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Masters-level education in archaeoastronomy at the University of Wales Trinity Saint David

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Abstract. The class in Archaeoastronomy at the University of Wales Trinity Saint David is taught as part of the MA in Cultural Astronomy and Astrology, within the University's School of Archaeology, History and Anthropology. This paper will present and review some of the postgraduate work produced in the course, reporting on its findings as examples of the level of work that may be expected on a taught MA course at a UK University.

Keywords. archaeoastronomy, University of Wales

1. Introduction

The MA in Cultural Astronomy and Astrology (MA CAA) at the University of Wales Trinity Saint David is in its ninth year of teaching, and fourth year at the University of Wales (it was taught in the Department of History at Bath Spa University from 2002 to 2007–8). The MA syllabus contains an emphasis on the religious aspects of the human relationship with the sky, and its methodologies tend to be a combination of the historical and anthropological (Campion 2008; Campion & Holbrook 2008). The Archaeoastronomy module was launched in January 2010, with Malville as the lead tutor. Students take two compulsory modules and then choose four others, from a list which includes Archaeoastronomy. They then write a 20,000-word dissertation based on an independent research project.

The emphasis in the archaeoastronomy module is on the astronomical component of archaeoastronomical methodology as it was felt that, in a single 20-credit module, requiring only 200 hours of formal study, it was inappropriate to include archaeology. Students can take several pathways through the module assessment: they may take a literary approach (for example, examining the history of the discipline) an ethnographic one (for example, investigating the modern use of archaeoastronomical sites by tourists or pagans), or astronomical (for example, conducting site surveys in order to test for possible astronomical alignments). The technical level at which we expect research to be conducted is determined by the fact that this is a distance-learning course and students need have no prior experience: this is their introduction to practical archaeoastronomy and it is seen as a training exercise. Research that contributes to the wider discipline is not required, although it is expected it may occur in the best student work. Also, at this level, we expect students to work with GPS, tape and compass. Theodolites were available through the School of Archaeology, although we announced that they were optional field techniques.

The astronomical option proved popular and, when the module was launched in the academic year 2009–10, seven out of nine students in the initial cohort set out to conduct site surveys in order to satisfy the requirement of a term paper. We saw these surveys as positive alternatives to library research. We report on three of the student projects as examples of the only current attempt, of which we know, to create an academic programme in archaeoastronomy.

2. Three student projects

2.1. *Fabio Silva, 'Orientation of Neolithic tombs in central Portugal'*

Fabio Silva re-examined the comprehensive survey of the orientations of Iberian Neolithic dolmens carried out by Hoskin (Hoskin & Pérez 1998; Hoskin 2001) and colleagues, including measurements of the axial orientation of some examples in central Portugal. Hoskin's study has already led to further work, for example by Gil-Merino *et al.* (2009). Hoskin concluded that most tombs in the Mondego plateau were aligned towards sunrise during the winter seasons, whereas tombs in the Vouga, Paiva and other nearby river basins were aligned towards winter 'sunrise/sun-climbing' (sun-climbing being alignments to the sun as it climbs out of the horizon after the actual sunrise). He then advanced the possibility that the dolmens themselves were aligned to sunrise on the day they were built (in winter), which would account for the spread in azimuths.

Archaeological evidence (Senna-Martinez & Ventura 2008) suggested that the megalith builders' way of life as semi-nomad pastoralists was tied to the orientation of the dolmens, namely that the monuments were built during the winter seasons when the pastoralists would be in lower ground, which is where we find the tombs in the Mondego basin. However, not all measured dolmens fit this picture, and especially not the ones from nearby basins. To test this seasonal model a new survey was planned and conducted during the spring of 2010, which incorporated previously unmeasured tombs from the region as well as trying to take note of landscape features and other possible orientations. Further data is given in Silva (2010).

