*JHA* ii (1971), 147–160

# THE ASTRONOMICAL SIGNIFICANCE OF THE LARGE CARNAC MENHIRS

A. THOM and A. S. THOM

We find in Britain many indications that in Megalithic times the Sun, Moon and stars were carefully observed at rising or setting. Probably no great accuracy was needed for stellar observations where the object was to identify the star so that the time of night could be estimated. But when we examine the solar and lunar sites we find that at many places the arrangements are such that declination differences of a minute of arc or less could have been detected. The method of observing was to make use of a small clean-cut distant mark, natural or artificial, on the horizon. As the limb of the Sun (or Moon) slid past the mark the observer moved into such a position that exact coincidence was obtained. The position was marked and the observation repeated next day.

An observing site of sufficient width was essential, especially for the Moon, for which a range of declination of over half a degree might be needed. At one site in Scotland (Kintraw) a platform had to be cut in the steep hillside, and here E. W. MacKie has recently uncovered the observing floor.

Perhaps exact lunar observations were made for scientific reasons, but it seems more likely that the object was to assist in the prediction of eclipses. The node of the lunar orbit revolves in 18·6 years, and so once in this period the monthly maximum in the lunar declination can attain an extreme value of $(\epsilon+i)$, falling 9·3 years later to $(\epsilon-i)$. We shall call these times the major and minor lunar standstills. Here $\epsilon$ is the obliquity of the ecliptic, and $i$ the inclination of the lunar orbit. While the mean value of $i$ remains constant for thousands of years, its actual value is subject to small fluctuations with a predominant term of amplitude $\Delta=8'{\cdot}7$ and period 173·3 days, *i.e.* half an eclipse 'year'. Eclipses can happen only when this perturbation is at or near a maximum.

It is only at or near the standstills that Megalithic Man could have made recordable observations of the declination changes produced by $\Delta$, and in fact in Britain we find observatories which show the positions for both $(\epsilon+i)$ and $(\epsilon+i+\Delta)$. Some places have foresights for both the positive and negative values of $(\epsilon+i)$ or of $(\epsilon-i)$; sometimes for both limbs. Often we find the backsights marked by tall single menhirs and occasionally by an alignment directed to the foresight.

Only occasionally, however, would the monthly declination maximum have coincided with the time of rising or setting, and so some method of extrapolating from the observed positions found on two successive nights, one before and one after the maximum, was necessary to obtain on the ground the extreme point for that lunation. It is believed that the stone sectors which we find in Caithness were designed for finding quickly the necessary extrapolation movement. Should sufficient evidence be forthcoming to establish this beyond reasonable doubt, then we must completely revise our ideas about Megalithic Man's ability to handle recondite problems. A full exposition will be found in *Megalithic lunar observatories*.[1]

| Line | Distance ft | Azimuth | Assumed Levels Eye m | Far Menhir m |
|---|---|---|---|---|
| $S$ to $M$ | 2651 | 233°42′ | 24 | 29 |
| $S$ to $K$ | 1463 | 223°08′ | 24 | 27 |
| $L$ to $M$ | 8760 | 63°31′ | 18 | 29 |
| $K$ to $M$ | 1246 | 246°37′ | 28·5 | 29 |

TABLE 1. Relative positions of the four menhirs.

In Brittany, especially around Carnac, we find today a greater concentration of Megalithic remains than anywhere else, and these have recently been surveyed by the authors and their colleagues. Unfortunately, the destruction has been correspondingly great, and amongst the thousands of menhirs left it is difficult to find a single stone which is *without doubt* in its original position. Many are marked with a square red plug showing re-erection but with the others we are left guessing.

This uncertainty made it necessary for us to apply modern statistical analysis to uncover the original layout of the main Carnac alignments, and this will form the subject of a second paper. This analysis of our large-scale survey enabled us to discover in detail the original geometrical design of Le Ménec indicated in skeleton form on pp. 152–3 in Figure 1 (which also contains in outline the Kermario and Kerlescan rows). The cromlechs which almost certainly existed at the ends of the Kermario section have been destroyed. It is to be regretted that a car park has been made over the site of the west cromlech; surely careful excavation would have revealed something here.

The accuracy and complexity of the geometrical designs shown up by this analysis makes one suspect that the object was to provide a geometrical solution to some astronomical problem as yet unformulated by us. That this was probably in connexion with the Moon is indicated by the huge lunar observatory centred on the greatest menhir in Europe, Er Grah or Le Grand Menhir Brisé, which lies broken in four parts near Locmariaquer. Another clue comes from the four large menhirs which stand to the north of the main alignments. A detailed study of these will now be reported.

*Four Menhirs near the Alignments*

The positions of these impressive stones are shown in Figure 1. The three marked $L$, $M$ and $K$ are well known, but the smaller eastern menhir $S$ is not often visited. It lies on the bridle path along the edge of the wood almost hidden by undergrowth. It is about 9 ft high, square in section (3 ft × 3 ft) with sides orientated roughly NW and SW. Today trees and huge banks of gorse and scrub make it impossible to see from any one of these stones to any of the others, but the 20 ft menhir $M$ at Le Manio is on high ground and would in the absence of vegetation be seen from all round. The menhir $L$ is in a hollow and surrounded by impenetrable hedges of gorse up to 15 ft high. We succeeded in taking a few spot levels which showed that the line to $M$ just cleared the ground at the critical position near $L$.

A careful traverse was made connecting the four menhirs. The nature of the

| Line | Azimuth | Altitude | Declination | Compare |
|---|---|---|---|---|
| *S* to *M* | 233°42′ | +21′ | −23°38′ | $(\varepsilon - s) = 23°38'$ |
| *S* to *K* | 223°08′ | +23′ | −28°46′ | $(\varepsilon + i - s) = 28°47'$ |
| *L* to *M* | 63°31′ | +14′ | +18°00′ | |
| *K* to *M* | 246°37′ | +4′ | −15°54′ | Sun upper limb at Martinmas/Candlemas = −16°00′ |

TABLE 2. Declinations shown by the four menhirs.

ground made it necessary for this traverse to have 44 sides and, as some of these were necessarily rather short, frequent checks on azimuth were made by solar observations. The results are given in Table 1. Time did not permit the differences in level being determined; these had to be estimated from the contours on the new 1 : 25 000 maps and so may be in error by a metre or more. The corresponding declinations are given in Table 2 together with possible explanations. It appears that we have one line for the winter solstitial setting Sun, one lunar line and a probable calendar line. The ideal declination of the Sun at the beginning of the 10th and 14th month of the Megalithic calendar has been shown to be −16°·26.[2] When we apply *s*, the Sun's semidiameter, we see that this is almost exactly the declination found for *KM*. The declination found from the longest line *LM* will be discussed later.

