

New Light on Stonehenge from Ancient Greeks

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Ancient Greek literature sheds new light on a continuing controversy between archaeologists and astronomers over the purpose of Stonehenge's architectural design; not unlike the divergent epistemologies of Laplace and Newton on the role of the Divine in the origin of the solar system:

“In 1799, the physicist Pierre Laplace presented copies of his *Treatise on Celestial Mechanics* to the new French Emperor, Napoléon Bonaparte. In it, Laplace sought to explain the origin of the solar system not as the product [of] divine design, as Isaac Newton had done, but as the result of purely natural gravitational forces. When Napoléon eventually summoned Laplace to discuss the *Treatise* in 1802, he asked Laplace directly about the role of God in his theory. ‘Newton spoke of God in his book,’ Napoléon said. ‘I have perused yours, but failed to find his name mentioned even once. Why?’ Laplace reportedly issued the now famous reply: ‘Sire, I have no need of that hypothesis’ ” (cited in Kaiser 1991, 267 by Meyer 1999, 1).

In the 1960s, two British astro-physicists concluded that Stonehenge was designed as a purpose-built lunar-solar observatory for predicting eclipses. Professor of Astronomy Gerald S. Hawkins (Boston University and Harvard-Smithsonian Astrophysical Observatory) suggested how Stonehenge could have functioned as a digital Neolithic computer to signal “a danger period when eclipses are possible.” (Hawkins 1964, 1258); an interpretation elaborated by the Director of the Cambridge Institute of Theoretical Astronomy, Sir Fred Hoyle, FRS:

“...I believe beyond reasonable doubt- that the purpose of Stonehenge was to *predict* the occurrence of eclipses. The fact that no serious difficulty is encountered as one delves deeper into the procedures for operating Stonehenge as an eclipse predictor provides, in my view, a very strong argument for thinking that Stonehenge was indeed used for this purpose” (Hoyle 1977, 4 and 157; cf. 1966; 1972).

Nonetheless, many British archaeologists “had no need of that hypothesis.” Foremost among these were Professor of Archaeology Richard J. C. Atkinson, CBE (University College, Cardiff) who directed of excavations at Stonehenge for the Inspectorate of Ancient Monuments in the Ministry of Works (1950-1964); and Professor of Archaeoastronomy Clive L. N. Ruggles, FRAS, FSA (University of Leicester):

“Hawkins second contention is that the fifty-six Aubrey Holes were used as a ‘computer’ ...for predicting movements of the Moon and eclipses, for which he claims to have established a hitherto unrecognized 56-year cycle.... It is questionable whether a barbarous and illiterate community..., which has left us no other evidence of numeracy, could successfully have recorded the data needed to establish a cycle which exceeded contemporary life-span.... (Atkinson 1966, 1302)

“...[D]etailed reassessments of the ideas of ... Gerald Hawkins... have shown that there is no convincing evidence that, at any stage, constructions at Stonehenge ...served as any

sort of computing device to predict eclipses...there is no reason whatsoever to suppose that at any stage the site functioned as an astronomical observatory.” (Ruggles 1997, 203)

For his part, Hawkins ultimately concluded that “My function as an astronomer is to do the calculations and to provide what could be called *numerical* artifacts which have to be taken into consideration in studying the structure” (Hawkins 2003). To that end, let us consider six such numerical artifacts from Stonehenge’s architecture also found in the astronomical literature of ancient Greece, viz.: **19**, **29**, **29.5**, **30**, **56**, and **59**.

19 & the Bluestone Horseshoe (Phase 3v, c.2550-1600 BC). Inside the Sarsen Circle of Stonehenge, **19** dolerite bluestones once stood in a horseshoe open to the midsummer sunrise (Figure 1).

“[They]...are so called from their colour, which in dry weather is a bluish-grey. But when they are wet after rain they acquire a noticeably blue tinge.... There can be no doubt now that it was from this very restricted region [in Wales] that the bluestones were chosen and brought to Stonehenge [in England]. The technological implications of this extraordinary undertaking are discussed below.... The spacing of the surviving stones makes it clear that the horseshoe originally contained **nineteen** pillars....” (Atkinson 1956, 34, 36, 42).

