Observatories in ancient Britain

Last week an American research worker published the hypothesis, supported by calculation, that Stonehenge was a "computer" whereby the Megalithic builders of ancient Britain could predict movements of the Moon and even eclipses. The author discusses it in relation to his own studies of Megalithic sites

by Professor Alexander Thom

AN observer of the rising Sun at the spring equinox will see it appear almost due east. If he then watches it rise morning after morning he will see it rise more and more to the north until at midsummer, in these latitudes, it will appear in the north-east. By mid-winter it will have retreated to the south-east. This was perfectly well-known to our Megalithic forefathers some 3500 years ago: witness the dozens of sites in Britain where alignments of stones pointing to the rising and setting points at the solstices still exist. In Figure 1, showing the site at Loanhead Daviot, in Aberdeenshire, the direction of of the rising midsummer Sun is indicated by the line through the major axis of an ellipse and the direction at midwinter is shown by the two outliers B and C as viewed from the main centre. In other sites, it is the line joining two circles, and, in others again, a line of upright stones. At Clava Cairns near Inverness all four points are shown. There is no need to labour the point: the examples are so numerous as to put the matter beyond all doubt.

The position regarding the equinoxes is more complicated. Megalithic man had no theodolite so he could not geometrically establish the point where the Sun rose when the Sun had zero declination. But he could measure time in days. He set a mark in the east in such a position that, having seen the Sun rise over it in the spring, exactly half a year elapsed before it set again over it in the autumn. We know this because, as I have shown elsewhere, the Sun on these two days had a declination of $+0.6°$, and we find alignments indicating the rising of a body with just this declination. For this, Megalithic man had to split the year exactly in two equal parts and so had to be able to count days. Thus he had some kind of arithmetic—how advanced we do not yet know.

What other knowledge had he? In my article "Megalithic geometry in standing stones" (*New Scientist*, Vol. 21, p. 690), I explained that, beyond doubt, they possessed and used an accurate unit of length (2.72 ft). This "Megalithic yard" (MY) evidently lingered in Spain as the Vara and then went to South America where, I have been told, it still exists. They sometimes halved this unit, as they halved their larger unit of 5 MY (13.6 ft). They liked all the dimensions of their constructions to be multiples of these fundamental units and showed great ingenuity in attaining this end. Look, for example, at the setting out of the ring Moel Ty Uchca in Wales (Figure 2*a*). The geometrical construction used is explained in Figure 2*b*, where it is also shown that they succeeded in getting the main radii as integers and, *at the same time*, the long radii almost exactly $13\frac{1}{2}$ MY. They were not so successful with the periphery as in the

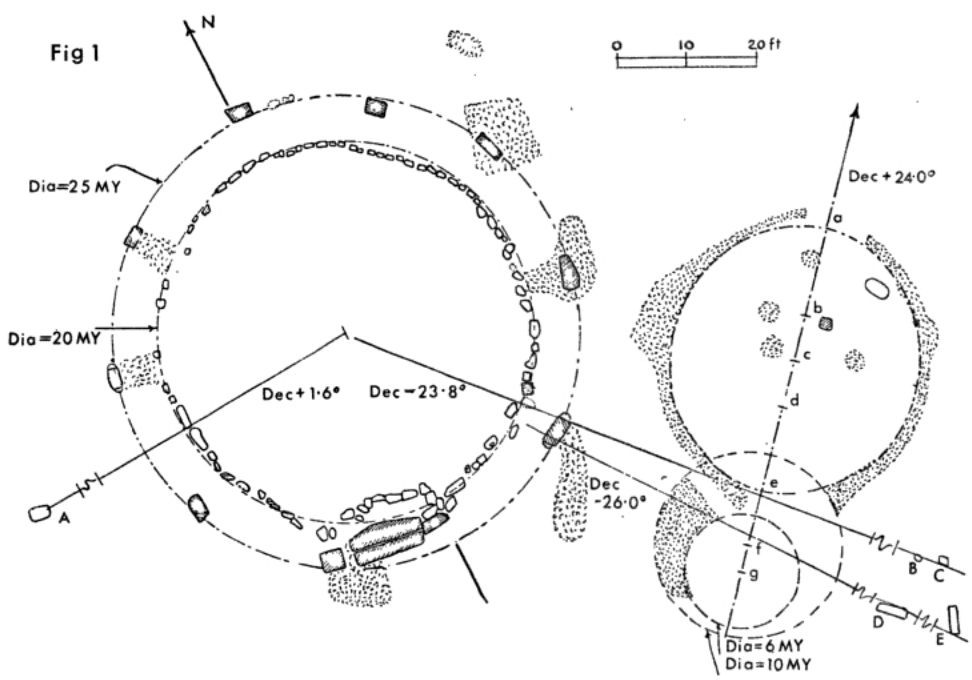

FIGURE 1. *The Megalithic site Loanhead Daviot. The outliers* B *and* C *(respectively 114.0 and 117.2 feet distant) indicate the direction of midwinter sunrise. The major axis of the ellipse* (ea) *gives a direction of midsummer sunrise.* (*The distances* ac *and* ce *are* s *Megalithic yards,* bc *and* cd *are* $2\frac{1}{2}$, ef *is 10 and* fg *is* $1\frac{1}{2}$ *MY.*)