The presence of these large menhirs ranged alongside the alignments and giving solar and lunar declinations suggests that the alignments themselves played some part in the observations or in their reduction.[3] This inference is greatly strengthened by an examination of the lunar observations made possible by the erection of the biggest menhir of all, Er Grah, to which we now turn.

*Er Grah, or The Stone of the Fairies*

This stone, sometimes known as Le Grand Menhir Brisé, is now broken in four pieces which when measured show that the total length must have been at least 67 ft. From its cubic content it is estimated to weigh over 340 tons. Hülle[4] thinks it came from the Côte Sauvage on the west coast of the Quiberon Peninsula. His suggestion that it was brought round by sea takes no account of the fact that the sea level relative to this coast was definitely lower in Megalithic times; neither does he take account of the fact that a raft of solid timber about 100×50×4 ft would be necessary—with the menhir submerged. It is not clear how such a raft could be controlled or indeed moved in the tidal waters round the Peninsula. Assuming that the stone came by land, a prepared track (? of timber) must have been made for the large rollers necessary and a pull of perhaps 50 tons applied (how?) on the level, unless indeed the rollers were rotated by levers. It took perhaps decades of work and yet there it lies, a mute reminder of the skill, energy and determination of the engineers who erected it more than three thousand years ago. Its commanding position on a peninsula in the Bay of Quiberon is shown in Figure 2.

In Britain we find that the tallest stones are usually lunar backsights, but there seems no need to use a stone of this size as a backsight. If, on the other hand, it was a foresight, the reason for its position and height becomes clear, especially if

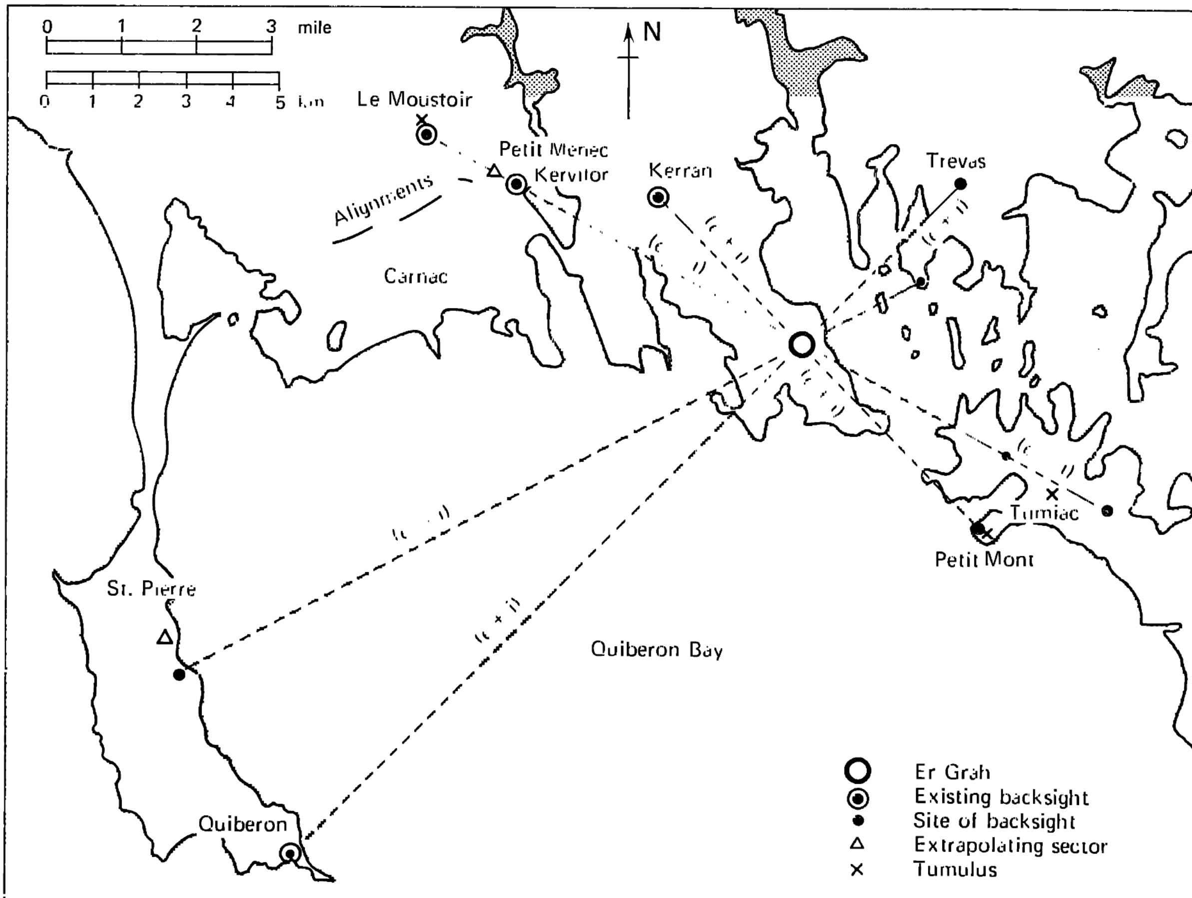



FIG. 2. Er Grah as a universal lunar foresight.

it was intended as a universal foresight to be used from several directions. There are eight main values to consider, corresponding to the rising and setting of the Moon at the standstills when the declination was $\pm(\epsilon \pm i)$. A preliminary examination has been made of all eight lines (Figure 2).