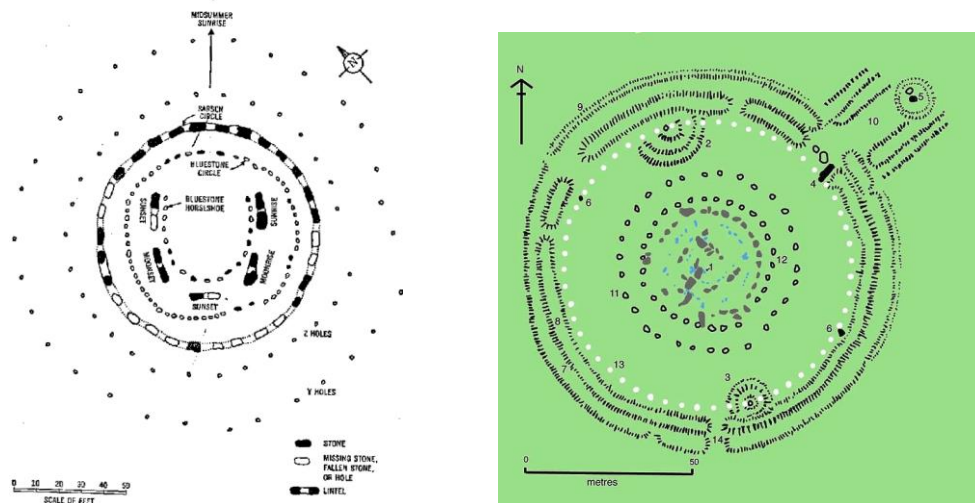


Figure 1. Reconstructed (left) and Unreconstructed (right) Plans of Stonehenge III (Hawkins 1973, 296; Adamsan. http://en.wikipedia.org/wiki/File:Stonehenge_plan.jpg)

While a modern archaeologist may have no use for an astronomical hypothesis, both the color and number of the bluestones could well have had ritual significance for, say, an ancient astro-architect. Although the color choice of *bluestones* reflecting a connection to the *blue sky* is as hypothetical as it is self-evident, astronomers have pointed out that the architect’s choosing **19** bluestones for the horseshoe constitutes an independent numerical variable reflecting the **19**-year cycle of the moon’s 235 Synodic months (or lunations); a cycle used by Greek astronomers Meton and Euctemon of Athens to regulate the Attic Calendar c.432 BC. Moreover, British

Archaeologist Robert S. Newall, FSA pointed out (Hawkins 1965, 96) that the ancient Greek historian Hecataeus of Miletus (c.550-476 BC) referred to a spherical temple to Apollo on the large island of *Hyperborea* (Beyond the North Wind) where “...the god [*theon* or Moon deity Selene – V.T.] visits the island every 19 years, the period in which the return of the stars [*astron* or luminous bodies – V.T.] to the same place in the heavens is accomplished....” (Diodorus c.50 BC, 47).

DIODORUS OF SICILY

“Ἀβαριν εἰς τὴν Ἑλλάδα κατατήσαντα τὸ παλαιὸν ἀνασῶσαι τὴν πρὸς Δηλίους εὐνοίαν τε καὶ συγγένειαν. φασὶ δὲ καὶ τὴν σελήνην ἐκ ταύτης τῆς νήσου φαίνεσθαι παντελῶς ὀλίγον ἀπέχουσαν τῆς γῆς καὶ τινὰς ἐξοχὰς γεώδεις ἔχουσαν ἐν αὐτῇ φανεράς. λέγεται δὲ καὶ τὸν θεὸν δι’ ἐτῶν ἐννεακαίδεκα καταντᾶν εἰς τὴν νῆσον, ἐν οἷς αἱ τῶν ἀστρων ἀποκαταστάσεις ἐπὶ τέλος ἄγονται· καὶ διὰ τοῦτο τὸν ἐννεακαίδεκαετή χρόνον ὑπὸ τῶν Ἑλλήνων Μέτωνος ἐνιαυτὸν ὀνομάζεσθαι. κατὰ δὲ τὴν ἐπιφάνειαν ταύτην τὸν θεὸν κιθαρίζων τε καὶ χορεύων συνεχῶς τὰς νύκτας ἀπὸ ἰσημερίας ἑαρινῆς ἕως πλειάδος ἀνατολῆς ἐπὶ τοῖς ἰδίοις εὐημερίμασι τερπόμενον. βασιλεύει δὲ τῆς πόλεως ταύτης καὶ τοῦ τεμένου ἐπάρχειν τοὺς ὀνομαζομένους Βορεάδας, ἀπογόνους ὄντας Βορέου, καὶ κατὰ γένος αἰεὶ διαδέχεσθαι τὰς ἀρχάς.

