HOOKE RESTORED

ROBERT HOOKE (1635-1702/3)

Founder of Modern Science

OR

HOOKE, NEWTON, AND THE SCIENTIFIC REVOLUTION

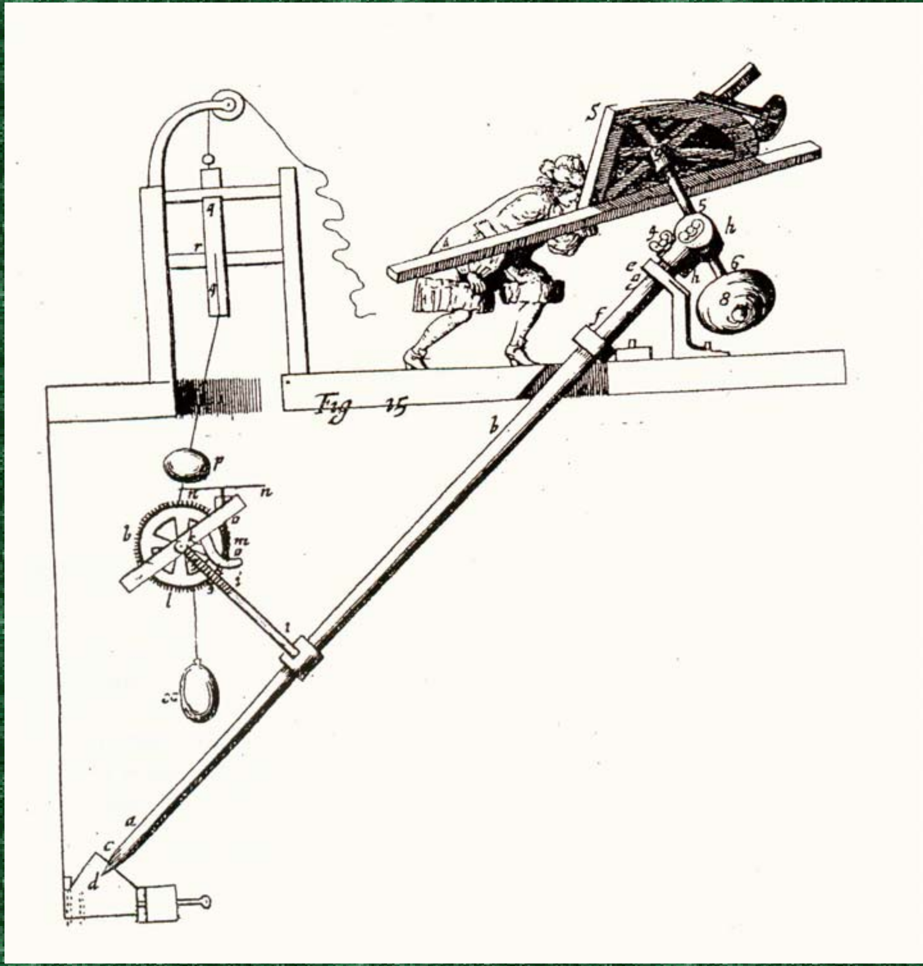
- (No Hooke biographer has been able to ignore Newton, but then no Newton biographer has been able to ignore Hooke.)

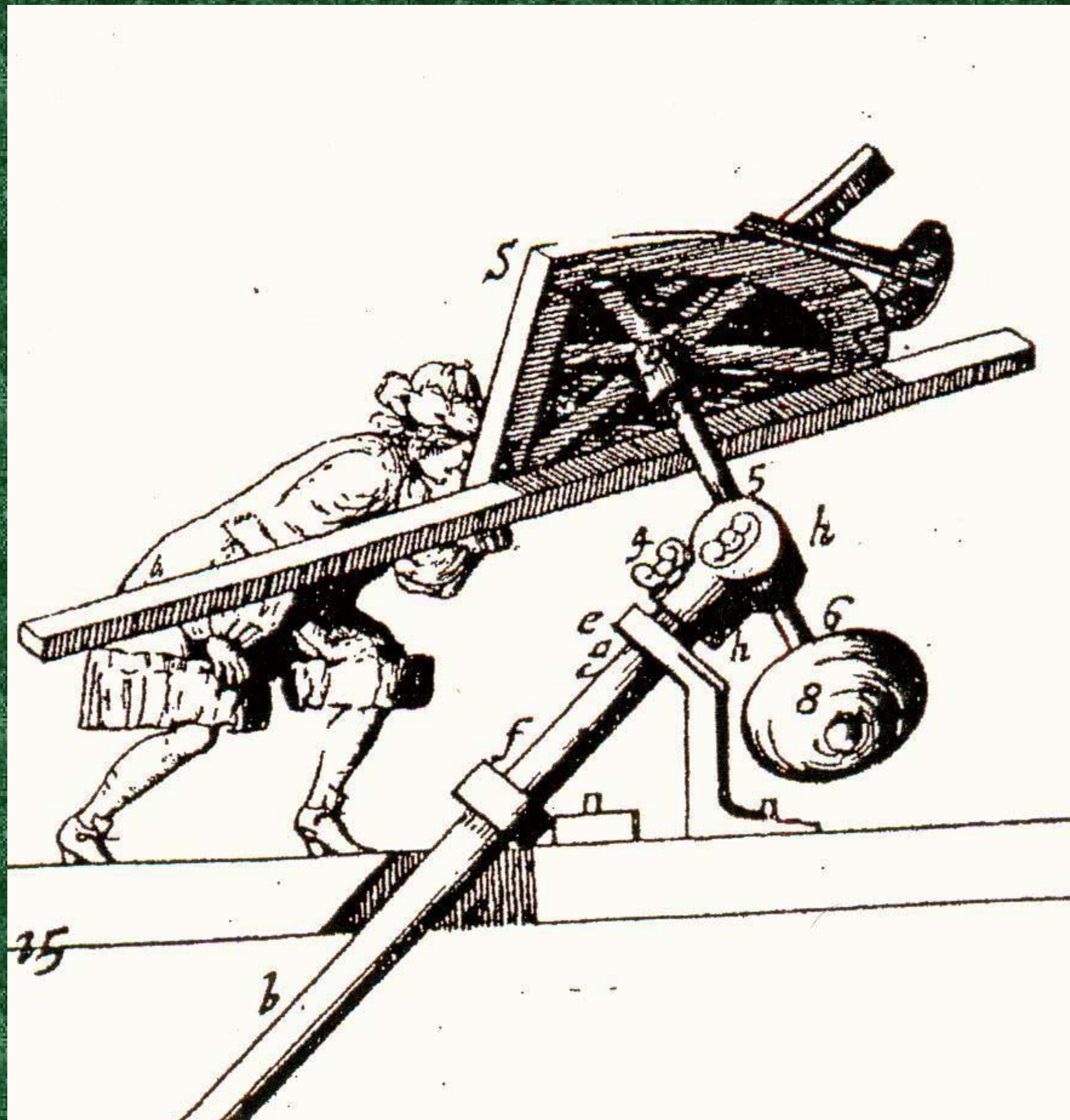
The only known portrait of Robert Hooke

The only known portrait of Robert Hooke

- Newton is assumed to have had a role in the disappearance of the RS's portrait of Hooke, known to have existed in 1710. Newton assumed the presidency of the RS eight months after Hooke's death

A pendulum-driven equatorial quadrant with self-portrait?

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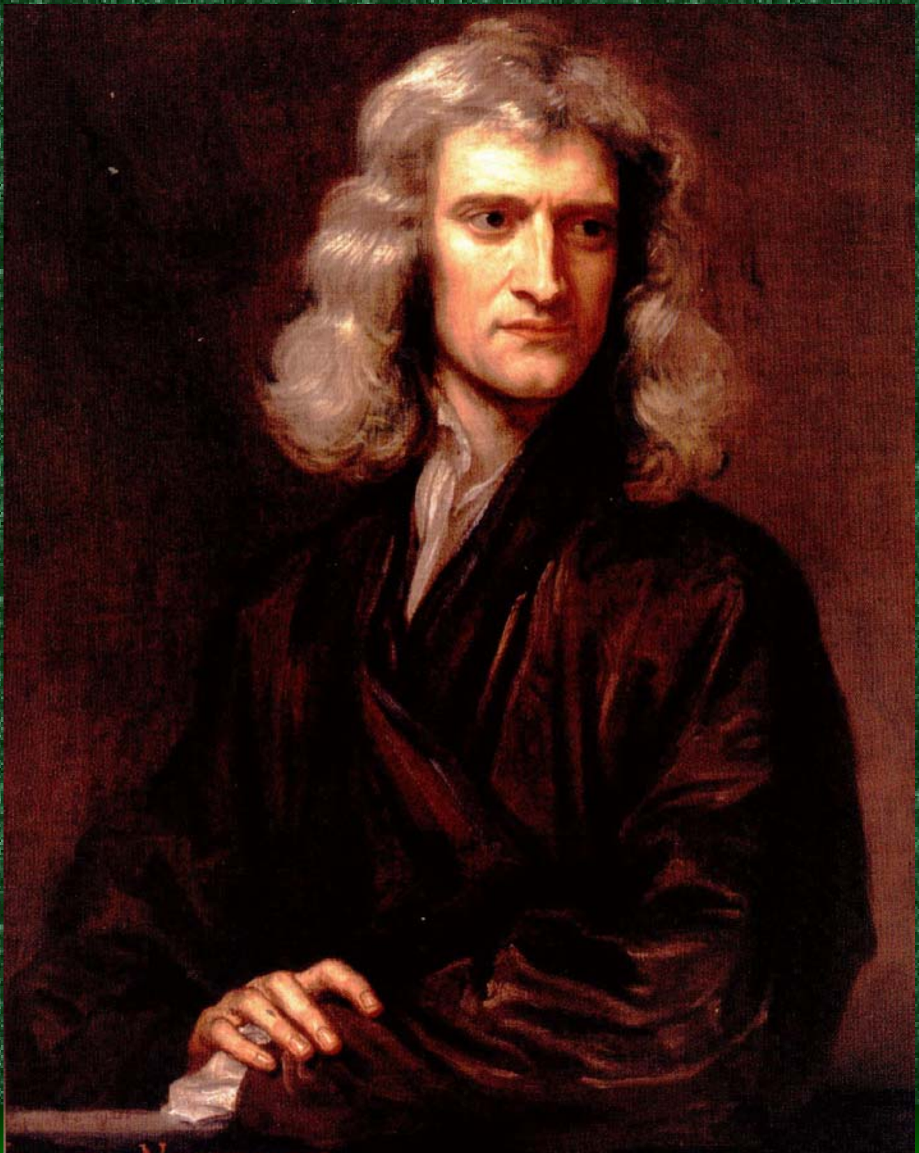
Isaac Newton (1642-1727)



- Hooke went up to Oxford in 1653, met members of the Oxford experimental science society (Ward, Willis, Wilkins, Wren,….), and became experimental assistant to Robert Boyle (Earl of Cork).

Robert Boyle (1627-1691)

- During Hooke’s apprenticeship with Boyle, he designed and built Boyle’s air pump, which he and Hooke used to establish what is often called “Boyle’s Law.”

The Hooke-Boyle air pump

- Hooke’s name should certainly be associated with it, since he probably carried out the experiments as well, but true credit belongs to Henry Power and Richard Towneley.

- During this period, Hooke also wrote his first paper, on capillarity, invented the “anchor escapement” for pendulum clocks and invented the spring-regulated watch.

An ATTEMPT FOR THE EXPLICATION Of the PHÆNOMENA,

Obſervable in an Experiment Publiſhed by the Honourable

ROBERT BOYLE, Eſq;

In the XXXV. Experiment of his Epiſtolical Diſcourſe touching the *AIRE*.

In Confirmation of a former Conjecture made by R. Hooke.

Nos cum non ſemper magna referre poſſimus, vera tamen ſed rara recitamus; neq; enim minori miraculo in parvis Natura ludit quam in magnis, Cardan de Vari. *L.8. Cap.* 43.

Tum vero de Scientiarum progreſſu ſpes bene fundabitur, quum in hiſtoriam naturalem recipientur & aggregabuntur complura experimenta, quæ in ſe nullius ſunt uſus, ſed ad inventionem cauſarum & axiomatum tan um faciunt, Verulamii Nov. Org. Aph. 99.

LONDON,
Printed by *J. H.* for *Sam. Thomſon* at the Biſhops Head in St. *Pauls* Church-yard, 1661.

- Much of the motivation for Hooke’s studies in horology was the problem of determining longitude at sea or in distant lands.
- Not solved until Harrison in about 1750.

- Hooke left Boyle’s laboratory (“with the thanks of the Society”)

Hooke and the Royal Society

- The Royal Society of London was founded in 1660 just after the Restoration of the monarchy (Charles II)
- After the apprenticeship with Boyle, Hooke became the Curator of experiments for the Society in 1662. Hooke served for 40 years and was the first salaried scientist.

Origins

- After a Wren lecture on November 28, 1660, 12 “virtuosi” gathered and
- "something was offered about a design of founding a college for the promoting of physico-mathematical experimental learning."

“The Royal Society for the advancement of experimental knowledge”

- Thoroughly Baconian
- “one great Man, who had the true Imagination of the whole extent of the Enterprise, as it is now set on foot: and that is, the Lord Bacon…” Thomas Sprat

"If any caution will serve, it must be this; to commit the Work to the care of such men, who, by the freedom of their education, the plenty of their estates, and the usual generosity of their Noble blood, may well be supposed to be most averse from such sordid distractions."

