Robert Hooke, Self-Assembly, and Force Laws

J. M. McBride
Yale University

ICMR Stereochemistry Summer School
UC Santa Barbara August 22, 2005

Preambles:

Force Laws
&
Snowflakes

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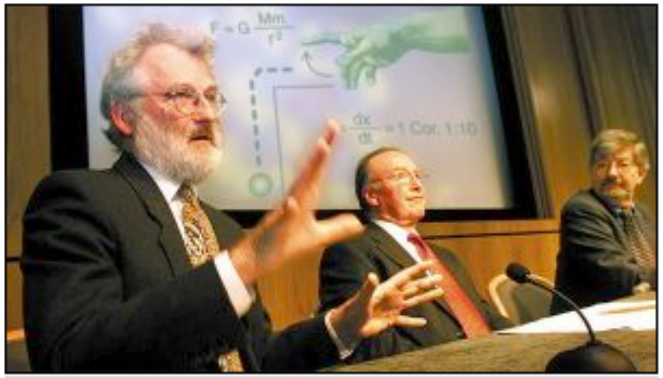
RELIGION

Evangelical Scientists Refute Gravity With New 'Intelligent Falling' Theory

KANSAS CITY, KS—As the debate over the teaching of evolution in public schools continues, a new controversy over the science curriculum arose Monday in this embattled Midwestern state. Scientists from the Evangelical Center For Faith-Based Reasoning are now asserting that the long-held "theory of gravity" is flawed, and they have responded to it with a new theory of Intelligent Falling.



Above: Rev. Gabriel Burdett (left) explains Intelligent Falling.

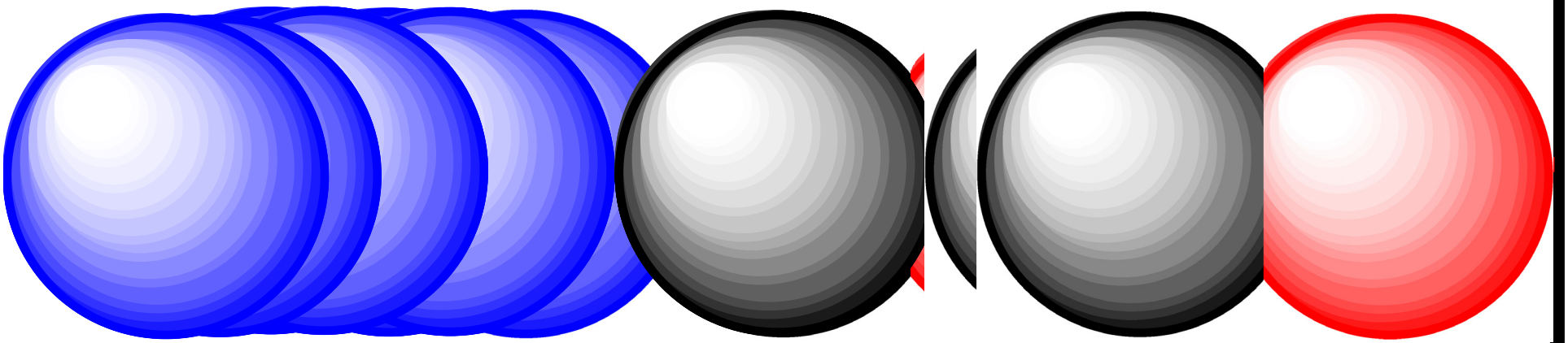
"Things fall not because they are acted upon by some gravitational force, but because a higher intelligence, 'God' if you will, is pushing them down," said Gabriel Burdett, who holds degrees in education, applied Scripture, and physics from Oral Roberts University.

Burdett added: "Gravity—which is taught to our children as a law—is founded on great gaps in understanding. The laws predict the mutual force between all bodies of mass, but they cannot explain that force. Isaac Newton himself said, 'I suspect that my theories may all depend upon a force for which philosophers have searched all of nature in vain.' Of course, he is alluding to a higher power."

Founded in 1987, the ECFR is the world's leading institution of evangelical physics, a branch of physics based on literal interpretation of the Bible.

"Things fall not because they are acted upon by some gravitational force, but because a higher intelligence, 'God' if you will, is pushing them down," said Gabriel Burdett, who holds degrees in education, applied Scripture, and physics from Oral Roberts University.

