‡6 Galileo vs 1618's Great Comet: "Fly like an Eagle"

by

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Yee men of Brittayne wherefore gaze yee so / Upon an angry Starr?
Verse by King James on the great comet of 1618.[1]

Abstract

A polemic between Galileo Galilei in Florence and the Jesuit Collegio Romano in Rome developed over one of the most spectacular comets in history, the third of three comets in 1618 — 400^{y} ago this year. Owing partly to his poor health, Galileo literally did not see any of these three comets — being possibly the only European astronomer in this curious position. This did not impede him from publishing on the matter, keen to display his new position as court philosopher to the Medicis. His first statement on the subject had been in 1619, "Discourse on the Comets" (penned by another, but on his behalf) where he advanced the traditional Aristotelian view that comets were vaporous exhalations from the Earth, but he added that they were, nonetheless, able to rise up somehow out from the atmosphere, so their subsequent motion in space was away from the centre of the Earth. The Jesuit Horatio Grassi countered this view, in his *Libra Astronomica* of that same year: explaining why a huge comet seen by all of Europe could hardly be a mere "vapour". Galileo then wrote his *Il Saggiatore* of 1623 as a riposte. It had no observational data, and compounded his initial errors by misplacing the comet into the constellation Scorpio rather than Libra.

It is surely the case that nothing Galileo wrote about the comet of 1618 was correct. There has been a failure of science historians over the centuries to acknowledge this fact. The Collegio Romano astronomers applied their telescope to the comet, arrived at a decent estimate of its parallax, reviewed several European accounts of it, and placed it beyond the Moon. We begin with a British comment upon this great comet by way of introduction.

A John Bainbridge, in London

A1 In 1618 John Bainbridge, lecturer at Gresham College on astronomy and medicine,[2] became one of the first astronomers to observe a comet telescopically.[3] The 3rd and last comet of that year was brilliant and spectacular, with estimates of its tail-length across the sky ranging up to 90°.[4] Bainbridge published his description of it, after having observed it continuously from Old Style (Julian) 18th November to 16th December, finding its average celestial movement to be 2°2/3 per day. Initially it moved faster, then progressively slowed before it finally vanished. He estimated its parallax against the fixed stars at less than 6 arcminutes, so he figured the comet's remoteness as at least 600 Earth-semidiameters, or about ten times the Earth-Moon distance.[5] Britain was on the Julian calendar, putting Bainbridge's first-detection of the comet on the 28th of November, New Style (Gregorian), which fits with other reports, e.g, Johannes Kepler first espied it on November 29th.[6]

[0] [Publisher's note.] Nick Kollerstrom will be ever remembered as saviour of the key document cracking the British Neptune conspiracy: see www.dioi.org/vols/w91.pdf, *DIO 9.1* ‡1 p.4 and §H8. His equally sensational exposé, *The Dark Side of Isaac Newton*, will be at bookstores in 2018 November.

[1] It was printed in the *Journal of the British Astronomical Association*, 1987, Vol.97, p.74.

[2] "Bainbridge, John" in the *Biographical Encyclopedia of Astronomy*, Ed T.Hockey, 2014, Vol. 1.

[3] T.Heidarzadeh, *A History of Physical Theories of Comets*, 2008, p.84.

[4] D. Seargeant, *The Greatest Comets in History*, 2009, pp.110-1.

[5] After reaching its perihelion on November 8th, comet C/1618 W1 then came closest to Earth on December 3rd, passing by at 0.36 AU — somewhat further than Bainbridge estimated: http://cometography.com/orbits_17th.html.

[6] Kepler, De Cometis Libelli Tres, 1619.

A2 John Bainbridge estimated its tail on December 3rd as being 45° in length,[7] noting how it always streamed away from the Sun, and surmised that the Sun's light was pushing it. [Fig.1 displays several lines reverse-extending the comet's tail towards the Sun's vicinity.] He described the comet as moving "continually retrograde" and Northwards. His diagram showed how it crossed over the ecliptic in between the scales of the Balance, moving in a straight line,[8] "appearing in the heavens to be the arch of a perfect great circle." Moving almost perpendicularly to the celestial equator (the dotted line slanting through Virgo's gown and Ophiuchus' hand in Fig.1), it crossed the ecliptic (marked line horizontally across bottom of Fig.1), about a degree east of the mid-point of Scorpio (15°Sco or 225° longitude). The astronomical difference between the *sign* of Scorpio (longitude 210°-to-240° on the ecliptic, thus marked with Scorpio's stingered-*M* symbol at Fig.1's very bottom) and the *constellation* of Libra (the Scales) which lay to the west (rightward in Fig.1) of the *constellation* Scorpio (a difference which seems to have confused Galileo), is clearly shown in Fig.1, where Libra's picture extends from longitude 216° (6°Sco) to 233° (23°Sco).

