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Exercises in Archaeoastronomy - I - Introduction

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Abstract

Here it is given the first article of a series proposing exercises in archaeoastronomy. After a short introduction to the series, it is given a sample of exercise. It concerns the study of the orientation of the Stonehenge monument. As shown by this example, the exercises will be well-defined cases, supplemented by solutions, and proposed in the framework of an experimental approach that everybody can repeat.

According to the Oxford Dictionary, archaeoastronomy means "the investigation of the astronomical knowledge of prehistoric cultures" [1]. In the Merriam-Webster Dictionary, we find a more generic definition: this dictionary tells that is "the study of the astronomy of ancient cultures" [2]. In any case, the etymology is clear. Archaeoastronomy is from archaeo-(ancient) + astronomy, and the term is existing from 1971 [3] or from 1973 [4]. Following the etymology, let us consider this science as the study of the ancient astronomy (not only that of the prehistoric cultures). More specifically, it is the systematic study of material and immaterial evidences associated with astronomy in the past. Let us note that other terms, such as astro-archaeology, are also used [5].

In the introduction of [5], astro-archaeology or archaeoastronomy is defined as the “astronomical interpretation of archaeological monuments and other material”. Besides the monuments, archaeoastronomy uses also historical and ethnographic records to link ancient people to the sky. So myths and religious beliefs, rituals and symbols associated with the Sun, the Moon, stars and planets are also studied [6]. For what concerns the monuments, archaeoastronomy focuses to recognize if they were intentionally built “in such a way as to capture sunlight on particularly important days of the year” [6]. Famous examples are the passage tomb of Newgrange (Ireland) and the main axis of Stonehenge (United Kingdom), both having a solstice alignment.

Among the first pioneers of this discipline, amalgamating ancient astronomy and archaeology [5], we can find the scientist and astronomer Sir Joseph Norman Lockyer, (1836 - 1920), or simply Norman Lockyer [7,8]. He and the French scientist Pierre Janssen are credited with the discovery of helium, by means of a spectroscopy of the sun. Actually, the name of this gas was coined by Lockyer after the Greek word 'Helios' meaning 'sun'. In 1885, Lockyer became the world's first professor of astronomical physics at the Royal College of Science, South Kensington, now part of Imperial College [9]. There, a Solar Physics Observatory was built for him, that he directed until 1913 [9].

“To facilitate the transmission of ideas between scientific disciplines, Lockyer established the general science journal Nature in 1869. He remained its editor until shortly before his death” [9]. A great mind versed in astronomy, archaeology and science in general, Lockyer was one of the first scientists that proposed an astronomical approach to ancient monuments (other scientists are mentioned by Lockyer in [8]). Travelling in Greece, he noticed the east-west orientation of many temples and in Egypt he found orientations of temples according to
sunrise/sunset on solstices. He had also studied Stonehenge, and its alignment along the sunrise on solstices [9].

As a matter of fact, Norman Lockyer was an astronomer who recognized the path of the sun involved in the ancient monuments. Also today, the current generation of archaeo-astronomers is made of persons that, like Lockyer, had been trained in the exact sciences (astronomy, physics or engineering) [6]. As a consequence, it seems that the archaeoastronomical studies are limited to a small circle of scientists. It is not so indeed. Archaeoastronomy can be appreciated by everyone, after a proper training. This training is the aim of a series of articles - the first of which is this article – based on exercises in archaeoastronomy, consisting in well-defined cases, supplemented by solutions.

Many of the exercises that I will propose are based on a "virtual archaeoastronomy", or "remote archaeoastronomy" [10], because we will investigate the orientation of the monuments by means of satellite images and software - free software - available on the web. We will use, among those available: suncalc.net, suncalc.org, sollumis.com for the azimuth and altitude of the sun, the Photographer's Ephemeris and mooncalc.org for the moon, and Stellarium for stars. Other software that we will use are CalSky and the Astronomical Applications of the U.S. Naval Observatory. Google Earth is used for the elevation profile of the site we will consider. Wikimapia will be also a fundamental resource for the identification of the monuments. References to books and articles will be given according to the specific problem considered, using Google Scholar.

Let us propose a first example of an exercise. We will start from a simple case, because astronomical and natural horizon are practically coincident; it concerns Stonehenge and the sun.

Example: Consider Stonehenge site. Using SunCalc.net software, determine alignments along sunrise/sunset. Investigate the stones involved in Wikimapia. Use Google Earth to visit the site and observe the horizon.

