\section{Hipparchos’ Eclipse-Based Star Longitudes: Spica & Regulus}

His 3 Worst Ref-Star Longitudes & 3 Eclipses ⇒ 3 Neat Fits

2nd Century BC Spherical Trig, But No Equation of Time

Muffioso Toomer’s Hipparchan Lunar Distance Verified

Muffia-J.H.A. Pb-Papers Reincarnate Ancient Muff

Classic Coherent Historical-Theory Fruitfulness

A Klan-Klod-Klue

A1 Among the numerous\(^1\) gymnastic hysterical-astronomy pratfalls enlivening JHA’s hefty (64 pp) James Evans 1987 double-lead-paper attack\(^2\) upon (then-minority) Ptolemy-doubters was JHA Assoc.Ed.-to-be Evans’ lordly illustration of their dumb overestimation of ancient ocular accuracy. To illustrate his point Evans 1987 n.50 (p.275) presents his own non-telescopic (cross-staff) 1981/7/16 Seattle observational determination of the longitude of a star (\(\lambda\) Sgr) by using a lunar eclipse (as Hipparchos had) — which after Evans’ reduction produced a longitude erroneous by \(-2^\circ/3\), thus according to him (\textit{idem}) showing that the huge errors in some ancient observations were so ordinary that such were a poor basis for learning anything about ancient science. As further examples, Evans specifically mentions (\textit{idem} & p.235) Hipparchos’ two hugely disparate Spica data (explained below: \(x\)B) which disagree by over \(1^\circ\). He then draws for us a Muffioso lesson (emph added): “\textit{No better demonstration could be wished} of the uncertainty attached to the method\(^3\)” of fixing stars’ longitudes by eclipses. However, when instructor Evans repeats the very same sermon (on Hipparchos’ eclipse-star errors) \(11^\text{th}\) later at Evans 1998 p.259 (“This shows the size of the possible errors in ancient measurements of absolute star longitudes”), he slyly deletes mention of his formerly prominent 1981 eclipse-star measures — which shows that (during the 1987-1998 interim) Evans had read Rawlins 1991W fn 288 (below: \(\S A2\)) and therefore learned that Evans’ and Hipparchos’ errors WERE NOT OF MEASUREMENT BUT OF BASIC SPHERICAL-ASTRONOMY MATHEMATICS (an embarrassment explained below at \(\S A2\)). I.e., when ineducable educator Evans’ 1\textsuperscript{st}-hand evidence somersaults, \textit{he just pretends he was right anyway}, unable to admit DIO scored & “premier” JHA bellyopped: standard JHA honesty and inquiring empiricism. All of which sets up an irony whose fruitful blossoming is the present paper’s main subject.

A2 As just noted: said irony’s core was revealed\(^3\) in Rawlins 1991W fn 288. Contra Evans, neither his own nor Hipparchos’ problems were observational. Both simply miscalculated the reduction of valid observational data by using invalid math: the \textit{wrong sign} for their parallax corrections. For the 1981 Evans case, at mid-eclipse, the longitudinal lunar parallax \(p_\lambda\) was virtually \(1^\circ/3\). So Evans’ sign-confusion created a huge net error because, whereas longitude parallax \(p_\lambda\) (the difference between topocentric [observer-centered: outdoor-visible] and geocentric [indoor-tabular] longitude: eq.2) is obviously supposed to be \textit{ADDED} when converting a calculated geocentric lunar longitude into a topocentric (observer-centered) longitude, Evans instead \textit{SUBTRACTED} it as if reducing

