Heliocentrist Aristarchos' Vast Vision
Five-Millennium Great Year of Cyclic Returns
Universe a Trillion Times the Geocentrists'
Geomobilist Obviously Discovered Precession
Measurer of the Misnamed 1-Second-Accurate "Babylonian Month"

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A Little-Understood Pioneer Scientist: Geocentrist Whaggism

A1 If one believed archonal historians-of-science (Neugebauer, Swerdlow, etc), one would conclude that Aristarchos of Samos was a mixed-up incompetent & data-fabricator (www.dioi.org/je02.pdf, §A & fn 70), instead of the immortal pioneer of heliocentricity which astronomers have long honored him as. E.g., oblivious to Voltaire's rejection, historians-of-science without exception trust an allegedly Aristarchan ms, "On the Sizes & Distances of the Sun & Moon", that is so dumb (*DIO 14* ‡2 §C1) that it has eclipses lasting half a day (O.Neugebauer *HAMA* p.642), and the ***INCREDIBLY-hitherto-unnoted*** requirement that the Moon daily move in retrograde! On the basis of this long-accepted but patently ridiculous ms, historians teach that Aristarchos believed the Sun was 2° wide (4 times the truth, due to an ancient foulup 1st revealed in 1991: *DIO 1.1* ‡7 fn 6; *DIO 22* ‡3 fn 95), discounting that no less a figure than Archimedes reports that Aristarchos correctly gauged the Sun's angular breadth as 1°/2.

A2 The reason so little real Aristarchan material survived is that Aristarchos was a groundbreaking heretic, whose very life was threatened by the Stoics (www.dioi.org/j117.pdf, §G), so that only a few genuine scraps & hints of his monumental advances survive. It is the happy work of the capable scientific historian (e.g., B. L. van der Waerden, Paul Tannery) to discern these from what little reached us, through the filter of little minds' intolerance.

A3 Aristarchos' most common appearance in modern textbooks is his finding that the halfMoon occurs 87° from the Sun. That is: off-quadrature by 3°, which was 1st suggested in 1991 (*DIO 1.1* ‡7 §C1) to be not a precise figure but an upper bound on how far from quadrature the Moon must be, before the lunar-terminator's curvature is visually discernable, as shown mathematically at *DIO 1.3* ‡9 §R9. Curiously, no textbook has yet connected the halfMoon experiment to Aristarchos-as-1st-heliocentrist, though it's obvious even to impenetrably-geocentrist Ptolemy that 87° entails that the Sun's distance be $\sec 87° \doteq 19$ times the Moon's, which was known to be c.60 Earth-radii (*Almajest* 5.13 has 59) so the solar distance was the product of these two data: over 1000 Earth-radii. Likewise, the radius of the Sun (1°/4 semidiameter) must be $19{\cdot}59{\cdot}(1/4)/(360/2\pi) \approx 5$ Earth radii. Since $5^3 = 125$, the Sun's volume must be over 100 times the Earth's (*Almajest* 5.16) — thereby recommending heliocentrism by the relative triviality of Earth's size. So Aristarchos' halfMoon test presumably caused him to anciently consider heliocentrism since (as Robert Newton put it modernly): *does the tail wag the dog?*

B A Previously Unexplained Universal Equation

B1 Geocentrists surely challenged Aristarchos: if Earth circuits the Sun, why don't stars exhibit parallactic loops? (***Though planets' huge parallactic loops had made no impression upon geocentrists***: www.dioi.org/j117.pdf, §F). Aristarchos' obviously replied: loops are there, but the stars are so remote that their loops are too small to be visible.

B2 Aristarchos' universe was then the largest ever proposed. Archimedes' *Sandreckoner* **hypothesizes without justification** that: EarthSize/SunDistance = SunDistance/StarsDistance > 1/10000 (T.Heath *Works of Archimedes* 1897 p.232). The equation had lain unsolved until 1992 (www.dioi.org/j139.pdf, fn 272), despite the obviousness of its explanation: ***1st to exploit heliocentrism's weighty consequences***, Aristarchos used the observational fact that both diurnal solar parallax & annual stellar parallax were invisible: thus, ***their provable limits were*** **EQUAL** — from such remoteness that human vision couldn't detect either side of the equation. (*If the parallaxes were visible, said equality would be a freak accident.*) Thus, ***each side of the equation is the parallactic ratio: baseline/remoteness***. Before the telescope, parallax-invisibility set an upper limit on that ratio: ***human vision's limit — 1/10000 RADIANS***.