- Hooke as *employee* of Royal Society, hence, not one of those "gentlemen free and unconfined")
- The membership (Fellows) came from the nobility, landed gentry, clergy, physicians

- Hooke charged with preparing three or four experiments for every meeting.
- This in large measure determined the course of his scientific career…being diverted from one issue to another at the whim of the Fellows

Brief Summary of Hooke's Career

- 1662-1702 Curator RS
- 1665 *Micrographia*
- 1665-6 plague (see Newton)
- 1666 Great Fire (80% of **City** of London burned)
- 1671 Exchange with Newton over light and color
- 1674 "An Attempt to Prove the Motion of the Earth Through Observations" (stellar parallax)

- 1677-82 Secretary of RS
- 1678 *De Potentia Restitutiva*
- 1677-1702 Council member (most years)
- 1679-80 Exchange with Newton on gravitation
- 1684 Newton’s *De Motu* (Kepler’s Laws)
- 1687 Newton’s *Principia* (Mathematical Principles of Natural Philosophy)

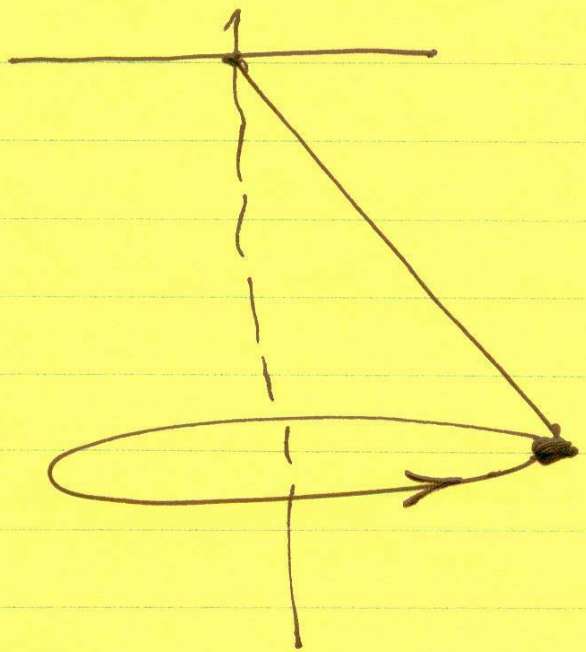
- March 3, 1702/3 Hooke dies. Leaves estate of over 9000 pounds
- 1891 Discovery of Diary (now in Guildhall Library, City of London)
- 1935 publication of Diary; beginning of resurrection of Hooke’s reputation
- 1956 first biography (‘Espinasse’)

- 2003 Tercentennary of Hooke’s death; plaque in Westminster Abbey (2005)
- 2006 Hooke MS. sold for $1.5 million

Summary of Experiments, Discoveries, Inventions, and Theories

- Pneumatics, including subjecting himself to lowered pressure in evacuation "receiver"
- Anchor escapement
- Spring-controlled watch
- Circular or conical pendulum as analogy to planetary motion

Circular or Conical Pendulum



- Cycloidal pendulum
- Interference, including “Newton’s Rings” before Newton
- Diffraction, independent of Grimaldi
- First binary star
- Rotation of Mars
- Jupiter’s Great Red Spot
- Periodicity of comets

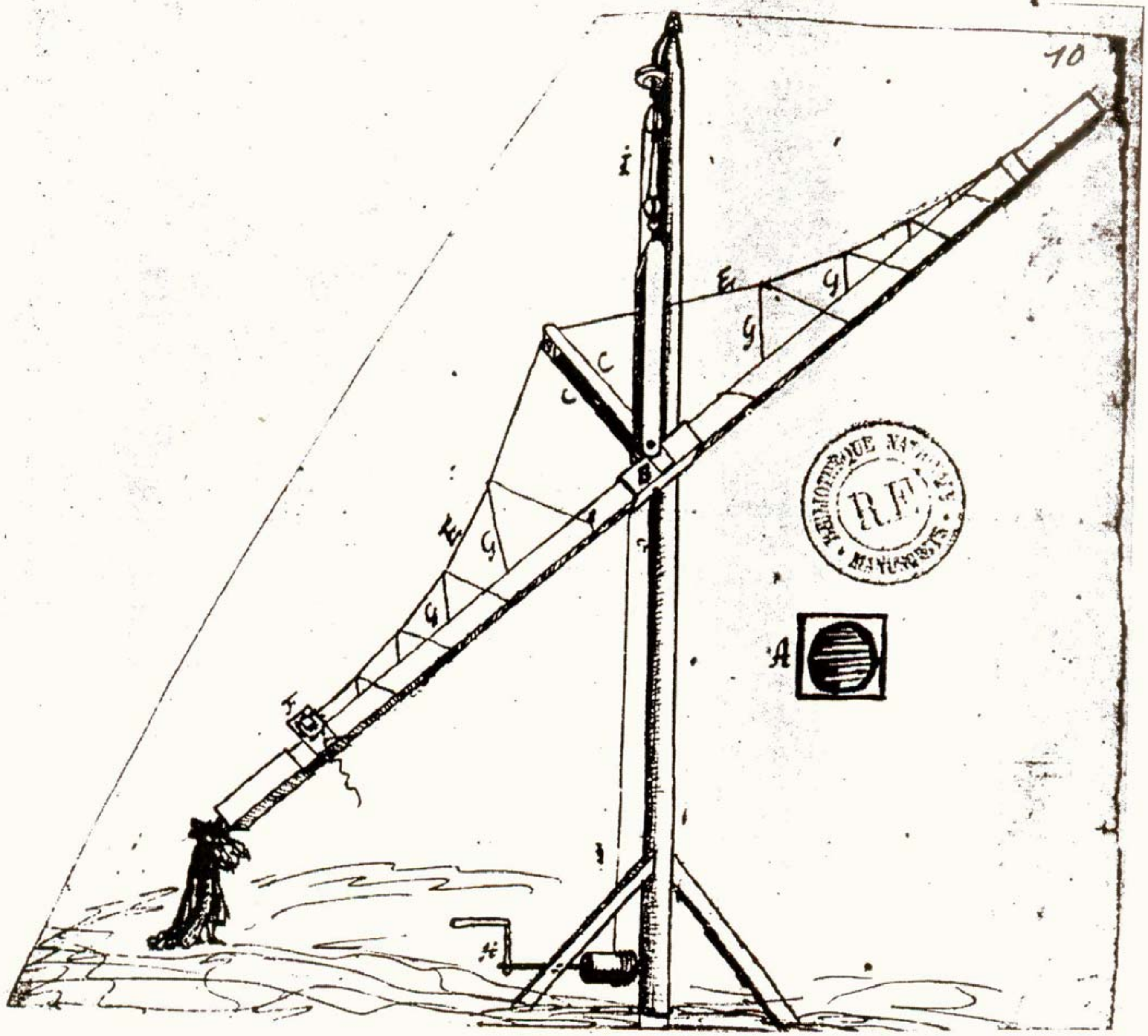
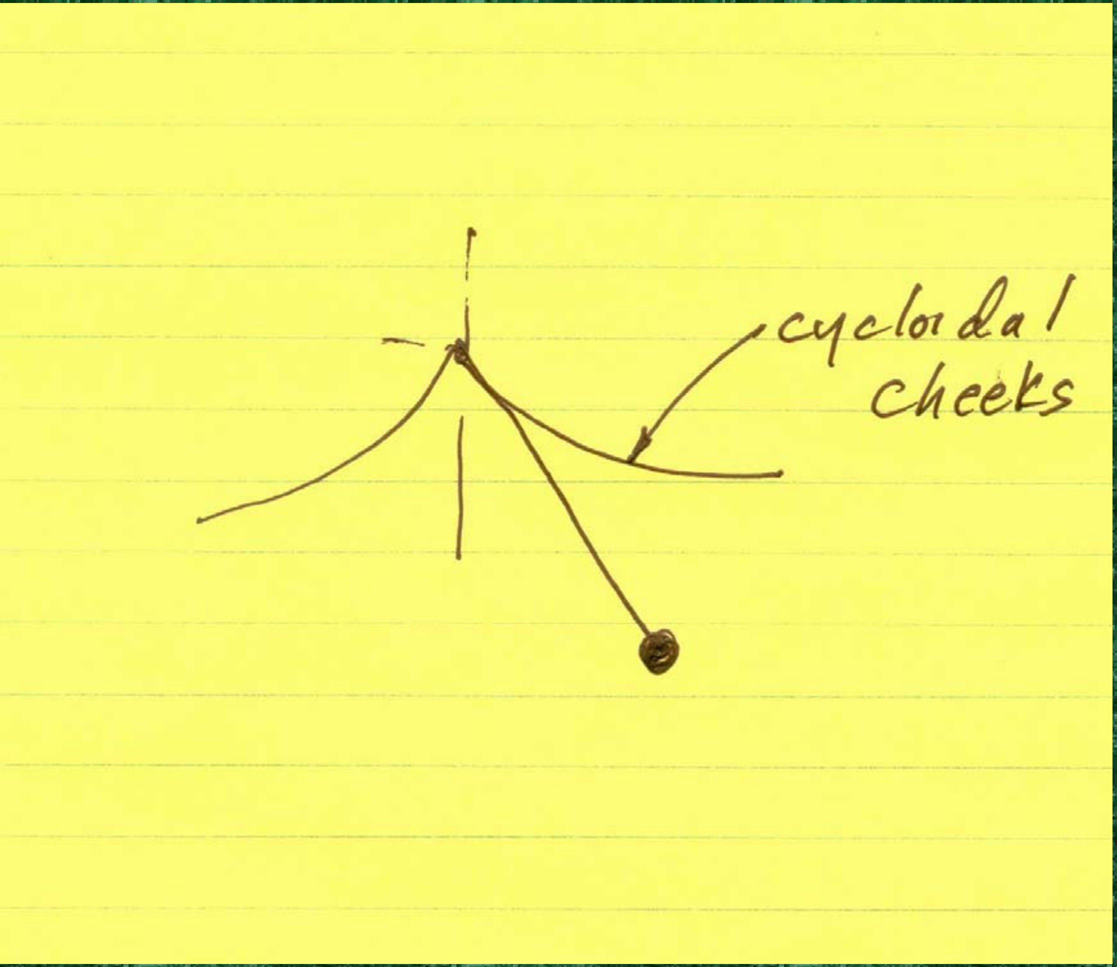


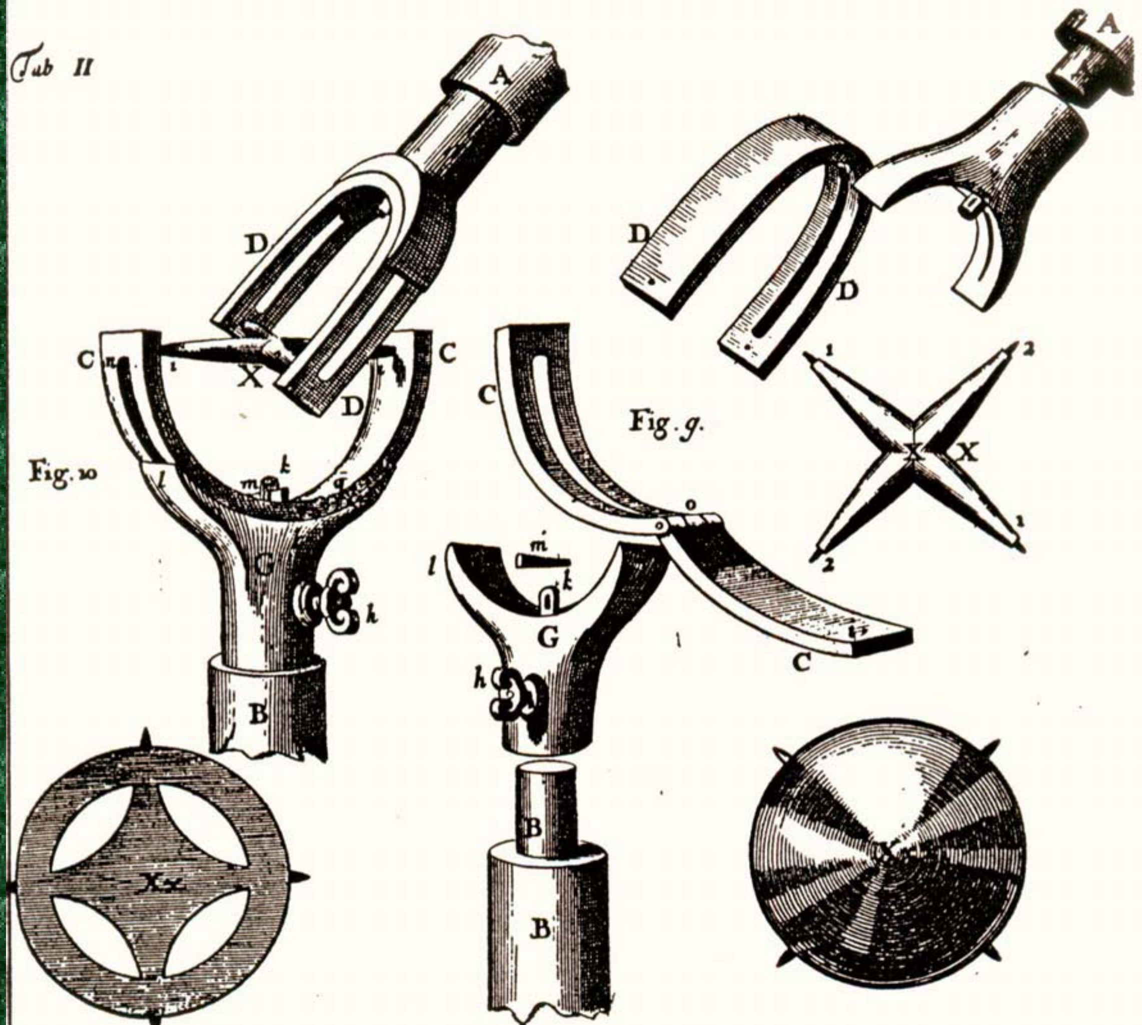
PLATE III. Hooke's long telescope, 1667

Pendulum with cycloidal cheeks—exact isochrony



- Universal joint
- “Nitrous component in air” responsible for respiration and combustion; experiments
- Discovery of the cell
- Wave-theory of light (w/Huygens, Fresnel)
- Fossils high above the sea, earthquakes and vulcanism (vs. Steno)

Universal Joint or “Hooke joint”



Hooke's Universal Joint.