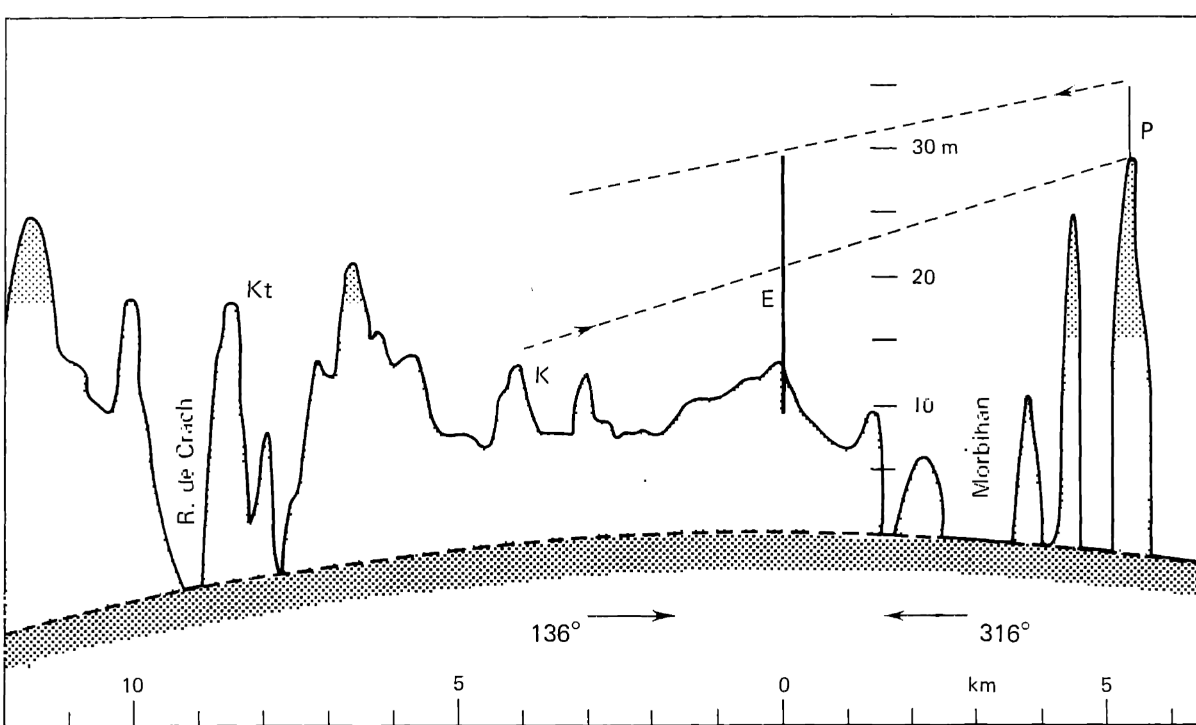
The first step was to construct, from the map contours, a profile of the ground along each line. Four of these are shown in Figures 3 and 4, in which the line of zero height is shown curved to the mean curvature of the Earth's surface decreased by the curvature of the refracted ray. This arrangement allows a line of sight to be represented by a straight line. We can thus assess the possibility that Er Grah was, in its upright position, visible from any point under consideration. It also makes it easy to see which positions are so high that Er Grah would appear below the horizon *behind.*

Since Er Grah now lies flat there is no possibility of seeing it directly, except from the SW. But there is a new water tower not very far away, and this is visible from all round. Accordingly, the next step was to determine the exact coordinates of the tower, relative to Er Grah. In the absence of any definite information regarding the exact spot where the stone originally stood, we measured from the *centre of the extreme north-west end* as it lies. We ran a traverse along the road so that the water tower could be sighted from several points sufficiently far apart, and so found that the centre of the tower lies 629 m distant at an azimuth of 335°15′. With this information anyone obtaining an azimuth from a suspected backsight to the tower can find the azimuth to Er Grah. For altitude, the top of the edge of the tower is 27 m above the ground under the north end of Er Grah.

We shall now consider each of the 8 possible lines on which Er Grah could have been used as a foresight (see Figure 2).

