Document: Astrolabe
AP World History

History of the Astrolabe

Following is a very brief overview of the history of the astrolabe. See the Links page for references to much more detailed and comprehensive treatments.

Origins of Astrolabe Theory

The origins of the astrolabe were in classical Greece. Apollonius (ca. 225 BC), the great codifier of conic sections, probably studied the astrolabe projection. The most influential individual on the theory of the astrolabe projection was Hipparchus who was born in Nicaea in Asia Minor (now Iznik in Turkey) about 180 BC but studied and worked on the island of Rhodes. Hipparchus, who also discovered the precession of the equinoxes and was influential in the development of trigonometry, redefined and formalized the projection as a method for solving complex astronomical problems without spherical trigonometry and probably proved its main characteristics. Hipparchus did not invent the astrolabe, but he did refine the projection theory.

The earliest evidence of use of the stereographic projection in a machine is in the writing of the Roman author and architect, Marcus Vitruvius Pollio (ca. 88 - ca. 26 BC), who in *De architectura* describes an anaphoric clock (probably a clepsydra or water clock) in Alexandria. The clock had a rotating field of stars behind a wire frame indicating the hours of the day. The wire framework (the spider) and the star locations were constructed using the stereographic projection. Similar constructions dated from the first to third century and have been found in Salzburg and northeastern France, so such mechanisms were apparently fairly widespread among Romans. See the page on the anaphoric star disk for a description of a modern recreation of the anaphoric clock.

The first major writer on the projection was the famous Claudius Ptolemy (ca. AD 150) who wrote extensively on it in his work known as the *Planisphaerium*. There are tantalizing hints in Ptolemy's writing that he may have had an instrument that could justifiably be called an astrolabe. Ptolemy also refined the fundamental geometry of the Earth-Sun system that is used to design astrolabes.

Early Astrolabes

No one knows exactly when the stereographic projection was actually turned into the instrument we know today as the astrolabe. Theon of Alexandria (ca. 390) wrote a treatise on the astrolabe that was the basis for much that was written on the subject in the Middle Ages. Synesius of Cyrene (378-430) apparently had an instrument constructed that was arguably a form of astrolabe. This is plausible since Synesius was a student of Hypatia, Theon's daughter. The earliest descriptions of actual instruments were written by John Philoponos of Alexandria (a.k.a. Joannes Grammaticus) in the sixth century and a century later by Severus Sebokht, Bishop of Kenneserin, Syria, although it is likely that Sebokht's work was derivative from Theon. It is certain that true astrolabes existed by the seventh century.

The Astrolabe in Islam

The astrolabe was introduced to the Islamic world the mid-eighth century. The astrolabe was fully developed during the early centuries of Islam. Arab treatises on the astrolabe were published in the ninth century and indicate a long familiarity with the instrument (the oldest existing instruments are Arabic from the tenth century, and there are nearly 40 instruments from the 11th and 12th centuries). The astrolabe was inherently valuable in Islam because of its ability to determine the astronomically defined prayer times and as an aid in finding the direction to Mecca (the *qibla*). It must also be noted that astrology was a deeply imbedded element of early Islamic culture and astrology was one of the principle

uses of the astrolabe. The picture is from a larger painting of the observatory at Istanbul in the 16th century.

Persian astrolabes became quite complex, and some were genuine works of art. There are a number of interesting stylistic differences between astrolabes from the eastern Islamic areas (the Mashriq), Northern Africa (the Maghrib) and Moorish Spain (al-Andalus). The astrolabe was also used in Mughal India in a somewhat less elaborate style.

The Astrolabe in Europe

The astrolabe moved with Islam through North Africa into Spain (al-Andalus) where it was introduced to European culture through Christian monasteries in northern Spain. It is likely that information about the astrolabe was available in Europe as early as the 11th century, but European usage was not widespread until the 13th and 14th centuries. The earliest astrolabes used in Europe were imported from Moslem Spain with Latin words engraved alongside the original Arabic. It is likely that European use of Arabic star names was influenced by these imported astrolabes. By the end of the 12th century there were at least a half dozen competent astrolabe treatises in Latin, and there were hundreds available only a century later. European makers extended the plate engravings to include astrological information and adapted the various timekeeping variations used in that era. Features related to Islamic prayers were not used on European instruments.

