

A POSSIBLE PYTHAGOREAN TRIANGLE AT STONEHENGE

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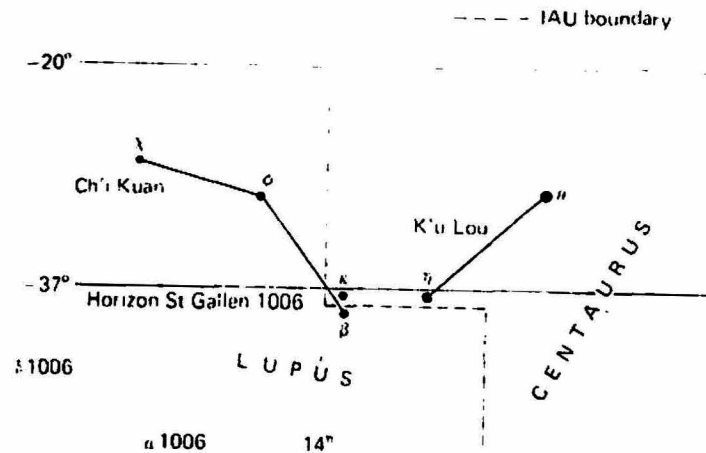


FIG. 1.

ordinary B2V, neither variable nor binary, with position (1950) $-41^{\circ}54'$, $14^{\text{h}}55^{\text{m}}54^{\text{s}}$.⁴ In 1006 an object near this star could fulfil the requirements for the St Gallen observations.

Three points for research:

- (1) As suggested by Stephenson, a field survey near St Gallen.
- (2) It is likely that a large establishment such as St Gallen would have had daughter houses; was there one of these in a better position?
- (3) A search for an ex-nova. There have been identifications with radio sources in the Lupus loop, also with NGC 5882. But what if the object were not a supernova? It certainly had 'size', but this could have been an optical effect, and there is no record of its being seen by day as happened with SN 1054 and 1572. It is said that details of the landscape could be seen by the light, which would imply a magnitude of about -6 ; but both Venus (say -4.4) and Jupiter (-2.5) cast shadows.

Have we then the case of a bright supernova fairly close to the Sun? This could leave a remnant of a small blue star of magnitude $+19$ or $+20$. Further, the position of SN 1006 might well be not in Lupus as now generally held but in Centaurus, at least as delineated by the IAU (see Figure 1).

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2. Xi and Po, *op. cit.*
3. Ho, *op. cit.*
4. Courtesy of the Director of the Royal Greenwich Observatory.

It has been known for some time that the diagonals of the station stone rectangle at Stonehenge intersect at about 45 degrees.^{1,2} This means that the rectangle is split by either of its diagonals into two right triangles whose smaller acute angles should be 22.5 degrees—one sixteenth of a circle. I believe that it has not been noted that these triangles are also close to 5,12,13 Pythagorean right triangles. This fact may be seen from the map published by Thom *et al.*,³ and also from other maps such as those given by Hawkins⁴ and the one by Euan MacKie appearing in Baity's review.⁵ We shall use the apparently standard rock and hole numbering system used in these last two references. Hawkins⁶ has given azimuths for the directions of lines between several of the stones and positions at Stonehenge, azimuths which he obtained using an aerial survey. From them we can calculate the acute angle between the direction defined by 93 and 92, and the direction defined by 93 and 91. The result is 22.899 degrees. Similarly, we obtain an angle of 22.531 degrees between the direction defined by 94 and 91, and the direction defined by 93 and 91. These values may be compared with 22.620 degrees for the 5,12,13 Pythagorean right triangle and 22.500 degrees for one sixteenth of a circle.