B Father Grassi in Rome

B1 The Jesuit Father Orazio Grassi, the Collegio Romano mathematics lecturer, published his observations upon the three comets of 1618, in his 1619 *Libra Astronomica et Philosophica*, or the "Astronomical and Philosophical Balance," under the pen-name "Sarsi".[9] He estimated it had appeared in 1618 on November 28th in the constellation Libra, a few degrees above the ecliptic. Its point of origin [his own Nov.29 original 1st sighting?] he estimated as having been 11°1/2 Scorpio, moving some 3° per day across the heavens; he wrote:

> On the twenty-sixth day [scribal error for Nov.28th Greg., 18th Julian], it [had passed] the ecliptic [& was] nearly 14°1/2 inside Scorpio, and on the twenty-ninth this new foetus was established in Scorpio at a longitude of about 11°1/2, between the two scales of the Balance [which, semi-contra Fig.1, he took to be α&β Libra], with a northerly latitude of almost 7°.[10]

B2 After thus describing the comet's motion, Grassi explained that he would not describe its origin because that question would be "astrological," i.e., he adopted the position of a mathematicus, whereby he would only describe the motions of the heavens, refraining from comment on the more philosophical issue of the comet's nature, or of what its "cause" might have been. He did however point out that the comet had appeared near to where the Sun and Mercury had last been conjunct,[11] also noted by Bainbridge.

B3 Grassi ascertained the comet's parallax by comparing three different sets of European observations with his own. Comparing his in Rome with some in Antwerp on December 6th, he found a parallax of 16′. At Innsbruck the comet was seen to pass by Arcturus on 13th December at 10°53′ whereas he had found 10°55′, a difference of two arcminutes. He admitted that his telescope apparatus did not give reliable arcminute accuracy — for that,

[7] J. Bainbridge, *An Astronomical Description of the late comet*, 1619, p.11; reprinted 1975.

[8] The discussion by Stillman Drake on comets may be of interest here, in *Galileo at work, His Scientific Biography*, 1978, pp.268-270, as to how, as a comet swings around the Sun, the absolute magnitude becomes brighter and the tail extends.

[9] Translations of the four texts here alluded to have been published in 1960 by S.Drake & C.O'Malley in *The Controversy of the Comets of 1618*: "An Astronomical Disputation on the Three Comets of the year 1618", Anon, 1619 (by Sarsi), pp.3-19; "On the Three Comets . . ." by Mario Guiducci (by Galileo), pp.23-65; "The Astronomical and Philosophical Balance" (by Sarsi) pp.69-132; and Galileo's "The Assayer" pp.163-336.

[10] *Ibid*, p.10. According to Fig.1, the comet crossed the ecliptic on the 27th, at 16°Sco. Sarsi's later 11°1/2 on the 29th does however concur.

[11] *Controversy*, p.9. [Mercury's solar conjunction was 4th November (Greg.) at longitude 12°Sco.]

