# Archaeology and astronomy

**Meeting report** **The interaction between archaeology and astronomy has a long, tangled and not entirely creditable history, marred by misunderstandings on both sides. But statistics and cultural awareness are bringing a better picture of how and why lasting monuments such as Stonehenge were built. Sue Bowler reports on a joint meeting of the Royal Astronomical Society and the Prehistoric Society, held at Jodrell Bank on 17 July 2009.**

1: Sunrise in Xochicalco, Morelos, Mexico (central sector of the Acropolis, 11 February 1998). This date can form part of an observational calendar of calendrically significant intervals connecting dates marked by alignments at different sites. (Ivan Šprajc)

Interactions between astronomy and archaeology over the past hundred years or so have been soured by workers from one field misunderstanding or misapplying data from the other, whether it was astronomers seeking alignments between structures of widely disparate ages, or archaeologists finding alignments with only sketchy astronomical significance. The speakers at this one-day conference presented the audience with a very different picture in their overview of archaeoastronomical research today, one in which astronomical alignments have a place among the other cultural, social and landscape features – known and unknown – affecting the location, position and orientation of ancient structures.

A key trend in archaeoastronomy, highlighted by chairman **Clive Ruggles** (University of Leicester), was the value of collecting enough data and taking a statistical approach – then at least truly significant alignments could be identified and then investigated. He drew attention to the work of Michael Hoskins, who worked on thousands of monuments in Polynesia and found broad groupings of alignments, some related to sunrise. But there were other alignments, some related to the landscape, for example. In particular he found that the main alignment in monuments in coastal sites was perpendicular to the coast; some of these were also aligned with astronomically significant directions but, it appears, coincidentally. Ruggles's message was that there are many reasons for alignments in ancient structures, and many reasons to find astronomical drawings on artefacts – maybe even that symbols of the Sun and Moon are pretty – and warned against reading too much into them.

The ancient monuments that survive today were significant to their builders in ways that we can only surmise. They were built deliberately and their placing, position and alignment were chosen. Measurements of orientation confirm this deliberate choice, in monuments from widely different ancient cultures.

## Egypt

**Juan Belmonte** (Instituto Astrofisica Tenerife) spoke about a joint Egyptian–Spanish survey of ancient Egyptian temples which confirmed that they were predominantly oriented east–west, reflecting the importance of the north–south running river Nile in the sophisticated culture. Sir Norman Lockyer was one of the first astronomers to suggest that the orientations of the temples were significant, but he used the chronology current in the 19th century; when the chronology was revised his ideas fell out of favour. The Egyptian–Spanish team spent five years measuring the alignments of 330 temples and found that the orientation with respect to the Nile was by far the most significant factor. But there were other peaks in the alignment statistics, notably with equinoctial, solsticial and seasonal directions. Temples in oases far from the Nile had solely astronomical alignments, for example aligned to the rising of Sirius or Canopus, which are significant seasonal markers related to the annual Nile floods. But some of the alignments for temples along the Nile that diverged from east–west, and appeared to have astronomical significance, were in areas where the course of the Nile was itself anomalous. They had been built perpendicular to the Nile, rather than close to astronomical orientations.

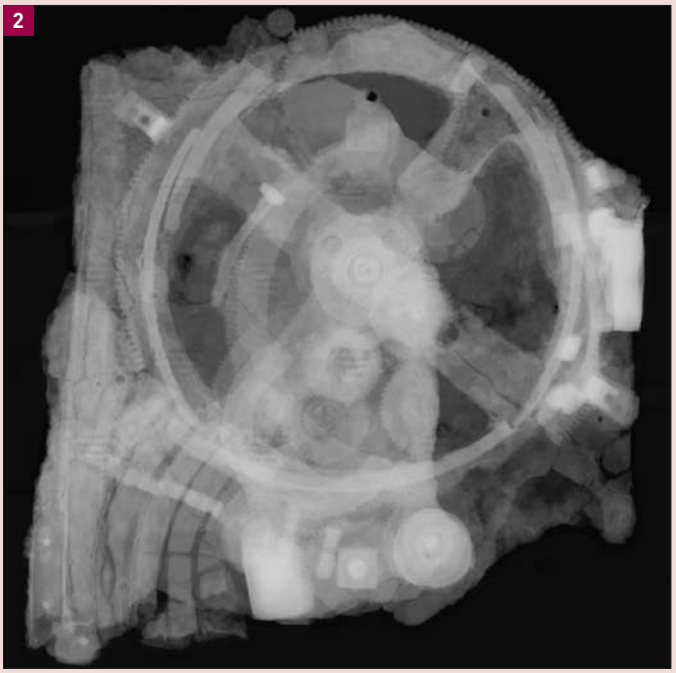
Mesoamerican sites described by **Ivan Šprajc** (Institute of Anthropological and Spatial Studies at the Scientific Research Centre of the Slovenian Academy of Sciences and Arts) also showed alignments, some with astronomical significance. They came from a group of pre-Spanish urban cultures that had in common intensive agriculture, religion involving a sacred ball game, and a calendar. Pyramids were a feature of these urban civilizations, and many of the larger buildings and groups of buildings did have an astronomical orientation, mostly to sunrise on certain dates. There were often multiple alignments within the monuments, with viewpoints that aligned on each side of a linked building to the summer and winter solstice sunrises, for example. Šprajc noted that walls and buildings were often also aligned to a prominent mountain on the local horizon, which doubled as an astronomical alignment. In other words, to achieve this the buildings would have to have been located astronomically as well as aligned astronomically. The people who built these monuments knew the astronomical alignments and built in places where there was also local significance to those orientations.