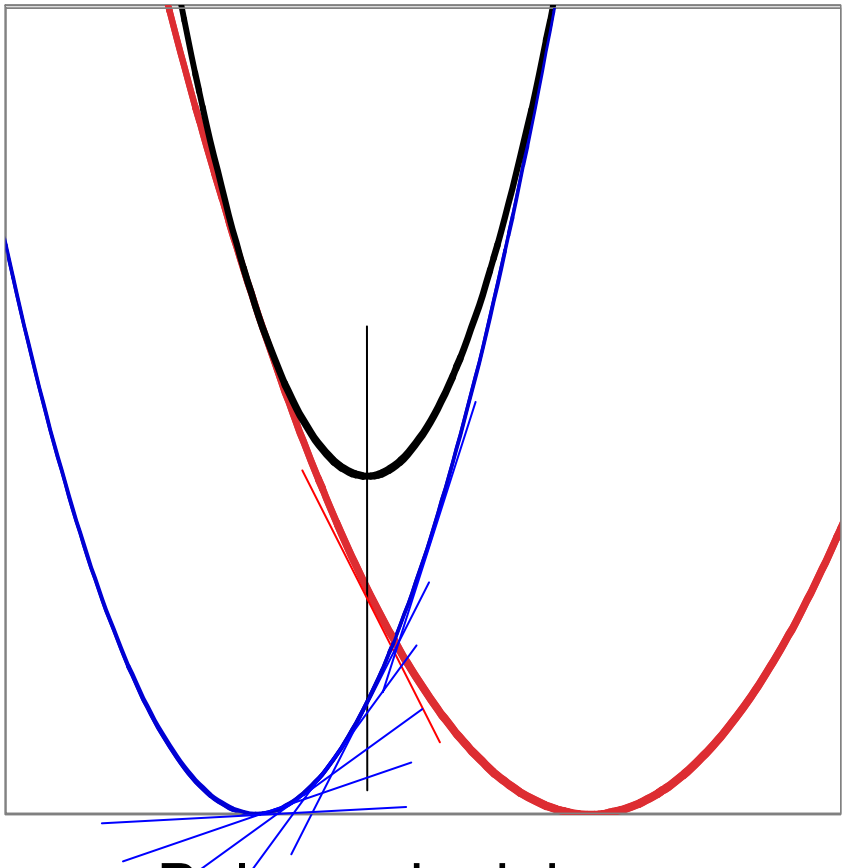
When does a Chain of Atoms Snap?