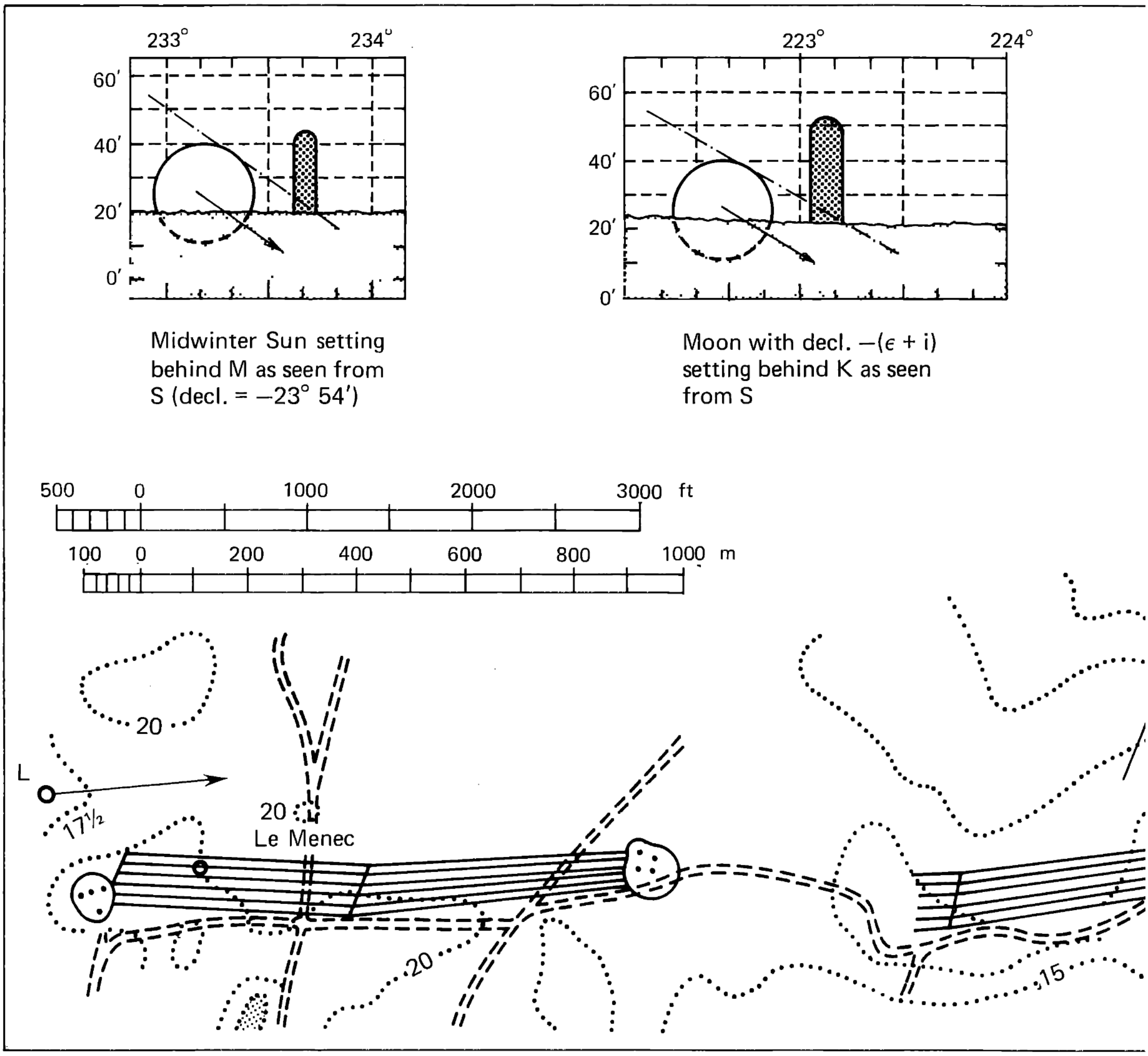
*The Line for* $-(\epsilon+i)$

Between the road junction at Le Chat Noir and Kerran there is a dolmen. Some 80 ft WSW from the dolmen there is a small menhir leaning over at about 45°. By careful solar observations, the azimuth of the water tower from this stone was found to be 132°52′·4. It follows that the azimuth of Er Grah is 116°13′·3. On the map this line beyond Er Grah seems to pass just to the left of the tumulus on Petit Mont (Figures 2 and 3) where the ground level is perhaps 31 m. Taking eye level as 16·5 m, we estimate the altitude to be 3′. Applying




Kt Kergoet K Kerran E Er Grah P Petit Mont

FIG. 3. Profile along line at azimuth = 136° for declination $= \pm (\epsilon + i)$, Earth's curvature being decreased by curvature of refracted ray.




A Menhir on Tumulus, to Er Grah decl. $= -(\epsilon - i - s)$

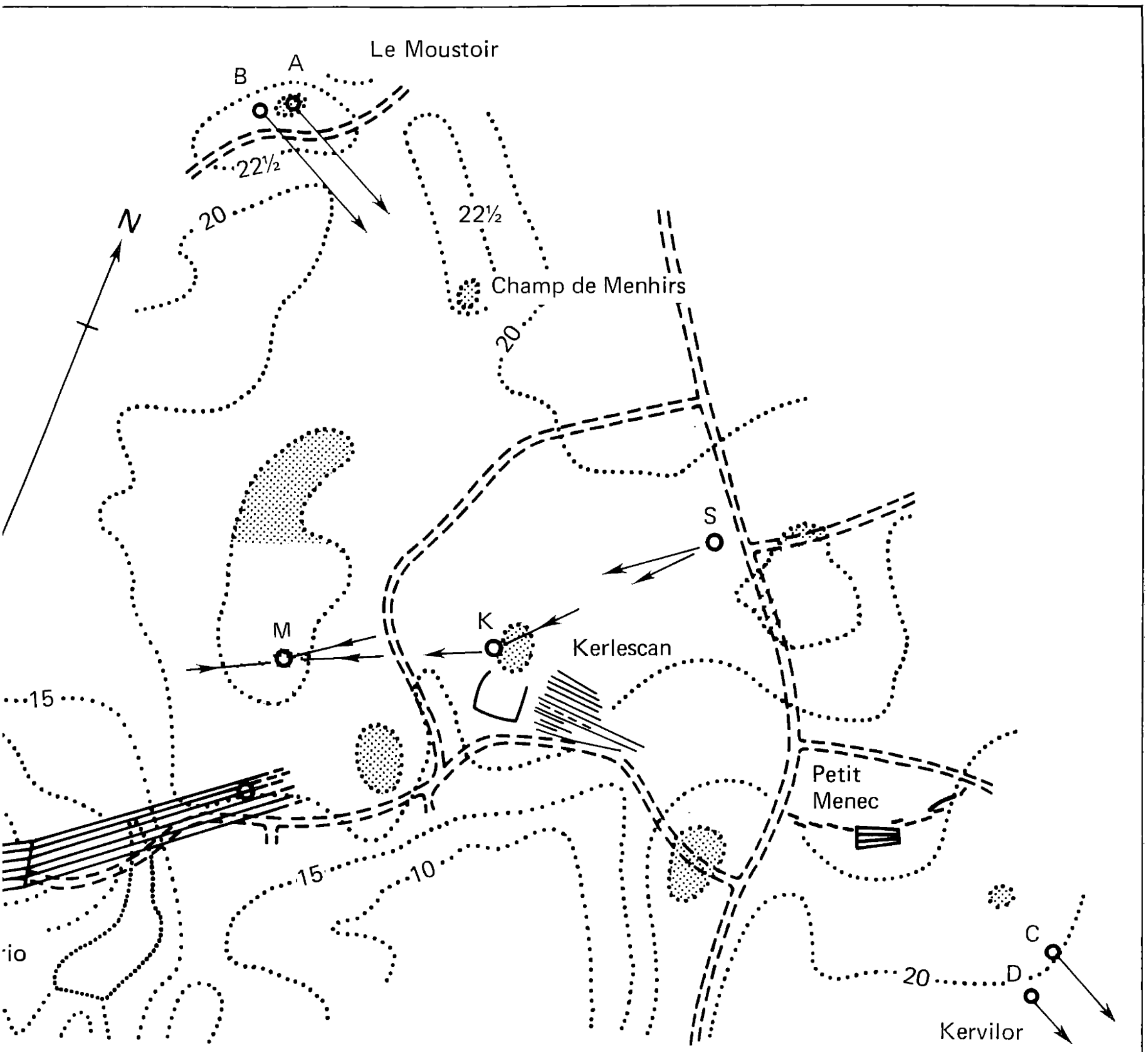
B Menhir beside Tumulus, to Er Grah decl. $= -(\epsilon - i - s - \Delta)$