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1. See also \textit{DIO} 3 \S 8 & fn 95-97, and \textit{DIO} 4.1 \S5 \S A. Funnier yet: www.dioi.org/cot.htm#scsp.
2. Typical of the modern Ptolemy salescorps, JHA Assoc.Ed Evans makes his attacks on DR only in captive arenas (safe there from reply or debate), while never citing any external source correcting his mis-science. Similar integrity: \S3 fn.56. On error-admission fear: \S4 \S G2; www.dioi.org/nottom.html#frgs.
3. Rawlins 1991W’s math has been verified in detail by Hugh Thurston and John Britton. We thank both for an arduous, specialized task.
an outdoor topocentric observation to find geocentric longitude. Thus the sign mixup would naturally cause an error of about \(-2^{\circ}/3\) or \(-40^\circ\) — and the laughably impossible "observational" longitude he reports is indeed (Evans 1987 p.275 n.50): “too small by about 40°”. (Typically, Evans has had no comment since, despite DR [South Bend, IN, 1997 June, face-to-face] and Hugh Thurston [by letter] gently bringing the matter to his attention).\(^4\) After correcting for this Muff, we can verify the admirable smallness of the 1981 observational error of Evans (a dedicated student of ancient instruments and possessor of a steady hand, since the cross-staff requires it): merely one or two arcmin — just the sort of accuracy DR has consistently\(^5\) ascribed to the best-accepted naked-eye observations.

A3 Only a scholar catering to modern Hist.astron’s cult-klan could straightforwardly propose that a 2\(^{\circ}/3\) nearly triply the loose 2\(^{\circ}/3\) is observational and so by implication helps excuse the tight adherence of Ptolemy’s “observations” to indoor-calculations (i.e., frauds) while disagreeing hugely with the outdoor sky.

A4 Note that a major author of Ptolemy’s fake’d “observations” (Almajest 5.12-13) is also off by 2\(^{\circ}/3\). (See discussion at R.Newton 1977 pp.182-191. Also DIO 8 §1 fn 13.) Scribbling a drawing will give one an idea of how ridiculous this is: mislocating a disk so grossly that the real and theoretical disks (1/2 wide in these lunar cases) don’t even come close to overlapping,\(^6\) the very feat Evans misclaimed he’d personally achieved in 1981 and is now too embarrassed and too steeped in Mufa academic integrity’ to retract.

A5 NB: After the three-fold (§A6) now four-fold (§F3) collapse of Evans’ implicit alibis (Hipparchos’ eclipse-stars & his own: §A1) for Ptolemy’s huge “observational” errors, the Muffa of course hasn’t abandoned its support [see §A1 sermon for the same old Ptolemy-worship the alibis were designed for. (Which figures, since evidence has little to do with that cult’s belief-system.) It hasn’t occurred to Muffosi (whose strong points don’t include philosophy of science) to ponder a simple question: if devotion to our favorite positions keeps leading us into embarrassing crankpot-level muffs, §A1 & DIO 2.3 §8 §§C10-C15), does this not suggest that said positions are less than completely secure?\(^7\)

\(^4\)Both inquirers were told by Evans that he would look into it. But he never communicated what he found. Except by implication: the deft Evans text-surgery cited at §A1 fn 7.


\(^6\)Rawlins 1987 n.50’s misadmonishment (§A1) is repeated in his later book: Evans 1998 pp.256-259; but this (post-DIO 1.3 fn 288) Spica sermon quietly avoids discussion of his Seattle observation of the 1981/7/16 eclipse in this connexion (just photo at p.48, 100s of pages distant from his Hipparchos-Spica comments), shifting attention instead to the previously unadjudged eclipse of 1977/3-4, seen from Spokane. (Why must Evans go back 21\(^{\circ}\) for a “recent” “Ibid p.256” eclipse [mildly reminiscent of a Ptolemy ploy: www.dioi.org/cot.hm#cknh], considering that Evans 1987 went back merely 6\(^{\circ}\) to find a usable eclipse? Implication: 1977 is ere 1981, and JE here has his sigmamanship OK at last, so: seeee, he knew how to do it all along. The catch: unlike at Evans 1987 n.50, no 1977 data are reported as outdoor-measured by Evans, though he repeatedly [Evans 1998 pp.256-257] speaks of “observations” or “observed”.) So he knows he screwed up the 1981 eclipse’s parallax-sign, but CAN’T admit that (§A2) DIO corrected it for him. (Note contrast to, e.g., DIO 2.1 §4 fn 18 & DIO 11.2 cover.) Or admit the falsity of his alibi-for-silence-on-errors pretense (DIO 9.1 §2) of not reading DIO. (Had he faced reality on Regulus at Evans 1998 p.259f, he could’ve made the present Regulus discovery himself.

