

## ‡4 Timocharis of Alexandria & the 185-Meter Stade

Empire Surveyor&Astronomer for Greek Pharaoh Ptolemy I?  
 The 1<sup>st</sup> Measurer of Earth's Circumference to 1% Accuracy?  
 185 Meter Stade: Among Top Ancient Science Achievements  
 Cascadingly Speculative Exploration of Empirical EoGeodesy

### A The Alexandrian Royal 185-Meter Stade's Origin

**A1** We know ancient Greeks measured large distances in “stades”, but: just how big was a stade? To find out, we start by jettisoning the flexibly *ad hoc* a-musings of the mod groupies who insistently (§B2) burden-curse Wikipedia with advocacy that Eratosthenes' Earth-size *WAS-SO* right, because his seeming overestimate couldamusta been an illusion due to his use of a shrimpy “Eratosthenian” stade of something near 158 meters. (See *DIO 6* ‡1 fn 47.) In blessed contradistinction to such ravings, we gratefully note: it's long been agreed among virtually all serious scholars that the size of the stade used during Alexandria's 3<sup>rd</sup> century BC golden age of science was the 185 meter “Attic stade”. Which, by the way, we'll see below should henceforth be called the “royal stade” or something like.

**A2** Only recently (*DIO 20* ‡1 fn 2) has the search for the origin of the 185 meter stade found an explanation which, though clearly speculative, is [1] consistent with the history of metrological standards we know were invented by other nations&epochs (§A4); [2] is based upon a chain (§A3) of completely conventional arithmetical divisions, where the basic 1<sup>st</sup> link is explicitly&repeatedly cited (*idem*) in antiquity; [3] is the only available explanation of the 185m stade's origin.

**A3** Our new theory's hitherto-neglected launching-attestation is found at Strabo 2.5.7 & Geminus, & etc, etc, etc (see O.Neugebauer *HAMA* 1975 p.590 fn 2): Eratosthenes & others divided *C* into **60 parts, not 360**. Since Greek math fractionated sexagesimally, it's remarkable that no one prior to 2012 ever took up Strabo's cue & kept right on dividing  $C = 40000000\text{m}$  according to well-known Greek convention: again by 60, & again by 60,

**WHICH YIELDS 185 METERS.**

**A4 Provocative?** The suggested origin attains further plausibility when we realize the modern meter & nautical mile were created *by just the same approach*, the meter defined decimally as  $1/10000000^{\text{th}}$  of the Equator-to-Pole meridian arc: so 1 meter  $\equiv C/4/10/10/10/10/10/10/10$ ; the nautical mile (nmi) is defined as  $1/60^{\text{th}}$  of a degree, itself  $1/360$  on the Earth's sphere, therefore  $1 \text{ nmi} \equiv C/360/60 = C/21600 = 1852 \text{ meters}$ , &  $1 \text{ stade} \equiv C/60/60/60 = C/216000 = 185 \text{ meters} = 1 \text{ nmi}/10$ .

### B Retro Royal Regularization Vs Madly Modly Motley

**B1** Throughout this exploration, we should keep in mind that Ptolemy I Soter (“Savior”) was one of history's most determined royal patrons of learning. Emperor Ptolemy [a] turned out a history of Alexander's & his own bloody<sup>1</sup> wars, [b] established the city of Alexandria

<sup>1</sup>A question with no clear answer, even for one who takes a side: the wars of Alexander & his general Ptolemy killed and enslaved many thousands of humans. Are their wars' passing collateral horrors ultimately justified by the fact that grand science, with its manifold long-term benefits, grew from those crimes' collateral loot-profits & technical advances?

on a permanent basis, [c] probably conceived the Pharos Lighthouse that was eventually realized by Sostratos, [d] founded the Museum to promote high scholarship, and [e] not only started the Library but is reputed in (presumably-exaggerated) legend to have raided ships arriving in Alexandria harbor, in search of books for the Library, copying anything found, then allowing the ships to leave port with only the copies!

**B2** The theory that such an ambitious ruler could have ordered a scientific survey is reasonable; though, if so, it is curious that no direct account of it has survived. But are there nondirect indications of such a survey? Aside from his empire's regularization of the 185m stade itself, we have the (formerly DIO-spurned) Kleomedes 1.10 account (& Claudius Ptolemy's *Geographical Directory* 1.3.2-3), with the Sun overhead in Aswan at Summer Solstice Local Apparent Noon (LAN), while the Sun is  $1/50^{\text{th}}$  of a circle from the zenith at SS-LAN in Alexandria, 5000 stades further north, Eratosthenes reasoned (by proportions on a sphere)  $C$  is 50 times larger, or 250000 stades (actually 256000: §B4). Modern Eratosthenesians remain oblivious to airbent-light-affected measurement's 1%-agreement with Eratosthenes' 19%-too-high  $C$  (www.dioi.org/g828.pdf, *Griffith Observer* 2018, **thereby utterly eliminating any need for §A1's stade-scrunching**), to *odd-hoc-rig* a fit already thus precisely achieved **without cheating**. (Those gel-bent on meshing his  $C$  with reality by tampering with the stade's length, are too narrowly-focused even to notice a valuably informative adjacent circumstance: 5000 stades is **angularly** right-on [§§C4&C6] for the Alexandria→Aswan latitude interval.)