C Stone 2 ft high, to Er Grah decl. $= -(\epsilon - i + s - \Delta)$

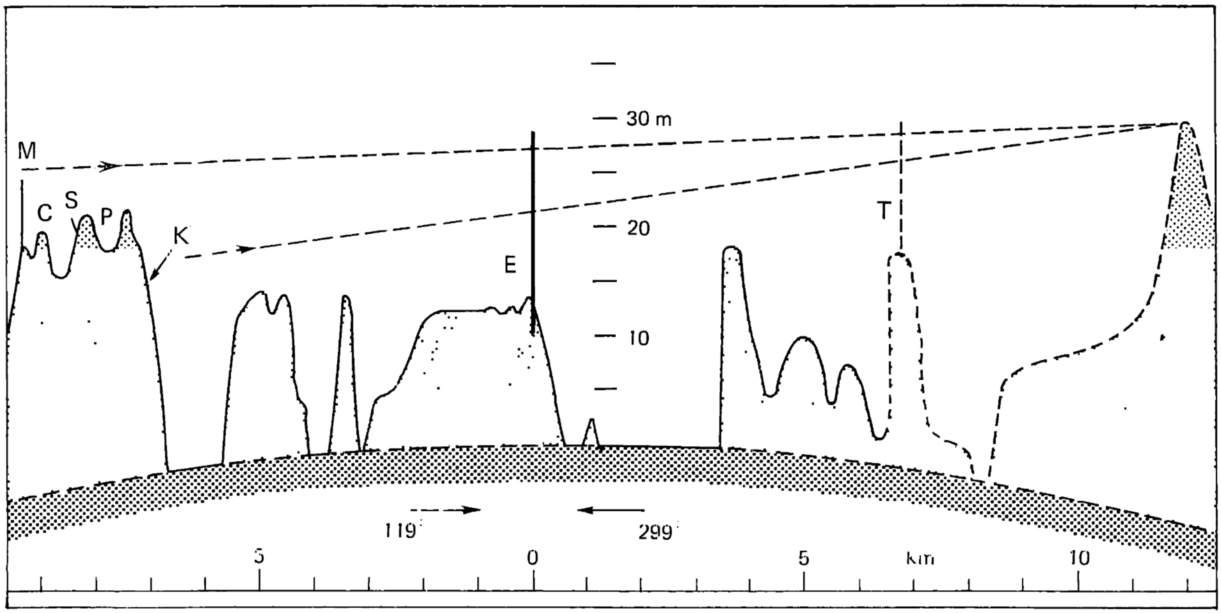
D Fallen stone, to Er Grah decl. $= -(\epsilon - i - s)$

(Ground above 25 m is shown shaded.)

FIG. 1. Alignments and menhirs near Carnac.




K Menhir 12 ft high
L Menhir 12 ft high, to M lunar decl. = +18°00′
M Menhir 20 ft high (Le Manio)
S Menhir 9 ft high




M Tumulus, Le Moustoir C Champ de Menhirs S Menhir (see Fig. 1)
P Petit Ménec K Kervilor E Er Grah T Tumulus, Tumiac (off line)

FIG. 4. Profile along line at azimuth = 119° for declination $= \pm (\epsilon - i)$, Earth's curvature being decreased by curvature of refracted ray.

mean parallax, 57′, we find the declination to be −28°46′. It has been shown[5] that *i*, the inclination of the lunar orbit, had the same value in Megalithic times as today, namely 5°08′·7, and so, if we assume that the upper limb was being observed, we find that the corresponding value of the obliquity of the ecliptic is about 23°53′ (as in 1580 B.C.).

Before we try to read too much into this result the azimuth ought to be checked by direct measurement to a pole erected at Er Grah, and somehow or other the horizon altitude should be measured. Bear in mind that, in the absence of a series of determinations at the site, refraction is uncertain by perhaps 1′. To show the importance of obtaining these measurements, let us assume that the above values are correct. Then either Er Grah is later than might be expected, or it stood 3 or 4 metres further to the SW than the present position of its NW end. Local people have expressed the idea, apparently based on some digging, that the large end (*i.e.* the NW end) was uppermost, and the small end in the ground. This would raise the declination by some 8′ so that one would have to think of the Kerran stone as showing $-(\epsilon+i-s-\Delta)$ instead of $-(\epsilon+i-s)$, where $s$ is the semidiameter.

The declination from the Kerran dolmen is 8′ or 9′ lower than that from the stone. As the dolmen may be much older than Er Grah, the fact that this is exactly the value of the perturbation can only be accidental, unless indeed this site was one of the controlling points fixing the position of Er Grah. The fact remains that we have, at Kerran, backsights which show very closely declinations of $-(\epsilon+i)$ and $-(\epsilon+i+\Delta)$.

*The Line for* $-(\epsilon - i)$

There are several places on this line (Figure 2) which seem possible. On the top of the tumulus at Le Moustoir there is a re-erected menhir, and working as carefully as possible from the grid coordinates on the 1 : 25000 map we find that the azimuth of Er Grah from here is $118°31' \pm 4'$. The altitude of the distant high ground is probably about $-3'$ and so the declination of Er Grah from this menhir is $-18°33' \pm 3'$, which is not far from $-(\epsilon - i - s)$.

The side movement possible on the top of the tumulus is about 10 m to the left from the menhir and 65 m to the right, and so there would at the 'standstill' always be one night when the Moon's upper limb could be seen momentarily as it rose behind Er Grah in the same way as it shows setting behind *K* in the inset in Figure 1.

The ground in front of the tumulus appears (Figure 4) to be too low, but an examination of the contours in Figure 1 shows that from the menhir near the SW end of the tumulus the sight line seems to clear the high ground. The estimated declination is $-18°18' \pm 3'$ which is only marginally higher than $-(\epsilon - i - s - \Delta)$.

Partly because of the lower value of the rate of change of declination with azimuth and partly because of the greater distance, the effect of an erroneous assumption regarding the exact position of Er Grah has much less effect on the declination at Le Moustoir than at Kerran. Nevertheless, it will be important for later investigators to run an accurate traverse from Le Moustoir to Er Grah, but