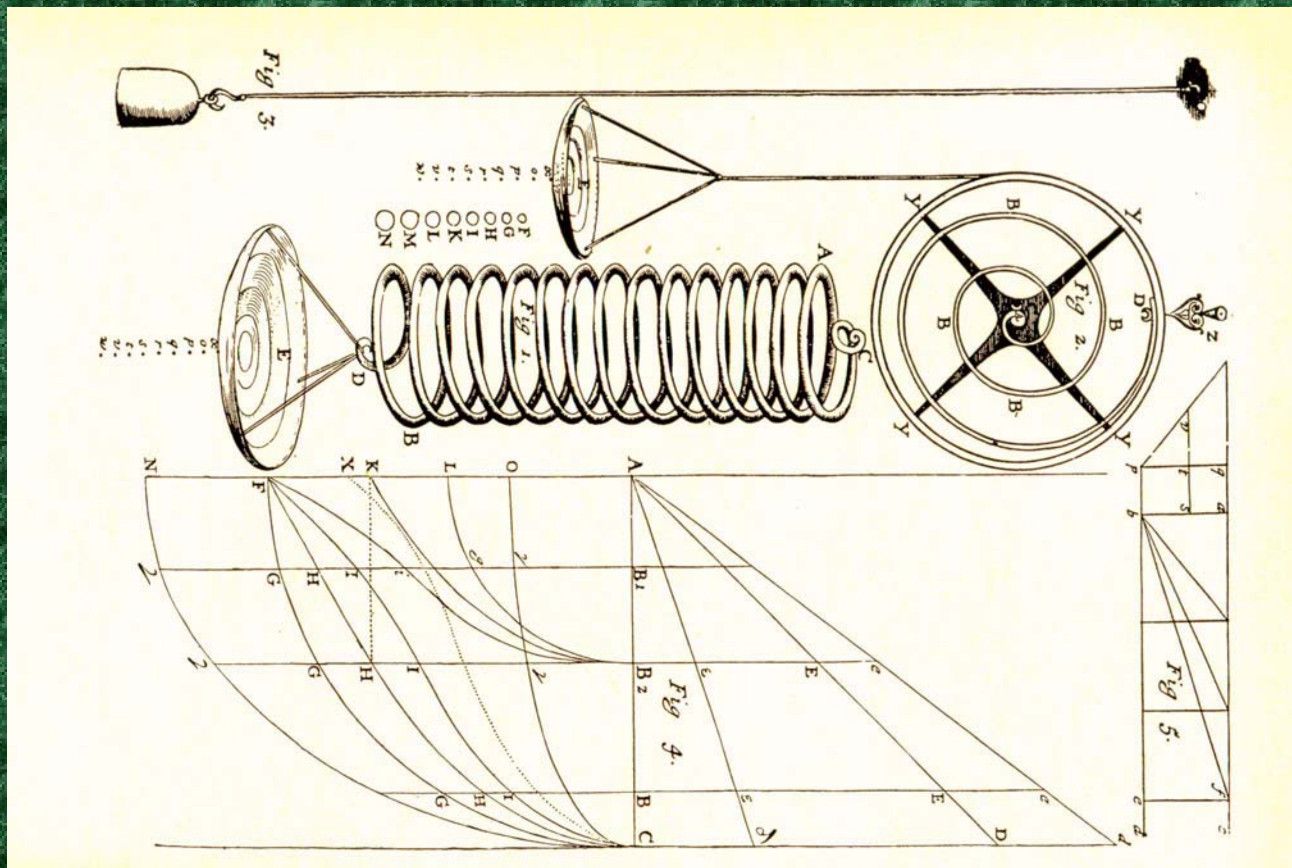
- Inverse-square gravitation/universal gravitation
- Planetary theory ; centripetal force (coined by Newton)
- Practical optics, design of grinding machines for non-spherical lenses/mirrors
- First Gregorian reflecting telescope
- Stellar aberration?

- Nature of heat—vibrations of tiny particles
- Magnetism
- Variation of gravity and barometric pressure with altitude; exps. at Monument, St. Paul’s
- Diving bells, etc.
- Evolutionary theory (see Ellen Tan Drake)

Hooke’s law

- And, of course, “Hooke’s Law” of elasticity
- *De Potentia Restitutiva*, or “Of Spring” (1678)
- “The Power of any Spring is in the same proportion with the Tension thereof”

Hooke figure of a spring



- Applied to all “springy” bodies, that is, metal, wood, stone, etc., hence a general property of elastic bodies
- This is what Hooke is known for by most physicists
- The civil engineer J.E. Gordon has called Hooke’s ideas on elasticity “one of the greatest intellectual achievements in history”

MICROGRAPHIA

- Recounts Hooke’s discoveries with the microscope; exquisite drawings of fleas, mites, feathers, etc. with his compound microscope.
- Hooke’s theory of light and color
- Natural philosophy, including (universal) gravitation
- Formation of lunar craters, the Pleiades.

MICROGRAPHIA:

OR SOME

Physiological Descriptions

OF

MINUTE BODIES

MADE BY

MAGNIFYING GLASSES.

WITH

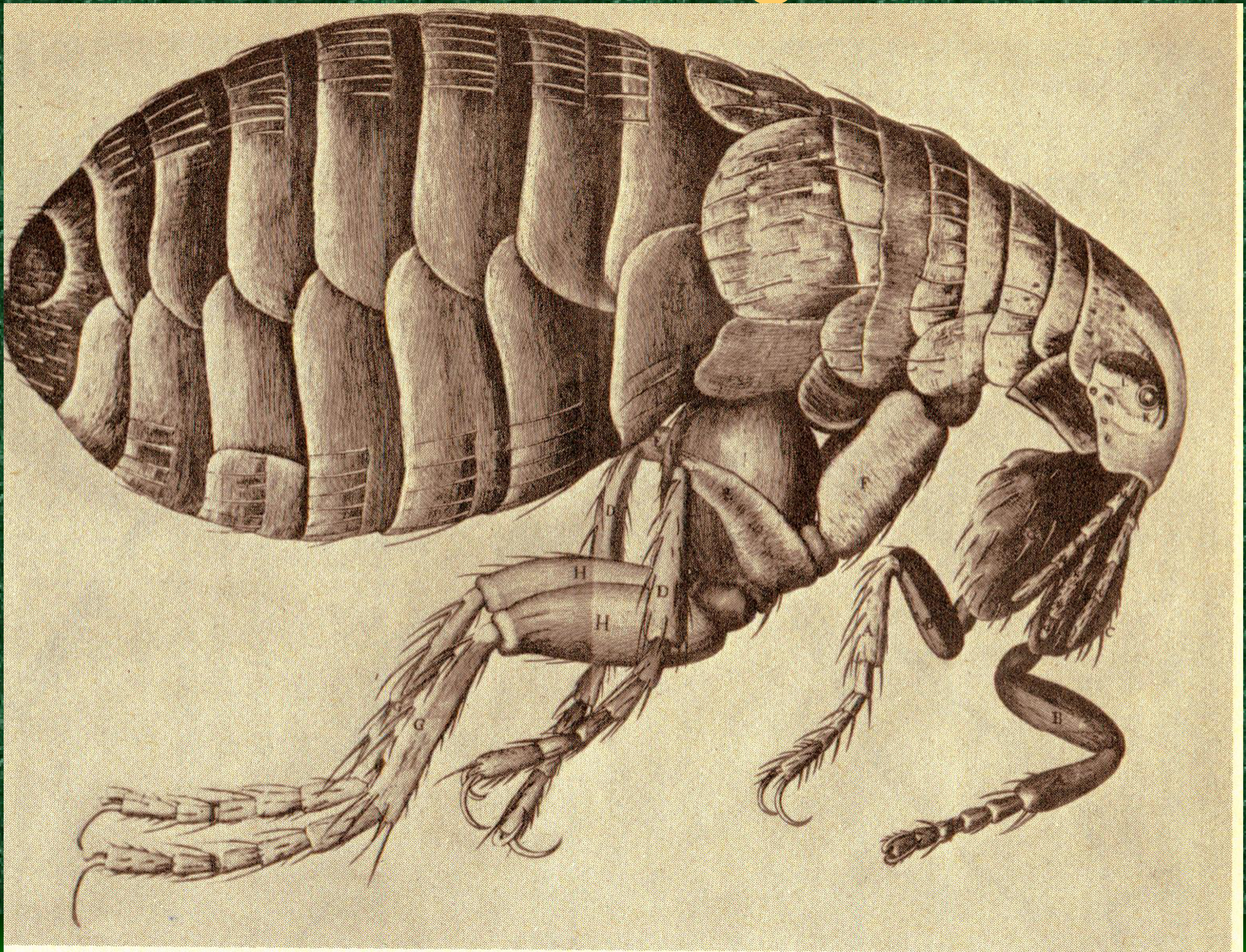
OBSERVATIONS and INQUIRIES thereupon.

By *R. HOOKE*, Fellow of the ROYAL SOCIETY.

Non possis oculo quantum contendere Linceus,
Non tamen idcirco contemnas Lippus inungi. Horat. Ep. lib. I.

LONDON, Printed by *Jo. Martyn*, and *Ja. Allestry*, Printers to the ROYAL SOCIETY, and are to be sold at their Shop at the *Bell* in S. *Paul's* Church-yard. M DC LXV.