In total, Silva measured the axial orientation of 31 dolmens, using a magnetic compass as, given the nature and state of the monuments, the precision of a theodolite would not translate into significantly greater orientation precision. Care was taken to avoid magnetic anomaly issues, and a new technique for obtaining the local values for the magnetic deviation was developed (Fig. 1). This involved choosing a number of features in the landscape surrounding each tomb, taking their azimuth bearings from the tomb, then going to each of them, recording their GPS positions and azimuth bearing of the tomb. Later, the compass bearings can be compared with the ones extracted from the GPS data. Their difference gives the magnetic declination, which one can average over all the measured features and get a standard deviation. This technique proved to be quite reliable for four to six measured features, giving average values close to the NOAA estimates and with standard deviations of roughly half a degree.

Silva's survey confirmed most of the results of the previous survey by Hoskin and colleagues, confirming Hoskin's measurements to within 3° in declination. However, he also opened up possible avenues of interpretation and further research, finding that more than half of the tombs of the region did not match the winter sunrise/sun-climbing interpretation as they had positive declinations, and thus would indicate spring or summer solar alignments. Also there were a few outliers, i.e. tombs that didn't fit this picture.

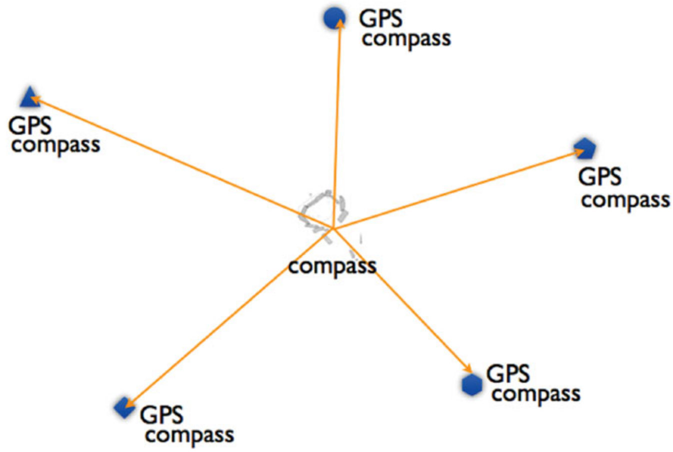

Figure 1. Obtaining local values for the magnetic deviation.

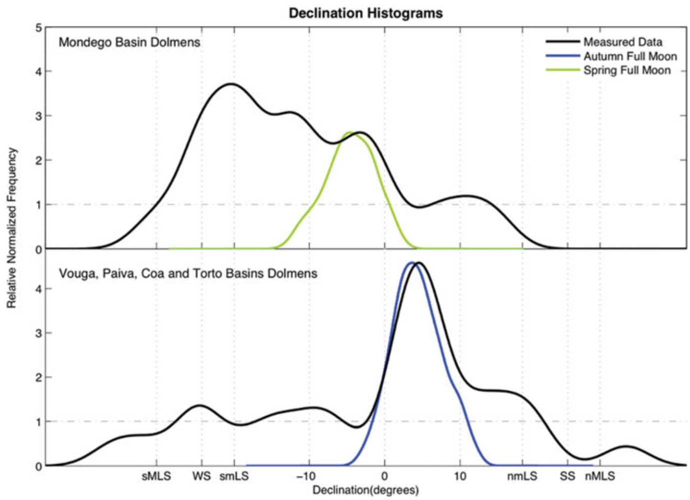

Figure 2. Histogram illustrating orientation of dolmens to spring and autumn Full Moons.

Some of the surveyed tombs suggest non-solar alignments, possibly lunar or even stellar (the entrances of a couple of Mondego dolmens forming one of the oldest Neolithic necropoleis of the region face towards the northern sky, which might indicate an early stellar association with death and the afterlife). The Mondego plateau dolmen declination histogram exhibits a peak at the expected position of the Spring Full Moon peak, whereas dolmens in other nearby basins have their most significant peak at the expected Autumn Full Moon peak (Fig. 2). These Equinoctial Full Moons are the closest Full Moons to the equinox, defining a point in space (i.e. in the horizon) as well as in time, in which the moonrise and sunrise points cross over. Essentially, the highest peaks in the declination histogram closely match the expected (simulated) Spring Full Moon and Autumn Full Moon rises, and also the minor standstills, which indicates a predominance of alignments to the Moon at various points (equinoctial and solstitial) of its yearly cycle, which would explain every single one of the dolmens measured by Silva. A fascinating outcome of his investigations has been the displacement of equinoctial full moons from the day of equinox, late in the spring and early in the fall, mimicking the effect of half-day counts.