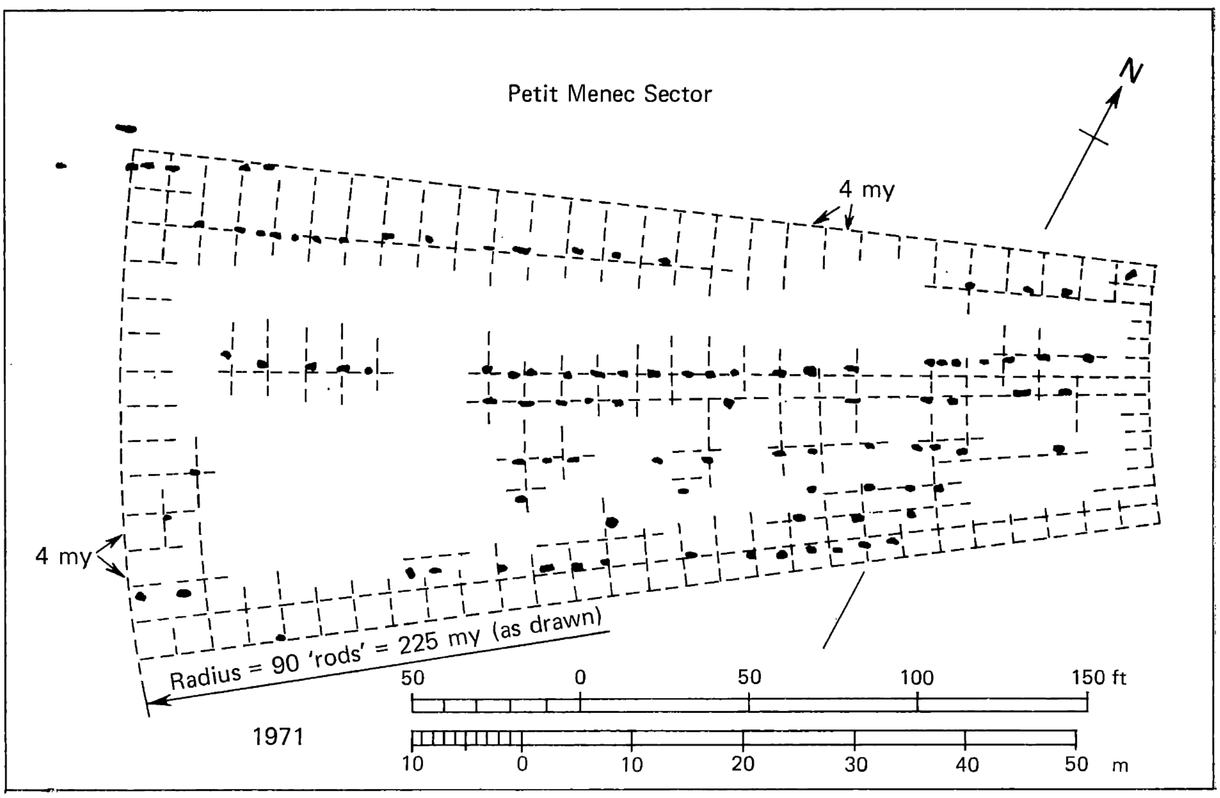



FIG. 5. Part of the site at Petit Ménec.

because of the woods this will not be easy. A simpler method might be to do as we did at Kervilor and run a traverse to some point from which the water tower is visible.

On the high ground behind the farm of Kervilor it was possible to find a spot from which the water tower was visible through a gap in the trees. Careful solar observations were made from here and a traverse run to the dolmen which is completely hidden in the gorse hedge and to two small stones *C* and *D* (Figure 1) near which the dolmen lies. The stone *C* is just through the gate between the rough rocky ground and the top field. It is an unimpressive stone, two or more feet high, and might be described as a boulder on edge. The lower stone (*D*) is a thick slab lying on the side of the lane running below the rough patch. The azimuths, altitudes and declinations of Er Grah as seen from these stones are:

| | | | | |
|---|---|---|---|---|
| *C* | Az. 119°08′ | Alt. −1′·0 | Decl. = −18°53′ | $(\epsilon - i + s - \Delta) = 18°52'$ |
| *D* | 118°27′ | −0′·3 | = −18°27′ | $(\epsilon - i - s) = 18°29'$ |

It may well be by chance that these stones lie so near to the ideal positions, but there is another possibility; perhaps the observing platform was on the relatively flat stretch (now cultivated) at the top of the hill. The distances between the nightly observed positions could then be taken to the sector at Petit Ménec (Figure 5) so that the extrapolation distance could be determined.

Let us assume that the Petit Menec sector was used for both Le Moustoir and Kervilor. It has been shown[6] that the width of the base and the height of the sector needed for extrapolation should be at least *G*, where *G* is the distance which the observers' (imaginary) position would move in the first half lunar day after the declination maximum. The ideal radius of the base is 4*G*. At the minor standstill $G = 12{\cdot}2 D \frac{dA}{d\delta}$, where *G* is in feet and *D* is the distance to the foresight in miles, *A* is the azimuth and $\delta$ is the declination. We find *G* for Le Moustoir to be about 114 ft and for Kervilor about 94 ft, assuming the line of movement to be at right angles to the sight line. An accurate survey of the Petit Ménec sector is shown in Figure 5. When the rows are analysed by the method to be described for Le Ménec in a later paper it is found that a quantum of 4 megalithic yards emerges with a probability level of about 4%. Further, each row has the statistical 'nodes' lying on the arcs shown. It is not possible to determine the exact radius, but it cannot be far from 600 ft which is 33% greater than the ideal for Le Moustoir and 58% too big for Kervilor. It has been shown[7] that an error in 4*G* of 33% is tolerable, so perhaps the whole sector was considered as being suitable for Le Moustoir. For Kervilor perhaps the eastern or narrower end was used. This would explain the long narrow shape of the sector, otherwise inexplicable because the length of sector required is only equal to the base width. Another possibility is that the Kervilor lengths were increased by 50% before being taken to the Petit Menec sector.

Perhaps both of these methods were tried, but one thing is certain: that, without some method of approximate extrapolation, an observatory of the kind we are postulating would be quite useless.

### *The Line for* $+(\epsilon - i)$

The observing site for declination $+(\epsilon - i)$ must have been between Rohu and the sea about a kilometre south from St Pierre. It could not have been much

