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**Figleaf Salad**

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## ‡7 Figleaf Salad

### Ptolemy's Planetary Model as Funny Science

The following is the textual basis of a DR talk given by invitation before the American Astronomical Society (Charlottesville, VA, 1990/10/22).<sup>1</sup>

#### A Cranking Up

**A1** I offer no hard definition of what constitutes crank or funnyfarm science. But a few examples will convey the odor of the animal better than a dictionary-definition can. [a] When parapsychologists are faced with favorite subjects' consistent failure under scientific controls, their standard conclusion is not that ESP is a chimera but rather: tight controls upset the subject and destroy the effect. [b] Those astrologers & psychics who claim to predict the future must face an obvious contradiction: why do they charge their clients, when, after all, they ought already to be rich from playing the stock market or the nags? The usual excuse: mystic powers always fail when applied to the possessor's own benefit. [c] Gore Vidal said of those who still believed in Dick Nixon at the pit of his Watergate fortunes: if the Nixon faithful saw him strangling his wife Pat, they'd say — well, she must have fainted and Dick was just helpfully holding her up by the neck.

**A2** Conventional wisdom of Historians of science (Hist.sci) holds that, though Ptolemy's model of the planetary system seems inadequate today, it was highgrade science for its own era, and those who think otherwise are inferior scholars: "whiggists", nonempathetic with a different time's "paradigm" (my least-favorite pseudo-scholarly word), and incompetent (‡1 §C7) when compared to Hist.sci's elite archons.

**A3** Below, I will show that the very opposite is true. Indeed, I will reveal follies & figleaves in Ptolemy's scheme which are so blatant that one soon realizes: [a] Geocentric astronomy was about as crackpot for ancient scholars as for modern. [b] Modern Hist.sci archons deserve a medal — preferably struck from their own magnificent brass — to reward Hist.sci's heroic protection of the academic community from exposure to the embarrassingly ludicrous secrets of Ptolemy's *Almajest*, which will be laid open below.

#### B The Heliocentric "Illusion"

**B1** All ancient astronomers knew that the planets Mercury and Venus visibly swing to&fro around the Sun (and are indeed never seen far from the Sun). Even geocentrists had to assent to the undeniable fact that the Sun is *the center* of these 2 planets' oscillating celestial patterns. So, anyone with the slightest openness of mind would have perceived the unobvious hint that both planets physically orbit the Sun. Not Ptolemy. He instead effectively maintained that: the provocative appearance of their circling the Sun was simply AN ILLUSION. Ptolemy hid the frightening truth under a delightfully imaginative figleaf, to wit: Mercury and Venus each actually circle *a point between us and the Sun*, so it only *appears* that each planet goes around<sup>2</sup> the Sun. Yes, just holding Pat up by the neck . . .

<sup>1</sup> Abstract in *Bulletin of the American Astronomical Society* 22.3:1040 (1990).

<sup>2</sup> The early 17th century discovery of the phases of Venus disproved this particular Ptolemy figleaf; however, Theon of Smyrna (1st century) and Tycho (16th century) had both already admitted that Venus circuiuted the Sun — so both men then just made the Sun (with attendant planets) go around the Earth! The Earth may move, but the pre-committed mind cannot.

**B2** Understand, this is the glorious Ptolemaic system, which Hist.sci unceasingly tells us was the intellectual epitome of ancient astronomy. (Ptolemy may indeed have been brilliant, but hardly in the sense implied.)<sup>3</sup> Neugebauer 1957 p.191: "one of the greatest masterpieces of scientific analysis ever written" — composed by "the greatest astronomer of antiquity" (Neugebauer 1975 p.931 & Gingerich 1980 p.264).

**B3** To a mind not yet purified by Hist.sci propaganda, there might seem to be something a little, well, Funny about an astrologer (fn 4) like Ptolemy, whose model-construction labors went so outlandishly far beyond necessity and sanity, in his religio-fanatical pursuit of a plausible-looking cover story for Mercury and Venus — one which would alibi away their paths' inconsiderately blatant (§B1) heliocentricity.