Hooke’s Drawing of a Flea



Hooke drawing of the lunar crater Hipparchus

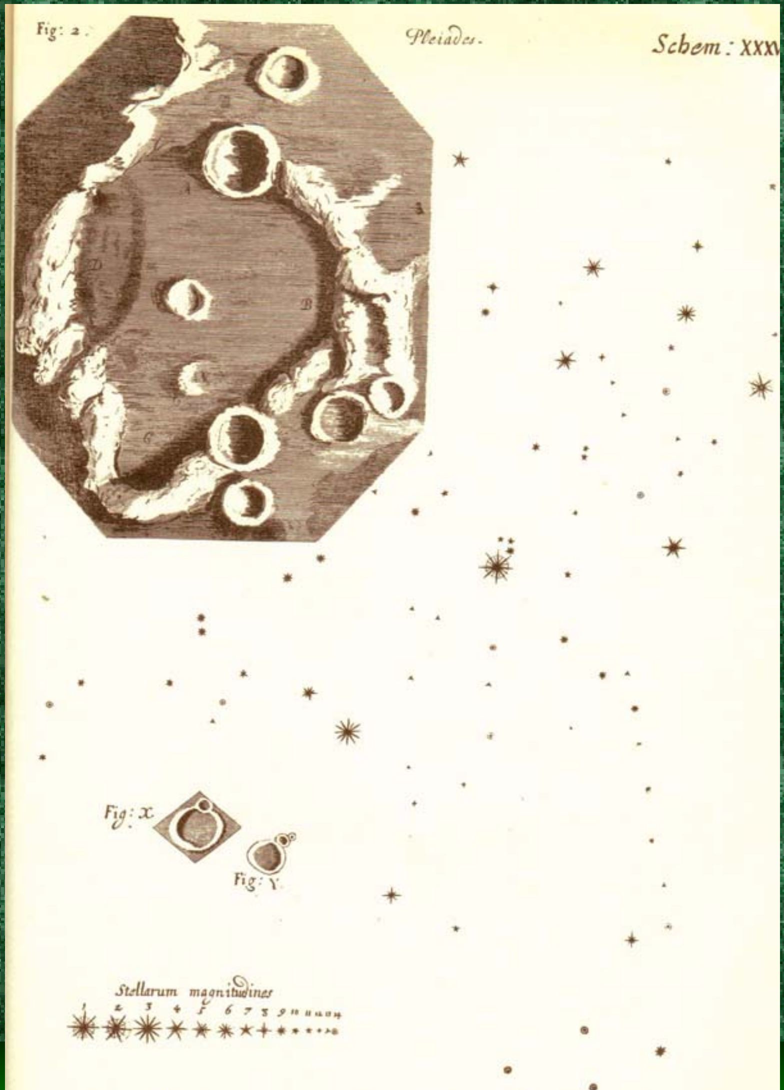
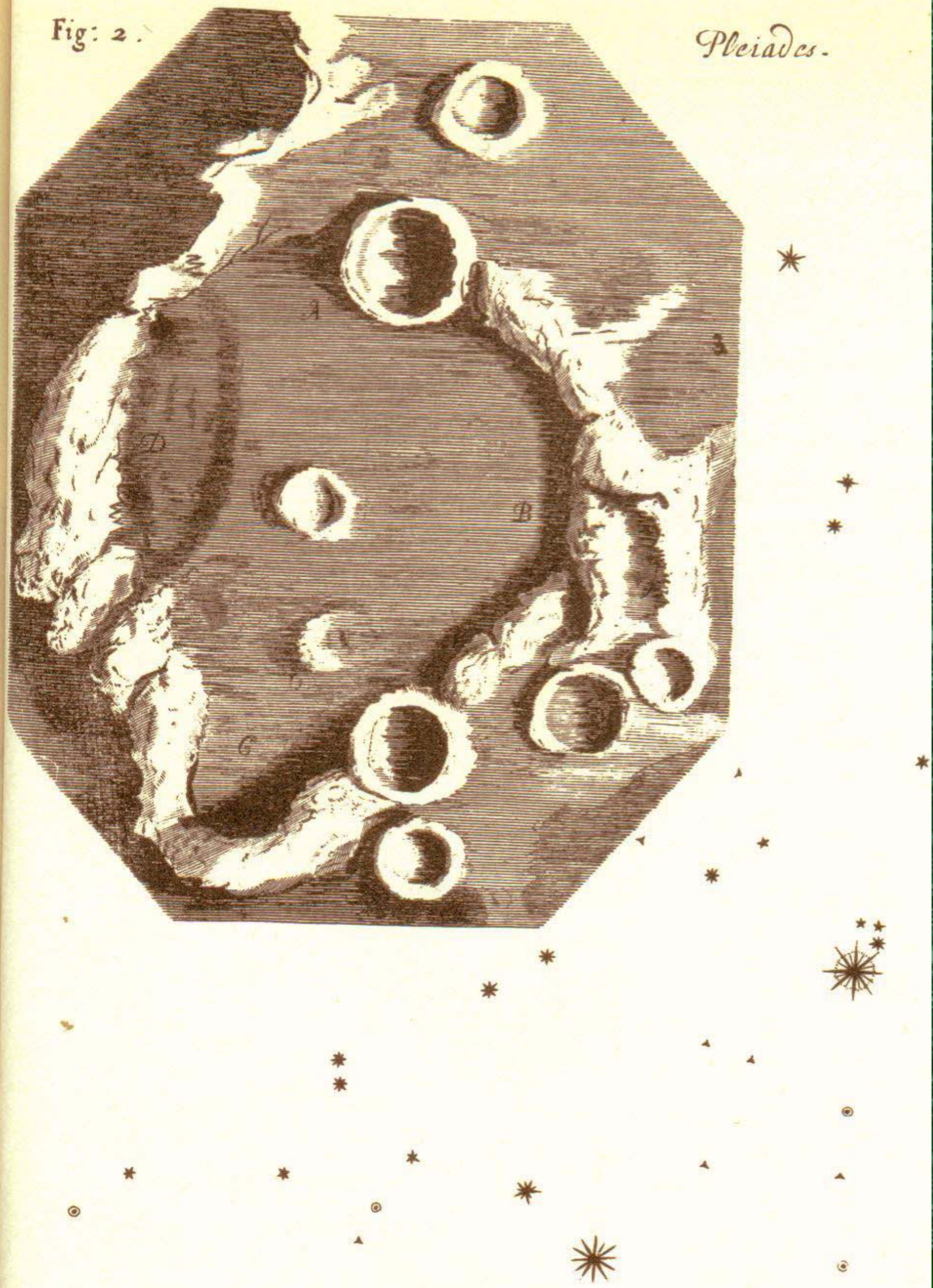
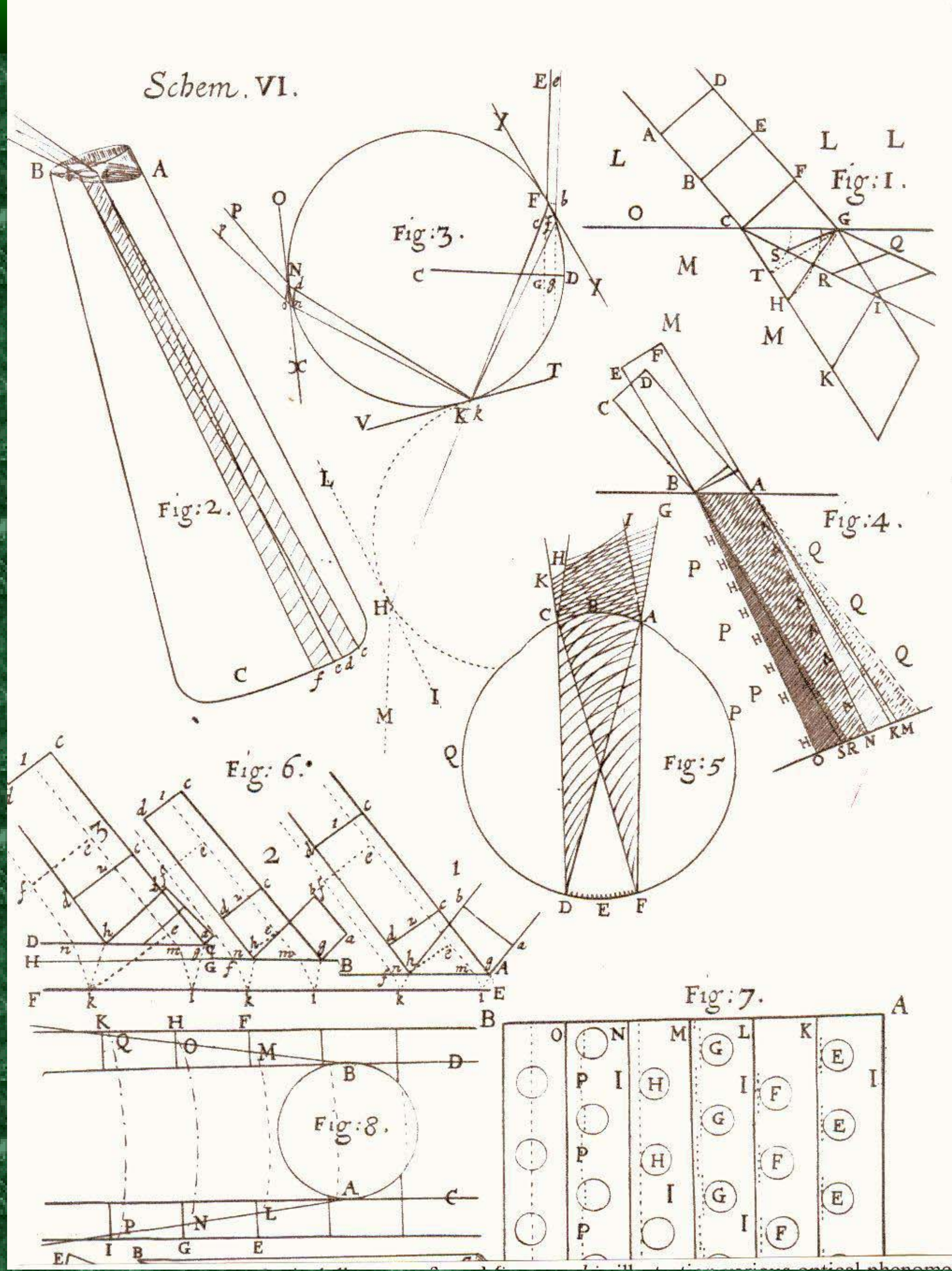


Fig: 2.



Pleiades.


Schem. VI.
Fig: 1.
Fig: 2.
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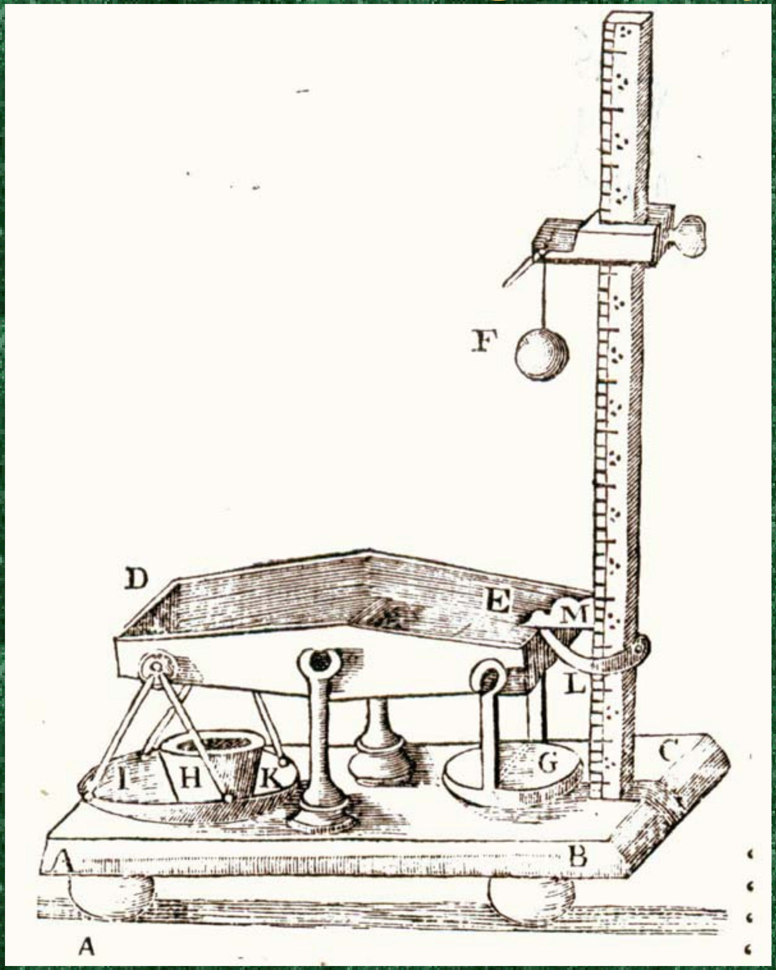
- Influenced both Huygens and Newton. We have Newton's notes on it.
- "it being very probable that the moon has a principle of gravitation…"
- "And to make this probable, I think, we need no better Argument, then the roundness….of the body of the moon it self"

- 1668 Hooke proposed to study the laws of motion (mostly collisions)
- Transformed into theoretical discussion among Huygens, Wren, and Wallis, with Hooke left on sideline to do experiments

- Hooke's interest was
- 1) springiness or rebound
- 2) whether "motion" is preserved
- 3) vis viva, I.e., mv^2 (Leibniz)
- Hooke carried out an experiment to show that "the strength of a body moved is in duplicate proportion to its velocity"

Hooke device to measure "force" of a falling body



Transfusions

- Hooke was pressed into service by physicians in the Society in their experiments in transfusing blood from one dog to another, one animal to another, and even from an animal to a man. It was proposed (not by Hooke) that they get a subject from Bedlam, the hospital for the insane…..

- These same issues occupied Hooke during the rest of his career: pneumatics, magnetism, earthquakes and fossils, sounding the ocean, diving bells, gravitation, parallax, etc.

Who was Robert Hooke?