Force Laws & Molecular Structure

$F = -k\,\Delta x$

Spring



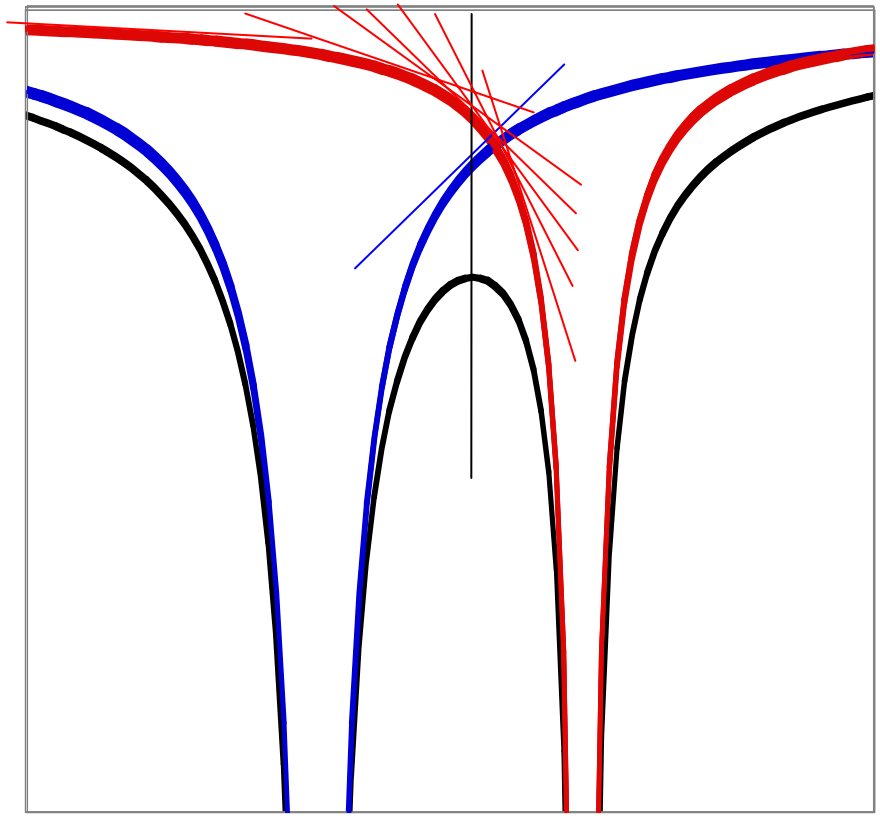
Balanced minimum

Single Minimum

Energy

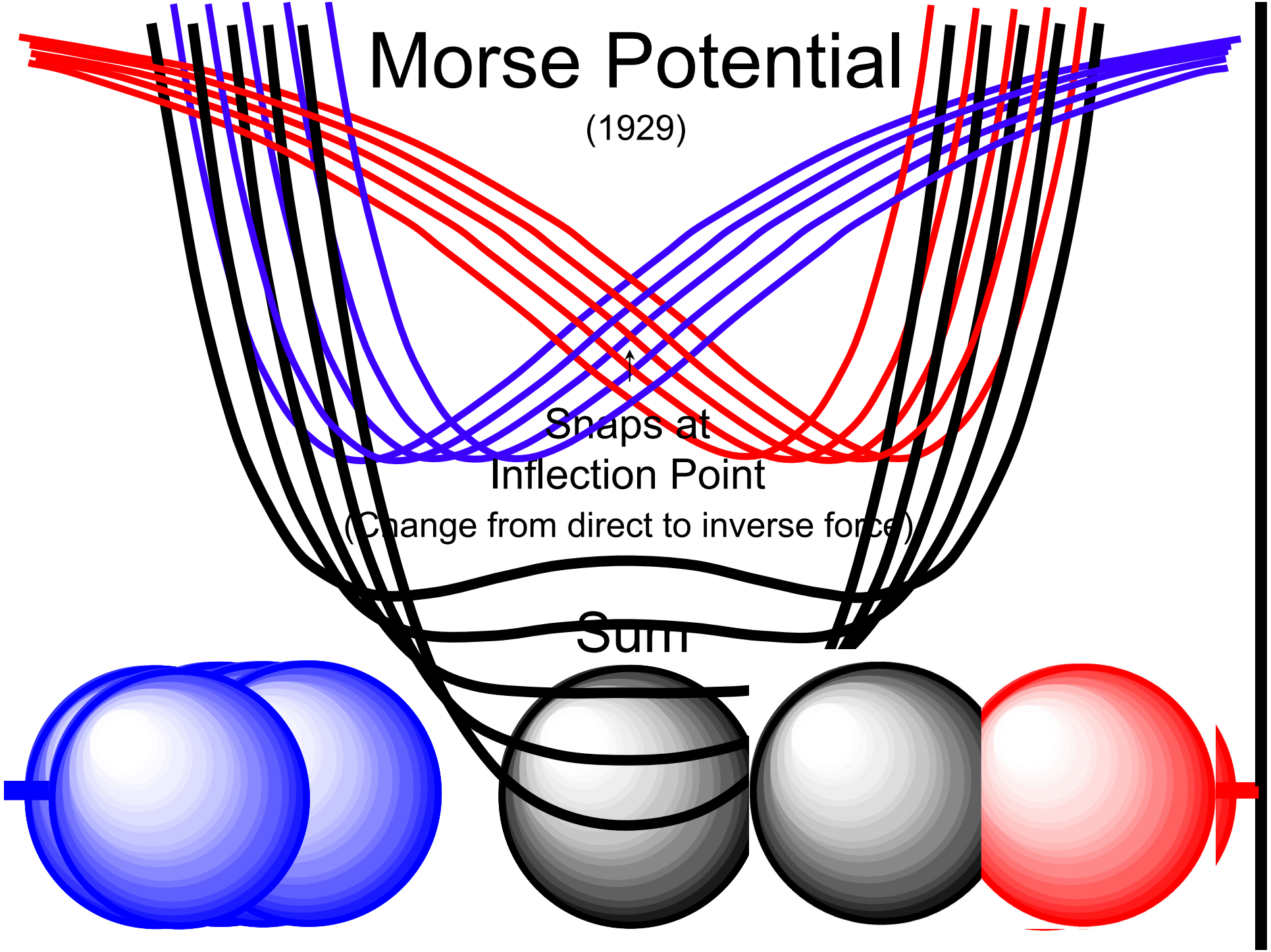
$F = -k / (\Delta r)^2$