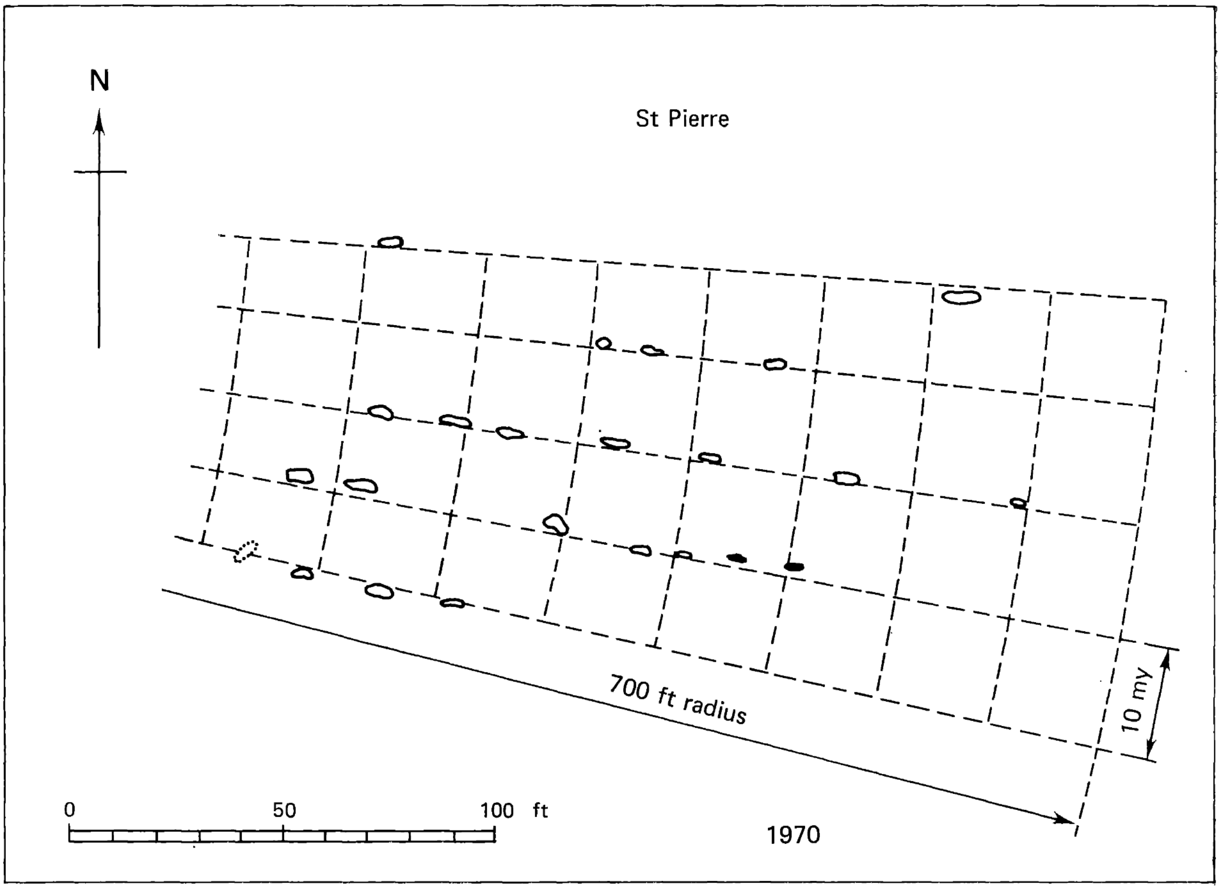



FIG. 6. The sector at St Pierre.

above the 10 m contour, or Er Grah would have appeared below the distant hills. The area is now occupied largely by gardens, houses, etc. and no trace of stones has so far been found. But in St Pierre there is a part of a sector (Figure 6) of which there is enough left to fix the radius as being about 700 ft, which is very close to the theoretical value for this site, namely $4G = 720$ ft.

*The Line for* $+(\epsilon+i)$

The observing site here was at the end of the main Quiberon peninsula. Near it is the impressive menhir called Goulvarh which is orientated in the required direction NE–SW. Off the north end of Belle Isle there is a reef now submerged, but which would have been an island in Megalithic times. As seen from Goulvarh the Sun at the winter solstice set over the reef and there may have been a clearly defined projection to use as a foresight. However, with the theodolite placed at Goulvarh, a number of accurate azimuth sets was taken to the Sun and Venus. A lamp placed on the higher part of Er Grah (15·4 km distant) then enabled the azimuth of the line joining the stones to be found (46°02′). With a hill horizon altitude of 2′ this gives a declination of 28°20′, which is about 42′ below $(\epsilon+i)$. It is interesting to note that the stone $L$ at Le

Ménec shows exactly the same deficiency when used with the stone $M$, and the stone $S$ at Temple Wood in Scotland shows 35′ deficiency.[8] The method of using these stones is not yet clear.[9]

We ran a traverse from Goulvarh to another menhir near the shore road and so found that this stone, as it stands today, is 622 ft from Goulvarh at an azimuth of 155°30′. It is orientated correctly, but it is set in concrete in a garden and may well have been moved there when the road was built. With Er Grah the declination is 28°43′ which is 4′ less than $(\epsilon+i-s)$. This menhir is some 6–8 m above the sea level which means that only the tip of Er Grah would have appeared above the distant hills; the original observing platform was probably lower. The ground above the rocky shore seems to be mostly sand, and so it is probably higher than it was in Megalithic times.

*The Four Lines for the Setting Moon*

No definite stone backsights have so far been found for the four positions from which the Moon was observed to *set* with declination $\pm(\epsilon\pm i)$ but the locations of the sites are fairly definite.

On the hilltop just to the west of Trevas there is a stretch of ground of sufficient width to accommodate all the necessary cases of $-(\epsilon+i\pm s\pm\Delta)$. This was checked by actual measurements to the water tower beside Er Grah. There are irregularities on the ground which do not seem natural, and may indicate that this ideal site, with Er Grah showing against the distant Belle Isle, had in fact been used.

The backsight for $-(\epsilon-i)$ may have been at Pointe de Locmiquel in what is now a cultivated field.

The line for $(\epsilon-i)$ passes over the centre of Arzon and just to the north of the huge tumulus at Tumiac. The backsights could have been either at Arzon or past the tumulus.

On the assumption that the observing site for $(\epsilon+i)$ was on the SE side of the Gulf of Morbihan, the only position providing the necessary side movement is on the high ground in front of the tumulus on Petit Mont. The gorse cover is so deep and thick that the ground could not be examined in detail.

It has now been shown that there is at least one site on each of the eight lines which has the necessary room for side movement. The results obtained at those sites where there are menhirs or stones are summarized in Table 3.