- Son of rural curate, Isle of Wight
- Westminster School, Dr. Busby
- Entered Oxford's Christ Church College as a chorister and "servitor" 1653
- MA 1663
- Oxford Experimental Science Club/Wilkins, Wallis (see Newton), Wren, Boyle

- Curator, 1662
- Fellow, 1663
- Gresham Professor of Geometry, 1665
- City Surveyor, 1666
- Architect, 1670s, 80s

- Boyle his patron, and one of three mentors in his life. Wren, friend and partner in rebuilding London and as architects.
- Wren and Hooke met almost daily at one coffee-house or another or at job site

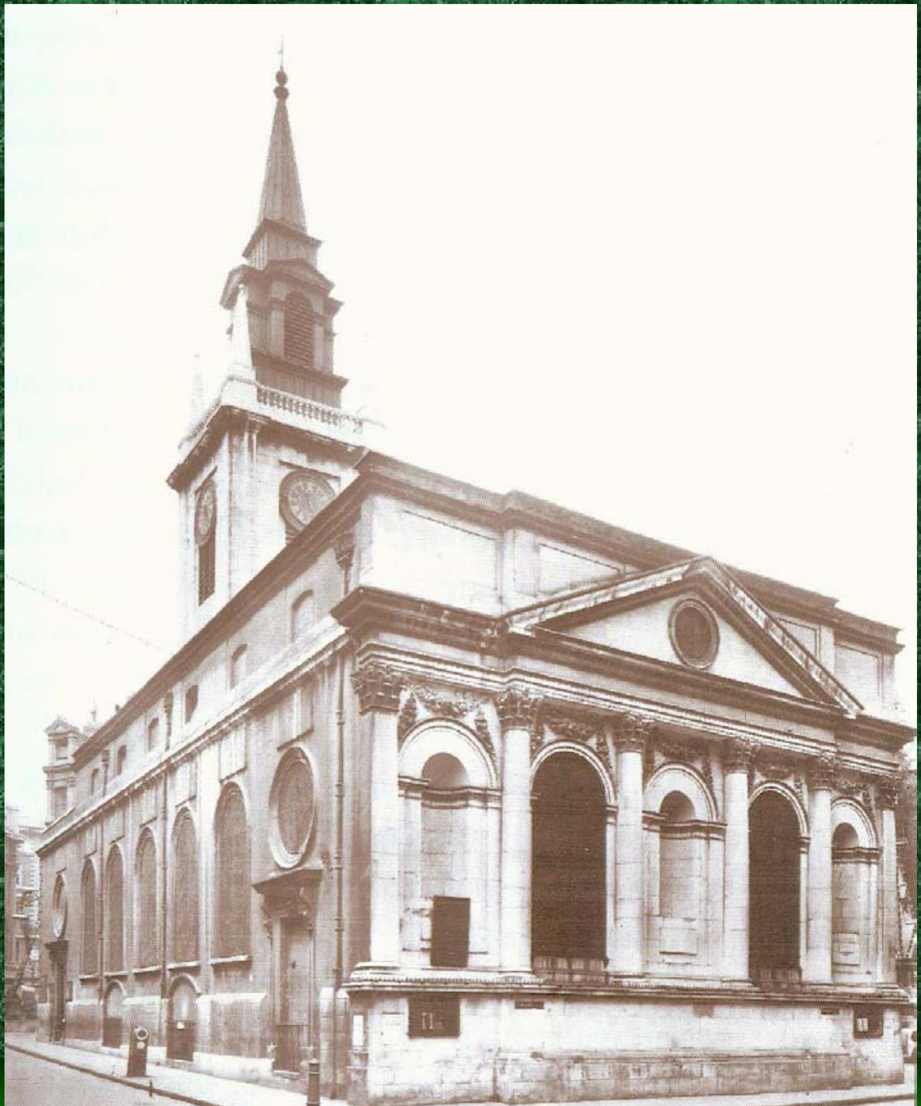
Christopher Wren (1632-1723)

- Many of the “Wren churches” were designed and built by Hooke (as many as 20), sometimes with Wren, sometimes entirely Hooke
- Hooke helped with the design of St. Paul’s which Wren worked on for nearly 50 years. Often they conferred on issues of the strength and shape of arches, etc.

- Hooke helped Wren design Greenwich Observatory
- Designed (with Wren) the Monument, marking the start of the fire
- Large civic buildings: Bedlam Hospital, College of Physicians, etc.
- Existing: Willen Church, Ragley Hall

Mary Magdalen, Willen

St. Lawrence Jewry, the City



Ragley Hall

Bethlehem ("Bedlam") Hospital

Bethlehem Hospital, Moorfields, of which Robert Hooke was the architect and builder. It survived until 1814. From a contemporary engraving

College of Physicians

THE COLLEGE OF PHYSICIANS 1673

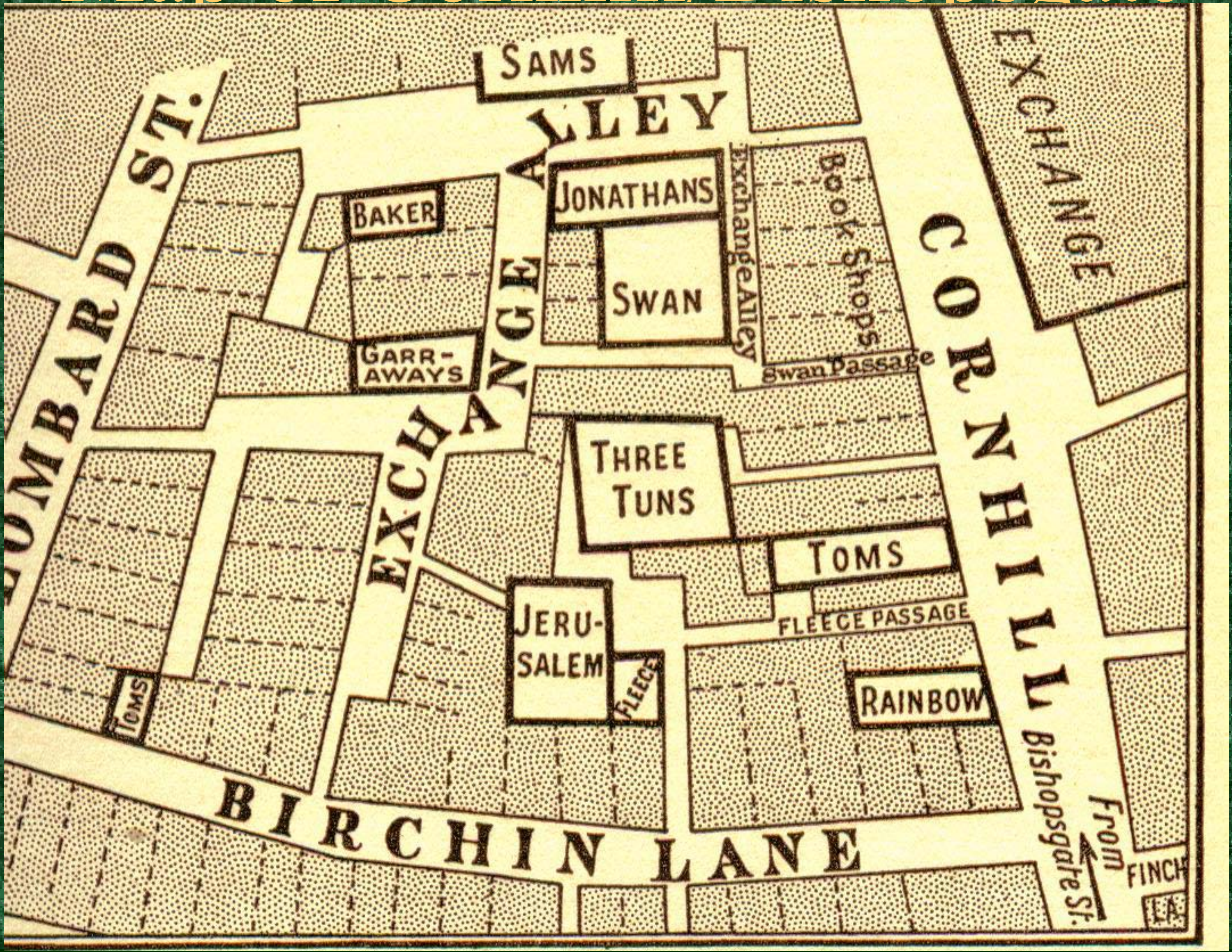
From the Pharmacopoeia Londinensis 1721

The Monument
A Zenith Tube

- Hooke was in constant contact with instrument makers, tradesmen, carpenters, stonemasons, at all stations in life, often at the coffee-houses he visited daily, sometimes several times daily.
- Heavily involved in surveying and with codes and practices

Also regularly met Wren, Halley, sometimes other fellows there as well. Especially Garraway's, Jonathans, etc. (Coffee houses introduced to London in 1652)

Map of Cornhill/Bishopsgate



Cornhill area of London today

Hooke's Diary

- First diary, discovered 1891, covers about a decade, 1672-83, entry for virtually every day. One of the essential documents of late 17-century England
- Second, 1688-93 (but only 24 months of entries)

- Almost everything we know of Hooke comes from his diaries, especially the first one.
- Very sketchy, laconic; unlike those of Pepys and Evelyn

- Friends included Wren, Boyle, Halley (essentially his protégé’), Samuel Pepys, Seth Ward (Bishop of Salisbury), John Wilkins (Warden of Wadham College when Hooke went there), Bishop Tillotson (Archbishop of Canterbury)

- Enemies, or those with whom he tangled:

Huygens, Leibniz, Hevelius, Flamsteed, Newton, Brouncker (Pres. RS for 15 years), Oldenburg (Sec'y of RS for 15 years)

Christian Huygens

Evaluation of Hooke

- "The most ingenious man who ever lived" –Andrade (1935)
- "The most, and promises least of any man in the world that I ever saw" Samuel Pepys, Diary

- Huygens to Oldenburg, 1675
- “I do not know how you put up with the ill-founded boastings of this man….”
- (Wren had no regard for Oldenburg, either)

Hooke and Newton, I

- Light and Color—presentation of Newton's theory of color to the Society in 1671-2
- Hooke's theory that color resulted from the modification of white light by refraction
- Vs.
- Newton's theory that white light is superposition of all colors

- The also disagreed over the nature of light. Newton’s corpuscular vs. Hooke’s wave theory of light

- Hooke’s comments on Newton’s study of light and color”
- “…as to his hypothesis….”
- “…for the same phenomena will be solved by my hypothesis, as well as by his…”

- Newton’s reply, six month’s later (described by Sam Westfall as “viciously insulting…filled with hatred and rage…”)
- Dispute apparently exacerbated by Oldenburg

Hooke and Newton, II

- Hooke-Newton correspondence, 1679-80
- Background:
- Hooke, in *Micrographia*, 1665:
- "it being very probable that the moon has a principle of gravitation…"
- (0:25)

- Hooke, May 23, 1666, to the RS:
- “….the second cause of inflecting a direct motion into a curve may be from an attractive property of the body placed in the center…”

- “An Attempt to Prove the Motion of the Earth Through Observations,” 1674:
- “…all coelestial Bodies whatsoever, have an attraction or gravitating power towards their own Centers,whereby they attract not only their own parts…but that they do also attract all the other Coelestial Bodies…”

- This is the first statement of the universality of gravitation, despite Newton’s statements to Conduitt and DeMoivre many decades later.

AN ATTEMPT

To prove the

MOTION

OF THE

EARTH

FROM

Obſervations

MADE BY

ROBERT HOOKE Fellow of the *Royal Society*.

Senec. Nat. Qu. lib. 1. cap. 30.

Ne miremur tam tardè erui quæ tam altè jacent.

LONDON,
Printed by *T. R.* for *John Martyn* Printer to the *Royal Society*, at the *Bell* in St. *Pauls* Church-yard. 1674.

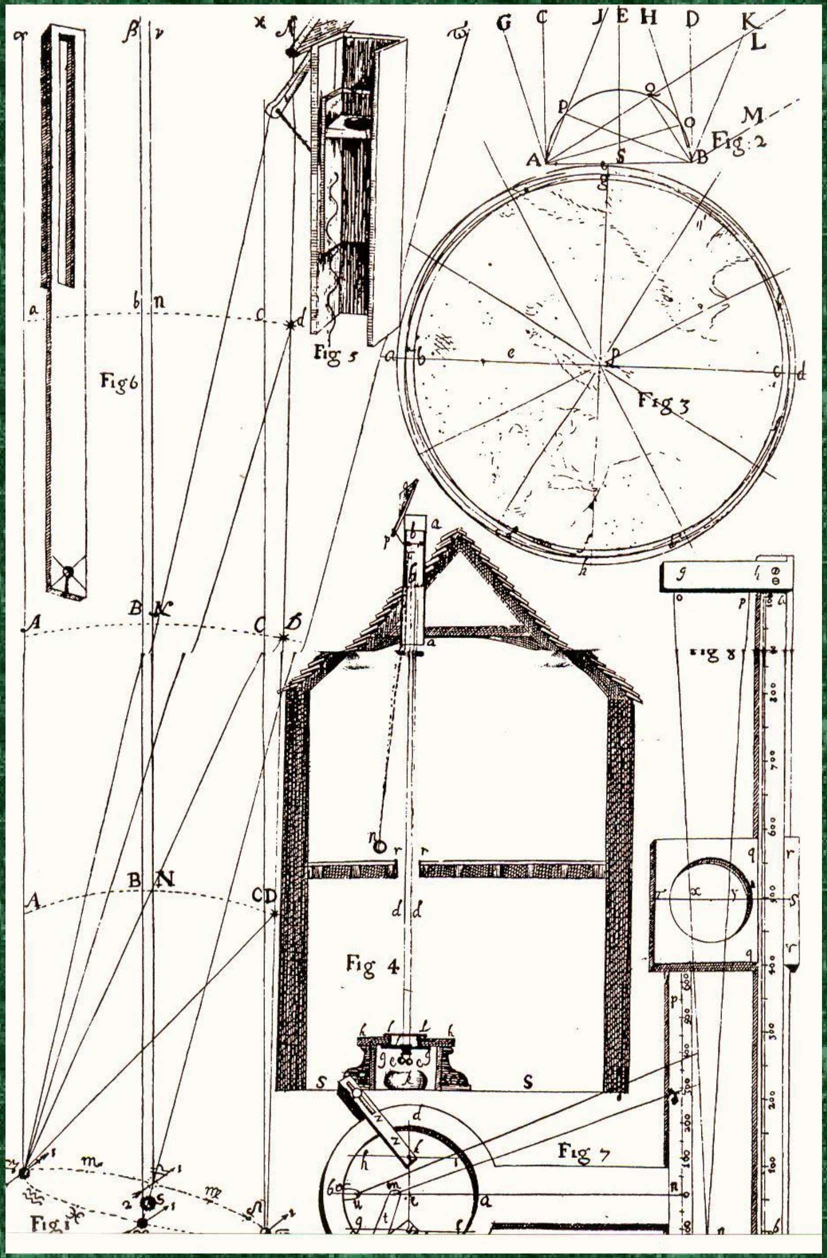


Fig 2
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Fig 8
Fig 1

- The evidence is that Newton held an aether-flow theory of gravity that depended on Cartesian vortices. It is clear that he thought in terms of centrifugal force and some counter-ballancing attraction.