\(^7\)More wages of shunning. For Evans’ citation-practice integrity, see §3 fn 24. (NB: This chauvinist lawyer-for-Ptolemy [www.dioi.org/cot.hm#nmur] & ft. H. Thurston [by letter] is heedless of the JHA’s M.Hoskin, hist.astron’s own Lord Sommers [DIO 2.3 §1 fn 18], Who’ll dispute the aptness? Another corruptive consequence of a cult’s living with the shame of knowing that its sacred mission — for centuries with an obvious inherent problem: 0\(^{\circ}\) longitude is the location of a solar event and the stars are invisible when the Sun is visible. The best-known pre-modern method was to use the Moon (or Venus) as a stepping stone: near sunset, find the arc between Sun and Moon while the former was still visible, then find the arc between star and Moon a little later (method nicely diagrammed by Evans 1987 p.235 Fig.4,2); finally, use mostly simplistic arithmetic (Rawlins 1982C App.B) to find the arc between star and Sun. But Hipparchos also applied an ingenious alternate method, which avoids such a rickety scheme: just measure how far a star is from the Moon at mid-eclipse, when the Moon is guaranteed to be virtually (though see fn 19) 180\(^{\circ}\) from the Sun.

B2 Ptolemy tells us (Almajest 3.1) that Hipparchos used the eclipses of -1454/21-22 and -134/3/20-21 to try locating Spica. The results: 173\(^{\circ}/2\) & 174\(^{\circ}/3\), resp, a terrible disagreement — over a degree! (Remember: the lunar semi-diameter is merely 1/4 degree.) So, we now apply the parallax-sign-error theory to both eclipses.

Velikovskian boldness and correctness has re-dated the Ancient Star Catalog by ordmag a millennium is that it showed that one could prove anything with statistics. (Is the Muffa aware that the Velikovskian believes that the Almajest is a late medieval document, and that the Nabonassar epoch [747 BC for most of us] is actually from the AD era? Full information available from the Velikovskians’ least favorite mongoose, Leroy Ellenberger, 3929 Utah Str, St.Louis, MO 63116; phone 314-772-4286. See also the excellent Isis review of Fomenko’s book. A central technical flaw undoing the entire Fomenko et analysis is revealed in the 1995-added note in DIO 4.3 §14.) Yes, one can prove anything with statistics — if the sample is biased or the math misconcept. But it is up to the Muffa to show what relation such a truism has to statistical findings it loathes, e.g., Rawlins 1994L. Doubtly suspecting statistical results in general is a pathetic pose. It should be added that two expert mathematicians (K.Pickering & H.Thurston) have already checked and verified in detail the math of the 1994 paper — a paper showing that Ptolemy not only stole the Catalog but clumsily attempted to hide this theft by the very method R.Newton 1977 had charged. Yet, Muffa publications — with their usual respect for academic decency & honesty — arrogantly continue to learn nothing from these results, in order that the Mufa of course hasn’t abandoned its support of the Fomenko hypothesis of a post-Flood destruction of mankind, which agrees 50 times better (Rawlins 1987 p.236) with his indoor tables than with the actual outdoor Sun. See Thurston on R.Newton at DIO 2.3 fn 18. (NB: This chauvinist lawyer-for-Ptolemy [www.dioi.org/cot.hm#nmur] & ft. H. Thurston [by letter] is heedless of the JHA’s M.Hoskin, hist.astron’s own Lord Sommers [DIO 2.3 §1 fn 18], Who’ll dispute the aptness?) Another corruptive consequence of a cult’s living with the shame of knowing that its sacred mission — for centuries with an obvious inherent problem: 0° longitude is the location of a solar event and the stars are invisible when the Sun is visible. The best-known pre-modern method was to use the Moon (or Venus) as a stepping stone: near sunset, find the arc between Sun and Moon while the former was still visible, then find the arc between star and Moon a little later (method nicely diagrammed by Evans 1987 p.235 Fig.4,2); finally, use mostly simplistic arithmetic (Rawlins 1982C App.B) to find the arc between star and Sun. But Hipparchos also applied an ingenious alternate method, which avoids such a rickety scheme: just measure how far a star is from the Moon at mid-eclipse, when the Moon is guaranteed to be virtually (though see fn 19) 180° from the Sun.
B3 For each eclipse, Hipparchos’ method was:

[a] Measure by armillary astrolabe9 the actual longitudinal difference $\Delta \lambda$ between the star, at longitude $\lambda_s$, and the mid-eclipse Moon at observed (topocentric) longitude $\lambda'_M$:

$$\Delta \lambda = \lambda_s - \lambda'_M \quad (1)$$

[b] Compute from his tables the longitudinal lunar parallax $p_\lambda$, which is the difference between $\lambda_M$ and the Moon’s true (geocentric) longitude $\lambda_M$:

$$p_\lambda = \lambda'_M - \lambda_M \quad (2)$$

[c] Without applying the equation of time, find via Hipparchos’ PH theory10 the Sun’s true geocentric longitude $\lambda_S$ at the time (according to Hipparchos’ lunisolar theory) of mid-eclipse, which yields true geocentric $\lambda_M$ by the simple equation:

$$\lambda_M = \lambda_S \pm 180^\circ \quad (3)$$

[d] Adding eq. 1 to eq. 2 and subtracting eq. 3 produces an equation for the desired stellar longitude $\lambda_s$:

$$\lambda_s = \lambda_S + p_\lambda + \Delta \lambda \pm 180^\circ \quad (4)$$

B4 If our theory is correct, Hipparchos mistakenly subtracted $p_\lambda$ and thus found (instead of $\lambda_s$) an erroneous value which we will call $\lambda'_s$ (the “$'$” subscript signifying that this longitude is infected with wrong-sign parallax):

$$\lambda'_s = \lambda_S - p_\lambda + \Delta \lambda \pm 180^\circ \quad (5)$$

B5 For the −145/4/21-22 eclipse: the outdoor longitude difference $\Delta \lambda$ (between Spica & the Moon) at the time when Hipparchos’ indoor lunisolar theory predicted mid-eclipse (23:38 Lindos Apparent Time),11 was about $-33^\circ.8$, so he likely measured close to $\Delta \lambda = -33^\circ.5/6$. [b] Hipparchos’ PH solar theory12 placed the Sun at about $\lambda_S = 27^\circ.2/3$ at

9 Hipparchos might read a slightly different result because of Earth-spin. The systematic errors of his Ancient Star Catalog indicate that he averaged 19th of time-delay after setting the armillary astrolabe (by his reference-object) before getting the reading on his quarry-object. (See Rawlins 1991H §G4:1/3 of −13’ is about −4’.) Whether the same error held during careful, repeated eclipse observations, we cannot be sure; but it makes little difference, given the rounding roughness of ancient data.

10 See Rawlins 1991W §K10. PH theory’s tables (possible tiny discrepancy suggested: ibid fn 199) at Almajest 3.2&6; $\lambda_s$ was (similarly to the case of the Hipparchos lunar observations reported at Almajest 5.3&5) pre-computed for the tabular time of eclipse. The present results agree with Hipparchos’ consistent neglect to apply the equation of time even to lunar data, as was earlier induced on quite independent grounds by Toomer, Jones, & DR. (Rawlins 1991W §§N1&N8. To repeat the note made there at the time: we thus have no evidence of the equation of time’s use before Ptolemy.) This omission has a serious effect on calculations (which is fortunate since it allows us to be sure of the eq.time’s neglect), as do the 0th-4th amplitude (and 0th-2nd amplitude periodic errors of the Hipparchos-Ptolemy solar & lunisolar theories, resp.

11 Hipparchos’ likely location on the island of Rhodes (Rawlins 1994L §§F-G), the city of Lindos is at 36°05’N, 28°05’E. Keep in mind that in antiquity (in the absence of reliable mechanical clocks) most timekeeping was by apparent & local time, customarily via sundial. Hipparchos’ clock-stars (Hipparchos Comm 3.5) would allow night timekeeping. But is also the “moondial” possibility, especially easy while a lunar eclipse is proceeding: a sundial (or equivalent) could find pretty accurate time just by adding $12^h$ to the Moon’s hour angle or (when moonlight was bright enough) to sundial-shadow position. (The method is slightly corrupted by lunar parallax. For the −140 eclipse, the time-error would add 1’ to the absolute magnitude of $\Delta \lambda$.)

