Reviews

Alessandra Pagliano

Le ore del sole. Geometria e astronomia negli antichi orologi solari romani

Edizioni Paparo,
Napoli 2019
pp. 312
ISBN 97888-31983-01-6

The book by Alessandra Pagliano grew out of research for the exhibition "Le ore del Sole" which took place from September 21st 2018 to January 31st 2019 at the Archaeological Museum of Naples (MANN), where twelve Greek-Roman sundial clocks were displayed. The sundial of the Great Hall of this Museum is also described in the book, showing an eighteenth-century astronomical instrument belonging to an uncommon type of camera obscura sundial.

The text was created from the theoretical and practical knowledge the author acquired on gnomonics thanks to the research carried out over the past years. In her studies, the fusing of the historical relationship between geometry and the representation of space and time is not only of theoretical interest, but it also has practical value. The knowledge described is, in fact, essential to the recovery of ancient sundials, which would otherwise remain devoid of their instrumental meaning.

The first part of the text collects and illustrates the fundamentals of gnomonics in their complexity as they involve a number of different disciplines. Pagliano introduces the themes linked to geometric models and the technology used for the survey and reproduction of the archaeological finds subsequently examined. In the first paragraphs, the author describes the historical importance of gnomonics, a method used since ancient times to regulate the timing of human activities and she points out its use in illustrating certain astronomical phenomena that would otherwise remain confined to the theoretical field, such as the identification of the 'true' solar time of a place, and the direction and speed of the apparent motion of the Sun. Interest also lies in the link between the single sundial and the place for which it was conceived, not only because of the ability to define the cardinal points, but also because the accurate functioning is linked to the latitude that determines the inclination of the solar rays. Another noteworthy topic discussed in the book is the deep connection that these specimens have with coeval culture, as shown by the interest in astrological elements in general.

The paragraphs by Luca Santoro about the historical and scientific framework of gnomonics and the analysis of the Farnese Atlas lead the reader from a general field to a more specific one, which is related to one of the most representative elements of where the exhibition takes place. The Farnese Atlas, which arrived in Naples in 1734, is a copy of a Hellenistic statue depicting the figure of Atlas holding the celestial globe–its representation constitutes a precious testimony on the astronomical knowledge of the time. It is possible to identify the celestial parallels of the equator, the tropics and the polar circles, as well as the main constellations. The solar ecliptic (apparent path of the Sun along the celestial sphere) has an inclination of about 24 ° with respect to the

celestial equator, which approximates the results of the coeval measurements. The results of the photogrammetric survey of the Farnese Atlas are illustrated by Pagliano who contextualises them in a convincing way not only with respect to the knowledge at the time of its realisation, but also with regard to its techniques and purposes of realisation of this work that generate and allow for an approximation compatible with an object not intended for scientific purposes. Pagliano also describes the role of photogrammetric survey in studying the sundials in the exposition which, in some cases, allowed the probable origin of the objects themselves to be established and the knowledge on these archaeological finds to be broadened. Thanks to 3D printing, it was also possible to integrate the missing parts of the sundials, without irreversibly affecting the original version.
This first part ends with a paragraph on digital technologies applied to enhance the cultural heritage by Claudio Cammarota–this shows how digital technology can be put at the service of the dissemination of the knowledge acquired in this category of subjects. Beside 3D printing, virtual models of the finds were generated to provide a better simulation of the luminous phenomena, and to allow users to interact autonomously thanks to the functions of Augmented Reality. Panoramic photography is used to explore the hall that hosts the camera obscura sundial.
The second part of the book is dedicated to cataloguing the sundials that were restored and exhibited in the aforementioned MANN exhibition and that previously laid in the museum's warehouses. The twelve cards for the solar clocks illustrate how these objects receive a better historical context precisely thanks to an appropriate cognitive apparatus that shows the complexity and the role that these essential tools had in the everyday life of ancient times. An essential step was to obtain the accurate findings using the processes already described. In fact, these integrated and corrected the information in the nineteenth-century catalogues, which sometimes contained misunderstandings and approximations about the geometric characteristics of the surfaces of the quadrants. The detected elements were also used to identify or confirm the possible origin of the sundial itself, as the dials are designed to work in a particular location, so much so that they would be rendered useless at a different latitude.
Each sundial is described in its formal characteristics, but above all in its functions and meaning within its historical context. The conical sundial A, found at the Stajan Baths of Pompeii, for example, confirms it was designed to work precisely at the place of its discovery, since the conical portion of the dial has a circular lower section contained in a plane whose inclination is equal at the latitude of Pompeii with respect to the vertical celestial meridian passing through the points E and O (40.75°). In the virtual model, the missing stone parts of the quadrant were integrated and a pyramidal gnomon with a triangular section was added, as was apparent by the hole that contained the lost one. In this way, the hour lines and daytime lines relative to the different moments of the year (solstices and equinoxes) have allowed this ancient instrument to perform its regulatory role in timing the functions that took place inside the baths. There is also an interesting contextualization with respect to the gnomonic culture of the Greek Roman era that stems from the exposure of Vitruvius and the invention and improvement of this specific type of quadrant, called *hemicyclium*. The text shows clear images of the original specimens and their models, with the addition of graphic elaborations capable of simulating and fully describing the functioning of the different sundials.
The last two paragraphs of the book deal with the description and survey of the camera obscura sundial in the Great Hall of the National Archaeological Museum of Naples. A camera obscura sundial (also known as gnomonic hole or pinhole sundial) consists of a meridian line (north-south oriented) usually positioned in an interior space with a narrow opening (smaller than the apparent image of the sun) through which solar rays pass and are able to project the solar image that, in the midday 'true' local, will be exactly on the meridian line. The projection occurs during the year with inclinations that are placed between the farthest limit to the hole of the winter solstice and the nearest one of the summer solstice. The projection of the solar image to the equinoxes takes place at a distance equal to the geographical latitude multiplied by the height of the gnomonic hole.
There are several sundials of this kind in Italy [Mesturini 2002], including two of the most famous, namely the one made in 1655 by Gian Domenico Cassini in San Petronio in Bologna and the one built in 1702 by astronomers Francesco Bianchini and Giacomo Filippo Maraldi at the church of Santa Maria degli Angeli e dei Martiri in Rome. These tools are still used today to study astronomical phenomena, such as the measurement of the delay of the earth's rotation, as shown by research carried out with the sundial of Santa Maria degli Angeli in Rome [Sigismondi 2010].
The specimen of the National Archaeological Museum of Naples was realised by Giuseppe Cassella in 1791. The line consists of 181 brass strips embed-

ded in marble slabs for a total length of 27.40 meters and the pinhole is located at 15.10 meters. The book displays the complex cognitive framework of gnomonics that would be difficult to frame without the interdisciplinary contributions of astronomy and archaeology, and without the clear graphic apparatus that accompanies each section of the text in a timely and appropriate manner. Pagliano's text claims the role of representation not only as a means of communication but also in sharing the projective foundations of optics and astronomy. The book illustrates a complete path that starts from a clear overview of the theme of sundials, to then further analyse case studies able to communicate the variety and value of the objects themselves and the disciplines that must be involved to protect this significant cultural heritage.

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