

‡5 Accurate Ancient Astronomical Achievements

A Clubby Historians-of-science Project Own Dishonesty onto Greeks

A1 Historians-of-science routinely call ancient astronomers geocentrist, inaccurate, & so nonempirical they *cheated*: snuffing data contra prevailing theories: *SciAm* 240.3:90-93 (vs below §E1 !! & *DIO* 21 ‡9 §A1). Such impure speculation, *citing no ancient supporting testimony*, ignores brilliant Greek achievements to the limit of pretelescopic possibility. E.g., measures of the Alexandria-to-Meroë terrestrial arc by odometer & solstitial noon solar altitudes at those cities found in 300 BC an Earth-circumference correct within 1% (‡4); eclipse analysis (R.Newton *Crime of Claudius Ptolemy* p.174 Fig.VIII.2; Plutarch *Mor* 923) fixed lunar distance within 2% (59 Earth-radii [*Almajest* 5.13] vs really 60); Mars' mean motion (*Almajest* 9.3) was found (by stationary points: Neugebauer *HAMA* 1975 p.390) to c.1'/100^y (*AmerJ.Physics* 55.3:237; *DIO* 11.3 ‡6 fn 26); solar diameter was correctly observed (*DIO* 20 ‡1 eqs.8-9) by Archimedes to be 30'±3'. Obvious problem: **how could men who allegedly just forged data to agree with preconception have ever evolved&advanced to the above accurate measurements?**

A2 The Greek achievement that most shocks&delights is 3rd century BC's measure of the length of the synodic or civil month *M*, good to one part in MILLIONS, by Aristarchos of Samos, famous too as 1st heliocentrist. How he got both synodic&anomalous months to 1^s, and how Hipparchos later determined the eclipse month even closer (!), is detailed in the article (‡6) following this one. Question for the anti-empiricalists: were all 3 of their adopted monthlengths correct to 1^s (or better) **BY ACCIDENT?**

B Eratosthenes' Earth and His Metrological Loyalists

B1 The sore-thumb exception to cult-surety re Greek inaccuracy is an even stalwarter cult's faith that Eratosthenes (3rd century BC) correctly observed the Summer Solstice Sun 1/50th of a circle from zenith at Local Apparent Noon (LAN) in Alexandria, but overhead at S.Solst LAN in Aswan 5000 stades southward. So he figured (Kleomedes 1.10, c.370 AD) Earth-circumference *C* is 50 times 5000 or c.250000 stades, 16% larger than real *C* = 216000 stades since the royal stade was 185 meters, as serious scholars agree. But Eratosthenes' loyal mod-groupies just *ad-hoc*-shrink the stade to c.158 meters, aiming at Making-Eratosthenes-Right. (Myth exploded by table of D.Engels *AmerJ.Philol* 106.5:309, 1985.) Yet runty-staders forget there were *two* (not 1) common standard ancient *C* values: Eratosthenes' too-high 3rd century B.C 256000 stades (*DIO* 14 ‡1 eqs.10-11) and Poseidonios' too-low 1st century BC 180000 stades (Strabo 2.2.2.) A lethal bar to stade-flexing is: if, to improve 256000 stades' fit to reality, one chooses a sub-185m stade, that will degrade 180000 stades' fit. And vice-versa. Irony: after centuries of cultists rigging the stade to force an Eratosthenes fit, we find (*Griffith Observer* 82.8:9-16, 2018) BOTH Eratosthenes' & Poseidonios' *C*s are explained *within 1%* by accounting for *atmospheric refraction's* effect on Earth-gauging light-experiments using the Pharos lighthouse. Poseidonios' *C* was dominant for 1000^y +, even used by Columbus in 1492. (So America's discovery was partly due to ancient innocence [§B2] of atmospheric refraction!) Though both Greek *C*s were off by serious factors (6/5 & 5/6), their 1% *precision* proves high engineering skill.

That double-match's dependence on the 185m stade is final proof of the value's reality. Its origin is likely based on a 300 BC Ptolemy I survey: see previous article ‡4.

B2 Another irony: Eratosthenians have never perceived that the Alexandria-Aswan 5000 stade gap in latitude *L* (which their apologia aim at alibiing the putative inaccuracy of) is *precisely accurate angularly*, as is Aswan-Meroë's 5000 stade gap (*DIO* 16 ‡3 §C; Strabo 2.1.20&5.7). By Eratosthenes' scale (*idem*) both gaps are 5000 stades/(700 stades/1°) = 7° 1/7, fitting to c.1' these cities' resp real latitudes: 31° 12', 24° 05', 16° 57'.