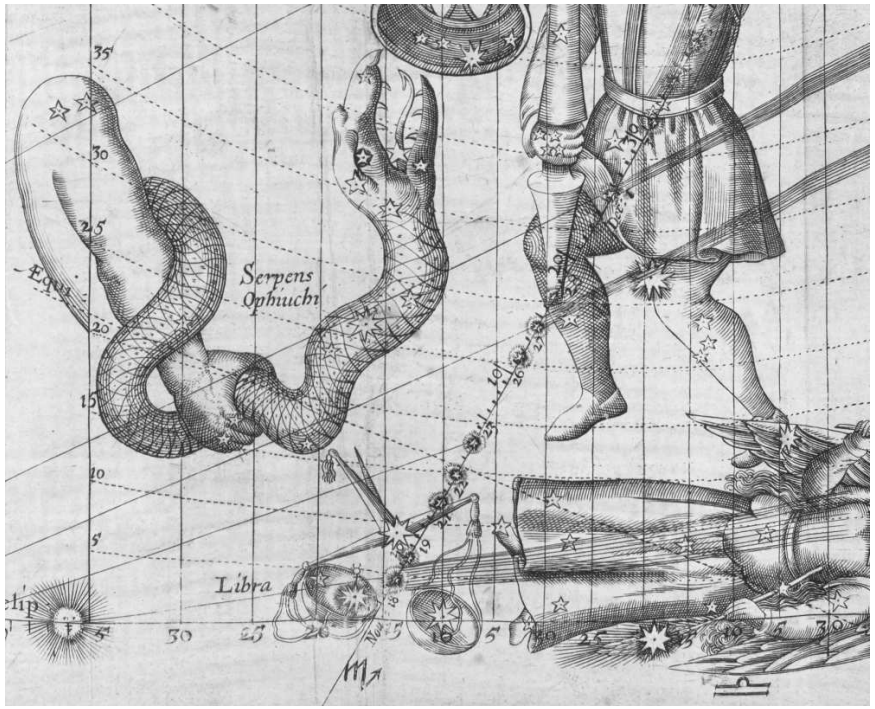

Figure 1: Path of 1618 great comet, drawn by astronomer John Bainbridge, with symbols of the signs Libra (right) & Scorpio (center) at the map's bottom, the horizontal ecliptic passing just above it, marked in celestial longitude degrees from 25°Virgo (175°) at far right to 10°Sagittarius (250°) at far left, near the Sun (6°Sgr). Curved dotted lines mark celestial latitude at 5° intervals. The slanted, near-straight cometary path bears Julian dates, "Nov 18" at its base, where appears the comet's huge tail near its max. The Northern Crown is at the map's top, Gemma (commonly Alphecca) its brightest jewel-star. At bottom right (southwest) is most of wingéd Virgo, its 1st magnitude star Spica (α Vir) just south of the ecliptic at longitude 19°Lib (199°); 33° above it (also at 19°Lib) lies brilliant zero-magnitude Arcturus (α Boo) in Boötes the Plowman, dominating the map's right side. At map-left is fanged Serpens Ophiuchi, in Ophiuchus' hand. Below that is Libra the Balance or Scales, containing a (partly) stellar near-equilateral triangle, whose northern apex-star is Zubeneschamali (β Lib) and whose southwestern (right) point is Zubenelgenubi (α Lib) in the Balance's western (left) weighing-pan. The triangle's southeastern (left) point is in the Balance's eastern pan: the swift planet Mercury (its tiny symbol just atop it), shown at its (very) temporary position of Nov 18, the date on which Bainbridge 1st saw the comet. Zubenelgenubi & Zubeneschamali are Arabic for southern & northern claws, respectively, vestiges of a remote pre-zodiac era when the scorpion grasped the stars now forming Libra.

he says, one would need something like the equipment of Tycho Brahe. On December 13th he saw it occult one of the stars in Bootes, as likewise in Cologne that same occultation was seen on the same day.[12] Thereby Grassi was confident in locating the comet beyond the Moon, because his trigonometry gave him that distance, owing to its small parallax. It was the similarity of perception of the comet's path from the different European locations which ruled out Galileo's claim (made on his behalf in the "Discourse of the Comets" 1619) that it had been a mere atmospheric exhalation — the Aristotelian view, plus its huge size also ruled out any such view. Seeing its straight-line motion in the sky, Grassi gave to the comet a circular orbit around the Sun, or maybe an elliptical one.

B4 Heidarzadeh has described Grassi's account as "a good example of technical writing about comets,"[13] noting how he compared his results concerning parallax and distance with other European observations, estimated the limits of telescopic accuracy, and tried to compute the dimensions and volume of the comet. However, Grassi achieved more than that: within the context of Tycho Brahe's scheme of things, Sarsi described the comet as probably going around the Sun in an elliptical path, and moreover as having its tail swing round to be always streaming out from the Sun. This is little-appreciated! Historians have normally averred that Grassi's theologically-determined view of an immobile Earth stunted his view; however, within the Tychonic system, the planets circled the Sun and so too could the comet. For Grassi, "If the comet were driven round the Sun . . . . What if the circle in which it is carried be eccentric to the sun . . . . What if the motion be not circular but elliptical. . . ?"[14] Grassi did not as such here aver that the view of a moving Earth was mistaken, he merely stated "these things are in no way permitted to us Catholics."