48. Τούτων δ’ ἡμῶν διευκρινημένων μεταβιβά-

BOOK II. 4: 5-48.

to Greece in ancient times and renewed the goodwill and kinship of his people to the Delians. They say also that the moon, as viewed from this island, appears to be but a little distance from the earth and to have upon it prominences, like those of the earth, which are visible to the eye. The account is also given that the god visits the island every nineteen years, the period in which the return of the stars to the same place in the heavens is accomplished; and for this reason the nineteen-year period is called by the Greeks the “year of Meton.”¹ At the time of this appearance of the god he both plays on the cithara and dances continuously the night through from the vernal equinox until the rising of the Pleiades, expressing in this manner his delight in his successes. And the kings of this city and the supervisors of the sacred precinct are called Boreadae, since they are descendants of Boreas, and the succession to these positions is always kept in their family.

48. But now that we have examined these matters

“Either the **19** year phase cycle or the 18.61 year nodal cycle was represented by the 19 blue stones inside the trilithon ‘horseshoe’ ” (Newham 1972, 47-48)

“ It is, of course, the eclipse year...which has the powerful relation to the number **19**, since an eclipse occurring at one moment will reoccur almost exactly **19** eclipse years in the future” (Hoyle 1977, 130).

29 Z Holes & 30 Y Holes (Phase 3vi, 1600 BC). The Y and Z holes (Figure 1) were discovered and excavated by Lieutenant Colonel William Hawley and R. S. Newall, FSA in the early 20th century (Atkinson 1956, 19). “[T]he Y and Z Holes...were obviously intended as the sockets for a double circle of bluestones, numbering 60 in all (there are actually only **fifty-nine** holes, since Z8 is missing)” (Atkinson 1956, 72).

While archaeologists have dated artifacts found in the holes and mapped the holes, they have not offered an interpretation of why the numbers of **29** and **30**, or their role in the overall architectural design of Stonehenge. Astronomers, on the other hand, have pointed out that:

“The double circle or spiral of the ‘Y’ and ‘Z’ holes represented the **59** days of two solar months.” (Newham 1972, 47)

“The **30 Y** and **29 Z** holes were an improvement in the counting device. Alternate months could use the short **29**-day interval, giving a mean month of **29.5** days.... The rings contain numerical information that corroborates the possible connection with the moon. (Hawkins 1973, 301)

29.5 Uprights of the Sarsen Circle (Phase 3ii, 2600 BC to 2400 BC). The Sarsen Circle contains a total of **29** and **one-half** uprights and pits (Figure 2). It remains an open question among archaeologists as to when one of the stones was shortened:

“The original number of uprights in the circle was thirty, but of these only sixteen remain in position. **One stone in the circle, no. 11, is much smaller than the rest**, measuring only 4 ft. wide by 2 ft. thick. It now stands only 8 ft. out of the ground, but **presumably at some time** the upper part has been broken off and removed from the site. The use of this markedly undersized stone (there can be no question of its width or thickness having **been reduced since its erection**) suggests that the builders were hard put to it to find sufficient blocks of the requisite size to complete the circle” (Atkinson 1956, 23-24)

“If we move a little around the sarsen ring to stone 11, we find a diminished, stumpy thing, less than 3m high compared to the normal 4m.... It could not have held a lintel connecting to the two adjacent full-size stones....” (Pitts 2001, 265)

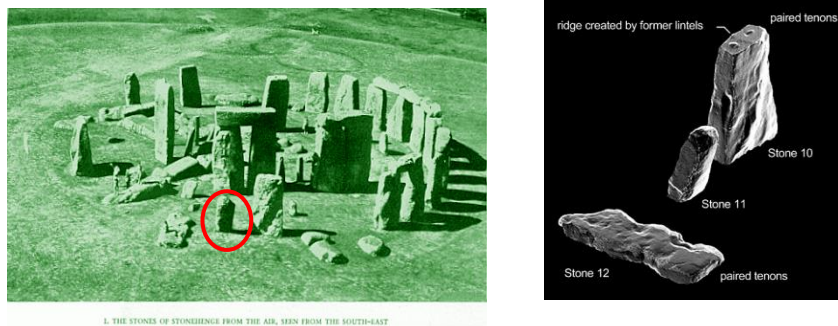


Figure 2. The 29.5-Stone Sarsen Circle and Laser Scan of “Shorty” Stone No. 11
(Atkinson 1956, Plate I; <http://www.solvingstonehenge.co.uk/page7.html>)