Gravity / Electrical Charge



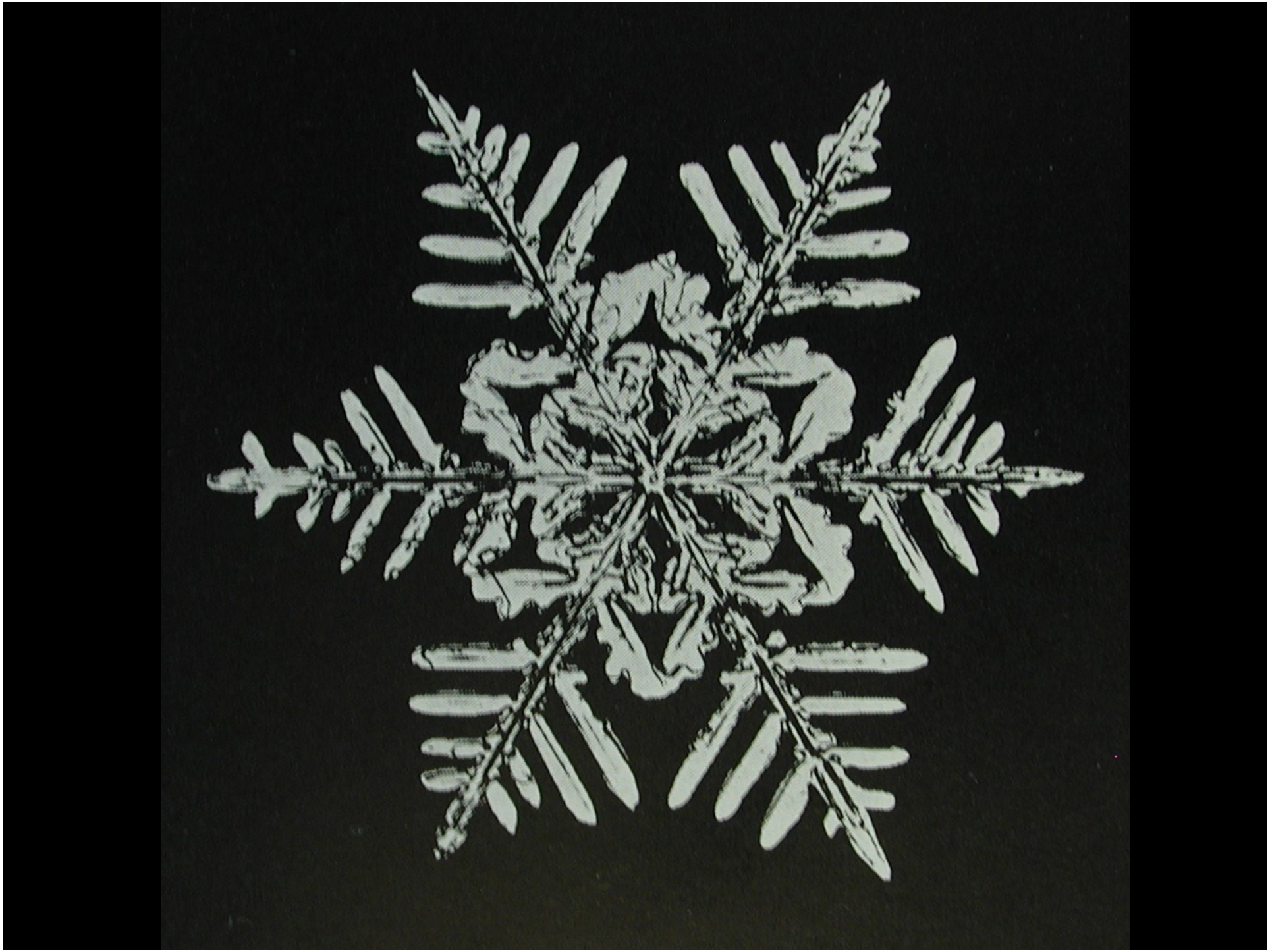
~~Balanced minimum~~ !

Double Minimum


Morse Potential
(1929)
Snaps at
Inflection Point
(Change from direct to inverse force)
Sum

Force Laws are
pretty Fundamental.