C Galileo Galilei in Florence

C1 In 1623 Galileo the court philosopher to the Medicis — no longer the mathematics lecturer at Padua — composed *Il Saggiatore*, "The Assayer".[15] His publication displayed a frontispiece of the three bees of the Barberini family, because Galileo's friend the Tuscan poet Maffeo Barberini had that very year been appointed as the new pope. His frontispiece also displayed, above Galileo's countenance, the use of a telescope and sextant, with observations being duly recorded. Not having seen the comets himself, how could he be in a position to comment on the matter, and know better than the Jesuits? The title he chose, *Il Saggiatore*, alluded to the assayer's precision balance, on which gold was weighed. His text moreover compared himself to the bold, high-flying eagle,[16] his critics being mere sparrows who shitted all over the place: "true philosophers are like eagles," he boldly affirmed:

> I believe, Sarsi, that they [good philosophers] fly alone, like eagles, and not in flocks like starlings. It is true that because eagles are rare birds they are little seen and less heard, while birds that fly like starlings fill the sky with shrieks and cries, and wherever they settle befoul the earth beneath them.[17]

Galileo was never burdened by undue modesty. These words were as Westfall observed a "provocative display of egotism".[18]

C2 Thus the titles of the publications by the two protagonists both allude to Libra the Balance, where no English-language science historian in four centuries has noticed what was, as we shall see, Galileo's catastrophic error. Galileo had received information on the

[12] Heidarzadeh, p 57; *Controversy*, pp.13-14.
[13] Heidarzadeh, p.60.
[14] *Controversy*, p.75.
[15] "The Assayer" at: http://content.wdl.org/4184/service/4184.pdf, online.
[16] James Reston, *Galileo a Life*, 1994, p.185.
[17] *Controversy*, p.189.
[18] R. Westfall, *Essays on the Trial of Galileo*, 1989, p.54.

comets from Virginio Cesarini. He had not actually seen any of the three comets of 1618, nor turned his famous telescope towards any one of them, having been too ill to get up and view them. Also he had eye trouble: "As a result of a certain affliction I began to see a luminous halo more than two feet in diameter around the flame of a candle, capable of concealing from me all objects which lay behind it. As my malady diminished, so did the size and density of this halo."[19] None of this prevented him from composing his polemical riposte. As *Il Saggitore* was published in 1623 one might have expected him to allude to other published comments upon the huge comet, e.g., that by Kepler of 1619 — but, he didn't. Perhaps as a philosopher, his new status in the Medici household, he did not feel the same need for observational data as a mathematicus.

D Grassi contra Galileo

D1 Galileo rejected Sarsi's rather logical argument that the comet's head was a solid object, placed above the Moon from considerations of parallax instead viewing it as a mere exhalation of "vapours" of the Earth, which had somehow drifted upwards, or possibly that it was a mere optical illusion which could not have any parallax (p.190): "the comet might be a mere simulacrum to which the argument based on parallax does not apply." It would not in that case have a distance from the Earth, any more than would a rainbow.

D2 In an earlier text Galileo had argued that exhalations from within the Earth had risen up, having a motion directly away from the Earth's centre, and that these somehow looked like a comet. In that case, replied Grassi, one would expect the strong northerly winds then blowing to have dispersed such a "smoky vapour." And why, wondered Sarsi, would such a vaporous exhalation want to move ever upwards, even beyond Earth's atmosphere? Anyone who had actually seen the comet, wrote Sarsi[20] — clearly enjoying the image of a bedridden Galileo too ill to get out and look at it — would not have taken such a view. Heidarzadeh politely summarised Galileo's theory as one "in which a century of observational and computational achievements is neglected," and according to which, "a cluster of exhalations moves uniformly along a straight line."[21]

E The Scorpion and the Balance

E1 Galileo denied the great comet of November-December 1618 had appeared in the Balance: Sarsi's motive for naming his monograph after the constellation Libra, Galileo explained,

> is that this comet mysteriously hinted to him by originating and appearing in the sign of Libra that he should balance and weigh it on accurate scales. . . .

Grassi assuredly had not placed it in "the sign of Libra," but in that of Scorpio. (The *constellation* of Libra was in the *sign* of Scorpio. See Fig.1. [Constellation Scorpio's main stars begin at δ Sco, longitude 27°Sco (237°), latitude $-2°$, a position which is on Fig.1's map but no Scorpio stars are shown since Bainbridge couldn't see any due to solar glare.])