**B4** Not a single Hist.sci professor has ever for a moment intimated to his trusting students that: Ptolemy's ploy here is peculiar — and revealing. Hist.sci's openmindedness is such that: this heretical if common-sense re-evaluation (of Ptolemy's Mercury-Venus nonheliocentricity) is not even broached as a possibility, much less a probability. No, to the ripe Hist.sci mind, the true crackpots (the *genuinely* dangerous enemies of accurate scholarship) are those modern scientists who think that Ptolemy should have gotten real.

**B5** One of Galileo's greatest anti-Ptolemaic discoveries was the Jupiter family of satellites: 4 hitherto-unknown moons *obviously circling a body other than Earth* — a clear microcosm of the Copernican vision. And how would Ptolemy have reacted, had he known of the jovian moons? Surrender? No chance. Since Hist.sci archons' amusing sense of superiority to mere scientists stems largely from their supposedly uncanny ability to put themselves in the place of past investigators, let's here demonstrate how easy it is for lesser scholars like ourselves to do so: we see immediately that Ptolemy would just protest that the seeming joviocentricity of Galileo's 4 new bodies was merely *an illusion* — actually, they circle (on their appointed epicycles) respective points between us and Jupiter: four new figleaves. Crazy?<sup>4</sup> Yes, but no more so than Ptolemy's identical ploys for Mercury & Venus (§B1) — which Hist.sci's most respected authorities trumpet as the constructs of genius!

#### C Those Geocentrist Wags

**C1** An experiment attributed to the immortal heliocentrist Aristarchos (280 BC) attempted to gauge the ratio of the Sun's & Moon's distances by observing the angle between these 2 bodies at half-Moon.<sup>5</sup> The figure he is alleged to have measured was 87°. <sup>6</sup> This may have been a lower bound. Regardless, the vital points here (often lost sight of when details are overemphasized): [a] The fact that half-Moon occurs nearly at luni-solar quadrature

<sup>3</sup> See §G4. I am reminded of my old Harvard prof, the refreshingly blunt skeptical philosopher Henry Aiken, who once shocked his students by asserting that the smartest philosopher was Aquinas. Aiken then explained: sure, you'd have to be a genius to defend Aquinas' incredible (inadvertently anthropocentric) edifice.

<sup>4</sup> Keep in mind that Ptolemy wrote astrology's bible, the *Tetr* — and worked 40<sup>7</sup> for a prominent miracle-cure temple at Canopus, Egypt. Details in Rawlins 1984A.

<sup>5</sup> Geometrically: half-Moon (linear terminator) occurs when the Moon is at a right angle in the slim Sun-Earth-Moon triangle.

<sup>6</sup> The correct mean value is 89°51', and the correct mean ratio is not 19 but close to 400. The sole purported surviving work by Aristarchos (Heath 1913 pp.353f) is on this subject, but I doubt its authenticity (regarding it as just an amateur's development of A's hypotheses), since much of it is based upon the writer's confusion of the word "μερος" (which means "part") with a sign of the zodiac (30°). Neugebauer 1975 pp.652 & 671 shows that ancient astronomers used "μερος" for 1/48th of a circle or 7° 1/2 — which is only a *quarter* of 30°. If we believe the writer of the famous pseudo-Aristarchos analysis, the Moon is 2° wide (Heath 1913 p.353) and lunar eclipses can last 1/2 a day! (Heath 1913 p.353: "the breadth of the [earth's] shadow is [that] of two moons" — that is, 4°, so that the Moon must move 6°, at c.1°/2 per hour, to entirely mid-traverse the Earth's shadow.) But no serious astronomer could possibly have accepted such patently ludicrous propositions. (Archimedes, in the "Sand-Reckoner" p.223, directly attests that Aristarchos correctly made the solar diameter equal 1°/2.) Since pseudo-Aristarchos' error is by a factor of 4, the treatise's otherwise-inexplicable confusions neatly evaporate upon our realization that the ancient pseudo-Aristarchos just mistakenly supposed that "μερος" was 30° instead of 7° 1/2 = 30°/4.