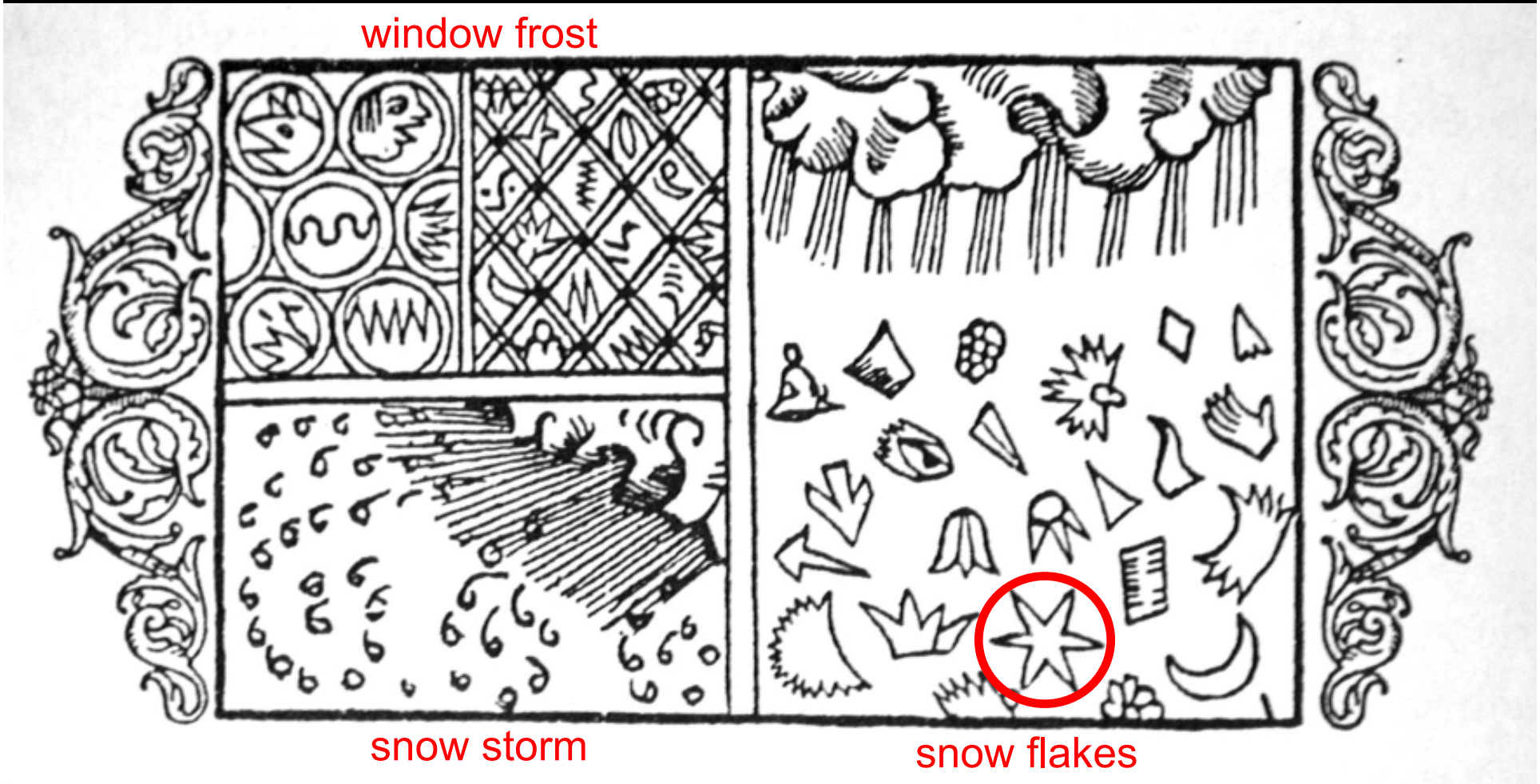
When / How / Why
by Whom
were they Discovered?