Confused by mean 1° errors in astrologer Ptolemy's *Geographical Directory*, scholars knew none of this ere 1982, when statistical studies (*Isis* 73:263 n.17; *PASP* 94:367 Table V's *y*-solutions; confirmed: *Centaurus* 27:280-310, 1984, *J.Astr.History&Heritage* 17.3:326-338, 2014) consistently found all 4 Greek 295 BC-159 AD astronomers, whose star data survive at *Almajest* 7.3&5-8.1, fixed latitudes to c.1' (*DIO* 22 ¶3 Table 2.)

B3 No attested anciently adopted obliquity was close to the actual value in Hipparchos' time, $23^\circ 42' 7''$. But 87^y ago (7/8 of a century), the eminent philologist A.Diller discovered (*Klio* 27:258-269) that about a dozen Hipparchan data, preserved by Strabo, showed Hipparchos' final observed&adopted obliquity was $23^\circ 2/3$. If obliquity was determined by the standard solstitial method (*Almajest* 1.12), then, accounting for atmospheric refraction, the result when ancient-conventionally rounded to the nearest 5', would equal $23^\circ 40'$, confirming Diller's discovery. Starting in 1982, scientists (not historians) statistically analysed the Ancient Star Catalog, Hipparchos' *Commentary*, & Pliny's circuli: all confirmed $23^\circ 2/3$ obliquity (*DIO* 4.2 p.56 fn 9). At *DIO* 16 ¶3 fn 50 & Table 1, DR proved Diller's theory fit all 14 Strabo-attested data, **even ones Diller didn't know of**: classic fruitfulness. History-of-science smears (Neugebauer *op cit* p.734 n.14) Diller's ideal success, promoting pals' theories instead (e.g., *idem* and *ibid* pp.304-6, 334-335), whose schemes fit under 1/2 of Strabo's data; including least-squaresless Jones (*JHA* 33.1:15-19, 2002) whose proposal fit so poorly he didn't dare tabulate it. (Unique. Diller, Neugebauer, & Rawlins all tabulate to verify fits.) Despite the Diller-DR theory's obviously superior — indeed flawless — success, **not ONE historian-of-science has ever agreed to it in EIGHTY-EIGHT YEARS**. Given capo-Gingerich's hatred (www.dioi.org/jm03.pdf fn 5) of DR and amity (¶8 fn 3; www.dioi.org/ja00.pdf fn 177) with DR-enemy NGS, his silence is no shock.

C Eclipse-Based Stars & Three Miracles

C1 The most prominent brief for bad ancient data, **two consecutive Pb articles** (J.Evans *op cit* p.259 [*JHA* 18:155-172&233-278]), cited 2 **atypically** awful celestial longitudes Hipparchos got (*Almajest* 3.1) by measuring Spica's angular distance from the Moon at mid-eclipse (180° from the Sun) 146 BC Apr 21 & 135 BC Mar 21. Errors were huge, 33' each. Evans tested the method himself via cross-staff, using 1981 Jul 16's eclipse to place star λ Sgr, finding longitude "too small by about 40'" — "on examining my notes from that evening" (*JHA* 18.4:275 n.50, 1987), notes which have eluded inquirers for decades (¶10 §B7). But hold! **All 3 errors are larger than the Moon** (mean diameter 31'), so in no case did the reported lunar disk even touch the real one. Is this credible, human eye acuity being better than 1', and Hipparchos' other lunar errors being merely $0^\circ .1$? Can one believe an outdoor observational error exceeding **the entire lunar diameter** even once — much less a triple-miracle? (A prime proof that sphtrig was in use in the 2nd century B.C., is Hipparchos' application of tables of lunar parallax, which still survive at *Almajest* 2.13. Top evidences for sphtrig's 2nd century BC currency: www.dioi.org/cot.htm#mmsz.) The Moon is the sole natural celestial body so nearby that the naked eye discerns diurnal parallax, the difference between the Moon's topocentric position (seen from Earth's surface) vs a computed geocentric position (seen from Earth's center, viewpoint of ancient tables and modern computers). Parallax tables give the difference so observed places are compared to computed geocentric ones, with parallax added. **But it is easy to instead subtract the tabular parallax by mistake**. Testing that theory on the 3 Evans-adduced observations in question: Hipparchos would pre-calculate mid-eclipse-time from his lunisolar tables; and, by 1981, eclipse mid-time prediction was in the newspapers. Reworking the data presuming Hipparchos&Evans mis-signed parallax: the errors, supposedly $-33'$, $+33'$, & $-40'$, instead drop to $-2'$, $+1'$, & $+2'$ (*DIO* 16 ¶1 eqs.6-8 and fn 22). Like Hume's *On Miracles*: were natural laws of vision suspended for 3 occult events; or: do humans occasionally err? (**NB**: Other cases of alleged antique errors or crudeness **that are just moderns' errors**: ¶10 §B11; www.dioi.org/j130.pdf §§G4&L-M; www.dioi.org/jg00.pdf; ¶1 §A & ¶2 §§B2-B4.)