Atkinson’s suggestion that “the builders were hard put to it to find sufficient blocks of the requisite size” for fashioning a full-size 30th upright is belied by the local sarsen stone quarries (<http://brian-mountainman.blogspot.com/2011/11/sarsen-speculations.html>). On the other hand, the astronomical explanation is simply “...that small stone (no. 11) in the sarsen circle was intentional, and that the circle represented the 29.5 days of the lunar month” (Newham 1972, 47) as was known to Sumerians (c.1800 BC) and Greeks (c.500 BC).

30 & the Station Stones (Phase 3, c.2600 BC). The Station Stones form a rectangle whose length to width ratio is 12:5, i.e., whose diagonals form twin 5:12:13 Heronian-Pythagorean rational right triangles with a common hypotenuse (Dibble 1976; Atkinson 1978, 50) (Figure 3).

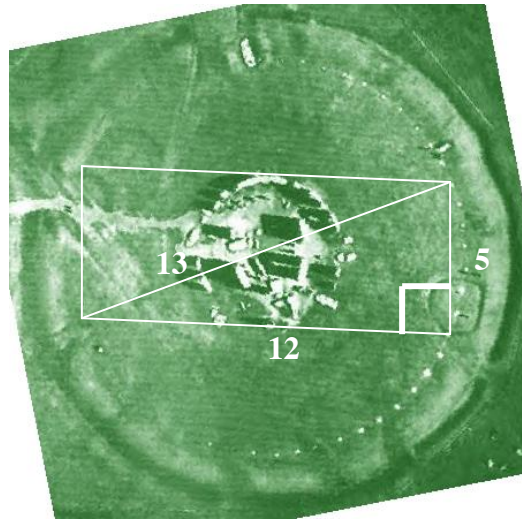


Figure 3. Aerial Photo of the Station Stone 5:12:13 Triangles

Three remarkable coincidences deserve notice regarding the 5:12:13 triangle:

1. It is one of three primitive Pythagorean triples (i.e., 3:4:5; 5:12:13; 12:35:37) found at megalithic sites in Britain (Thom 1967, 27);
2. It is *unique* in that its Area ($5 \times 12/2 = 30$ Ratio Units squared [RU²]) and its Perimeter ($5 + 12 + 13 = 30$ linear RU) equal the same number; and
3. The Ratio Unit number (**30**) for both its Area and Perimeter is the nearest integer to the moon's *Synodic Period* (29.5306 days).

Not only did the designers of the Station Stone Rectangle incorporate 5:12:13 rational right triangles into their astro-architectural plan anticipating both Pythagoras of Samos (c.570 BC–c.495 BC) and Heron of Alexandria (c. 75 AD) by more than 2,000 years, but they also oriented the sides of the Station Stone Rectangle to the extreme risings and settings of the midwinter and midsummer Moon ($\pm 29^{\circ\text{decl}}$) and Sun ($\pm 24^{\circ\text{decl}}$).

56 & the Aubrey Holes (Phase 1, c.2950-2900 BC) Thanks to Atkinson's extensive field work at Stonehenge, we know that "[t]here are **fifty-six** Aubrey Holes, set in an accurate circle 288 ft. in diameter.... Thirty-four of them have been excavated.... The locations of the unexcavated holes have been found by probing and 'bosing' [sub-surface echo-location]" (Atkinson, 1956, 11-12) (Figure 4).

However, Atkinson's contention that Hawkins' 56-year eclipse cycle as "hitherto unrecognized" (Atkinson 1966, 1302) must be rejected in light of the following passage attributed to the Greek astronomer Eudoxus of Cnidus (fl. 370 B.C.) by Plutarch (AD c.46-120) explicitly linking the **56-sided (-angled) polygon to lunar eclipses**:

"There are some who give the name Typhon to the shadow of the earth, into which they believe the **moon** falls and so suffers **eclipse**...which the sun remedies by instantly shining