- No evidence that he understood the inverse-square character of gravity until after the correspondence with Hooke in 1679-80.

- Hooke to Newton, 24 November 1679
- “For my part I shall take it as a great favour if you shall please to communicate by Letter your objections against any hypothesis or opinion of mine, And particularly if you will let me know your thoughts of….

- ….that of compounding celestiall motions of the planets of a direct motion by the tangent & an attractive motion towards the centrall body.”

- Newton to Hooke, 29 November 1679
- After pleading preoccupation with "country affairs," he told Hooke that he
- "had for some years past been endeavouring to bend myself from Philosophy to other studies…."

- The “other studies” were in alchemy and theology. Newton went on to say:

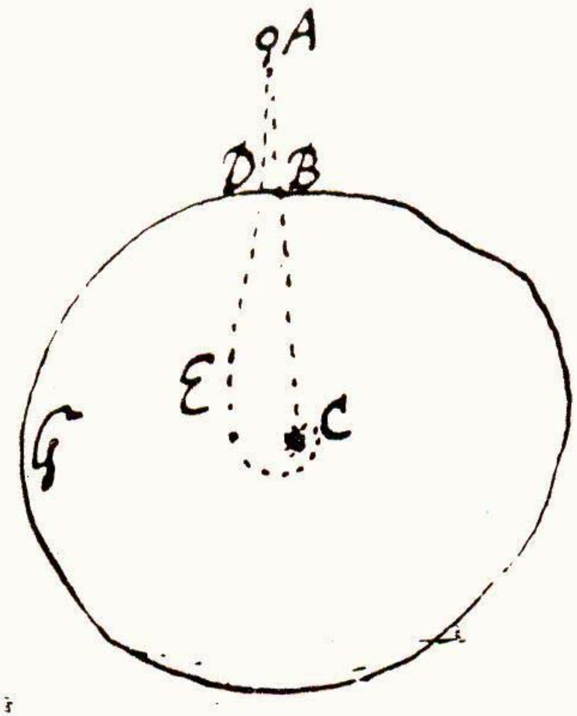
- “..you will incline ye [the] more to believe me when I tell yt [that] I did not before ye receipt of your last letter, so much as heare (yt I remember) of your Hypothesis of compounding ye celestial motions of ye Planets, of a direction motion by the tangt to ye curve…”

- “And having thus shook hands with philosophy & and being also at present taken of other business, I hope it will not be interpreted out of any unkindness to you or ye R. Society that I am backward in engaging myself in these matters…”

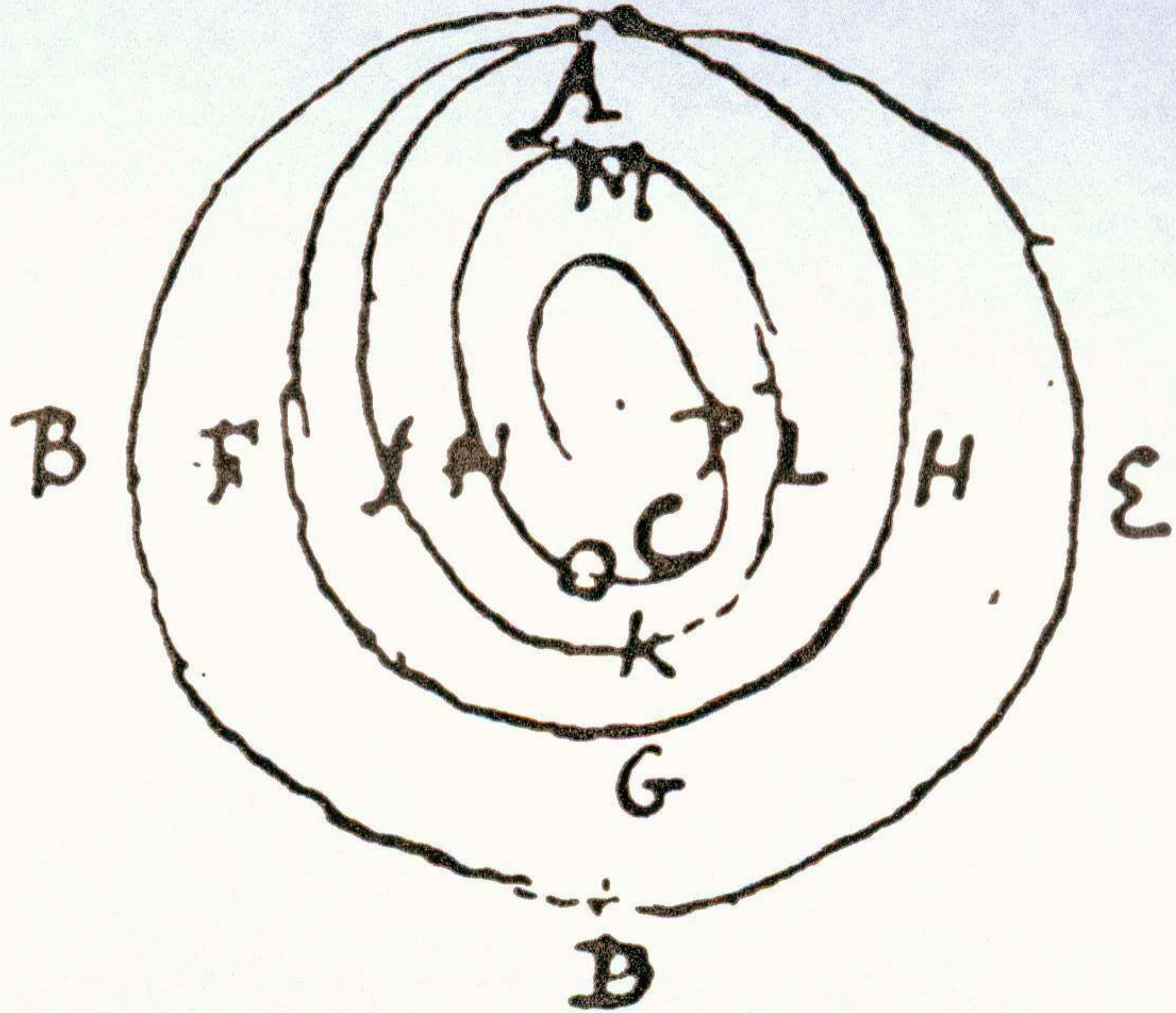
- And…
- "If I were not so unhappy as to be unacquainted with your Hypothesis above-mentioned (as I am with almost all things which have late been done or attempted in Philosophy) I should so far comply with your desire as to send you…

- what Objections I could think of against them if I could think of any…"
- Despite this, Newton offered Hooke a way of demonstrating the motion of the Earth, by dropping a body from a large height, and noting ("contrary to ye opinion of ye vulgar") that it would fall to the east, "describing in its fall a spiral line…"

Newton’s drawing



- Hooke to Newton, 9 December 1679
- Hooke agreed that the body would fall to the east but "….nothing att all akin to a spirall but rather a kind [of] Elleptueid."
- If the body could move freely through the Earth, the path would be an ellipse, or if there were resistance, a decaying elllipse.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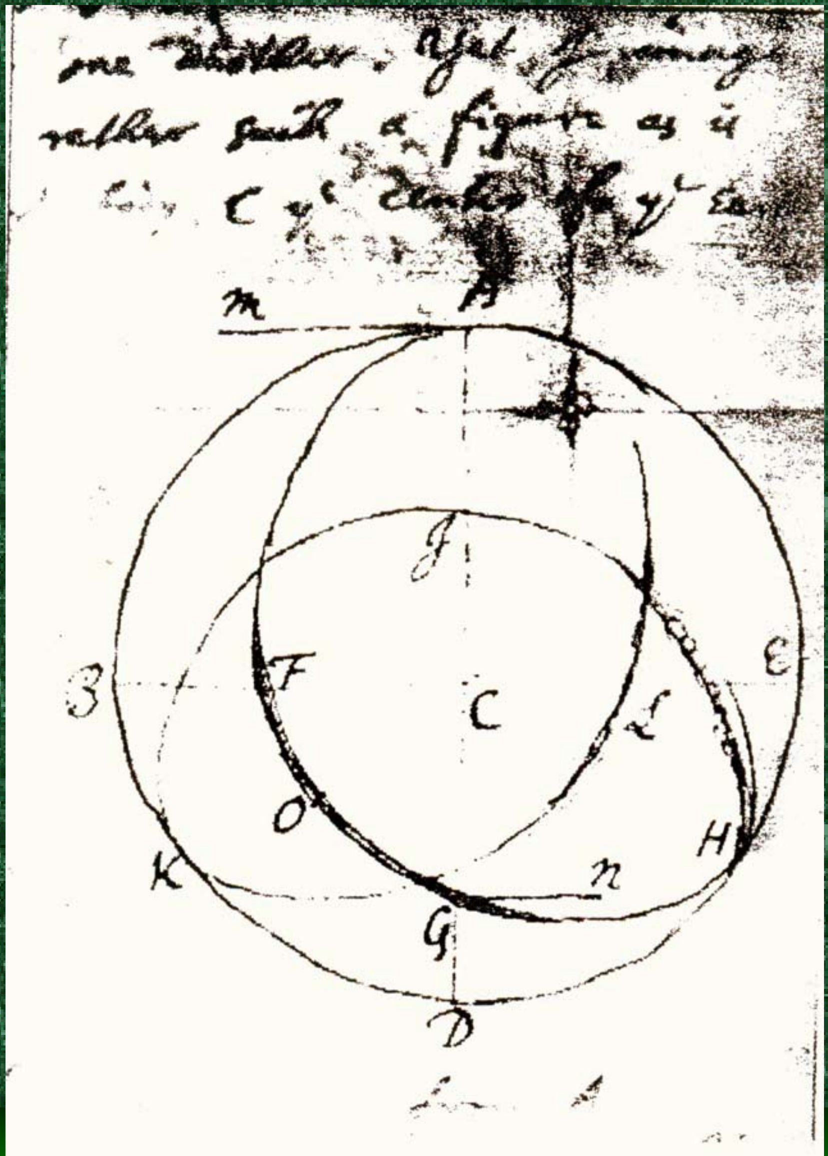
- Furthermore, Hooke said, the body, at London, would fall to the southeast.
- The reason is due to the non-inertial centrifugal and Coriolis forces. The centrifugal force has a southerly (meridianal) component which displaces the body to the south.

- The Coriolis force acts on this, producing a westward-directed force, but the Coriolis force acting on the center-direction motion of the falling body is to the east and much greater, hence the eastward component of the displacement.

- Newton to Hooke, 13 December 1679
- Newton agreed that the object would fall not to the east, but southeast, and then argued that “if…gravity be supposed uniform” it would “circulate with an alternate ascent & descent made by it’s vis centrifuga & gravity alternately overballancing one another”

Newton's figure



- It may be that Newton actually computed this path, which itself is remarkable.
- Amazingly [to me, at any rate], in his reply Hooke said that this path it what one would get by having a ball rolling on the interior of a conical surface, demonstrating remarkable understanding of dynamics.

- Hooke to Newton, January 6, 1679/80
- Amazingly [to me, at any rate], in his reply Hooke said that this path it what one would get by having a ball rolling on the interior of a conical surface, demonstrating remarkable understanding of dynamics.

- But the most important part of the reply is as follows:
- Assuming that the attraction is always "in a duplicate proportion to the Distance from the Center Reciprocall," [inverse-square] "that the velocity will be in a subduplicate proportion to the Attraction and Consequently….Reciprocall to the Distance

- Hooke was wrong about this, but he went on to say he did not believe that the inverse-square nature of gravity persisted to the center, but that “the more the body approaches the Center, the lesse will it be Urged by the attraction.”

- This remarkable claim is something Newton first proved in the *Principia*. We prove in undergraduate mechanics [a result which is identical to the electric field in the interior of a uniformly charged sphere, obtained by Gauss's Law], that
- $g=-4\pi G\rho r$

- That effectively ended the correspondence. Newton was virtually silent for four years. He did correspond with Royal Astronomer Flamsteed on comets, particularly the great one of 1680-81.

