic astronomical computing machine found in a wreck of c.80 A.D. at Antikythera and now in the National Museum, Athens. When assembled, the geared calendar is operated by turning the 'rete' of the astrolabe. One circular opening on the back reveals a lunar phase diagram, while a rectangular opening gives the age of the moon (and therefore the date in a lunar calendar). Below, within a zodiacal calendar scale, are two concentric rings, the outer ring inset with a small gold disc representing the sun, the inner ring formerly having a similar inset representing the moon. The rotations of these rings show the relative positions of the sun and moon, and the position of the sun in the zodiac.

The astrolabe is made in brass and damascened with silver and gold. The highly decorated rim has pictorial representations of the signs of the zodiac, between figures of warriors. There are two plates, for use in latitudes 30° and 32°; 36° and 40°.

Inventory no. 48213

On one of the wheels is engraved, 'Its owner is the poor man Hasan Shāh'.

Armillary Sphere

ARMILLARY SPHERE

Most armillary spheres follow the astronomical system of Ptolemy, with the earth stationary at the centre, while a few adopt the later Copernican arrangement, where the earth moves around the sun with the other planets. This unique Italian armillary sphere is constructed according to the planetary system of Heracleides of Pontus, who lived in the 4th century B.C. According to this arrangement, Venus and Mercury revolve around the sun, while the moon, the sun, Mars, Jupiter and Saturn revolve around a central earth. In the seventeenth century this system was supported by the Italian astronomer Andreas Argolus (1570-1650). Despite dealing with such an ancient proposal, the armillary sphere is up-to-date in other respects. Jupiter is represented as having four satellites and Saturn as having three. While Galileo had discovered the satellites of Jupiter, the third satellite of Saturn was discovered in 1672 by Cassini, who discovered the fourth in 1684. This suggests a date for the instrument between 1672 and 1684. The horizon ring carries the name of Dominicus Sanctes Sanctini, who so far is not known as a maker of other instruments.

Inventory no. 57517

Armillary Orrery

ARMILLARY ORRERY

Richard Glynne was a maker of mathematical instruments, such as sundials and armillary spheres, who also sold maps at his shop in London, identified by the sign of 'Atlas & Hercules'. He advertised 'all Kinds of Dials, Spheres and Globes of all Sizes.' The armillary orrery, dating from around 1720 and standing just over a metre in height, must have been at the top of his range: an impressive and expensive purchase by one of his most wealthy customers. It is an attempt to combine one of the oldest forms of astronomical instrument, the armillary sphere, with what was then one of the most recent, the orrery or planetarium. The armillary sphere is the enclosing outer part of the instrument, composed of rings representing the circles of the celestial sphere, such as the equator, the tropics (Capricorn is missing) and the zodiac: it was best suited to illustrating the traditional Ptolemaic system with the earth stationary at the centre of the cosmos and the heavens rotating around it. The celestial sphere rotates on an axis in this instrument but – somewhat inconsistently – at the centre is a planetarium based on the Copernican system, where the sun is central and the earth both rotates on its axis daily and moves in an annual orbit. The earth and moon, Mercury and Venus are moved by wheelwork activated by a hand-crank, while Mars, Jupiter and Saturn are pushed round by hand. The drum at the north celestial pole has wheelwork moving the celestial sphere and a dial and hands for displaying the time.

Inventory no. 57605

Planetaria

PAIR OF PLANETARIA, PTOLEMAIC AND COPERNICAN

Dating from around 1700, this is an unusual – perhaps unique – solution to the problem of representing the cosmos by an instrument and accommodating both the traditional Ptolemaic arrangement, with the earth at the centre, and the Copernican, where the earth is in orbit around the sun, accompanied by the moon and rotating on its axis once a day. The two systems are treated in a pair of matching instruments, which follow diagrams in J.C. Sturm's *Scientia Cosmica* of 1670. Each planetarium has an outer ring for the zodiac and concentric rings for the planets, each carrying a planetary symbol. Since the zodiac is horizontal, the earth – whether at the centre in the Ptolemaic system or in orbit in the Copernican – is inclined. The orbital rings, each carried by four curved supports rising from the centre, can be rotated to represent movements and configurations of the planets; the exception is that in the Copernican instrument the earth is carried by a train of three wheels, so that it rotates as it is moved around in its orbit. In the Ptolemaic instrument the symbols for Mercury and Venus, and for Saturn and Jupiter, are erroneously reversed, perhaps as the result of some subsequent repair. Although unsigned, it is likely that the instruments were made in London by John Rowley.

Inventory nos 68353, 19978;
on loan from Christ Church, Oxford

Copernican Planetarium Inv. 19978

Ptolemaic Planetarium Inv. 68353

Grand Orrery

GRAND ORRERY

The partnership between Thomas Heath and his former apprentice Tycho Wing lasted from 1751 to 1773, with premises at various addresses in the Strand, London, and this is one of their most ambitious creations – a complete 'grand orrery' with all the known planets and satellites fully driven by clockwork. The pendulum-regulated clockwork movement is beneath the base plate and it drives the planets out to Saturn with their respective periods, as well as the moon, four satellites of Jupiter (discovered by Galileo) and five of Saturn. The earth moves over a calendar scale giving the date. The glazed mahogany case is designed both to be appropriate to an elegant room and to reveal the wheelwork in addition to the planetary system – a clear sign that the mechanism was meant to impress the viewer as well as the motions of the planets.

Inventory no. 39896
on loan from All Souls College, Oxford.