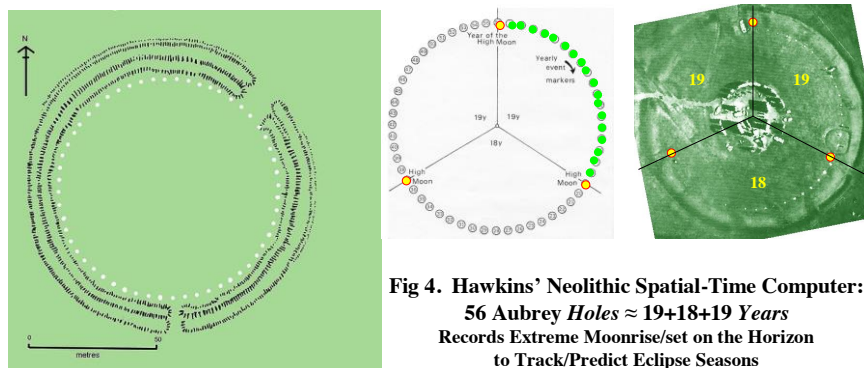
back upon the moon when it has escaped the shadow of the earth....“The Pythagoreans also clearly believe Typhon to be a demonic power, for they say that he was born on an even measure, the **56th**; further, they say that the nature of the triangle belongs to Hades, Dionysus and Ares, that of the quadrilateral to Rhea, Aphrodite and Demeter, Hestia and Hera, and that of the dodecagon to Zeus, while that of the **56-sided (-angled) polygon** is said to belong to Typhon, as Eudoxus [of Cnidus, Greek astronomer, fl. 370 B.C.] has reported....”

δεδεμένον. | ἐν δὲ τῇ τοῦ Ἡλίου θυσίᾳ τοῖς σεβομένοις τὸν θεὸν 363
παρεγγυῶσι μὴ φορεῖν ἐπὶ τῷ σώματι χρυσία μηδ' ὄνω τροφήν
διδόναι. φαίνονται δὲ καὶ οἱ Πυθαγορικοὶ τὸν Τυφῶνα δαιμονικὴν 15
ἡγούμενοι δύναμιν· λέγουσι γὰρ ἐν ἀρτίῳ μέτρῳ (τῷ) ἑκτῷ καὶ
πεντηκοστῷ γεγενῆσθαι Τυφῶνα· καὶ πάλιν τὴν μὲν τοῦ τριγώνου
(φύσιν) Ἄϊδου καὶ Διόνυσου καὶ Ἄρεος εἶναι· τὴν δὲ τοῦ τετραγώ-
νου Ῥέας καὶ Ἀφροδίτης καὶ Δήμητρος καὶ Ἑστίας καὶ Ἥρας· τὴν
δὲ τοῦ δωδεκαγώνου Διός· τὴν δὲ (τοῦ) ἑκαπεντηκονταγώνου 20
Τυφῶνος, ὡς Εὐδόξος (fr. 293) ἱστορήκεν. (31.) Αἰγύπτιοι δὲ πυρ-
ρόχρουν γεγενῆσθαι τὸν Τυφῶνα νομίζοντες καὶ τῶν βοῶν τοὺς
πυρροὺς καθιερύουσιν, οὕτως ἀκριβῆ ποιούμενοι τὴν παρατήρη- 25
σιν, ὥστε, καθ' ἓαν ἔχη τρίχα μέλαιναν ἢ λευκὴν, αὐτοὺς ἡγεῖσθαι·
θύσιμον γὰρ οὗ φίλον εἶναι θεοῖς, ἀλλὰ τούναντίον, ὅσα ψυχὰς 25

Typhon, and when they make round cakes in the festivals of the months of Paṓni and Phaḡphi, as an insult they stamp on them an image of a tied ass. In the sacrifice to Helios they instruct those 363 who venerate the god neither to wear golden objects on the body nor to give food to an ass. The Pythagoreans also clearly believe Typhon to be a daemonic power, for they say he was born on an even measure, the 56th; further, they say that the nature of the triangle belongs to Hades, Dionysus and Ares, that of the quadrilateral to Rhea, Aphrodite, Demeter, Hestia and Hera, and that of the dodecagon to Zeus, while that of the 56-sided polygon is said to belong to Typhon, as Eudoxus has reported.