12 See Rawlins 1991H §C6 for the standard Almajest 3 solar orbit which Hipparchos used during the period (§D5) which includes all of the eclipses here discussed.

this time. (So geocentric $\lambda_M = 207^\circ.2/3$.) [c] The Almajest syzygial lunar theory puts the eclipsed Moon at 58°.3. (We define 1° as one Earth-radius.) [d] For this distance at the Rhodos klima 36°N, the Almajest 2.13 parallax tables give $p_\lambda = +20'$. [e] So eq. 5 (which, recall, proposes using the wrong sign for $p_\lambda$) yields:

$$\lambda_s = 27^\circ.2/3 - 1^\circ.3/ - (+33^\circ.5/6) + 180^\circ = 173^\circ.1/2. \quad (6)$$

B6 For the time of −134/3/20-21 tabular mid-eclipse (just before 3°), Hipparchos’ outdoor measure of $\Delta \lambda$ would find close to $-2^\circ.3/4$. [b] Hipparchos’ PH theory gives solar $\lambda_S = 357^\circ.1/4$. [c] The Almajest geocentric lunar distance is 64°.9. [d] Thus, for latitude 36°N, Almajest 2.13 $p_\lambda = -15'$. [e] So eq. 5 yields:

$$\lambda_s = 357^\circ.1/4 - (-1^\circ.4/4 + (-2^\circ.3/4) - 180^\circ = 174^\circ.3/4. \quad (7)$$

B7 We note that both results (eqs. 6&7) exactly equal the quite inaccurate (and even more grossly disparate) $\lambda$ values reported at Almajest 3.1. (See §B2.)

B8 These matches strongly suggest the validity of the wrong-$p_\lambda$-sign hypothesis. They also offer other historical information, which we turn to next.

C The Hipparchos Lunar Model’s Scale

C1 As we know (e.g., Rawlins 1991W eqs.23&24 and §R), Hipparchos used several different lunar distances throughout his career. If his mean distances assumed for the present parallactic computations differed drastically from c.60°, this would affect $p_\lambda$ inversely-proportionally. The fits attained here suggest that he or his computers used conventional values during the period of the present calculations. Which is consistent with our finding at fn 14.

C2 One can argue for nonpreliminary Hipparchan mean lunar distances of from 52° to 67°. (See Rawlins 1991W eqs.23-24 & §R1.) But use of these values instead of Ptolemy’s (59 Earth radii: Almajest 5.13 & Toomer 1984 p.251 n.49) will affect eqs. 6-8 by only a very few arcmin. Nonetheless, though the present eclipse analyses (as well as fn 14) can work for 67°, they won’t for 52°.

C3 A reasonable conclusion is that we here have come upon indications in favor of Gerald Toomer’s finding (see, e.g., Toomer loc cit) that Ptolemy’s 59° lunar mean distance was that of Hipparchos.

D Hipparchos’ Sph Trig Reconformed by His Parallax Corrections

D1 It has long been recognized (e.g., Neugebauer 1975 p.323) that parallax tables were in use in the 2nd century BC. (This was always obvious from Almajest 5.5, but perhaps no one has previously caught the implication for the on set of spherical trigonometry.14

13 We assume accurate observation and the ancients’ common practice of rounding quantities to fractional degrees. Our fits here are almost too good (fn 22), which can be due to [a] Hipparchos having averaged a careful series of data for each eclipse, and-or [b] DR having acquired Ptolemy’s habit of favoring (postulating likely Hipparchan) roundings that lead to exact agreement. But the putative latter factor’s net effect is trifling.

14 Toomer 1984 p.227 n.21 correctly points out the accuracy of Hipparchos’ longitudinal parallax correction for the lunisolar observation he made on −126/5/2 at 6:20 Rhodos Apparent Time. (See also Neugebauer 1975 pp.92 & 323.) His correction was rightly positive (so he [or a member of his school] had by this late point in his career straightened out the signage of his procedure): $1^\circ.8 + 1^\circ.12$. (That is, $212^\circ/2$, apt to a lunar distance of well over 60 Earth-radii.) The actual parallax was about $+1^\circ/4$, though that from Ptolemy’s tables was $+19'$ for his ludicrous lunar distance of 43 Earth-radii. (The
E Sources of Error in Hipparchos’ Placement of Regulus