C2 Though Ptolemy's fraudulence is by now general knowledge among historians of science, their fear of blackball by Gingerich's boy Jimmy Evans, *JHA* Editor, keeps most mute on the point. Evans is apparently proud to be The Bulwark (www.dioi.org/ju00.pdf §§F9-F10) preventing his field from advancing to a realistic grasp of Greek astronomy. His exclusive priority instead: kissing unto death the brains of his Ptolemy-worshipping sponsor, institutional-pawn Owen Gingerich, going along with the establishment lie that Ptolemy was "The Greatest Astronomer of Antiquity", in order to continue an anti-truth phony war, just to fake establishment infallibility & deny credit to heretics. For another NGS fake-controversy & promotion of one more liar: www.dioi.org/ja00.pdf ¶21 [p.105].

C3 Too many of the most prominent historians (incl. a MacArthurian & *JHA*'s Editor) deem ancient equinoxes more accurate than solstices (standard confusion of precision with accuracy: Newton *op cit* pp.81-82), claiming nil north-south solar motion prevents accurate solstice time-determination: Swerdlow 1979 *American Scholar* 48:523-531, p.527; Evans 1998 *History & Practice of Ancient Astronomy*, Oxford U, p.206. Contra the obvious: if one tosses a ball straightup & catches it 4^s later, a child knows it peaked at 2^s (*DIO* 1.1 ¶5 fn 20; *DIO* 20 ¶2 eqs.5&21, Table 3, & §§D-J). Unfamiliar with the **science** of equal-altitudes (e.g., Bowditch *Navigator* 1981 ed. vol.2 p.799; *DIO* 20 ¶2 eqs.5&10-21) **historians-of-science are HISTORICALLY naïve too** (classicist-mathematician Gerald Toomer the commendable exception), since **all known Greek scientists found yearlengths via solstices not equinoxes**: Meton, Euktemon, Kallippos, Dionysios, Aristarchos, Hipparchos, Astronomical Cuneiform Text #210 (sources for each at www.dioi.org/jm02.pdf, fn 11). Hipparchos' 14 Rhodes equinoxes show: scatter 2^h; systematic error 7^h (Britton 1967 Yale U diss. p.24; Newton *op cit* p.78; *DIO* 20 ¶2 §B4), all but ordmag 1' from non-observational factors (*idem*), **none degrading solstices** found by equal-altitudes: measuring the apparent noon Sun's altitude a few weeks ere solstice, waiting for the noon Sun to return to that altitude, then taking the mid-time as solstice (*DIO op cit* eq.5). Before&after systematic errors are of virtually equal size but opposite sign and therefore cancel each other. Newly translated papyrus *P.Fouad* 267A bears a Hipparchos 158 BC Jun 26 18^h solstice typically correct to ordmag 1^h. Reconstructions of solstices of Kallippos, Aristarchos, & Hipparchos show errors of just 1^h-3^h (*DIO* 20 ¶2 Table 3).

C4 At *Almajest* 5.15, geocentrist-nonastronomer Ptolemy put the Sun 1210^f (Earth-radii) away, affecting 10^f precision. Uncertain solar distance became order-of-magnitude's historical origin, as real scientists rounded it to the nearest power of ten in Earth-radii: 100^f Eratosthenes (*DIO* 14 ¶1 eq.11; Carman & Evans 2015 [attributionlessly expanding a *DIO* footnote into a 16pp *Isis* lead article: *DIO op cit* fn 6 & eq.9; *DIO* 22 ¶1]); 1000^f Hipparchos (*DIO* 1.3 ¶9 eq.23); 10000^f Aristarchos-Archimedes (T.Heath *Works of Archimedes* [c.260 B.C.] Cambr U 1897 p.232; *DIO* 14 ¶2 eqs.13-15) & Poseidonios (Neugebauer *op cit* p.656 eq.16). Vision expert (I.Thomas *Greek Math Works* 2:2-3 [LCL]) Aristarchos, knew human ocular acuity is ordmag 1/10000th radians; so diurnal parallax's invisibility (esp. at Mars stationary points) was convincing evidence the Sun's distance was at least 10000^f: see Heath *loc cit*). (Really 23000^f, so the ancients' ordmag was right.)