**B3** §B2 is a semi-mythical version of the actual standard method: ground-measuring a North-South arc of the Earth, computing  $C$  via multiplying by  $360^\circ$  & dividing by the astronomically-measured difference between the geographical latitudes  $L$  of the arc's 2 ends (applied: §C7). Note that the Kleomedes legend reflects just the way ancient professional-level engineers would do the job: find latitudes within  $1'$  by measuring the altitude of the SS-LAN Sun, which in the region we're considering is *only negligibly affected by atmospheric refraction*, thus it's ideal for finding a  $C$  with **minuscule systematic error**, unlike the 2 later (§B4) widely-used  $C$  values, which became so dominant that  $C \equiv 216000$  stades (§A4) was overwhelmed & soon so-forgot we have no direct record of it. We've examined elsewhere (*Griffith Observer* 2018 *op cit*) why these 2 values were so attractive. So precise. So simply-found. So erroneous.

**B4** A potential reason for the disappearance of  $C \equiv 216000$  stades — which is correct-by-definition (as is 40000000 meters) — is that once Ptolemy I's laborious survey had established its metrology, the most brilliant Hellenistic scientists designed 2 mathematically cleverer & physically efficient  $C$ -gauging methods, each ingeniously using Alexandria's Pharos lighthouse, resulting in 3<sup>rd</sup> century BC Sostratos'  $C = 256000$  stades & 1<sup>st</sup> century BC Poseidonios'  $C = 180000$  stades, as derived in *Griffith Observer* (*op cit* 2018) via the 185m stade: **conclusive evidence at last of 185m's Greek adoption**. Both Pharos-based techniques efficiently gauged Earth with little physical labor & *thus could be repeated as often as one liked*, while a vast survey had neither advantage. Such factors ensured rapid post-300 BC submersion of the accurate survey-based 216000 stades in favor of finding  $C$  by a way which though convenient was infected with large atmospherically-caused errors. *It shouldn't escape notice* that Eratosthenes' attested (§A3) advocacy for dividing  $C$  into 60<sup>ths</sup> **connects him** (*idem*) to the 185m stade, indicating that the 185m yardstick was already the official Alexandrian unit of macrogeography by his time. But tying him to the standard 185m stade argues that *there never was* a 158m "Eratosthenian" stade in his era. Or ever.

**B5** No doubt there were various local stades used here&there before Ptolemy I regularized the Empire's metrology, and it is unfortunate that this motley collection has modernly caused so much confusion by those who wish achronologically to apply such to Alexandria. By analogy: we all know that when navigators and geographers invented the nautical mile (§A4), they made an ordmag 10% alteration but retained the term "mile" because the difference between nmi and statute mile was not huge. Presumably the same idea occurred to Ptolemy I Soter for the stade.

## C Expert Astronomical Surveyors Timocharis' & Philo's Achievement Vs Eratosthenes & Poseidonios' Tragically Efficient Undoing of It

**C1** We don't know just when high surveying accuracy was achieved, but Giza proves indeed it was very early, since the Great Pyramid's sides are mostly within  $c.1'$  of perpendicularity, the whole structure celestially oriented N-S-E-W within  $3'$ , nearly 5000<sup>y</sup> ago! (See www.dioi.org/g835.pdf, *Griffith Observer op cit* 2018; *DIO* 13.1 pp.2-3 & ‡2.)

**C2** Who supervised Ptolemy Soter's 300 BC survey of his empire? The only name we have from that epoch who did astronomy and applied it to finding geographical latitude was Timocharis, whose observations of stars, Moon, & Venus are found at *Almajest* 7.2-3&10.4 (earning him a portrait-niche on the wall of Tycho's observatory 1900<sup>y</sup> later). Also Philo, who observed solar altitudes at Meroë at this time (Strabo 2.1.20).

**C3** Three ancient Alexandrian astronomers left us star-declination data: *Almajest* 7.4. It was not realized until 1982 that their data show all 3 knew their geographical latitude  $L$  to ordmag  $1'$  (*Isis* 73:259-265 fn 17). And in 1994 it was found (*DIO* 4.1 ‡3 §F6) that, of the three men, Timocharis alone knew *exactly* the  $L$  of his home-base, Alexandria:  $31^\circ 12'$  (*DIO* 22 ‡3 Table 2), suggesting he was a master of the type of ringed metal instruments appropriate for a survey.