Observatories in ancient Britain *continued*

ellipse at the Sands of Forvie, described in my previous article, but after all 42.85 MY is, in the circumstances, a remarkably good approximation to 42.5.

Possessing a knowledge of geometry, arithmetic and astronomy these people would inevitably have been attracted by lunar phenomena and eclipses. The Moon is much more irregular in its movements than the Sun. Its orbit plane is inclined at some 5° to the ecliptic—which is the plane of the Earth's orbit and so, viewed from the Earth, is the apparent path of the Sun among the stars. The line of intersection of these two planes (the line of nodes) gradually rotates completing a circuit in about $18\frac{2}{3}$ years (strictly, 18.61 years). So, as the Moon goes round the Earth it is sometimes seen north of the part of the Sun and sometimes to the south. It can therefore rise further north than the Sun at midsummer and it can set further south.

Let us think only about a particular time of year, say midwinter, or rather the Full Moon which occurs nearest to midwinter and let us decide to watchc this Moon rise year after year. It will be found—in fact it follows from what has been said above—that this Moon's rising point will gradually move north and then move south, going through a cycle in 18 or 19 years.

I think that there can be no doubt that Megalithic man observed and recorded this in stone. There are several lines in Britain, apart from those at Stonehenge, giving the extreme rising or setting point of the Moon—one was pointed out by Sommerville early this century. One, which I found recently (the Communion Stones in Dumfriesshire) appears to have a "backsight" consisting of four rows of stones. It is just possible that the observer moved along the rows year by year as the Moon neared its climax, using always the same foresight—a stone on a hilltop. It may be that this site gives the right declination by chance, but it made me think about the 18 rows of stones in the main sector in the mysterious site at Mid Clyth in Caithness, already described in the *Mathematical Gazette*. Perhaps the observer moved along a different row in each year of the cycle. Possibly the centre *g* of the Loanhead Daviot site (Figure 1) shows, from the main centre, the most southerly setting point of the midsummer Moon.

These are speculative guesses, but now Professor Gerald S. Hawkins has come into the open with the hypothesis that Stonehenge was a very advanced type of lunar observatory (*Nature*, Vol. 202 p. 125). To understand his ideas we must remember that at midwinter, with which we shall continue to deal, when the Sun is at its lowest declination the Full Moon being of necessity opposite the Sun is at, or near, its greatest declination. Now the Heel Stone at Stonehenge shows the rising points of the midsummer Sun and, when the Moon happens to be on the ecliptic at midwinter full Moon, the Heel stone will also show the moonrise point. But the moon is only on the ecliptic when it passes through one of the nodes either coming north or going south and this will happen about every nine years.

An eclipse can only happen when the Sun, Earth and Moon are in line; and since the Sun stays on the ecliptic eclipses can only happen when the Moon is also on the ecliptic, for example when, at midwinter, it rises over the Heel stone. We have seen how the midwinter Moon can rise a few degrees north or a few degrees south of the rising point of the midsummer Sun. These extreme positions are shown by stones D and F (Figure 3). These things are incontrovertible but Professor Hawkins goes a good deal further. A particular configuration of the Sun and the Moon can only repeat itself when the Sun has gone through an integral number of revolutions (years) *and* when the lines of nodes of gone through an integral number of revolutions (each $18\frac{2}{3}$ years). We get this roughly after 18 or 19 years, but much more exactly after 56 years because $18\frac{2}{3}$ x 3 is 56. There are 56 holes in the Aubrey ring at Stonehenge and Hawkins points out how the ring could be used as a computer to predict eclipses.