D Aristarchos' Grasp of "Newton's 1st Law" & Distance to the Stars

D1 To see that geocentrists' Aristotelian objections (e.g., *Almajest* 1.7; Toomer 1984 p.45) to heliocentrism were invalid & that all planets could keep moving forever, required [as DR realized 2022/1/8] Aristarchos' **3rd century B.C.** understanding of "Newton's" 1st Law: inertia of objects. **Including planets**. (Actually Hooke's [re]discovery **2000^y later**.) Geocentrists also rejected heliocentrism for implying stars' unobserved annual parallax. (All 5 planets' **MUCH-HUGER** annual parallax had made no impression on ancient geocentrists. **NOR on some prominent modern historians**: *DIO* 1.1 ¶7 §F.) Aristarchos' reply: stellar parallax was there, but it was invisibly small from stars' remoteness, which, again applying vision's limit, must be at least 10000 Sun-distances, or Astronomical Units

(AU). Multiplying this by the above parallel finding that the AU was at least 10000^f: the stars must be at least 10000-squared or 100000000^f distant. Crudely: given that annual-parallaxless-Ptolemy's stellar distance was order-of-magnitude 10000 Earth-radii (Van Helden 1985 p.27), the heliocentric universe's width was ordmag 10000 times greater than geocentrists'; volume, greater by 1000000000000, a trillion.

D2 Historians-of-science treat antiquity's *central* astronomer, Aristarchos — pioneer-heliocentrist & (§A2) month-measurer to 1 part in millions — as fringe and an incompetent fabricator (DIO 14 ‡2 §§A1, A3, & A6) —

perhaps projection at its funniest.

Such slander's basis is "On Sizes&Distances of the Sun&Moon" (supposedly written by him), which makes Sun&Moon 2° wide & implies unrealities like lunar eclipses lasting half a day (Neugebauer 1975 p.642), even (**unnoted for 2000^y**: DIO 14 ‡2 §§C1[e]&C3) as seen from Greece or any other Mediterranean site:

the Moon every day visibly RETROGRADING briefly among the stars!

But Archimedes said (Heath *op cit* p.223) Aristarchos' lunisolar diameter was 1°/2: correct & 4 times smaller than "Sizes" claimed. Why the 4-factor trigger for historians' abuse of him? Simple: the pedant pseudo-Aristarchos who concocted "Sizes" says (T.Heath *Aristarchus of Samos* pp.352-353) the lunisolar diameter is 1/15th of a *part* of the zodiac, thinking "part" = a zodiacal sign, 30° wide. But the real Aristarchos he copied from meant an ancient angular unit: "part" (μερος) = circle/48 or 7° 1/2 (Neugebauer *op cit* pp.652&671); 1/15th of that is 1°/2, in accord with both reality & Archimedes.

E Separating Real & Mythical Ancient Science

E1 The myth of unempirical Greek science endures from confusion of ancient pseudo-science with the real thing, to try alibiing the error-enormity of Ptolemy's fabrications by (*SciAm* 240.3:90-93, 1979) decreeing it normal Greek science to report only data agreeing with prevailing theory: self-evidently impossible (§A1) & contrary to well-known ancient science, since Hipparchos reported data jarring with his theories and *even with each other* (*Almajest* 3.1, 4.11, 6.9). Typifying the gulf between fake&real ancient science: the 4 allegedly outdoor Sun "observations" (*Almajest* 3.1&7) by history-of-science icon & astrology-bible author C.Ptolemy, "The Greatest¹ Astronomer of Antiquity" (Neugebauer *op cit* p.931 [pure grantbeg-hype], echoed verbatim by Gingerich, *Science* 193:477 & *Isis* 93.1:70) are **50 times closer to places calculable indoors** from Hipparchos' 280^y-old tables (*Almajest* 3.2&6) than to the real Sun's outdoor-sky positions, so their errors average -1°.1 (tables' mean 137 AD error: Thurston DIO 8 ‡1 ⊙1), twice Sun's diameter! Historians who think this is science are less likely to look askance at current *JHA* Editor's grossly miscalculated yet (so illustrative of cultish integrity) **STILL-UNRETRACTED** 1987 proposal (§C1) that outdoor observer Hipparchos committed comparably outré ocular errors, contra his consistent accuracy (*idem*): his equinox observations are only 3 times nearer his tables than reality (vs Ptolemy's **FIFTY TIMES**) — and even that only because the tables are, after all, based upon his own slightly imperfect outdoor observations.

E2 The astronomical&geographical fumbblings of occultists have nothing to do with the brilliant work evaluated here & should never be melded or confused with it. Hopefully the foregoing's separation&revelation of genuine ancient science will encourage future historians' realistic&grateful appreciation of Greek astronomy, man's 1st attainment of precise prediction — the mark of mathematical science.

¹No historian-of-math on Earth is demented enough to contend that Euklid was "the greatest mathematician of antiquity" (*Isis* 93.3:500-502). Re fellow-handbook (www.dioi.org/jm01.pdf §T) author Ptolemy: what makes the Gingerich-Evans-*JHA* cult such Special Children? Not so naïve: the 1st competent translators of Ptolemy's *Almajest* & *Geographical Directory* entitle each a *HANDBOOK*.