Thom and his associates have, of course, already discussed the use of exact and approximate Pythagorean right triangles by Megalithic man.^{7,8} In particular, at Crucuno⁹ they found that the stone rectangle is based on 3,4,5 Pythagorean right triangles. They point out that the latitude of Crucuno is remarkably close to that required if the diagonals of the rectangle are to point to the rising and setting positions of the Sun at the solstices as Charriere has suggested. A similar situation obtains at Stonehenge. Hawkins and White,¹⁰ referring to Newham and Charriere, point out that the latitude of Stonehenge is "practically optimum" for the summer solstice sunrise line to be perpendicular to the low summer moonrise line. Once these are set, the low winter moonset line which completes the triangle is "not rearrangeable by man" and yet approximately completes the simple geometry of the 5,12,13 right triangle, or, alternatively, the 22.5 degree right triangle. Thus the shape of the station stone rectangle is completely and independently defined both by the simple geometry of the triangles and by the astronomical directions, and the two definitions approximately agree. This fact depends, of course, on the choice of latitude of the site, which it may help explain. It also depends on the actual relative motions of the Earth, Sun, and Moon, and therefore it may well have been significant to "Megalithic man", although we would regard it as a coincidence. We should note that it has already been pointed out by others¹¹ that Ballochroy appears to be another site at which site selection creates a simple geometry for some of the astronomical directions.

The maps suggest some other arrangements which may be of interest. It appears that the line defined by C and E connects with the Heel Stone and also with Stone 60 in the trilithon horseshoe. Also there appears to be an un-numbered

stonehole approximately in line with the Heel Stone and Stones 51 and 52 on the other side of the trilithon horseshoe. Position *F* appears to be in line with the Heel Stone and Stones 6 and 7 of the sarsen circle, and thus approximately tangent to the sarsen circle at a point close to its intersection with the diagonal of the station stone rectangle. Position *D* may have a similar function on the other side. This situation suggests that sightings back from the Heel Stone, or angles subtended at the Heel Stone by circles and other structures, may have had some significance, perhaps in construction. Positions *C*, *D*, *E*, and *F* may have also been intended to help form astronomical alignments, as suggested by Hawkins and White.¹²

I would like to thank Samuel Shepley and Peter Crawley for helpful discussions.

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3. Alexander Thom, Archibald Stevenson Thom and Alexander Strang Thom, "Stonehenge", *Journal for the history of astronomy*, v (1974), 71-90, pp. 76-77.
4. G. S. Hawkins, *Beyond Stonehenge* (New York, 1973), 59, 284, 297.
5. E. C. Baity, "Archaeoastronomy and Ethnoastronomy So Far", *Current anthropology*, xiv (1973), 389-449, p. 392.
6. Hawkins, *op. cit.*, 299.
7. A. Thom, *Megalithic sites in Britain* (Oxford, 1967).
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10. G. S. Hawkins and J. B. White, *Stonehenge decoded* (Garden City, New York, 1965), 154.
11. Hawkins, *Beyond Stonehenge*, 250. Also A. Thom, *Megalithic lunar observatories*, 36.
12. Hawkins and White, *op. cit.*, 134.

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THE STONEHENGE STATIONS

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Professor Dibble's interesting note (above, pp. 141-2) raises questions about the significance of the Stonehenge Stations which deserve detailed examination. It has been said more than once that Stonehenge lies close to the latitude in which the azimuths of extreme northerly sunrise and extreme southerly moonrise are at right-angles, and that this accounts for the nearly rectangular figure of the four Stations. It must not be forgotten, however, that Station 94 has never been excavated and that the positions marked for it on various plans are hypothetical. This note therefore deals with the other three Stations only.

For orthogonal azimuths with declinations $\pm \epsilon$, $-(\epsilon - i)$ the necessary condition is $\cos^2 A_s + \cos^2 A_m = 1$, where A_s and A_m are the azimuths respectively of the rising Sun and Moon. If we assume a uniform horizon altitude of $30'$, which approximates to the actual conditions at Stonehenge, then for the

astronomical definition of rising the critical latitude varies between $49^\circ 49' \text{ N.}$ for 3150 BC and $50^\circ 3' \text{ N.}$ for 1700 BC, these dates being respectively the upper and lower 95% confidence limits for the corrected radiocarbon dates for Stonehenge I and Stonehenge IIIa. For the first-gleam definition of rising (which in practice requires about $2'$ of the upper limb to be visible) and for the alternative full-orb definition the values are greater and smaller by about $2'$ of latitude. Since the latitude of Stonehenge is about $51^\circ 11' \text{ N.}$ it follows that the site lies some 75 miles too far north for this pair of extreme azimuths to be orthogonal.