Starting at an arbitrary date, 1610 BC, which was presumably an eclipse year, place six marker stones round the ring as shown in Figure 3. These are spaced 9, 9, 10, 9, 9, and 10 so the alternate stones a, b and c are spaced 18, 19 and 19. Now every year lift the stones and advance each one hole clockwise. After 9 years stone **x** will have got to the Heel stone position and the moon at midwinter will again

Fig 2a

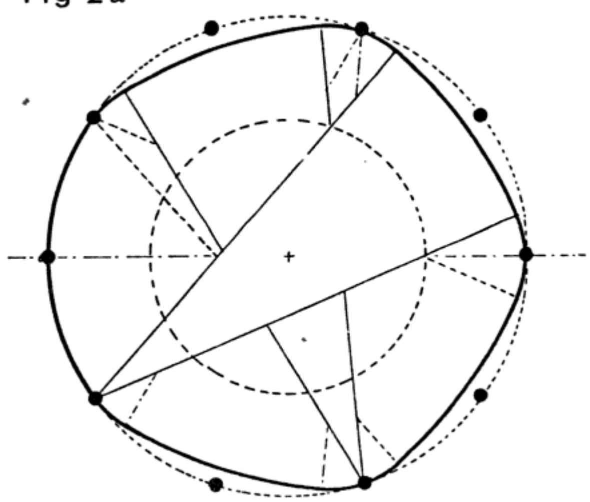

Fig 2b

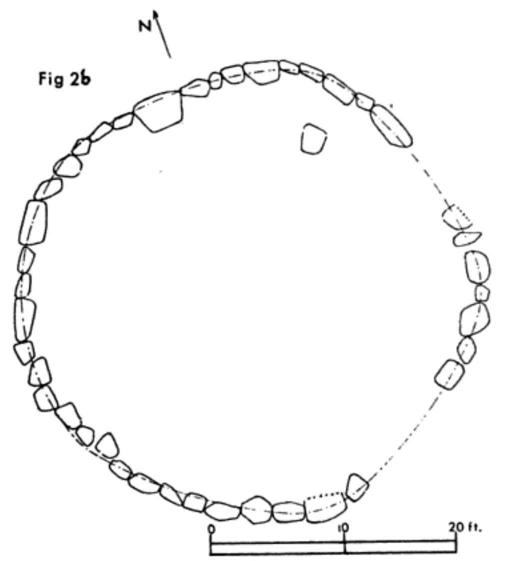

FIGURE 2. *Megalithic geometry exhibhited by the ring Moel Ty Ucha in Wales* (a). *The geometrical construction is indicated in* (b). *Set out outer circle with radius 7 MY. Divide this circle into ten equal arcs. Set out inner circle with radius 4 MY. Draw the five "corner" arcs with centres on the inner circle. Draw the four flat arcs with centres on the large circle. The radius of these arcs wilrl be found to be $13\frac{1}{2}$ MY. The periphery is 42.85 MY.*