**C4** It is reasonable to assume that accurate observations by Timocharis at Alexandria and Philo at Meroë were the basis for Strabo 2.5.7 correctly saying that the latitudinal distance between the two sites was 10000 stades, remarkably correct for a round figure, since for 700 stades/degree the corresponding latitude difference is  $14^\circ 17'$ , vs actually  $31^\circ 12' - 16^\circ 57' = 14^\circ 15'$ . This impressive accuracy lay unnoted until 2009: *DIO* 14 ‡3. (Centuries of *distance-fantasizing* re the nonexistent 158m "Eratosthenian stade" diverted from the interval's neat *angular* latitude-match.)

**C5** Did Ptolemy I order his new empire surveyed? Martianus Capella *De Nuptiis* 598 (c.420 AD) wrote of "King Ptolemy's surveyors". Their geographical arc (§B3) could've *extended essentially unimpeded* from Alexandria south along its meridian,  $29^\circ .9$  E, until it finally encountered a Nile tributary at a latitude virtually equal to Meroë's (but very slightly further south of that city). The arc could have been measured for distance by a large-radius camel-drawn odometer-wheel & for latitude-degrees via celestial sightings using the sort of metal meridian transit-circle described at *Almajest* 1.12 (illustrated: Toomer *Almagest* 1984 p.61 Fig.C).

**C6** Greek scientists knew to  $c.1'$  the latitudes of Alexandria, Aswan, & Meroë & that they were spaced at 5000 stade intervals (§C4) which at 700 stades/degree (§C4) is  $7^\circ 1/7$  or  $7^\circ 09'$ . The actual latitudinal gaps are close, resp,  $7^\circ 07'$  and  $7^\circ 08'$  or 789 km and 790 km. (We here account for Earth-nonsphericity. Though Earth-circumference  $C \equiv 40000$  kilometers by definition [§A4], the ellipsoidal Earth's N-S curvature in the Alexandria-Meroë region fits a circle of radius 39900 km. Note: since Aswan&Meroë are east of  $29^\circ .9$  E longitude, odometer-measuring latitudinal differences on the Alexandrian  $29^\circ .9$  E meridian would've obviously required using points [on the  $29^\circ .9$  E meridian] west of Aswan&Meroë, confirmed by transit observations to be at exactly those cities' latitudes.)

**C7** Such hard-wrought data easily finds  $C$  (§B3) via  $C = 360^\circ / (14^\circ / 4) \cdot 1579$  km = 39900 km. (Of course, ancients wouldn't have used meters or kilometers!) The surveyors' triple-division by 60 (§A3) then created a brand-new Royal Stade of 185 meters.

**NB:** If the measure of  $C$  were off by even 1%, the new stade would differ by  $c.2$  meters.

**C8** Historians-of-science are D&D (§11 §D2; www.dioi.org/jL09.pdf §A) to demonstrable (§C3) high ancient accuracy; yet they have nothing at all to put in competition with *DIO*'s theory of the 185m stade's origin. Thus, that theory stands unchallenged in implying a 300 BC Earth-size measurement that was correct to 1%, Ptolemaic passing establishment of which should be remembered as one of ancient science's pinnacle achievements.

**C9** But *progress is not necessarily forever* — as we have seen all too convincingly here (§B4) from the fate Eratosthenes&Poseidonios' dilettantism visited upon genuine scientists

Timocharis&Philo's knowledgeably accomplished & unprecedentedly accurate measure, *very nearly burying*<sup>2</sup> *that epochal feat* **FOR ALL TIME**. Analogously, after more than a century of science's progressively greater appreciation of Charles Darwin, over 1/2 the US population rejects him, including tens of millions of religious nuts who aim at expunging him — so he's still substantially taught in few US highschools. (In Europe, there's no such creationist-created stigma against Darwin.) Likewise, after centuries of astronomers' expertise (J.Delambre, C.Peters, R.Newton) has exposed astrologer-occultist Claudius Ptolemy's suffusive fraudulence, a gang of innumerate "History-of-science" politicians has (with knowing winks from the scandal-averse American Astronomical Society and — for ultimate irony — the American Association for the ADVANCEMENT of Science: ‡8 §A1) wiped that wisdom off the map for the better part of a century.

### **Is any human achievement ever permanently safe from humanity?**<sup>3</sup>

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<sup>2</sup>The Timocharis-based 185m stade, divided into 600 more-convenient feet, must have been adopted long enough, before the Sostratus-Eratosthenes re-measure of *C*, that it would have been too much trouble to shift everything to a new stade based on the later *C*. Which is indeed fortunate, since had there been such a shift, we probably *would never have even have known* of Timocharis' dedicated, scrupulous, epochal achievement.

<sup>3</sup>See "Subtractions From the Sum of Human Knowledge", *DIO 30* (2021) = [www.dioi.org/ju00.pdf](http://www.dioi.org/ju00.pdf) .