2.2. *Tore Lomsdalen, 'Astronomy and intentionality in the temples of Mnajdra'*

Lomsdalen examined the Neolithic Mnajdra South Temple on Malta, one of the survivors of the enigmatic temple-building culture on Malta (Trump 2002). It has already been suggested that the temples may have been constructed with intentional astronomical alignments, including possibly to the heliacal rising of the Pleiades and lunar standstills (Ventura 1999; Cox 2001, 2009). Ventura (1999) found that Maltese shaft tombs have a tendency to a south-easterly orientation. Of the extant Neolithic megalithic monuments in Malta, the Mnajdra South Temple is the only one with a seemingly intentionally defined eastern orientation. From the temple site, the horizon has an elevation about 4° at equinox and summer solstice and close to 0° at winter solstice. Lomsdalen's study investigated solar alignments at the spring equinox and the summer and winter solstices. Further data on this study is included in Cox & Lomsdalen (2010). Lomsdalen's project (which is ongoing) requires photographing and documentation of actual solar and lunar risings in order to confirm or disconfirm the evidence of site plans.

At present the architecture of Mnajdra South Temple allows a cross-jamb view of sunrise around the time of the solstices. The entrance to the temple is formed by opposed pairs of orthostats, forming a corridor about 3m long, 1.75m wide and 3.1m high. Two diagonal views seen from the waist of the temple, lightening the rearmost inside corner of a southern and northern erected orthostat, indicate respectively the sunrise at summer and winter solstice, based on an offset-illumination (Fig. 3).

A deliberate orientation could have been found by bisecting the position of the sight-lines of the winter and summer sunrise. However, in the period around 3000 BC, the same view would have coincided with the rising point of the Pleiades close to the time of the spring equinox. Fig. 4(a) illustrates the sunrise at spring equinox 2010 illuminating the central altar situated 15.4m back from the entrance. Fig. 4(b) illustrates sunrise at the summer solstice 2010 seen from the entrance illuminating the southern orthostat. So far, Lomsdalen's photographic documentation confirms Mandjra's orientation to the spring equinox, and summer and winter solstice, rising sun.

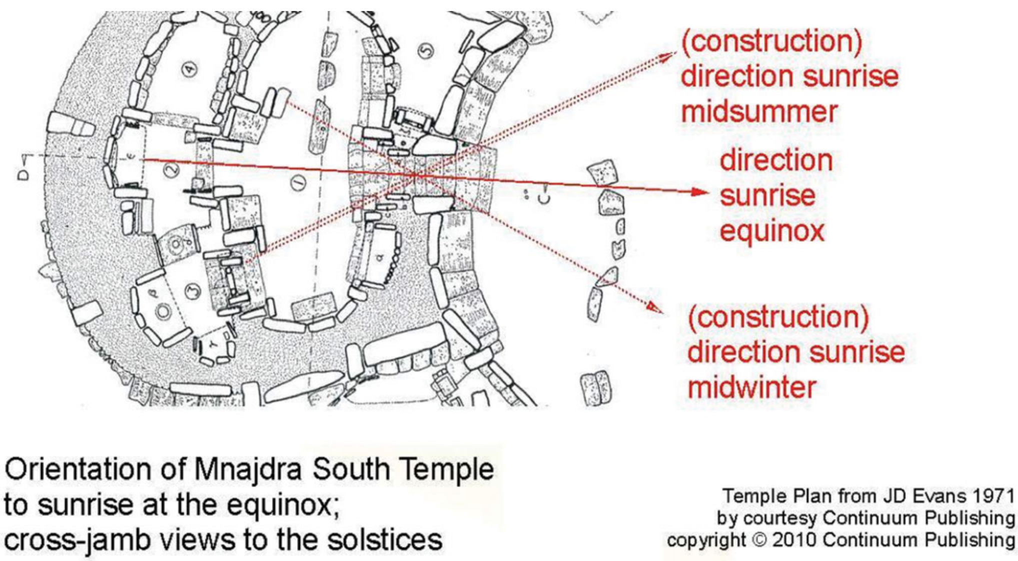

Figure 3. Solar orientation at equinox and solstices at the Mnajdra South Temple. (Adapted from Evans 1971)