proves that the Sun is many times farther away than the Moon. Aristarchos is said to have made the distance ratio 19 (or perhaps: at least 19), since  $\sec 87^\circ \doteq 19$ . [b] The Moon was well known in antiquity to be c.60 Earth-radii distant (*Almajest* 5.13); and the solar semidiameter was (angularly) c. $1^\circ/4$  or  $\pi/720$  radians. Thus, the Sun's radius in Earth-radii must obviously be about  $(60 \cdot 19) \cdot \pi/720 = 19\pi/12 \doteq 5$ . Cubing this result to obtain an approximation to the Sun/Earth volume-ratio, we find<sup>7</sup> that it exceeds 100.

**C2** Hist.sci archons seldom emphasize the curious fact that ancient geocentrists did not deny these conclusions — indeed, the ancients were quite aware that the Sun is many times larger than the Earth. Even the geocentrist bible (*Almajest* 5.16) makes the Sun's volume 170 times bigger than the Earth's!

**C3** R.Newton, the modern pioneer of skepticism regarding Ptolemy's pretensions, asks a lethal common-sense question: how could the Sun be dominated by a body over 100 times smaller?! Does the tail wag the dog? We know no personal details about Ptolemy, but one has to wonder: was he smiling when he wrote (*Almajest* 5.16) that the solar tail is 170 times bigger than the terrestrial dog? [But could Ptolemy outsmile unique ultra-wag Eratosthenes — whose solar volume =  $1/12$  Earth's?! See *DIO* 14 ‡1 eq.16. (Note added 2009.)]

## D Inverts

**D1** With respect to the common-sense principle now known as Occam's Razor, there is a flagrantly unacceptable feature of the Ptolemaic system: the inner and outer planets have different models. (Not so for the heliocentric<sup>8</sup> system.) In Ptolemy's scheme, each planet's model contains an annual motion: for the outer planets (Mars, Jupiter, & Saturn), the *epicycle* has period  $1^y$ ; for the inner planets (Mercury & Venus), the *deferent* has period  $1^y$ . Why this bizarre model-inversion?

**D2** From the heliocentric perspective: for both Ptolemaic models, the annual motion is simply the Earth's motion in geocentrist disguise. So why can't we have a consistent model? The answer is simple: if we tried imposing an outer planet model upon an inner planet (or vice-versa), then *the epicycle would be bigger than the deferent carrying it* — which would result in a cumbersome arrangement, with the Earth inside a hugely-swinging epicycle. (This would of course destroy Ptolemy's precious nested-spheres cosmology.)

**D3** Indeed, if the inner planet model were imposed upon an outer planet, the epicycle's center would always be in the direction of the Sun (i.e., the planet would circle a point on the line connecting us and the Sun — just like the inner planets), which might provide onlookers the same dangerous whiff of heliocentrism that the inner planets' motion did (§B1). Thus, using inconsistent models (for inner & outer planets) was useful to those who wished to put over the geocentric system.

## E Noneccentric Epicycles

**E1** A feature of Ptolemy's astronomy that once seemed unexplainable (until Rawlins 1987): why are all his epicycles forced to be circular? The answer turns out to be elementary. We noted (§D1) that each Ptolemaic planet model has an annual motion; however, the reader may not hitherto have been aware of the precision involved: each planet's annual motion is not just roughly equal to the Sun's — in *Almajest* 9.4, these motions are (for all 5 planets) tabulated as equal to the Sun's, agreeing to a 50 billionth of a degree per day. Moreover, the mean longitude of the motion is also the Sun's (at any time). That is, for all five planets, both circular elements (of the annual part of each planet's orbit) are identical to the Sun's:  $\epsilon$  (mean longitude at epoch) and  $n$  (mean motion).

<sup>7</sup> This is not quite the way Ptolemy figures it at *Almajest* 5.16, but it's quicker and gets a result at the same ordmag.