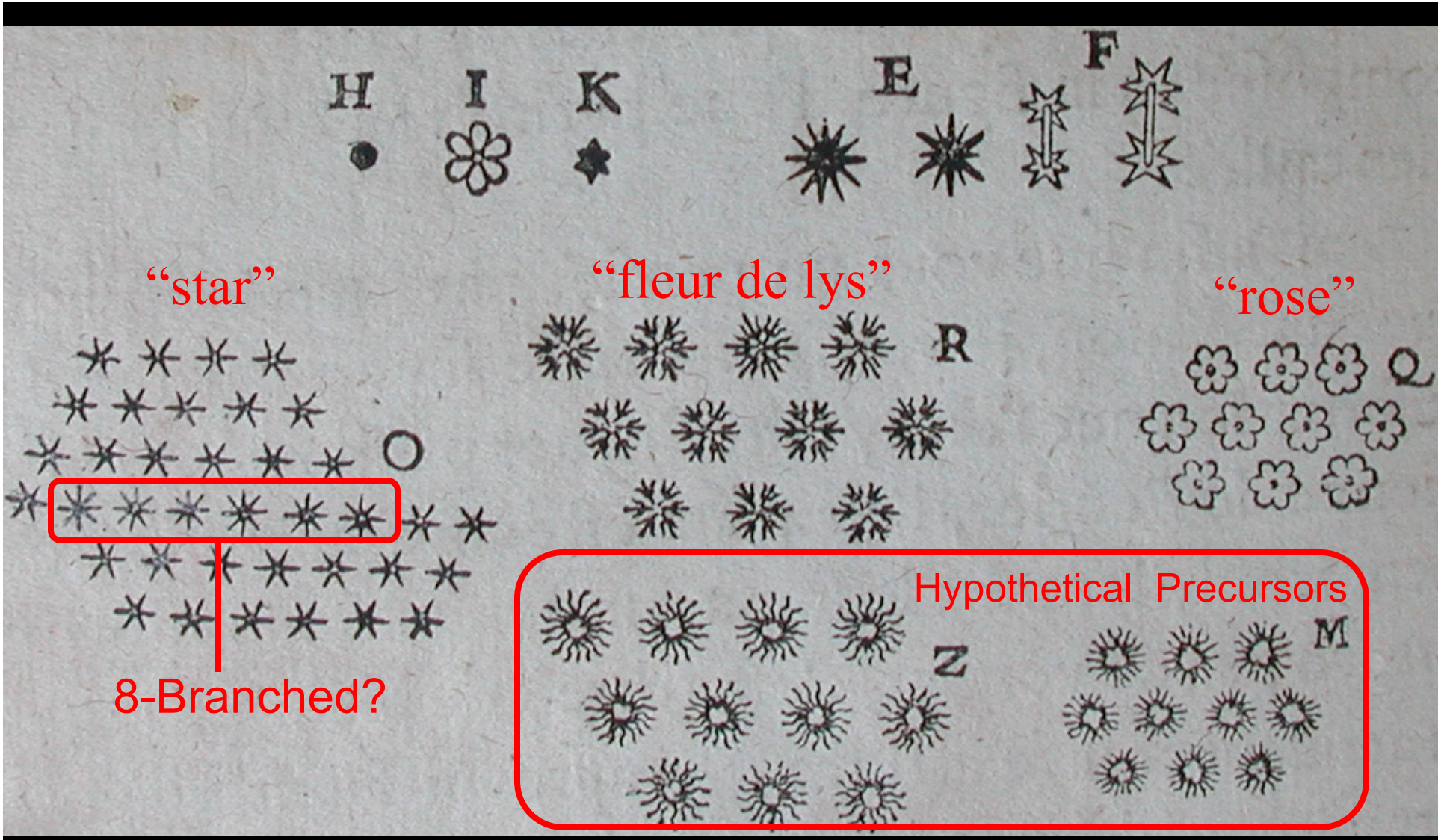
Chapt. 23: On the snow castles of children