Hipparchos tried (assuming clear weather) confirming his Regulus longitude via the −131/17/18 eclipse (record not extant), the result would have been roughly 119°1/2, not discrepant enough (like the enormous Spica −145 vs −134 clash) to cause his rejection of the −140 value in favor of an astrolabe-based result (as with Spica).但我们不能排除这种可能性，因为有其他未经证实的月面观测（例如，15 & §C2）。

15 See §3 Table 2 (or DIO 5 Table 0, DIO 4.2 [1994] p.56 Table 1). 16 Rawlins 1985G §16. 17 We may get a glimpse of the inevitable escape routes (from this evidence) at A. Bowen & B. Goldstein Amer Philos Soc Proc 153.2/233 (1991) where triggish work is (automatically) ascribed (p.235) to arithmetic methods (an approach that has caused other amusing Muffa catastrophes: e.g., fn 15 & DIO 1.2); and ancient testimony regarding predecessors’ technique is doubted (B&G n.5).

18 If Hipparchos tried (assuming clear weather) confirming his Regulus longitude via the −131/17/18 eclipse (record not extant), the result would have been roughly 119°1/2, not discrepant enough (like the enormous Spica −145 vs −134 clash) to cause his rejection of the −140 value in favor of an astrolabe-based result (as with Spica).
E6 Two curious historical notes in passing: [a] Regulus’ λ was not used as a ref-star for astrolabe—placing the other Catalog stars of Leo, whose mean error at epoch was merely −15’ (20’ offset from Regulus’ error). [b] Hipparchos stayed with his −140 Regulus λ fixed by eclipse, even after −134 indication (via Spica) of the method’s unreliability.

E7 Late Ptolemy works’ use of Regulus as a foundation-point suggests that Hipparchos held Regulus as a pivotal star in his astronomy, which could help explain why his −140 measurement of its position was retained inviolate to the end of his career. And Ptolemy’s.

F Evaluating Hipparchos & the Sign-Slip Theory

F1 We conclude that our parallax-sign-error theory has survived the §E2 fruitfulness test: 4 hits for 4 at-bats. But the traditional image of Hipparchos as among the greatest of ancient scholars survives less robustly. (See also Rawlins 1991W §N16&S.)

F2 A temperate conclusion is that Hipparchos was a vital promoter of astronomy in antiquity, if not quite the critical scientific figure he was once thought to have been. (Indeed, some of his attempts at improving basic astronomical parameters may have degraded them. See, e.g., Rawlins 1991W §S1.) He is today most famous for discovering precession, yet Rawlins 1999 shows that it was known to Aristarchos of Samos about 1 1/2 centuries earlier.

F3 But this doesn’t dim our gratitude for his merits, e.g., [a] Grounded in empiricism.24 [b] Developed nested calendar (Rawlins 2002A ffn 14&17) and durable luni-solar theory. [c] Likely invented the clever “circuli” scheme (§I §I). [d] Determined accurate obliquity. [e] Took accurate solstices [DIO 20 §2 Table 3]. [f] Oversaw creation of his ever-remembered Ancient Star Catalog, the oldest extant detailed compendium of the starry heavens.

References

David Dicks 1994. DIO 4.1 †1.
O.Neugebauer 1975. History of Ancient Mathematical Astronomy (HAMA), NYC.
D.Rawlins 1994L. DIO 4.1 †3.
D.Rawlins 1999. DIO 9.1 †3. (Accepted JHA 1981, but suppressed by livid M.Hoskin.)
D.Rawlins 2002A. DIO 11.1 †1.
Gerald Toomer 1984. Ed. Ptolemy’s Almagest, NYC.

23I have elsewhere (Rawlins 1991W fn 253) suggested that Hipparchos’ stable of mathematicians sometimes operated independently of him. (Perhaps occasionally with eyes aroll.) The nonrelation of Regulus to Leo’s Catalog stars hints at an instance of this.

24All 4 observations examined here (3 ancient & 1 modern), superficially in error by ordmag 1°, fit our parallax-sign-slip theory and so turn out to have been accurate to within a very few arcmin.