<sup>8</sup> For evidence that ancient heliocentrists even produced ephemerides (a point 1st understood by van der Waerden 1970) see ‡6 fn 36 & [despite a DR misjudgement] *DIO* 11.2 ‡4 §G3.

**E2** Ptolemy's insistence upon noneccentric epicycles seriously degraded the potential accuracy of his ephemerides, causing errors reaching  $1^\circ$  for Mars,  $3^\circ$  for Mercury (R.Newton 1977 pp.279, 323; Rawlins 1987 n.36). Thus, to pretend that his theories accorded with reality (often within  $1'$  and in all cases to within  $0^\circ.1$ ), Ptolemy was driven to fake his "observations" (§E2). But, why did he bring all this trouble on himself? — what was the gain? For the answer to this question, I quote from Rawlins 1987 (pp.237-238, emph in original):

Ptolemy's peculiar requirement that all epicycles be noneccentric is not as naïve as it may appear at first glance. The method in this seeming madness is obvious as soon as one tries to imagine eliminating the noneccentric feature: if both deferents and epicycles were eccentric, then all the outer planet epicycles and the inner planet deferents [the annual motion circles] would have eccentricities [ $e$ ] and apogees [ $A$ ] just equal to those of the solar orbit! It was already suspicious enough that these circles exhibited inexplicable fidelity to the Sun's mean-longitude-at-epoch [ $\epsilon$ ] and mean motion [ $n$ ] . . . . If it were also publicly acknowledged that not just two but *all four planar elements* [ $\epsilon, n, e, A$ ] were (for the appropriate orbital circles of all five planets) identical to the Sun's — well, at that point, the heliocentrist heresy could probably no longer be contained. . . . Ptolemy systematically fabricated<sup>9</sup> perfectly accordant "observations" in order to promote the pretended reality of the noneccentric epicycles that constitute the prime geocentrist figleaves<sup>10</sup> which he and his religio-astrological cult employed to hide the falsity of the theologically preferable geocentric system. The attendant suppression of the heliocentric theory held back for over a millennium our realization of the true distances<sup>11</sup> of the planets, the data required for the discovery of Kepler's 3<sup>rd</sup> Law — itself the key revelation leading on to Newton's Law of Gravitation and the resultant flowering of mathematical physics.

**E3** In addition to the 4 planar elements' identity with the solar orbit, accurate astronomical work would have found that the planets' annual-motion circles would also be parallel to the plane<sup>12</sup> of the solar orbit. So, for all 5 planets, 6 orbital elements would match the Sun's (30 elements, net). Extremely hard to explain away without heliocentricity.

## F Parallax as Epicycle

**F1** Despite the foregoing (or in innocence of it), Pedersen 1974 p.11 states that "there is no question that [the *Almajest*] was a greater scientific achievement than [Copernicus' 1543] *De revolutionibus*". Today, the 19<sup>th</sup> century discovery of stellar parallax (not Copernicus' book, 3 centuries earlier) is generally regarded as the clincher that finally & forever disproved geocentricity. In the esteemed *Proceedings of the Institute for the History of Science*, Derek Price (Yale Univ Hist.sci) & Francis Johnson have both stated that, in Copernicus' day, there was no empirical reason to prefer heliocentricity! Johnson even adds (Clagett 1962 p.220) the astonishing claim (forgetting J.Bradley's 18<sup>th</sup> century discovery of aberration) that until the F.Bessel-T.Henderson measurement of stellar parallax in the 1830s, geomobility

<sup>9</sup> R.Newton 1977 & Rawlins 1987.

<sup>10</sup> "Ptolemy's Ivy Leaf" (K.Locher *JHA* 15.1:32; 1984/2) has no relation to the present discussion.

<sup>11</sup> Also, according to geocentrist Ptolemy, the stars are just outside the orbit of Saturn. By contrast, heliocentrist Aristarchos placed them far, far beyond (as Archimedes reports: "Sand-Reckoner" p.222). The obvious reason: the invisibility of stellar parallax told Aristarchos that the effect is quite small — thus, the stars' distances must be enormous.