Olaus Magnus (Rome, 1555)

Chapt. 22: On the various shapes of snow

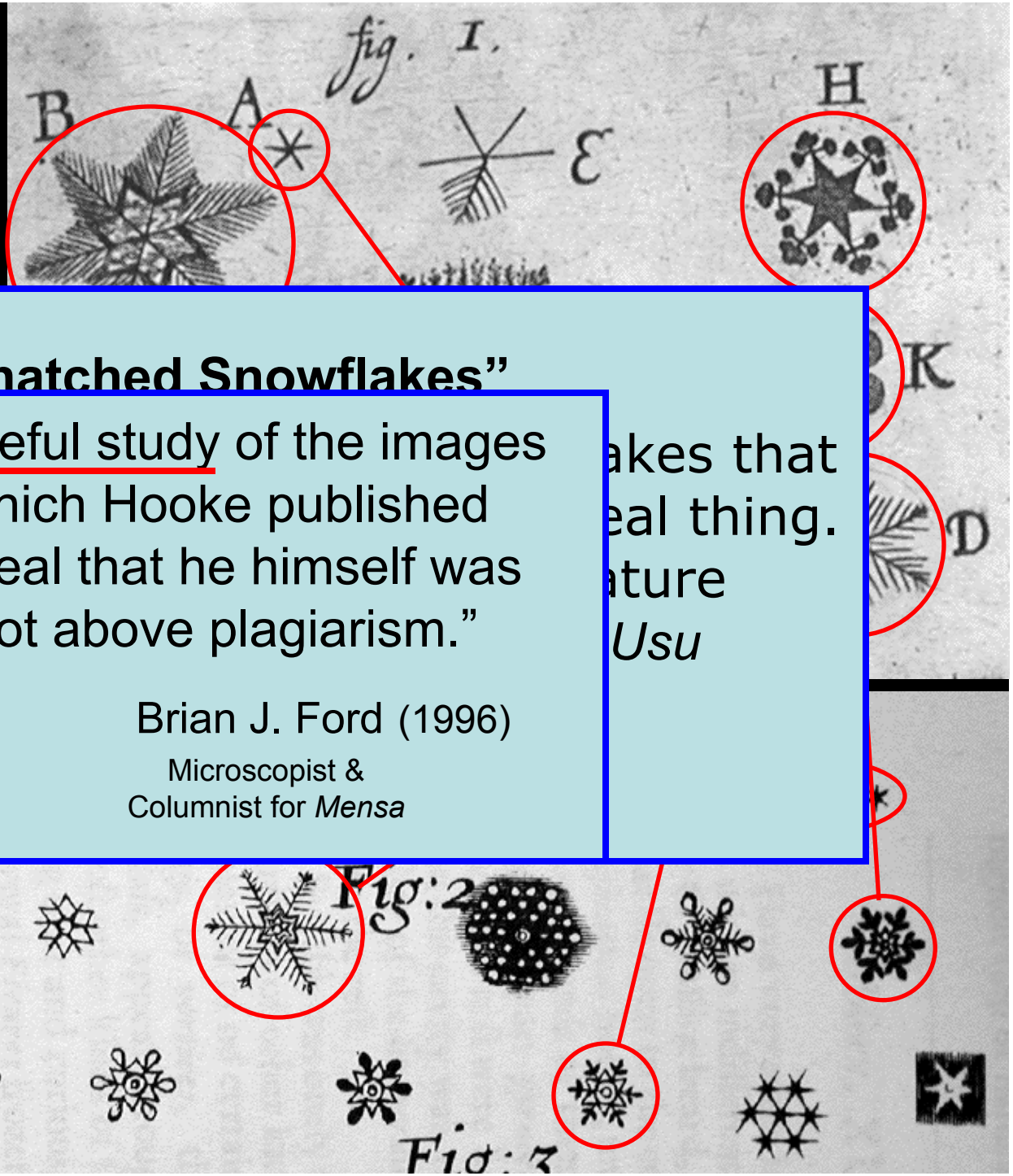


Olaus Magnus (Rome, 1555)



René Descartes
Les Météores (1637)

Erasmus Bartolinus (1661)



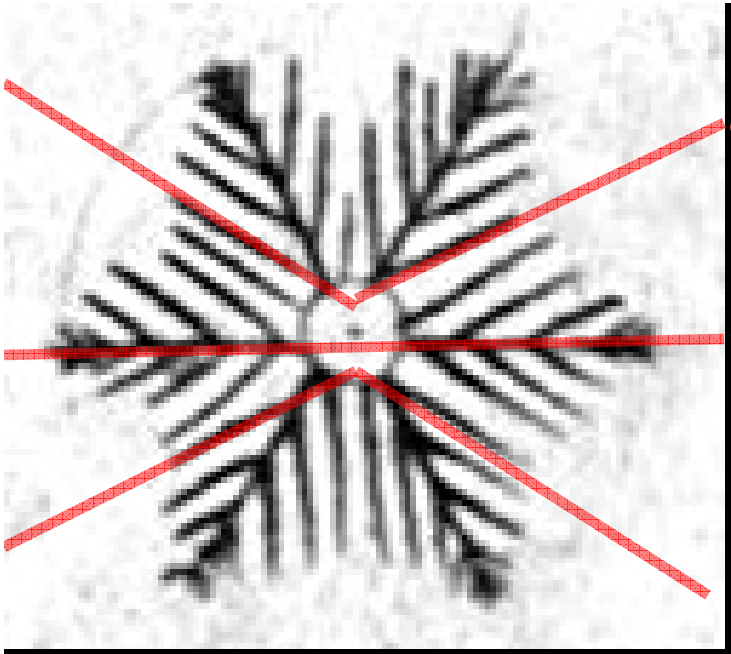
"Snatched Snowflakes"

"…Hook … akes that look mo… eal thing. These ir… ature but fron… *Usu* *Medico* C…

"Careful study of the images which Hooke published reveal that he himself was not above plagiarism."

Brian J. Ford (1996)