B3 Two confirmations in that connection: [1] Aristarchos is known to have studied vision and light (I.Thomas *Greek Mathematical Works 2*:2-3, 1941). [2] Both sides of the equation are said by Archimedes (*loc cit*) to be greater than 1/10000. (Invisibility implies lesser-than; but, then, Archimedes-the-*Sandreckoner* sought a finite universe to fill with sand.) The human eye can see to 1/10000 of a radian. (Is there any historian-of-science who is aware of that?) The author got 1′/3 by direct experiment 40^{y} ago in San Diego. The human eye's foveal cones are 0′.4-0′.5 apart. Dawes' Limit for the eye as a 1/4-inch-aperture telescope is 0′.3. All these estimates cluster around 1/10000 radians.

B4 Diurnal parallax would most easily be spotted for Mars at stationary points near closest approach, but no such effect was anciently recorded. And *Almajest* 7.1 reports secular immobility of stellar positions. It appears therefore that Aristarchos knew each side of §B2's ratio-equation was less than 1/10000, so the Sun was at least 10000 Earth-radii distant (Poseidonios agreed: Neugebauer *op cit* p.656), and the stars were at least 10000 Astronomical Units away.

Which meant that the distance to the stars was at least $10000^2 = 100$ million Earth-radii. Since Ptolemy put the stars at ordmag 10000 Earth-radii (A.Van Helden *Measuring the Universe* 1985 pp.27f), Aristarchos' distance was 10000 times greater; thus the Aristarchos universe's volume was, crudely speaking, about 10000^3 or a trillion times larger than the geocentrists'. Given the 2 men's relative comprehension of the universe's dimensions, it's all the more inexcusable that modern academe demeans genuine, reality-grounded scientist Aristarchos while glorifying fabricator Ptolemy.

C Determining the "Aristarchan Month" to a Fraction of a Second

C1 The length of the mean month M was anciently found by noting that eclipses occurring 4267 months apart did so at virtually the same interval, within an hour, $126007^{d}01^{h}$ (*Almajest* 4.2), because of a corresponding integrality: the cycle also took almost exactly 4573 anomalistic months, meaning that any non-uniformity of motion due to lunar-orbit eccentricity was nearly the same at both ends of the interval and so cancelled out the eccentric irregularity. By simple arithmetic, this determined $M = 29^{d}31'50''08'''20''''$ (explicitly attested at *Almajest* 4.2-3), as we'll see below at §D1. Since the interval varied by less than an hour, one need only divide 1^{h} or 3600^{s} by 4267 to limit the error in M: under 1^{s}, and this was presumably improved-upon by averaging. In fact, M was correct then to a fraction a time-second, or 1 part in millions. And it still is. Dividing 17 into both the above periods, the ancients arrived at the wellknown compact relation, $251^{u} = 269^{v}$ — where superscripts u and v signify synodic and anomalistic months, respectively. Note that all this was achieved over 2000^{y} ago, by Greek ingenuity, without aid of reliable clock or telescope.

C2 Because M is embedded in Babylonian cuneiform material (e.g., BM55555) as early as c.200 BC, it is commonly called the "Babylonian month". But, below (§D1), we'll check it against a development nearly a century earlier.

D Millennial Vision

D1 Aristarchos didn't only think-big spatially but temporally — spawning a cycle of nearly 5000^{y} duration, a cycle with a wide spectrum of integral returns: see below at §D5. Over 100^{y} ago, Paul Tannery realized (T.Heath *Aristarchus of Samos* 1913 pp.314-315) that Censorinus 19.2 had revealed Aristarchos' long-cycle "Great Year" as 2434^{y}. *DIO 11.1* ‡1 eq.7 doubled that to 4868^{y} by deriving it via one of two simple-math routes (*DIO 11.1* §A8), from *Almajest* 4.2's saros equation (itself originally derived from M: *DIO 11.1* ‡1 §§A3-A6): 1 saros $= 223M = 18^{K}10°2/3 = 4868^{K}/270 = 1778037^{d}/270$ (where superscript K connotes Kallippic or Julian years: $365^{d}1/4$ each). Dividing by 223 produces monthlength $M = 1778037^{d}/223/270 \doteq 7973^{d}06^{h}15^{m}/270 = 29^{d}31'50''08'''20''''$ — ***precisely matching*** §***C1***, thus establishing that the "Babylonian month" (§C2) was achieved by Aristarchos' scrupulous analyses, decades ere any cuneiform text using it, so it ought properly to be called the "Aristarchan month".