For the extreme azimuths of setting with declinations $-\epsilon$, $+(\epsilon + i)$, however, the critical latitude is much closer to Stonehenge, being in the range $51^\circ 16' \text{ N.}$ to $51^\circ 30' \text{ N.}$ for the same limiting dates for the astronomical definition of setting, with a difference of about $1'$ of latitude less or more for the alternative definitions.

Figure 1 shows the range of values that would be taken by the included angle 91-92-93 for each of the four possible pairs of extreme azimuths with declinations $\pm \epsilon$, $\pm (\epsilon - i)$, using the observed horizon altitudes and the extreme rather than the mean values for the parallax and semi-diameter of the Moon. The lower end of each range corresponds to the earlier of the limiting dates.

Case II corresponds to Professor Dibble's choice of azimuths, but is clearly inconsistent with his additional hypothesis that these three Stations define a Pythagorean triangle. Case III, however, could be consistent with that hypothesis. For the included angle at 92 to be exactly 90° the relevant dates and azimuths are:

Case III(a)	Last Gleam	2575 BC	91-92	229	52'
			92-93	319	52'
Case III(b)	Full Orb	2860 BC	91-92	229	0'
			92-93	319	0'

For the actual figure of these three Stations the best evidence is probably that of the 1:96 plan of Stonehenge (drawing no. 123-130) made by the Ministry of Works (now Department of the Environment) in 1959, which incorporates the results of the excavation of the stoneholes at 91 and 92 in 1923 and 1921. This suggests that the centres of the latter, and the centre of Stone 93, form a triangle with sides of 112.40ft, 269.60ft and 282.75ft. The azimuths 91-92 and 92-93 are respectively $230^\circ 37'$ and $321^\circ 12'$, and the angle included at 92 is $89^\circ 25'$. This is so close to a right-angle that one may assume with some confidence that this was what the builders were aiming at.

Clearly, however, at both 91 and 92 the point of observation—the peak of the stone—was not necessarily co-incident in plan with the centre of the stonehole. Moreover although Stone 93 is still standing, in its present state it is no more than the battered stump of what must surely have been a taller stone. Furthermore, its sides have been dressed to at least 9in. below the present ground and even further, therefore, below the original ground level, which was at least 18in. higher, so that it is impossible that the dressing could have been done after the erection of the stone. Dressing of this kind is elsewhere confined to stones of period IIIa and later, and does not occur on Stone 91 or on the Heel

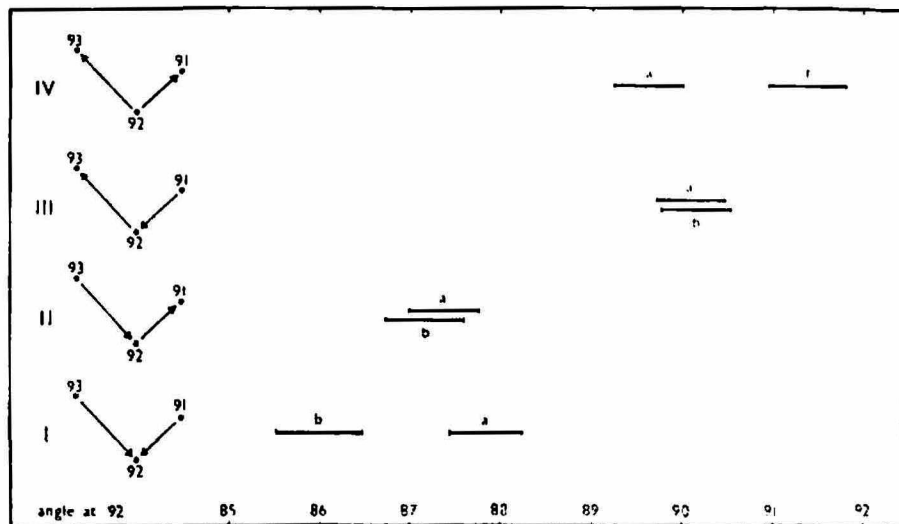


FIG. 1.

Stone. It is thus probable that Stone 93 is a later replacement of an earlier marker, and not necessarily in precisely the original position. In all three cases, therefore, it is not only possible but also likely that the point of observation was displaced from the apparent centre, though the relevant dimensions suggest that such displacements could not have exceeded about 3ft.