- In a lecture on comets, stimulated by the comets of 1680-81 and 1682 ("Halley's comet"), Hooke said:

- "..I shall…shew…that the power of Gravity does decrease at farther and farther Distance from the Center of the Earth, and consequently that the Line of a projected body is not truly Parabolical [i.e., Galileo], but Elliptical, though it should be made *in vacuo*…"

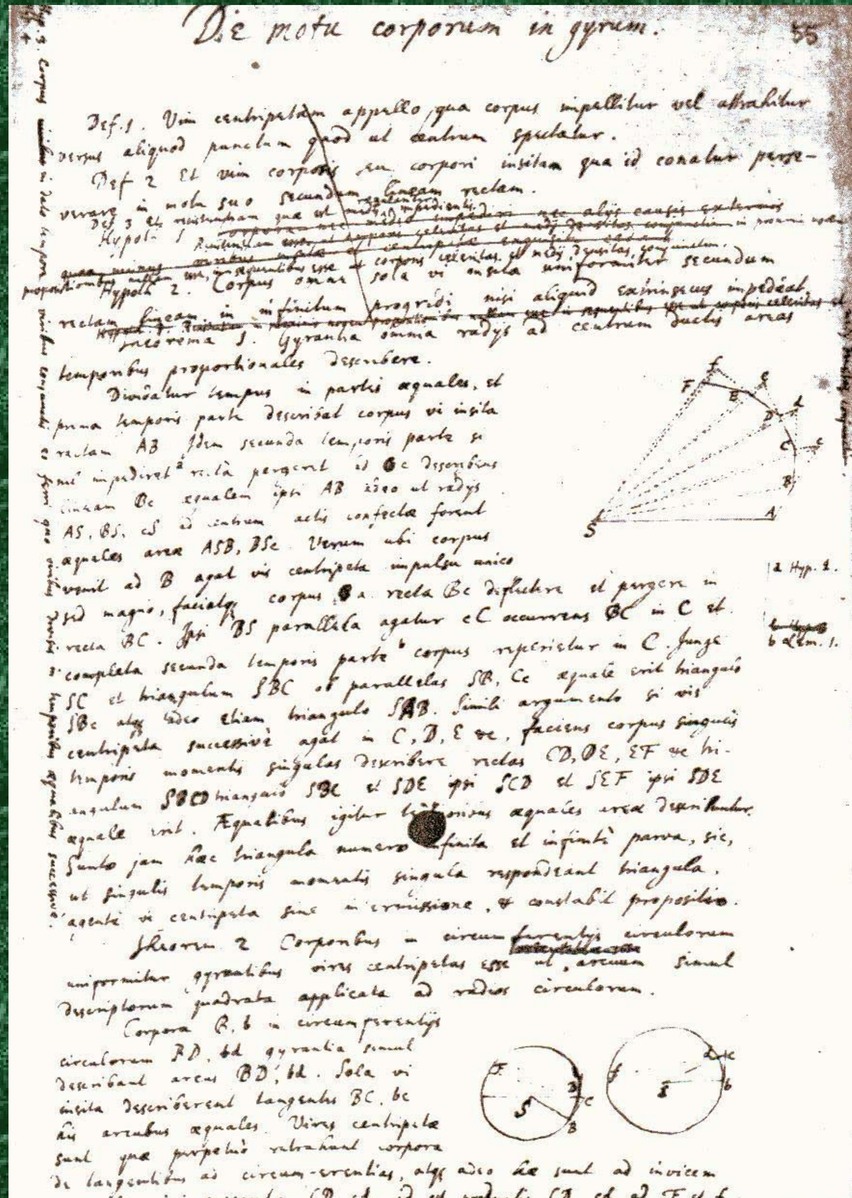
- Here Hooke is claiming that an inverse-square force (see the letter to Newton) will result in an elliptical orbit, something Newton was the supposedly the first to claim in 1684 (see below)!

- According to Halley, he, Hooke, and Wren were talking about the problem over coffee in January 1684 [83/84]:
- "..falling in discourse about it, Mr Hook affirmed that upon that principle all the Laws of the celestiall motions were to be demonstrated, and that he himself had done it.."

- “I declared the ill success of my attempts; and Sr Christopher to encourage the Inquiry sd,that he would give Mr Hook or me 2 months time to bring him a convincing demonstration therof….Mr Hook then sd that he had it, but that he would conceale it for some time that others triing and failing, might know how to value it…”

- Nothing coming of this, Halley went to Cambridge to pose the problem to Newton in August. Newton responded to Halley's question about the orbit that would result from an inverse-square force that it would be an ellipse, that he had a proof, but could not find it.

- Whether he had a proof or was making an educated guess, as Hooke probably did two years earlier, soon he had worked it out, and *De Motu* was brought to Halley in November. *De Motu* is sometimes considered a first draft of the *Principia*, though it only concerns itself with Kepler’s Laws.



De motu corporum in gyrum.

55

Def. 1. Vim centripetam appello qua corpus impellitur vel attrahitur versus aliquod punctum quod ut centrum spectatur.

Def 2. Et vim corporis seu corpori insitam qua id conatur perseverare in motu suo secundum lineam rectam.

Hypoth 2. Corpus omne sola vi insita uniformiter secundum rectam lineam in infinitum progredi nisi aliquid extrinsecus impediat.

Theorema 1. Gyrantia omnia radijs ad centrum ductis areas temporibus proportionales describere.

Dividatur tempus in partes aequales, et prima temporis parte describat corpus vi insita rectam AB. Idem secunda temporis parte si nil impediret recta pergeret ad c describens lineam Bc aequalem ipsi AB adeo ut radijs AS, BS, cS ad centrum actis confectae forent aequales areae ASB, BSc. Verum ubi corpus venit ad B agat vis centripeta impulsu unico sed magno, faciatque corpus a recta Bc deflectere et pergere in recta BC. Ipsi BS parallela agatur cC occurrens BC in C et completa secunda temporis parte corpus reperietur in C. Junge SC et triangulum SBC ob parallelas SB, Cc aequale erit triangulo SBc atque adeo etiam triangulo SAB. Simili argumento si vis centripeta successive agat in C, D, E &c, faciens corpus singulis temporis momentis singulas describere rectas CD, DE, EF &c triangulum SCD triangulo SBC et SDE ipsi SCD et SEF ipsi SDE aequale erit. Aequalibus igitur temporibus aequales areae describuntur. Sunto jam haec triangula numero infinita et infinite parva, sic, ut singulis temporis momentis singula respondeant triangula, agente vi centripeta sine intermissione, et constabit propositio.

Theorem 2. Corporibus in circumferentijs circulorum uniformiter gyrantibus vires centripetas esse ut arcuum simul descriptorum quadrata applicata ad radios circulorum.

Corpora B, b in circumferentijs circulorum BD, bd gyrantia simul describant arcus BD, bd. Sola vi insita describerent tangentes BC, bc his arcubus aequales. Vires centripetae sunt quae perpetuo retrahunt corpora de tangentibus ad circumferentias, atque adeo hae sunt ad invicem ut spatia ipsis superata CD, cd, id est productis CD, cd ad F et f.

Plate XXI. The first page of Newton's "De motu corporum in gyrum."

- The rest is history, as they say. The *Principia* was brought into print by Halley in 1687. Hooke claimed that Newton had plagiarized his ideas, Newton threatened to withhold Book III in response, and poor Halley had to try to sooth Hooke's hurt and Newton's anger, and had to personally bear the cost of publication.

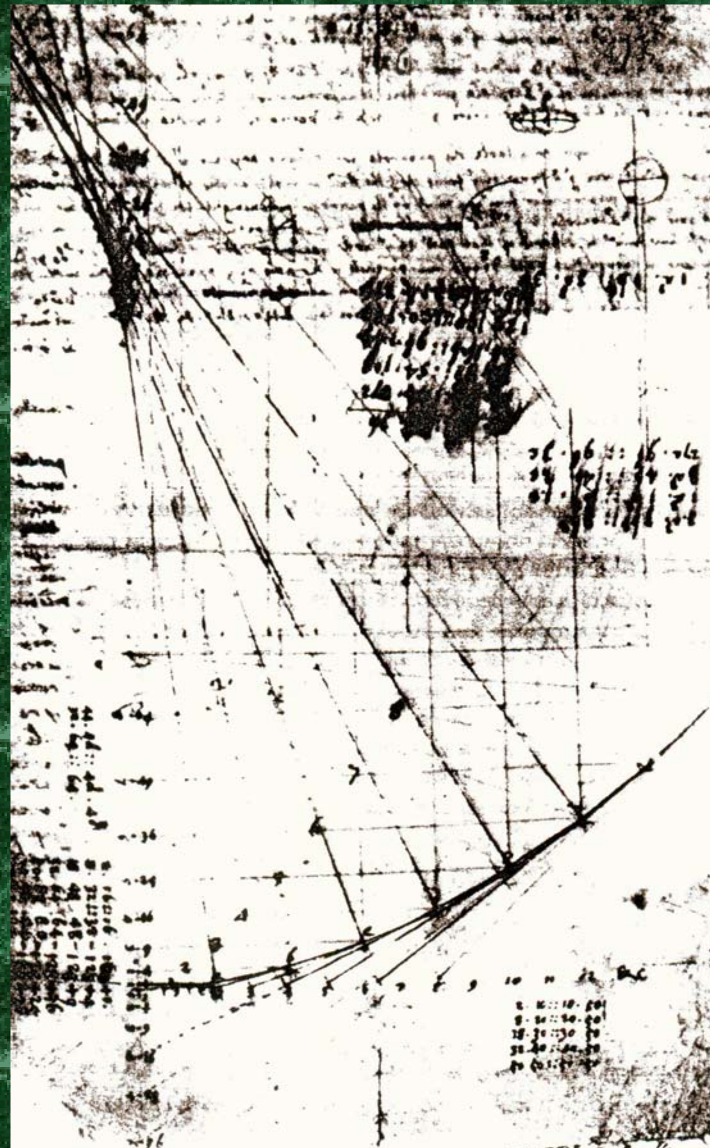
Hooke's Place

- There is little doubt that Hooke provided Newton with the dynamical to solving the problem of planetary motion, and also the motivation. But is this all Hooke did?

- We know that Hooke claimed since about 1677 that he could solve, or had “perfected” the solution to the problem. We can be fairly sure that Hooke did not have a clear idea of what a solution would be….no one did before Newton.

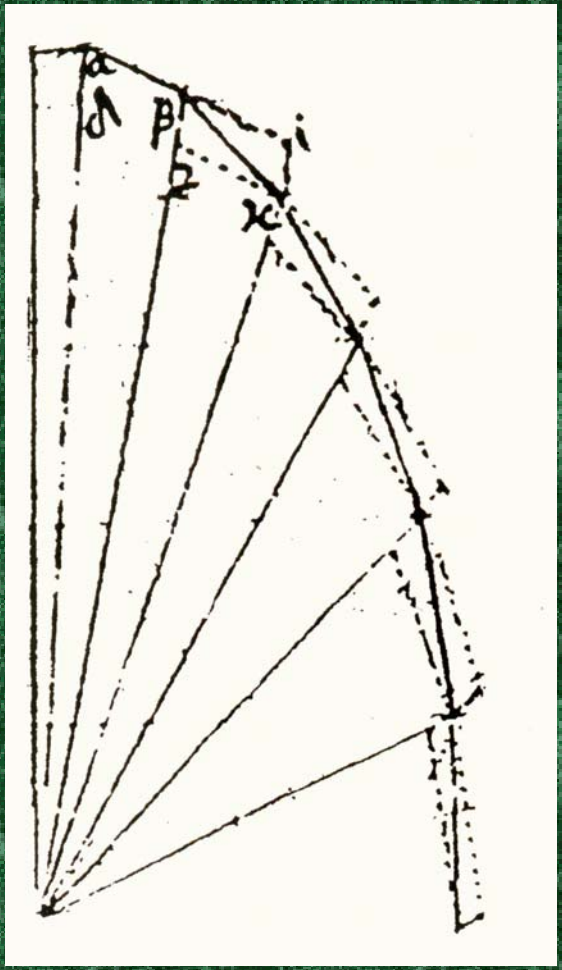
“On Circular Motion”

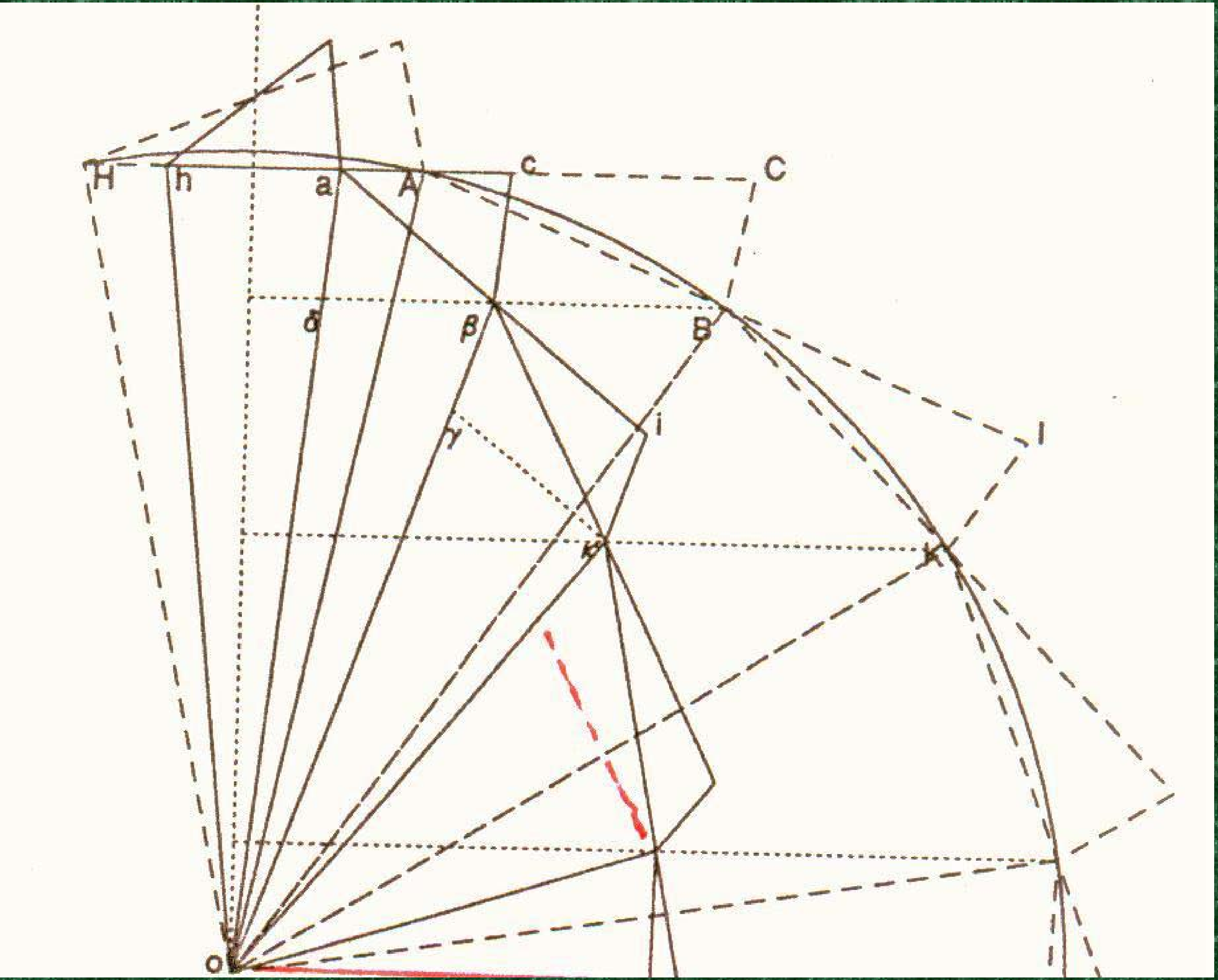
- There is, in the Trinity College, Cambridge library, a Hooke manuscript titled “On Circular Motion,” whose significance has only become apparent.