The British Museum's tag on cuneiform BM55555 (§C2) agrees: photo of tag&clay at www.dioi.org/cot.htm#xpnd.

D2 In 1980, Aristarchos' sidereal year and his "tropical" year — actually Metonic year (§§D3-D4) — were discerned (*DIO 9.1* ‡3 Tables 1&2) on two Vatican mss (Neugebauer *HAMA* p.601): sidereal $365^{d}1/4 + 1/152$ (*DIO 22* ‡3 §G6), and tropical-Metonic $365^{d}1/4 - 15/4868$, respectively — expressed in continued-fraction format. Both these yearlengths are marked with Aristarchos' name, and each is *prior to anything Babylonian* on these Vatican mss' yearlength lists, which are *unexceptionally chronological*. (As not a single historian-of-science has ever pointed out, since none deviate from their sacred tenet that Babylon inspired Greek astronomy.) Both denominators are Aristarchan: his solstice was 152^{y} after Meton's; and his cycle (§D1) is 4868^{y}. (Thanks to the accumulated research from Tannery to *DIO*: 4868 can be related to Aristarchos in no less than four ways: *DIO 22* ‡3 fn 88.)

D3 Later, in 2002, it was realized (*DIO 11.1* ‡1 §A) that 4868 Metonic years, *based on Meton's famous relation*, $19^{y} = 235^{u}$, equals $4868^{y}\cdot235^{u}/19^{y}\cdot29^{d}31'50''08'''20'''' = 1778021^{d}12^{h}44^{m} \doteq 1778022^{d}$ (15^{d} short of §D1's 1778037^{d}); division by 4868 reveals the source of the Vatican ms' Aristarchan Metonic year (§D2): $365^{d}1/4 - 15/4868$ (*ibid* §B2), confirming the continued-fraction decipherment of §D2.

D4 Aristarchos compared Meton's Peloponnesian War-memorial S.Solstice to his own S.Solstice, to find a wrong tropical year (*DIO 20* ‡2 eq.2): $[(-279/6/27\ 6^{h}) - (-431/6/27\ 18^{h})]/152 = 365^{d}1/4 - 1/304$, which chanced to fall within 1^{s} of his Metonic year (§D3), so he wrongly melded the two. Precession deduced (*DIO 9.1* ‡3 §D5) from the c.$1°/100^{y}$ difference (low by $0°.38/100^{y}$) between his sidereal&tropical years. So, quite aptly, geomobilist Aristarchos — not geostatist Hipparchos — was the true discoverer of the Earth's precessional wobble. Ptolemy later (*Almajest* 7.2-4) took precession as exactly $1°/100^{y}$, ultimately exposing his theft of 1000 stars (*DIO 22* ‡4 §B6).

D5 Aristarchos' Great Year was designed to ensure integral cyclic returns: 1778037^{d}, 60210^{u}, 4868^{y}, 270 saroi. (Don't miss the hitherto-unperceived, quite clever cycle of Hipparchos proposed&analyzed at *DIO 11.1* ‡1 fn 14.)

D6 Aristarchos was nearly blotted out of memory by the Stoics (*DIO 1.1* ‡7 §§G2-G3), and he is now virtually blotted out of serious intellectual history by today's history-of-science cult (§A1 above; *DIO 22* ‡2 §N9).

D7 Archimedes was the greatest ancient mathematician, yet even he did not (§§B2-B3) perceive the source or sense of the greatest ancient scientist's universal ratio-equation (*idem*).

D8 The above reveals a heretic who, while fighting leaden opposition, was 1^{st} to measure a celestial period to an accuracy of 1 part in ***millions*** & was the 1^{st} cosmologist who appreciated the enormity of the universe in space&time.

When will academe wake to his measure?