One of the problems in interpreting astronomical alignments is being sure that the alignment is genuinely astronomical. It is easier for

2: Computed radiography image of part of the Antikythera Mechanism. (© Antikythera Mechanism Research Project)

3: The aboriginal "emu-in-the-sky" constellation and the emu at the Elvina engraving site, in Kuring-Gai Chase National Park, near Sydney. (Barnaby Norris)

4: Midwinter sunset at Stonehenge. (Clive Ruggles, www.cliveruggles.net)





archaeologists to be confident that cultures used astronomy when there is evidence in the form of writing or figures. Belmonte described how ancient Egyptians attached considerable significance to the constellation we know as the Plough, which they called Meskhet, meaning a bull's leg. Hieroglyphics show that Meskhet was significant for rituals with the dead, and its position in the sky may be significant in the orientation of some of the temples.

The Mesoamerican cultures also wrote about astronomy, showing that people of the time did observe the skies carefully; their sophisticated calendar reinforces the idea. The calendar was complex, comprising a 365-day year and a 260-day cycle used in astronomical calculations. The 260-day cycle used 20 day signs and 13 numbers to give each day in the cycle an individual identifying combination. There is evidence that the alignments were used for the agricultural year and to record dates separated by calendrically significant intervals, such as the quarter days in the year, 23 March and 20 September.

Ancient Egypt also had a sophisticated civil calendar comprising twelve 30-day months plus five extra days; as a result, the civil and seasonal calendars drifted apart over the centuries. At the time when the great temple at Karnak was built, the civil and seasonal years were in harmony, and the winter solstice took place at the start of the civil year. Karnak was built perpendicular to the Nile – at a place where the river was not running due north – and aligned to the winter solstice sunrise. Belmonte suggested that this coincidence of timing and place could have been significant when choosing where to build the temple: a site that is perpendicular to the Nile and aligned with a significant astronomical direction could have been a deliberate choice.

However, we do not always have a clear or accurate assessment of the capabilities of an ancient society, as **Mike Edmunds** of Cardiff University made clear when he talked about the Antikythera Mechanism. This bronze artefact, found in 1901 in a shipwreck from around 70 BC, shows astounding levels of workmanship in its bronze gearwheels, not thought to be a feature of Greek culture at the time. And, despite displaying the peak of astronomical knowledge from when it was made (probably between 140 and 90 BC) it does not seem to have a particular practical use. But for its chance discovery, we would have had no idea that this society could actually produce such a device, although there are cryptic references in literature of the time.

## Greece

The Antikythera Mechanism Research Project, a collaboration between Greek and Uk researchers and the companies X-Tek and Hewlett-Packard, has used modern imaging methods to reveal the structure of the device in breathtaking detail. A clever photographic technique applied to the 70 fragments revealed surface details and lettering; X-ray tomography produced a 3D model of the principal fragments that researchers could scan through, layer by layer, to show all the preserved cog wheels, and how they were arranged. A further benefit of the latter technique is that it enhanced faint text engravings on and below the surfaces. It is likely that there were more than 40 gear wheels in the original device, and the mechanical design was superb – nothing remotely like it is known for another 1200 years, until the cathedral clocks of around 1100. The mechanism was a calendar, an astronomical calculator, a tellurium, and an orrery, but it was not a navigational tool nor does it show specifically astrological information. There are dials showing the lunar and solar metonic cycle, the Saros cycle and the prediction of eclipses, the position of the Moon in the Zodiac (including the first anomaly) and the position of the Sun in the Zodiac, the phase of the Moon (shown by a half-silvered ball) and there are signs of a planetary display. The astronomy displayed is based on period relationships known from Babylonian astronomy and all the dials show information that an astronomer of the time would be expected to know. The ingenuity with which it is made is exemplified by the clever "pin and slot" device shown to link cog wheels and show the Moon's first anomaly – the varying distances travelled across the sky night by night, which we now know arise from its elliptical orbit.