<sup>12</sup> See Rawlins 1987 n.38.

was “an open question in science”.<sup>13</sup> But I will now exhibit<sup>14</sup> (§F3) the obvious falsity of one of the most durable and widely-accepted myths in scientific history, namely: the seemingly plausible notion that stellar parallax’s discovery in the 1830s firmly established heliocentricity.

**F2** To see the truth of the matter, let us start by supposing that Ptolemy had lived long enough for Bessel to face him with the reality of the stars’ tiny annual loops: would Ptolemy have suddenly given up and converted to heliocentrism? (Just as easy a question: how often do lawyers convert each other in the courtroom?) The visible effect of parallax is merely a looping motion of period 1<sup>y</sup>. Add this oscillation to the star’s transverse “proper motion”, and (as a little doodling will quickly show) the net motion is: a zig-zag-zig path — direct then retrograde then direct — that is, essentially *the very same path a planet describes*. How could this discovery possibly discomfit Ptolemy? — hell, he *lived* to alibi such effects. I have asked two 1990 audiences what he would have said to stellar parallax, and (within a few seconds) both<sup>15</sup> figured it out (though Hist.sci never has), namely: stellar epicycles.

**F3** Quoting from DR’s 1976 analysis (fn 14), one sees that Ptolemy himself purveyed the common misunderstanding that Price and Johnson share (§F1):

Ptolemy asserts ([*Almajest* 9.1]) that the planets have no detectable parallax . . . — meaning, of course, *diurnal* parallax. But, in fact, the planets exhibit huge *annual* parallax [the planets’ familiar retrograde loops] . . . . Indeed, Ptolemaic planetary astronomy can be seen as largely a design *for* converting the parallactic effect, of the Earth’s annual revolution, into “epicycles” (deferents, for the inferior planets) allegedly inherent in the planets’ own motion. . . . the hypothetical 19<sup>th</sup> century Ptolemy, confronted [via Bessel’s stellar parallax data] with this familiar [annual] motion, would therefore have concluded, not for geomobility, but [instead for] a new Triumph of Ptolemaic astronomy: even the stars have our [*Almajest*]’s annual epicycles!

**F4** Planetary parallax is as real as (essentially the same as!) stellar parallax — indeed, it even *looks* like it (§F2). We saw above (§E) that the noneccentricity of Ptolemy’s epicycles was a figleaf (hiding Sun-planet element identities). But we now find that Ptolemy’s epicycles were *themselves* figleaves, hiding the most crucial phenomenon of the helio-vs.-geo-centric debate: planetary parallax. I.e., a proof of heliocentricity which is just as powerful as stellar parallax (namely, planetary parallax: planets’ retrograde loops) had always been grossly visible (requiring no telescope or heliometer) — even while geocentrists were denying that the Earth circuted the Sun . . . .

## G Paradigm or Modern Cleanthes

**G1** Thus, it is an utter misconception to suppose (with Hist.sci) that the long dominance of geocentricity was primarily based upon intellectual considerations (evidence or

<sup>13</sup> Price (“Contra-Copernicus”) at Clagett 1962 pp.215-216: Ptolemy’s *Almajest* “was at least original in many of its parts. The *magnum opus* of Copernicus does not have that distinction beyond its first few pages. . . . [and its central theory, heliocentrism] could not be proved or disproved by any observation available at that time. No wonder good scientists remained skeptical until the new & decisive evidence was forthcoming. . . . Copernicus made a fortunate philosophical guess without any observation to prove or disprove his ideas . . . his work as a mathematical astronomer was uninspired. . . . his book is conservative and a mere re-shuffled version of” Ptolemy’s *Almajest*. Johnson (Clagett 1962 p.220): “The fact that should be emphasized and re-emphasized is that there were no means whereby the validity of the Copernican planetary system could be verified by observation until instruments were developed, nearly three centuries later, capable of measuring the parallax of the nearest fixed star [Henderson’s work]. For that length of time the truth or falsity of the Copernican hypothesis had to remain an open question in science.”