Fig 3

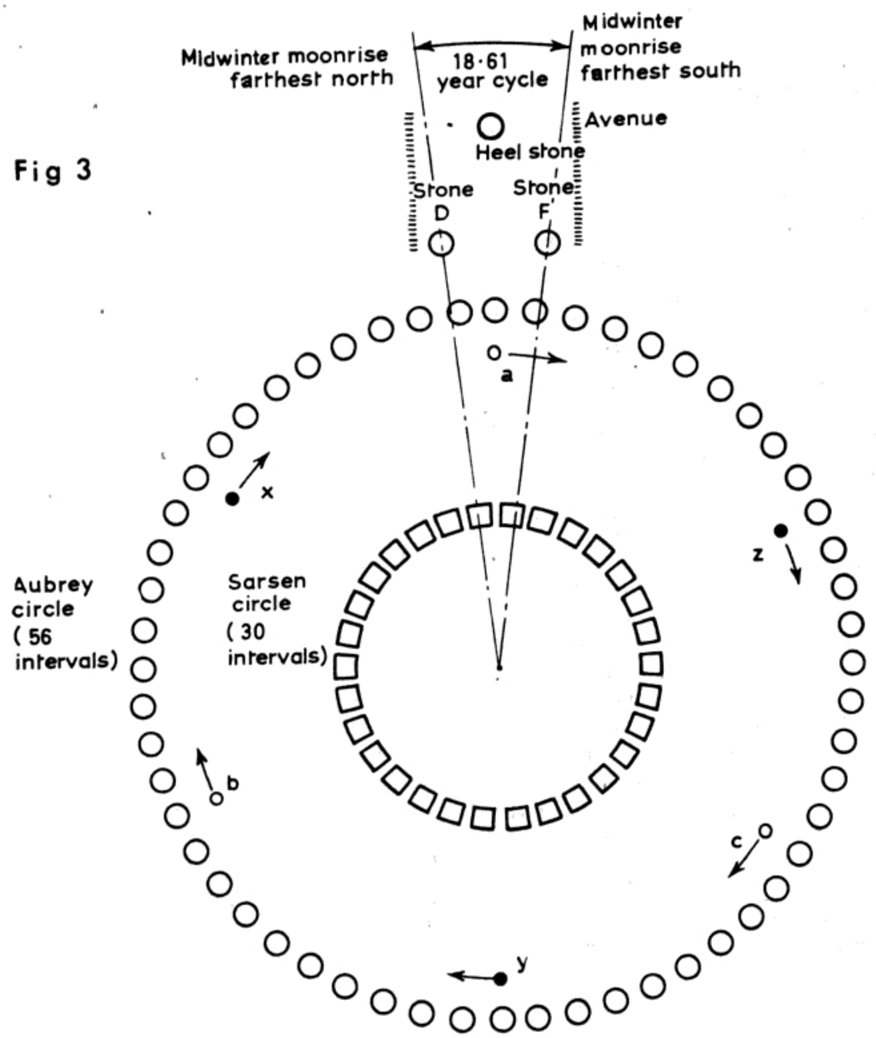

FIGURE 3. *Stonehenge as a lunar observatory. In the opinion of Professor G. S. Hawkins the 56 Aubrey holes surrounding the stone circle at Stonehenge correspond closely to three times 18.61 years—18.61 years being the mean period during which midwinter moonrise oscillated between its two extreme positions as marked by stones* d *and* f. *By moving sets of marker stones* (a, b, c *and* x, y, z) *forward by one hole each year one can, Professor Hawkins argues, keep track of the Moon's motion. The arrival of a marker stone at a particular position in the circle would signal positions for winter moonrise, or when eclipses were likely. In Professor Hawkins' hypothesis the Sarsen circle gave 30 intervals corresponding to the days of the lunar cycle (actually 29.53 days, average).*

be on the ecliptic. After 18 years stone *b* will be at the Heel stone—and so on indefinitely. The alternate stones show complete revolutions of the line of nodes.

An eclipse at midwinter can only occur in a year when one of the stones is at the Heel stone. Professor Hawkins has had elaborate computer calculations made showing that the 9, 9, 10 spacing used as above will predict eclipses correctly indefinitely provided a small adjustment is made every 300 years. He also shows how, by moving the same kind of marker round the 30-stone Sarsen ring one interval per day, a prediction can be obtained showing which Full Moon will be nearest to the solstice.

That Megalithic man used Stonehenge in the manner suggested may be hypothetical, but great support is given by the writings of Diodorus about 50 BC. I append a translation by D. L. Stockton. There is a possibility that, by a study of the surveys of the many other large sites in Britain, we may be able to find independent confirmation. This in contingent on securing publication in a suitable form, of the many surveys that already exist, so that they are available to all workers in the field. At present there is a shortage of funds for this purpose.

Diodorus of Sicily: **History,** Book II chapter 47.
D. L. Stockton translates:—
Since we have thought the northern parts of Asia worth describing, we consider it not inappropriate to set out the tales which are told about the Hyperboreans. Of those who have recorded the old tales, Hecataeus and some others say that in the Ocean opposite France there is an island no less in size than Siciliy. This island (they say) lies to the north, and is inhabited by people called Hyperboreans, so named because they live beyond the (starting-point of) the north wind [hyper + boreas gives *Hyperboreans*: D.L.S.].

The soil of this island is excellent and bounteous, and so remarkably fertile that it produces two harvests each year. The story is told that it was the birthplace of Lato [mother of Apollo and Diana/Artemis: D.L.S.], wherefore Apollo is held highest in honour there of all the gods . . .

There is also in the island a magnificent precinct of Apollo, and a wonderful temple adorned with many dedications, and circular in shape. And there is a city sacred to this god: the majority of its inhabitants are bards [literally: "Lyre-players": D.L S.], and they are forever singing hymns, with harp accompaniment, in the temple to the god, celebrating his deeds. . . . And they say that the Moon as seen from this island appears to be only a very little way from the Earth, and that one can distinctly perceive variations in the level of the terrain.

It is also reported that the god [this must be Apollo, not the Moon, since the noun in Greek is masculine: D.L.S.] visits the island every 19 years, this being the period at the end of which the stars in their revolutions return to their starting point. And it is for this reason that this cycle of 19 years is called by the Greeks the Great Cycle (or the Cycle of Meton). And during this visitation the god plays on the harp and dances every night without break from the vernal equinox to the rising of the Pleiads, taking delight in all that is done to do him honour. The rule of this city and the charge of the precinct is in the hands of the family of the Boreadae, the descendants of Boreas, and this authority is handed down among them from generation to generation.