> . . . I note that Sarsi confidently begins altering things to suit his purpose at the very first opportunity, a style maintained thereafter throughout his essay. He chanced to think up this pun on the correspondence between his balance and the celestial Balance, and, since it seemed to him that his metaphor would be considerably enhanced if the comet had first appeared in Libra, he freely asserted that it arose there. He felt no concern about contradicting the truth.

[19] *Controversy*, p.319; Dava Sobel, *Galileo's Daughter*, 1999, p.86.
[20] *Controversy*, p.87.
[21] Heidarzadeh, pp.63&64.

"*If* the comet had first appeared in Libra" — had it not done so? Is Grassi accused of "contradicting the truth" in asserting such? Then, alluding to an earlier anonymous publication *Disputation* from the Collegio Romano (in fact also by Grassi) re the comet,[22] which had stated ". . . it was born in Scorpio, that is in the principal house of Mars" Galileo sarcastically concludes that Sarsi

> might have entitled his work, "The Astronomical and Philosophical Scorpion" — that constellation which our sovereign poet Dante called that ". . . figure of the chilly animal / Which pricks and stings the people with its tail."[23]

Galileo's polemical reply had the great comet appear in the constellation of the Scorpion, not the Balance: he was far from being the first, or the last, to muddle up signs and constellations. Both titles of these works alluded to the Balance: Sarsi's "philosophical Balance" and Galileo's more delicate precision-balance, that of the gold-assayer. Then, shifting his metaphor, Galileo claimed to have been stung in some Scorpion-like manner, but it's hard to see why. He and no-one else had muddled up the sign and constellation of the Scorpion — which had been moving apart from each other for two millennia.

E2 Galileo has accused Sarsi of "contradicting the truth" because of his title's allusion to the "celestial Balance" — i.e., the constellation of the Scales. He has quoted Sarsi re the comet's origin in the *sign* of Scorpio, "the principal house of Mars": that has to be an astrological allusion (Scorpio was traditionally "ruled" by Mars), i.e. the tropical-zodiac sign, which cannot be a *constellation*. But then in the same sentence, Galileo goes on to quote Dante re the Scorpion constellation — as would have been, he avers, more appropriate for this comet! In no way did that comet pass across the stars of the heavenly Scorpion.

E3 Stillman Drake, in his opus *Galileo at Work, His Scientific Biography*, merely says of the comet that "its home was determined as near the middle of Scorpio," leading us to wonder whether his view had been derived more from reading Galileo than the views of European astronomers. The comet was travelling at a steep angle to the ecliptic, so it is misleading to his readers to allude to the tropical-zodiac sign in this manner rather than the constellation. James Reston in his biography *Galileo a Life* described (p.177) how the great comet of 1618 "moved towards the northern scale of the Libra, growing in intensity, and finally arrived in the constellation of Scorpion." It didn't do that at all (see Fig.1). Reston has evidently been unduly swayed by Galileo's text.

E4 *Il Saggiatore* has Galileo famously expressing the view: "Philosophy is written in this very great book which always lies open before our eyes (I mean the universe), but one cannot understand it unless one first learns to understand the language . . ." where the characters of that language were "triangles, circles and other geometrical figures." Not having seen any comet since that of 1577 in his youth, he is here claiming to have access to some interior universe: a Pythagorean view which delighted his readers.

E5 Galileo interpreted a truly massive comet as being a mere optical illusion — and, in the wrong sign! His polemic, heavily sardonic, could not have been more wrong. Had he discussed his views with other mathematici, who had actually seen it, he might have avoided bungling the issue so badly. Galileo experts down through the centuries have never taken their hero to task for this.[24] Laced with heavy sarcasm, his book's insulting tone towards the Collegio Romano paved the way for the more complete breakdown in their relationship in his later trial.

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[22] *Disputation* (anon), Collegio Romano, 1618: Reston, *Galileo a Life*, p.178.

[23] *Controversy*, pp.171-2. Vol.VI of Galileo *Opere*, 1933, p.221.

[24] David Wootton, in his 2010 Yale University Press biography, *Galileo, Watcher of the Skies*, has a 14-page chapter about Galileo's *Il Saggiatore* entitled "Comets" from which one would hardly gather that the opus was about this 1618 great comet. His discussion does not make contact with any astronomical issues around that comet. Should scholars not acknowledge the wrongness of "heroic" biographies — which themselves do not acknowledge when their main character was totally wrong.