We must now try to think of how a position was found for Er Grah which would have satisfied the requirements. Increasingly careful observations of the Moon had probably been made for hundreds of years. These would have revealed unexplained anomalies due to variations in parallax and refraction, and so it may have been considered necessary to observe at the major and minor standstills at both rising and setting. At each standstill there were 10 or 12 lunations when the monthly declination maximum and minimum could be used. At each maximum or minimum, parties would be out at all possible places trying to see the Moon rise or set behind high trial poles. At night these poles would have needed torches at the tops because any other marks would not be visible until actually silhouetted on the Moon's disc. Meantime some earlier existing observatory must have been in use so that erectors could be kept informed about

| Site | Lat. | Az. | Alt. | Decl. | 'Expected' decl. |
|---|---|---|---|---|---|
| Kerran, small menhir | 47°35′·9 | 136°13′ | 3′ | −28°46′ | $-(\varepsilon+i-s) = -28°47'$ |
| Kerran, dolmen | 47°35′·9 | 136°29′ | 3′ | −28°54′ | $-(\varepsilon+i-s+\Delta) = -28°56'$ |
| Le Moustoir, menhir on dolmen | 47°36′·7 | 118°31′± | −3′ | −18°33′± | $-(\varepsilon-i-s) = -18°30'$ |
| Le Moustoir, menhir near dolmen | 47°36′·7 | 118°09′± | −2′ | −18°18′± | $-(\varepsilon-i-s-\Delta) = -18°21'$ |
| Kervilor, stone *C* | 47°35′·2 | 119°08′ | −1′ | −18°53′ | $-(\varepsilon-i+s-\Delta) = -18°52'$ |
| Kervilor, stone *D* | 47°35′·2 | 118°27′ | 0 | −18°27′ | $-(\varepsilon-i-s) = -18°30'$ |
| Quiberon, Goulvarh | 47°28′·4 | 46°02′ | 2′ | +28°20′ | $+(\varepsilon+i-s-\Delta) = +28°38'$ |
| Stone near Goulvarh | 47°28′·4 | 45°22′ | 3′ | +28°43′ | $+(\varepsilon+i-s) = +28°47'$ |

Note: The 'expected' declinations assume $\varepsilon = 23°53'\cdot 8$ (1700 B.C.), $i = 5°08'\cdot 7$, $s$ = mean semidiameter = $15'\cdot 5$, $\Delta = 8'\cdot 7$.

TABLE 3. Sites with menhirs or stones which may be backsights, to be used with Er Grah as a foresight, for lunar observations.

the kind of maximum which was being observed; they would need to know the state of the perturbation.

Then there would ensue the nine years of waiting till the next standstill when the other four sites were being sought. The magnitude of the task was enhanced by the decision to make the same foresight serve both standstills. We can understand why this was considered necessary when we think of the decades of work involved in cutting, shaping, transporting and erecting *one* suitable foresight. It is evident that whereas some of the sites, such as Quiberon, used the top of the foresight Er Grah, others, such as Kerran (Figure 3), used the lower portion. This probably militated against the use of a mound with a smaller menhir on the top. Much has rightly been written about the labour of putting Er Grah in position, but a full consideration of the labour of finding the site shows that this may have been a comparable task.

We now know that for a stone 60 ft high the siting is perfect. We do not know that all the backsights were completed. But the fact that we have not yet found any trace of a sector to the east does not prove that the eastern sites were not used because the stones may have been removed. Perhaps the extrapolation was done by the simpler triangle method or perhaps it was done at a central site like Petit Menec.

No one who sees Er Grah can fail to be impressed, or to ask the reason for its being there. Many explanations have been advanced but they all fail to account for the sheer size of the stone or indeed for its position. The explanation we have given covers both size and position.[10] In use, both the height of the top and the vertical length were needed—the top for backsights where the hills appeared behind the stone and the bottom for the nearer backsights when the horizon was lower. The reasons for the choice of the position have already been given.

It is for the reader to decide whether or not we have collected enough evidence to permit acceptance of our explanation.

*Acknowledgements*

The above surveys were made following a suggestion by Dr Glyn Daniel that we should examine the stones in Brittany. Accordingly we took expeditions to

Carnac in 1970 and 1971. The surveys were cooperative efforts on the part of a number of people: David T. Austin, Beryl Austin, J. B. Austin, M. J. Austin, A. K. D. Austin, Dr R. Colton, Dr T. R. Foord, J. M. Gorrie, G. Luff, Robert L. Merritt, Norman and Andrew L. Merritt. The projects were financed by the Lloyd Foundation, Cleveland, Ohio; by the Hulme Fund, Brasenose College; and by the British Broadcasting Corporation. For the loan of surveying instruments, etc., thanks are due to Messrs Vickers Ltd, Messrs W. F. Stanley Ltd, Mr Alister Brown and the Geography Department, University of Glasgow.

## REFERENCES

1. A. Thom, *Megalithic lunar observatories* (Oxford, 1971).
2. A. Thom, *Megalithic sites in Britain* (Oxford, 1967), 110.
3. A great many declinations can be obtained by drawing lines on the map joining the isolated menhirs scattered over the countryside, but until these lines are examined and surveyed on the ground they are valueless. Two, however, may be mentioned because both *appear* to make use of the huge stone at Le Manio ($M$) as a lunar foresight. From the menhir in the woods a kilometre SW from Le Moustoir the azimuth of $M$ is about 118°·7. With an estimated altitude of 0°·3 the consequent lunar declination is −18°·3, which may be compared with $-(\varepsilon-i-s)=-18°{\cdot}2$. Similarly, from a menhir on the map just to the east of Kerlagad the menhir $M$ shows a lunar declination close to $-(\varepsilon+i)$.

   In both cases it will be necessary to run a difficult traverse through the woods to the menhir at Le Manio before any importance can be attached to these declinations.
4. Werner Hülle, *Steinmale der Bretagne* (Ludwigsburg, 1967), 49.
5. Thom, *Megalithic lunar observatories*, 78.
6. Thom, *Megalithic lunar observatories*, chap. 8.
7. *Ibid.*, 105.
8. *Ibid.*, 47.
9. But see *ibid.*, 51.
10. The site at Carnac is also discussed in P. R. Giot, *Brittany* (London, 1960), which includes a bibliography.

---

*Editorial Note:* A second paper by A. and A. S. Thom, entitled "The Carnac Alignments", will appear in our February issue. The same issue will also include "Precession and Trepidation in Indian Astronomy before A.D. 1200" by David Pingree, "Aristotelian Planetary Theory in the Renaissance" by Noel Swerdlow, "The Origin of the Lunar Craters: An eighteenth-century view" by Roderick W. Home, and an essay review by Addi Wasserstein of *Early Greek Astronomy to Aristotle* by D. R. Dicks; and our series of papers in the history of modern astronomy continues with "The Development of Research in Interstellar Absorption, *c* 1900–1930" by D. Seeley and R. Berendzen.