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Figure 4. (*a*) (*left*): Spring equinox sunrise at Mnadjra illuminating the central altar situated 15.4m back from the entrance. (*b*) (*right*): Summer solstice sunrise at Mnadjra seen from the entrance illuminating the southern orthostat.

2.3. *Liz Henty, 'Recumbent Stone Circles: review of archaeoastronomical theory based on fieldwork conducted at three sites'*

Henty's project reviewed archaeoastronomical theory pertaining to the megalithic recumbent stone circles (RSCs) of northeast Scotland. It included a detailed study of three such circles (Sunhoney, Midmar Kirk and Tomnagorn) within a close area west of Aberdeen. Previous published research into RSCs includes that by Thom (1967), Ruggles & Burl (1985) and Burl (2000). Ruggles (1999: 97–99) includes an extensive literature review, suggesting that both landscape features (orientation upon prominent landmarks) and astronomical factors (possible alignment to midsummer full moon) were significant. Burl (1969–70: 75) suggested a NE alignment to midsummer sunrise. Henty was interested in both celestial and topographical considerations. She conducted her own survey using compass and GPS and concluded that there are possible discrepancies in Thom's plans, suggesting the need for fresh surveys. (Thom's plans are all based on a 'best-fit' circle. If lines are drawn that link the stones, they all appear to be flattened circles). Henty also considered the midsummer Full Moon hypothesis. Using Stellarium planetarium software, she found that, at the sites' latitude, in midsummer the time between the moon's rising and setting is around four hours. It skims along the horizon (Fig. 5) and because the horizon altitude behind the recumbent is around 8° at both Midmar Kirk and Sunhoney, it cannot be visible (using a test date of 11 June 2006, full moon at major southern standstill).†

† This is evident in the published literature, e.g. Ruggles, *Archaeoastronomy* no. 6 (suppl. to *Journal for the History of Astronomy* 15), 1984, S74–S75. –Ed.

Figure 5. The distant horizon from the Sunhoney circle.

Figure 6. Tomnagorn: Bennachie in the distance and megalith in the foreground. The recumbent was behind Henty.

Indeed, the visible winter solstice sunset occurs some 26° south of the recumbent centre. Further research needs to be carried out to find where in the circle the astronomical events are actually visible both at midsummer and midwinter. Focusing, following Ruggles (1999: 97–99), on topographical features, Henty found alignments, not previously identified, to landscape features opposite the recumbent. At Tomnagorn, for example, the recumbent is opposite Bennachie, a locally revered landscape feature (Fig. 6). At Sunhoney and Midmar Kirk the recumbent is opposite the Barmekin of Echt, an ancient cattle-fold, which brings to mind Sims' (2006) theory that the monuments were built by cattle herders, given the dating problems in relating the cattle-fold to the megalithic circle.

3. Conclusion

The function of the MA CAA archaeoastronomy module is to train students who may have no prior experience in the basic tools of archaeoastronomy and familiarise them with the literature. At this stage of a taught MA, they are not expected to conduct original research. They are, however, expected to use their initiative in designing a suitable project, making contact with other researchers, and exploring appropriate resources. In this sense, students are expected to be able to function as autonomous learners. All students encountered a range of problems, from time limits to site access and poor weather, and part of the training is a test of their ability to navigate such difficulties and cope with problems of uncertain evidence. Such pedagogical issues could be discussed within the

European Society for Astronomy in Culture (SEAC) Education Committee. The three students whose work is reported on here showed great initiative in the design and conduct of their projects and have produced results which add to prior studies. We regard this as a good foundation for further work.

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