The purpose of the mechanism remains unclear – but it doesn't seem to have any direct practical application, such as navigation. The dials could be moved by a knob of some sort at the side, so that it could be used for prediction or to demonstrate the cycles. Edmunds speculated that it might have been used for teaching astronomy, as a prestige display in a temple, or even as a very clever, high-status toy. Again, the missing cultural dimension is the key to understanding what role this device played in the relatively well-understood Greek society of more than 2000 years ago.

An insight into the problems of inferring cultural information from information that might be preserved in the archaeological record came from **Ray Norris** (Australia Telescope National Facility), a radio astronomer who is also working on astronomy with Aboriginal groups in modern Australia. Norris spoke about the place of astronomy in this living culture, which had long been dismissed by the white culture in Australia. He felt that, although this sorry state of affairs is now changing, sharing astronomical

knowledge could act as a bridge between the two cultures. Much of what he has found – from rock art and stone carvings, and by asking around about astronomy, and finding out who in Aboriginal groups (which have a strong oral tradition) knows about the stars – runs counter to accepted and published ideas about the extent of astronomical understanding in these cultures. He has found a wealth of stories on astronomical themes, some using stories to reinforce socially acceptable behaviour, as well as practical applications of astronomical knowledge and also some "no go" areas, where topics he was asking about had sacred significance.

Many Aboriginal clans move in cycles around their territory over the year; they use the first visible rising just before dawn of particular stars to determine when it is time to move to a new place. Some groups use the stars to determine when a food source will ripen and become available each year. One published example of such a seasonal signal was the use of the evening star, assumed in publications to be Venus, to say when a particular berry was ripe. But any astronomer can tell you that there is no seasonal significance to when Venus rises in the evening, and the Aboriginal astronomers were no different. Norris asked and found that this use of the term "evening star" referred not to Venus but to a particular bright star that did in fact come above the horizon at the time when the fruit became ripe, making sense of an otherwise meaningless astronomical association.

But there are also stories about the natural world, about the Moon and tides, and about phenomena such as eclipses. In some, the Moon is seen as a man who gets fatter and fatter, then falls dead for three days before coming back to life and starting the cycle again. The Sun is often seen as a woman, chasing the Moon through the skies. Eclipses are described as bodies coming together, sometimes as a man and woman coming together, and may be shown as such in ancient rock carvings. There are also aligned lines of stones and landscape features that may have astronomical and cultural significance, and this is an area of continuing research. It is clear that astronomy, while significant to many of these complex cultures, is one factor, often with a practical use and a social role, but it is by no means dominant.

## Stonehenge

Insight into the culture in which monuments such as Stonehenge were built is an elusive yet highly significant goal. **Mike Parker Pearson** (University of Sheffield) concluded the formal presentations with a summary of the modern view of Stonehenge as part of a landscape of henges on the high dry chalklands, peripheral to the centres of population, which were on surrounding lowlands. The interpretation of this position, and the archaeological evidence, is that these henges, Stonehenge included, were places where people met, rather than places where they lived. During the third millennium BC, for example, Stonehenge was – as far as is known – the UK's biggest cremation cemetery, but there is little sign of people living or farming there. The solsticial alignments, common to the stone and timber henges, represent something important, but it is not clear what, especially given the debate about the cultural function of these structures. It may indicate that seasonal visits were important, perhaps, especially with the solsticial alignment of the avenue leading to Stonehenge. Here again, there are signs that the location as well as the alignment had significance, with the possibility that natural alignments in the landscape – if the avenue originated as a landscape feature that matched midwinter sunset, for example – led to the siting of Stonehenge where it is.

This interplay between landscape features and significant astronomical directions comes across as a feature of the ancient Egyptian, Mesoamerican and Neolithic cultures described by the speakers. The element that they seem to share is awareness of the skies – an awareness verging into fascination with it for its own sake in the case of the makers of the Antikythera Mechanism. But awareness of the skies does not translate into anything approaching what we understand by astronomy today. All the speakers agreed that claims that these monuments were observatories were meaningless in the current context of the word. No ancient peoples would think in the way that we think of an observatory: a place for systematic observation and interpretation of the skies. Events in the sky appeared to be well known, important and to be taken into account in the siting and orientation of monuments that had some – largely unknown – cultural significance. It is easier to interpret alignments as astronomical where there is written evidence of knowledge and interest in astronomy in that society, as in Mesoamerica or Egypt, but societies can have the interest and knowledge without it being written down, as contemporary Aboriginal culture demonstrates. And we should bear in mind always the fundamental lesson of the Antikythera Mechanism, which is that we may know rather less than we think about the capabilities and priorities of ancient societies. ●

*"Archaeology and Astronomy: Disciplines in Collision or Collusion?" was jointly organized by the Prehistoric Society and the RAS as part of IYA2009 events at Jodrell Bank.*