The clock in the picture is on the Prague, Czech Republic, town hall and was originally constructed in about 1410. Click on the picture for a more complete description.

The astrolabe was widely used in Europe in the late Middle Ages and Renaissance, peaking in popularity in the 15th and 16th centuries, and was one of the basic astronomical education tools. A knowledge of astronomy was considered to be fundamental in education and skill in the use of the astrolabe was a sign of proper breeding and education. Their primary use was, however, astrological. Geoffrey Chaucer thought it was important for his son to understand how to use an astrolabe, and his 1391 treatise on the astrolabe demonstrates a high level of astronomical knowledge.

Astrolabe manufacturing was centered in Augsburg and Nuremberg in Germany in the fifteenth century with some production in France. In the sixteenth century, the best instruments came from Louvain in Belgium. By the middle of the seventeenth century astrolabes were made all over Europe. It is likely that most early astrolabes were designed and built by a single individual. It is known that some particularly lovely examples were made by a team consisting of a designer, engraver and decorator. Later European instrument makers established workshops with several employees, but the style and level of workmanship was defined by the master and the workshops often closed when he retired or died. A particularly interesting workshop was founded by Georg Hartmann in Nuremberg in about 1525. It is clear that Hartmann used an early form of planned production to produce his high quality instruments. It is likely that most workshops acquired parts of finished instruments from specialists or other shops were employed for services such as gilding. Brass astrolabes were quite expensive, and only the wealthy could afford a good one. Paper astrolabes became available as printing developed, and many were surely made, although few survive.

The picture is a page from *Elucidatio fabricae ususque astrolbii* (1512), by Johannes Stoeffler, who was professor of mathematics at the University of Tübingen. This treatise was one of the most popular astrolabe references and established something of a standard for European astrolabe design.

Several interesting astrolabe variations known as *universal astrolabes* which make a single instrument usable in all latitudes were invented in the 15th and 16th centuries, but due to their high cost and complex operation, never gained the popularity of the planispheric type. These instruments projected the celestial sphere on the equinoctial colure and lacked the intuitive appeal of the planispheric type.

An astrolabe derivative where the circular astrolabe is reduced to a quadrant was described in 1288 by Profat Tibbon of Montpelior. Few examples of astrolabe quadrants, commonly called the *quadrans novus* (new quadrant) survive, but many treatises on its construction and use were published. A form of astrolabe quadrant was quite popular in the Ottoman Empire until the early 20th century. Several quadrants using the stereographic projection were introduced in the 17th century. One of the most popular was devised by Edmund Gunter (1581-1626) in 1618. Gunter's quadrant was quite easy to use in comparison to the older *quadrans novus* and become widely used.

The Astrolabe to Modern Times

The use of the astrolabe declined in the last half of the 17th century. The invention of the pendulum clock made clocks much more reliable, and more specialized and accurate scientific devices, such as the telescope, became available. Astrolabe production continued into the 19th century, particularly in the Arab world. Much like sundials, any instruments made today are for curiosity or fun, although the educational value of the astrolabe is still appreciated.

Astrology

Astrology has had a major influence on the history and development of astronomy. The ancient astronomers were motivated to measure the positions of the stars and planets and to keep track of eclipses for astrological reasons (the word "horoscope" is from the Latin *horoscopium* which, in turn, is from the Greek words for "boundary" (the horizon) and "target" (object of observation). Their terminology, measurements and techniques were the foundation for the astronomical knowledge that eventually evolved.

Many old astrolabes had astrological features that would allow the user to determine horoscopes. Creating a horoscope requires knowledge of the positions of the planets and the ecliptic for a certain date and time. The astrologer interprets the aspects to advise his client. The astrolabe was a convenient way to determine a horoscope because much astrological stress was placed on the position of the ecliptic. Of particular interest were the ecliptic degree on the eastern horizon (the ascendant), the ecliptic degree on the western horizon (the descendent) and the ecliptic degree on the meridian (the degree of mid-heaven). In use, the astrolabe is set to the time and date of interest (birth, death, coronation, etc.) and the ecliptic degrees are read directly. The astrolabe could be used to find the "house" occupied by a planet, but an ephemeris was required to find the planetary coordinates for a date.