(Griffiths 1970; 165, 189 and 207)

The design choice of a **56-sided (-angled) polygon** for the Aubrey Holes is of fundamental importance because it coincides with a remarkable lunar cycle where the moon's skyline position and phase synchronize enabling eclipse prediction. As Hawkins pointed out, “In favor of this solution - that the Aubrey Holes were used as a computer- are these facts: (1) the number **56** is *the smallest number* that measures the swing of the moon with an over-all accuracy of better than 3 days, and (2) lunar cycles provide the only method of long-range eclipse prediction related to the seasons of the year.” (Hawkins 1965, 144)



(Drawing at left by Adamsan after Cleal et al. 1995 http://en.wikipedia.org/wiki/File:Stonehenge_phase_one.jpg)

56/3 & the Area of the Sarsen Circle (Phase 3ii, 2600 BC to 2400 BC). Atkinson noticed that great labor was expended polishing the interior surface of the Sarsen Circle, while the exterior was left in its original rough state. “This polishing...now survives only on the inner faces of certain stones, such as the lower part of stone 10 (Plate IVA).... [T]he main concern of the builders was to produce a presentable finish on those surfaces which would be seen from the *interior* of the site. The best finish thus occurs on the inner faces of the uprights” (Atkinson 1956, 121).

Investigation as to why the extra effort was made to polish the Sarsen Circle interior led the author to an interesting finding regarding its geometry. Because the outside diameter (OD) of the Sarsen Circle is tangent to the Station Stone Rectangle (5x12 Ratio Units or RU), the Sarsen Circle OD equals 5 RU and outside radius is 2.5 RU (Figure 5).

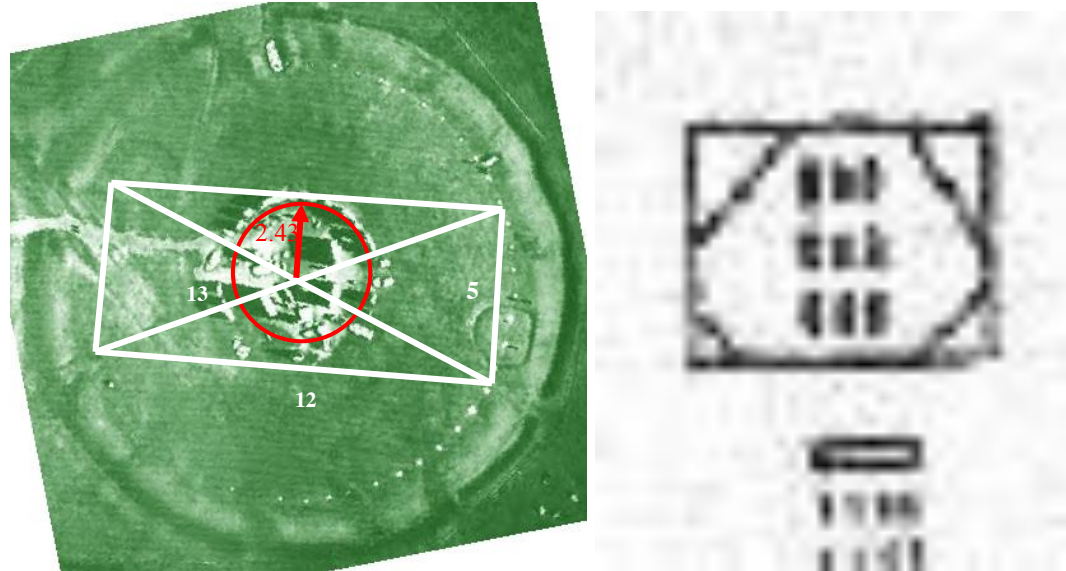


Figure 5. Aerial Photo of Sarsen Circle, Interior Radius = 2.43 Ratio Units and the Octagon inside a 9 by 9 Square from Problem 48, Rhind Mathematical Papyrus

Photogrammetric analysis suggests that the average width of the Sarsen lintels is 0.57 Ratio Units and therefore the interior radius is 2.5 RU - 0.57 RU = 2.43 RU. Table 1 calculates several Sarsen Circle interior areas for various ancient ratios for π . One of these ratios $(256/81 = 4[8/9]^2)$ (Gerdes 1983) used by the Egyptian scribe Ahmes (Ahmose) (c. 1600 BC) produces an **Area = 18.66 Ratio Units²**. While archaeologists may have no need for this numerical artifact, astronomers might point out its coincidence with the $56/3 = (19+18+19)/3 = 18.66$ **Years** of the Stonehenge Eclipse Cycle; just as if astro-architects at Stonehenge III had literally carved their knowledge of an eclipse cycle period into a stone circle plotted with the ratio $\pi = 4(8/9)^2$.