To accommodate the orthogonal azimuths tabled above it can be shown that the displacements for 91, 92 and 93 respectively would be about 0.7ft, 3.1ft and 3.0ft for case III(a), and about 1.6ft, 5.1ft and 5.0ft for case III(b). The former set is perhaps marginally within the limit of acceptability, and would allow for a close approximation to a Pythagorean triangle with sides in the ratio of 5:12:13, though not for one with sides integral in Megalithic yards or rods. The latter set of displacements are clearly too large.

We may thus perhaps conclude very tentatively (the short length of the sight-lines and the uncertainty in the exact figure justify nothing more) that the intention of the builders was to mark the extreme southerly and northerly settings of the Sun and Moon in about 2600 BC, a date consistent with the hypothesis that the Stations were established in period I.

If this is so, then it can plausibly be assumed that the remaining sides of the 'rectangle' were likewise intended to mark the extreme risings at the same date. The relevant azimuths for 93-94 and 94-91 are $49^{\circ} 24'$ and $142^{\circ} 3'$, and the included angle at 94 would be $87^{\circ} 21'$. This is clearly inconsistent with the concept of a rectangle composed of two matched Pythagorean triangles, and suggests that the figure of the four Stations may never have been intended to be rectangular. It is for the excavators of the future to test this very tentative hypothesis.

ESSAY REVIEW

SIXTEENTH-CENTURY BROADSIDES

Erschröckliche und warhafftige Wunderzeichen 1543-1586. Faksimiledruck von Einblattdrucken aus der Sammlung Wikiana in der Zentralbibliothek Zürich. Herausgegeben von Bruno Weber [folio volume of plates, 46 leaves]. *Wunderzeichen und Winkeldrucker 1543-1586.* Bruno Weber (Urs Graf Verlag, Dietikon-Zürich, 1971). Pp. 153 [commentary]. Swiss fr. 1070; Swiss fr. 250 for the commentary volume alone. (Distributor for Canada, Japan, and the United States: Bernard M. Rosenthal, Inc., 251 Post Street, San Francisco, Ca. 94108. \$402; \$94.)

By the middle of the sixteenth century the publishing of broadsides ("einblatt-drucke" in the more descriptive German) had become well established as a means for conveying the news of strange, wonderful, or noteworthy happenings. These sheets with their text and woodblocks, in essence the forerunners of modern newspapers, were hawked by peddlers who carried their wares from town to town throughout Europe.

An enthusiastic collector of such ephemera was the Swiss reformer and preacher Johann Jakob Wik (1522-1588); his collection is now preserved in Zürich's Zentralbibliothek, where it ranks below only the Gotha and Nuremberg collections as the largest group of sixteenth-century broadsides preserved today. The Sammlung Wikiana contains nearly 400 broadsides and a comparable number of pamphlets; many of them are unique or exist in only a handful of copies.

The Wik broadsides deal with a wide variety of topics - monster births (both animal and human), violence, the Turks, politics, exotic animals and savages—but nearly a quarter concern heavenly phenomena, both celestial and meteorological. Hence the collection is a valuable source for the history of astronomy, or at least the popular, almost folklorish, aspects. Both Tycho's nova of 1572 and the Great Comet of 1577 came within the decades of Wik's intensive collecting.

The potential usefulness of astronomical broadsides for historical studies has not passed unnoticed. In 1911, inspired by the popular interest in Halley's Comet, F. S. Archenhold, editor of *Das Weltall* and director of the Treptow Observatory near Berlin, organized the publication of a portfolio of 25 facsimiles of comet broadsides spanning the period from 1460 to 1788.¹ Shortly thereafter he issued a checklist of 80 comet broadsides.² More recently three of the facsimiles have been restruck from the same lithographic stones as part of the 75th-anniversary celebrations of the Archenhold Sternwarte. They have been described by Diedrich Wattenberg in an article, "Drei Einblattdrucke aus dem 16. Jahrhundert".³

Also in 1911 Wilhelm Hess published a book that is in some ways the forerunner of the Wikiana volume: *Himmels- und Naturerscheinungen in Einblattdrucken des XV. bis XVIII. Jahrhunderts*.⁴ The thirty illustrations