First, let us remember what we have told in the introduction. Lockyer has studied Stonehenge, and its "alignment along the sunrise on solstices". Therefore, we can use suncalc.net on June 21 and December 21. “SunCalc - sun position, sunlight phases, sunrise, sunset, dusk and … at the site suncalc.net, is a little online application with interactive map that shows sun movement and sunlight phases during the given day at the given location". Let us consider June 21, a possible alignment is given in the Figure 1. The pivot represents the observation point. The yellow line represents the direction of the sunrise, the red line the sunset. The orange curve is simulating the path of the sun in the sky. The alignment in the Figure is given by two large stones. To identify the stones we can use Wikimapia, as in the Figure 2. The stones are the Heel Stone and the Slaughter Stone.

Figure 1: Screenshot of suncalc.net software, on 21 June. The yellow line is the direction of the sunrise according
to the local astronomical horizon. The red line represents the sunset. The orange curve is showing the path of the sun in the sky. Being this line closer to the pivot, it means that the sun is reaching the highest altitude in the sky.

Figure 2: Image composed from two screenshots of Wikimapia, after the selection of the two stones.

About these two stones we read that the Heel Stone "lies north east of the sarsen circle, beside the end portion of Stonehenge Avenue. It is a rough stone, 16 feet (4.9 m) above ground, leaning inwards towards the stone circle. It has been known by many names in the past, including "Friar's Heel" and "Sun-stone". At summer solstice an observer standing within the stone circle, looking north-east through the entrance, would see the Sun rise in the approximate direction of the heel stone" [11]. In [12], we find that the Slaughter Stone "lies prone, midway between the central monument and the Heel Stone just east of the primary solstice axis. The name comes from the (incorrect) belief that it was the stone where sacrifices were carried out … The Slaughter Stone originally stood upright with its north-eastern end planted in the ground".

Let us consider Google Earth. First, we can see again the monument and the two stones we have considered for the alignment. Note that software has several tools. One is the ruler, which is indicated in the Figure 3. It gives the possibility to draw lines and measure them. Moreover, if the select the line, we can see also the corresponding elevation profile of the place. In this case, as we have already told, the elevation profile is not essential. Using Street View, it is possible to visit the place. Another tool of Google Earth gives the possibility to simulate the path of the sun in the sky (see Figure 4). "Clicking View – Sun, will add a time slide to the interface. You can now move time, and see the sun rise, set and create shadow all over the globe. All the information is astronomically correct – so you can see the change in sunrises over the year" [13].
To complete the exercise, let us find some literature about Stonehenge and links to astronomy. Use Google Scholar, searching terms Stonehenge and Astronomy, in the custom range 1900-1910. Besides [8], some other results are given in [14-18]. In [18], we find Stonehenge mentioned in a book on Atlantis.

Let us repeat the search by Google Scholar, for the most recent articles on Stonehenge, choosing "Since 2017". So we find a remarkable article [19]. It is a paper which examines "how specific megaliths at Stonehenge and Avebury were positioned relative to others and to particular sunrises such as to produce watchable effects arising from solar movement and resulting lithic shadows". The Figure 5 of [19] shows that, in midsummer week, the sunrise shadow of the Heel Stone enters the Stonehenge monument and reaches the focal stone called the Altar.
Stone. "This is a reconstruction photographed by the author (G. Terence Meaden) sitting with his back against the Heel Stone".

Actually, we can simulate the shadows using a software: it is the SunCalc.org software. Here we can see the result in the Figure 5, for Stonehenge. We have already used this software in [20], to simulate the study of S. Hood, published in 2004 [21], on Long Meg and Her Daughters, a Bronze Age stone circle near Penrith in Cumbria.

![Figure 5: Screenshot of suncalc.org. The shadow simulated is that of the Heel Stone.](image)

Let us conclude with a short discussion of the example. The simulations are given on 21 June. However, what happens if we simulate on 20 June or 22 June, or on a day of the week about the solstice? We could repeat and see that nothing changes. Because it is the time of solstice. The term solstice is coming from Latin solstium, that is, sol– (sun) + sistere, which is meaning “to make stand”. This term is therefore representing the fact that sun, when it is rising or setting, seems to indulge to stay at the same point of the horizon for some days.

Like the sample given above, all the exercises that I propose in the articles of the series have an “experimental” feature. That is, everybody can repeat them. Only a few equations will be used, being the astronomical calculations included in available software. In the next article, we will discuss the horizon and the horizontal coordinates and some problems on sunrise/sunset alignments of monuments.

References

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