<sup>14</sup> The following demonstration (§F3), regarding Ptolemy’s hypothetical incorporation of stellar parallax, was sent by DR to the 1976 IAU meeting at Grenoble via O Gingerich (Ptolemy’s chief modern public relations man) — who answered it by simply refusing to read it there.

<sup>15</sup> In the 1st instance: my fertile freshman student Josh Renzi 1990/10/12. The 2nd: a bright, enthusiastic Amer Astron Soc audience at the 1990/10/22 AAS Planetary Sciences Division meeting, Charlottesville, VA.

“paradigms”). When Aristarchos first broached the heliocentric theory publicly, he was not crushed by logic or lack of crucial experiments. He was simply threatened.

**G2** From Plut *Mor* 923, we learn that Cleanthes (the leader of the Stoics) recommended “an action for impiety against Aristarchus the Samian on the ground that he was disturbing the hearth of the universe because he sought to save <the> phenomena by assuming that the heaven is at rest while the earth is revolving along the ecliptic and at the same time is rotating about its own axis.”

**G3** What killed ancient heliocentrism was not evidence. It was force. From the hemlockian fate of Socrates, we know what a charge of “impiety” led to. Had heliocentrists persisted, armed policemen attached to the prevailing theocratic dictatorship would have removed the offenders to prison — perhaps en route to execution. What has this brutal fact got to do with: mythical “decisive” new evidence (for which good-skeptical-scientists allegedly waited), “paradigms”, “whiggism”<sup>16</sup> — and all the other highflown alibis & cult-fads that Hist.sci archons have for decades hauled out to try to pretend that there is something of genius in Ptolemy’s geocentric contraption?

**G4** Ptolemy’s real genius was political. He made himself the advocate — the paid lawyer — for the dominant government view, which was effectively: popular realization that the Earth is not the universe’s center could be corrupting to public morals. (Given the course of history since Copernicus: I won’t take a firm position against that viewpoint. However, the truth and the beneficence of an idea are two separate issues.) The enormity of the gulf, that separates so many scientists from the currently fashionable Hist.sci center, is illustrated by a simple consideration here: obviously, scholars of principle ought to condemn (not alibi & laud) Ptolemy’s convenient going-along with powerful false orthodoxy (hiding heliocentricity beneath the *ad hoc* layers of a gov’t-certified figleaf salad). (To anyone among *DIO*’s scientist-readers who has behaved ethically, perhaps courageously, in the face of an unprincipled power-type: stop to consider how Hist.sci will record your respective careers.) What is it about certain Hist.sci archons that attracts them so magnetically to the seemingly-repellant task of glorifying a sell-out scholar? (Hist.sci’s peculiar compulsion in this connection is especially incongruous since the Hist.sci field is so admirably bereft of careerists — and indeed is justly famous among scientists for its quintessential rectitude.)

**G5** To investigate the self-evident ancient-modern parallel here a bit further: how have Hist.sci archons treated modern skeptics regarding Ptolemy’s pretensions? [a] Flee debate for 20<sup>y</sup>. [b] Alibi Ptolemy with the same<sup>17</sup> prejudiced intensity he exhibited when explaining away planetary parallax. [c] Slander dissenters in as vile a fashion as possible. (E.g., ‡1 §C7 & ‡3 §D.) [d] Apply totalitarian force: threaten and suppress<sup>18</sup> (& attack in politically safe forums).

Cleanthes lives.

<sup>16</sup> E.g., O Gingerich to DR 1979/12/10.

<sup>17</sup> Quoting from DR’s 1990 abstract (*BullAAS* 22.3:1040) for this paper: If used with great care, Ptolemy’s *Alm* is an invaluable sourcebook for our knowledge of ancient astronomy. But his famous patchwork celestial model’s sole genuine claim to greatness is merely as a classic study in adamant unfalsifiability. The same might be said of the equally motley zoo of alibis for Ptolemy, conjured up by his modern team of admirably imaginative “historian” defense-lawyers.

<sup>18</sup> Details: ‡6 fn 15 & ‡5 fn 24.

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