- I learned about it in a paper by Patri Pugeliese, and after reading it, thought I had discovered a Hooke proof of elliptic motion; Pugeliese had discounted Hooke's efforts.
- Unfortunately, Michael Nauenburg, a retired high-energy theorist, had already found and written a full analysis of it.

Hooke's drawing




H
h
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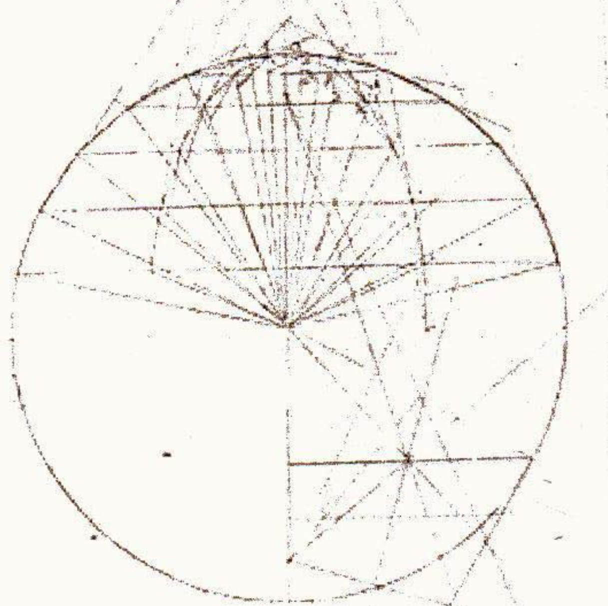
- What we have is a geometric proof that a central attractive linear force (-kx) will generate an elliptical path.

Let AB represent the impresst velocity ~~[illegible]~~ in the tangent of ~~[illegible]~~ ellipse and AD the velocity impresst by gravity [illegible] parallel & equall to AC [illegible] the [illegible] of gravity that moves the body at [illegible] where the only [illegible] [illegible] the velocity [illegible] the centre [illegible] the velocity [illegible] make [illegible] equall to parallel [illegible] then the [illegible] now if the velocity to gravity had been [illegible] then the [illegible] in proportion [illegible] had moved in a circle [illegible] in a circle [illegible] ellipse [illegible] the proportion that [illegible] [illegible] making the body [illegible] shall [illegible] and shall describe equall areas in equall times shall be polygonal in an ellipse.



when the velocity and Direction of the motion of a body doth keep it Receding from the center ballanced by the Power of gravity then doth the body move in a circle if the gravity be to the center of it

But if the Recesse over ballance it, it goes then further off: and the contrary of contrary, and the polygone becomes various according to the differing degrees of gravity at differing distances from ye center.

- Why Hooke chose this force law isn’t entirely clear. Two possibilities present themselves:
- 1) it is easier than $1/r^2$
- 2) it fits the circular pendulum analogy

- Did Hooke try the inverse-square force as well?
- How could he not, since it was the problem of interest.
- It is more difficult, but not terribly so than the linear force, though I don’t think anyone has worked it out.

- What of the date? The date on the manuscript is September 1685. The development could be earlier, perhaps much earlier.

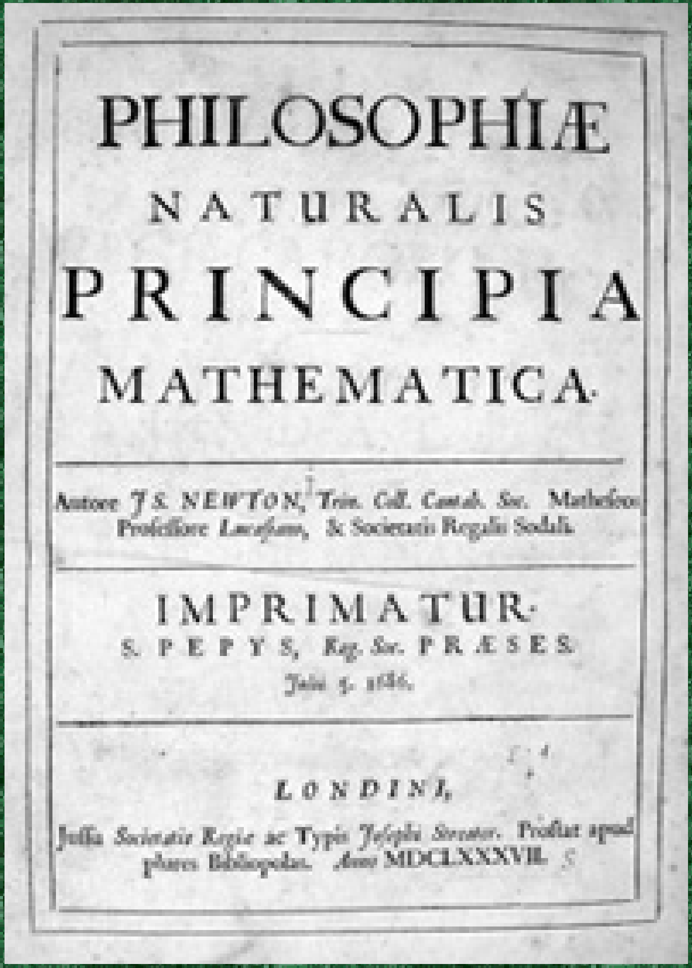
- September 1685 is about 10 months after Newton gave Halley his *De Motu*.
- Hooke, as a senior member of the Society presumably had access to the MS. of *De Motu*.
- Was his manuscript just a belated attempt to catch up, perhaps after seeing Newton's solution?

- The techniques used by Newton and Hooke are similar, but different enough to suggest that Hooke’s was independent.
- If Hooke had just copied Newton, he surely would have worked out the important case of the inverse-square force.

- On that view, Hooke’s proof is independent, perhaps earlier, perhaps not, implying that Hooke was able to do, in some sense, what he kept saying he could do.

- In the end, Hooke could never have written a work like the *Principia*. He did not have the time, the ability to focus on a problem to the exclusion of everything else the way Newton could, or the mathematical tools to do what he did in the *Principia*.

Frontisepiece of Newton's *Principia* (1687)



PHILOSOPHIÆ
NATURALIS
PRINCIPIA
MATHEMATICA.

Autore JS. NEWTON, *Trin. Coll. Cantab. Soc.* Matheseos Professore *Lucasiano*, & Societatis Regalis Sodali.

IMPRIMATUR.
S. PEPYS, *Reg. Soc.* PRÆSES.
Julii 5. 1686.

LONDINI,
Jussu *Societatis Regiæ* ac Typis *Josephi Streater*. Prostat apud plures Bibliopolas. *Anno* MDCLXXXVII.

- Hooke was, however, a very great figure in early modern science, a consumate experimentalist who provided experiments at every meeting for years, providing the only reason the Society had to exist.
- He also had great physical intuition and insight into physical problems.

- At meeting after meeting, Hooke’s explanations are almost always the clearest and most cogent, while other members often indulge in flights of fancy.

- It has now become a cliché to call Hooke “London’s Leonardo,” an apt comparison for more than one reason. First, of course, the diversity and originality of his ideas. Second, because of the scattered pebbles, the unfinished ideas, that he left behind.

- But Da Vinci had the good fortune not to be followed by a Newton.

- He may very well have thought that with the "motion by the tangent and attraction toward the center," plus the force law, that he had the solution in hand.
- (Hooke taught geometry but showed little interest in the new mathematics)

Speculations ("whig" history)

- Variability of Earth's magnetic axis and how it might be revealed in rocks
- Variation of gravity with time
- Heat as internal motion of small parts of an object
- Whether magnetizing a body changes its weight!

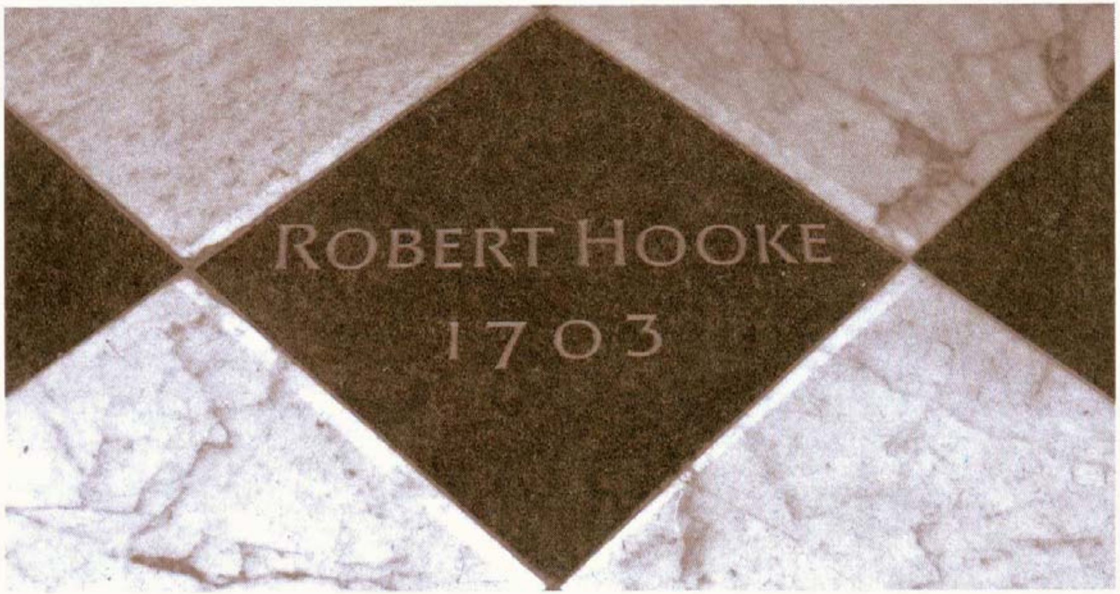
- Effect of mountains on the Earth’s rotation, etc.
- Of course there was no theoretical structure to contain this ideas.

- The last meeting of the Society he attended was in July 1702. Hooke died, intestate, on 3 March 1702/3:
- “His Corps was decently and hansomely interr’d in the Church of St. Helen in London, all the Members of the Royal Society then in Town attending his body to the Grave, paying the Respect due to his extraordinary Merit.”

- In th 19th century, his bones, along with others, were dug up and dumped in a mass grave in north London. A stained glass window in St. Helen Bishopgate honoring Hooke was destroyed by an IRA bombing in 1992. Nothing remained to show that Hooke had ever lived.

- Except the Monument (with no reference to Hooke on it), and the Hooke churches (all attributed to Wren)

Hooke memorial, 2005. Westminster Abbey



Memorial to Hooke in Westminster Abbey. The memorial has been carved into a black marble lozenge which is part of the pavement that Dr Richard Busby paid for and Robert Hooke laid for him. The memorial is to the north of and close by Busby's grave in the Lantern, at the foot of the steps to the Sacrarium. The memorial was dedicated on 3 March 2004.
(By kind permission of the Dean and Chapter of Westminster)

The Under Master of Westminster School invites

Dr Robert D. Purrington

to the Dedication of a Memorial to Dr Robert Hooke (1635-1703)
at 6.00pm on Thursday 3 March 2005
in Westminster Abbey

and afterwards to a reception in Cheyneygates
by kind permission of the Dean & Chapter of Westminster

Evensong is sung at 5.00pm
and you are very welcome to attend that service

RSVP: Mr E A Smith
The Under Master
Westminster School
17 Dean's Yard
London SW1P 3PB

Further Reading

- New biographies by Lisa Jardine and Stephen Inwood
- Robert Hooke: Tercentennial Studies, 2006
- (chapter by RDP)
- New biographies of Wren, Halley, as well.
- Scientific biography, unpublished as of 2006, RDP