Table 1. Sarsen Circle Interior Area & Ancient Values for π

Given: Outside Diameter = 5 Ratio Units

Average Width of Sarsen Circle Lintel = 0.57 Ratio Units

Average Circle Interior Radius = 2.43 Ratio Units

Area of Circle = $\pi \times r^2$

Date (circa)	Culture	π (Ratio)	π (Decimal)	Radius ² (Ratio units ²)	Area (Ratio Units ²)	Remarks
-1900	Babylonian	25/8	3.1250	5.905	18.45	Tablet, Arndt & Haenel 2006, p. 167
-1650	Egyptian	256/81	3.1605	5.905	18.66	Rhind Papyrus, Prob. 48, $(16/9)^2$
-800	Hebrew	3/1	3.0000	5.905	17.72	I Kings 7, 23; II Chronicles 4, 2.
-250	Greek	22/7	3.1429	5.905	18.56	Archimedes of Syracuse, Upper Limit
500	Chinese	355/113	3.1416	5.905	18.55	Zu Chongzhi (Tsu Chhchung-Chih)
1630	Modern	-	3.1416	5.905	18.55	To 39 digits

Source: http://en.wikipedia.org/wiki/History_of_pi#History

59 & the Bluestone Circle (Phase 3iv, c.2550-1600 BC). To date, British archaeologists have yet to agree on the exact number of stones in the Bluestone Circle (Figure 1). Excavations by Hawley (1924-28) and Atkinson (1954) "...when plotted on a large-scale plan in combination with surviving stones, enable a new and far more accurate estimate to be made, of 57 stones with a possible error of one stone more or less." (Atkinson 1956, 38) "Atkinson in 1956 thought there had been 56, 57 or 58, but four years later he revised his estimate upward, to 59, 60 or 61" (Hawkins 1965, 59). "They may have originally numbered 60." (Cleal et al. 1995, 29) "Atkinson, with the advantage of Hawley's excavations, estimated sixty, give or take a stone.... (North 1996, 430)

Pending a definitive Bluestone Circle count, perhaps the best estimate of the number of bluestones is the median (58.5) of the estimated range of 56 to 61. Therefore, one might reasonably estimate that there were either 58 or **59** bluestones in the circle. While neither numeral holds special significance for archaeologists, historians of astronomy recognize the integer **59** as the ancient approximation of paired lunar Synodic Periods (each 29.5306 days) which avoids fractions, viz., two alternating integers, such that 29 days + 30 days = **59** days:

"The strong possibility that there were fifty-nine blue stones inside the Sarsen circle would provide a more suitable means of representing... the **59** days of two lunar months." (Newham 1972, 47)

"The numbers associated with the bluestone circle and the rings of Stonehenge II have not been definitely established by archaeologists at the present time. The current estimates for the stones in the bluestone circle are **59**, 60 and 61. The first figure, of course, would give the best fit to the lunar month....a counting system that was known to exist in later eras elsewhere in the world." (Hawkins, 1973, 301)

Indeed, the "Double Month" of **59** days was well known in the ancient world, e.g., at the Sumerian city of Mari (modern Tell Hariri, Syria) c.1800 BC, grain allocations "were already reckoned on the basis of alternating 29- and 30-day lunar months." (<http://cdn.preterhuman.net/texts/other/crystalinks/calendars2.html>) The Greek astronomer Geminus of Rhodes (c. 10 BC) records that Solon, Archon of Athens (594/3 BC), taught that, "The moon-year has 354 (= 12 x 29.5) days. Consequently they took the lunar month to be 29 ½ days and the double month to be **59** (= 29 + 30) days. Hence it is that they have hollow (29 day) and full (30 day) months alternatively, namely because the two-months period according to the moon is **59** days...." (Aristarchus c.250 BC, 287) The alternating 29- & 30-day month convention is still observed in both the modern Jewish הלוח השנה *Haluach Hashana* and Muslim (*Hijri*) calendars. <http://stevemorse.org/jcal/mrules.htm>

Given the new light from ancient Greeks on the numerical artifacts encoded in Stonehenge's astro-architecture, one is led to conclude, as did Professor of Mathematical Astronomy Douglas C. Heggie (University of Edinburgh), that "...the discoveries made in recent years about megalithic science demand a substantial or even radical revision of the archaeologist's standard picture of life and society in the late Stone Age and early Bronze Age" (Heggie 1981, 229). Therefore, archaeologists might well "have need of that hypothesis," as "the numbers have spoken and their message is quite clear" (Hawkins 2003).

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