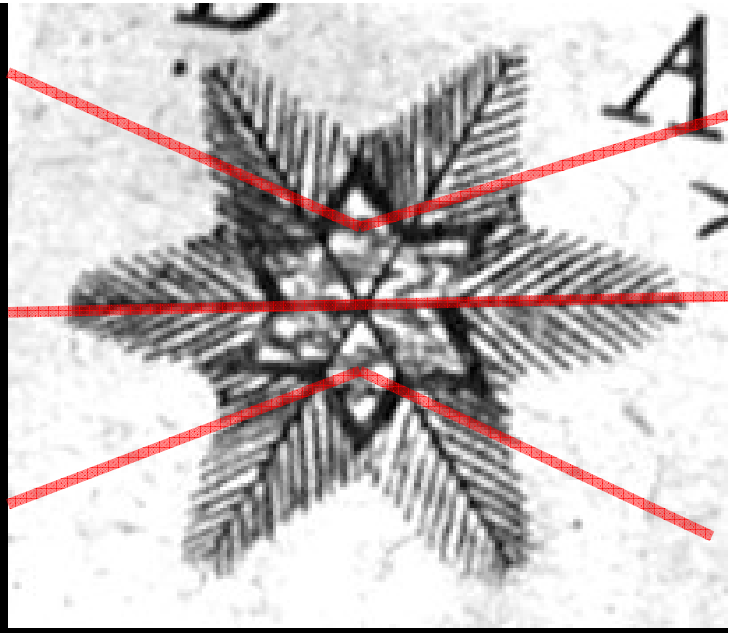
Microscopist &
Columnist for *Mensa*



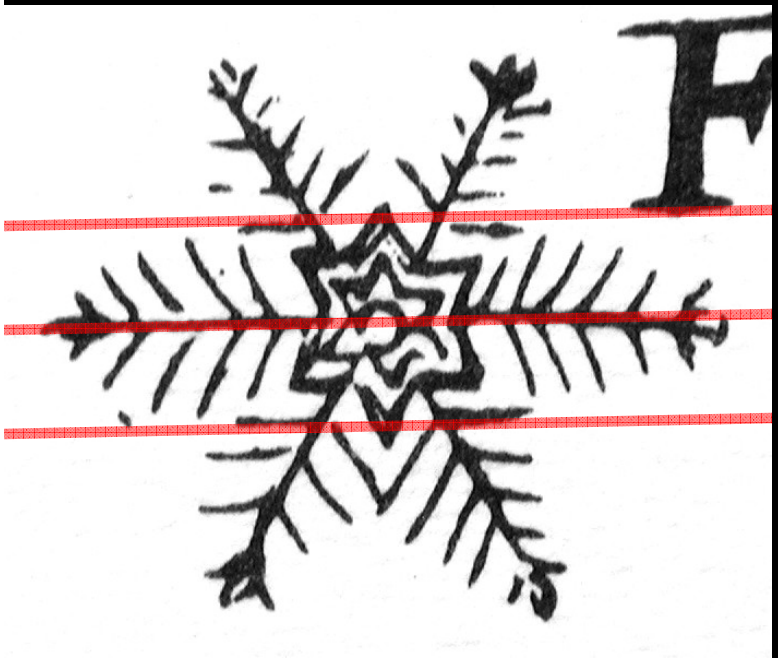
Secondary

Primary

Bartholinus
(1661)

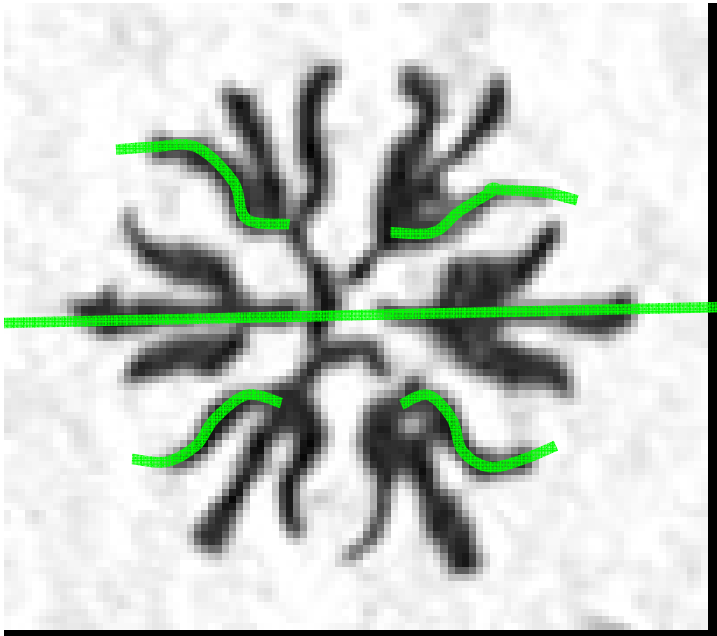


Herringbone



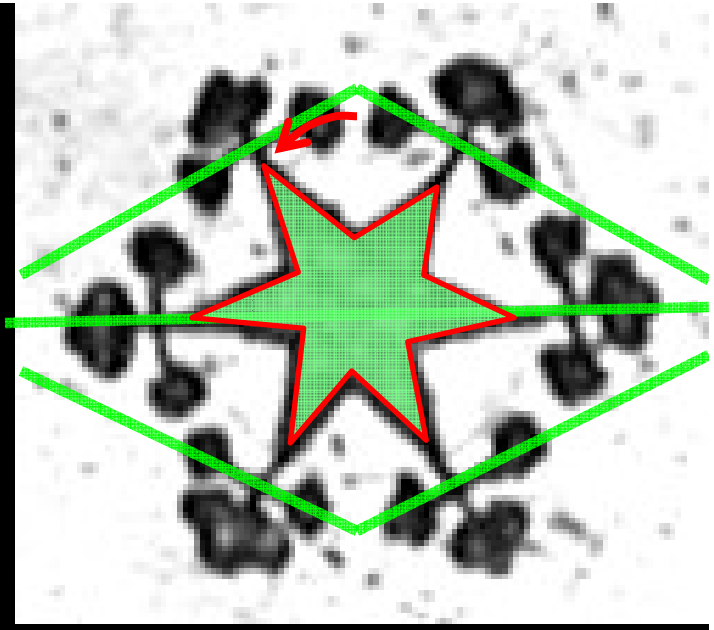
Hooke
(1665)

Wilson
"Snowflake"
Bentley
(1865-1931)

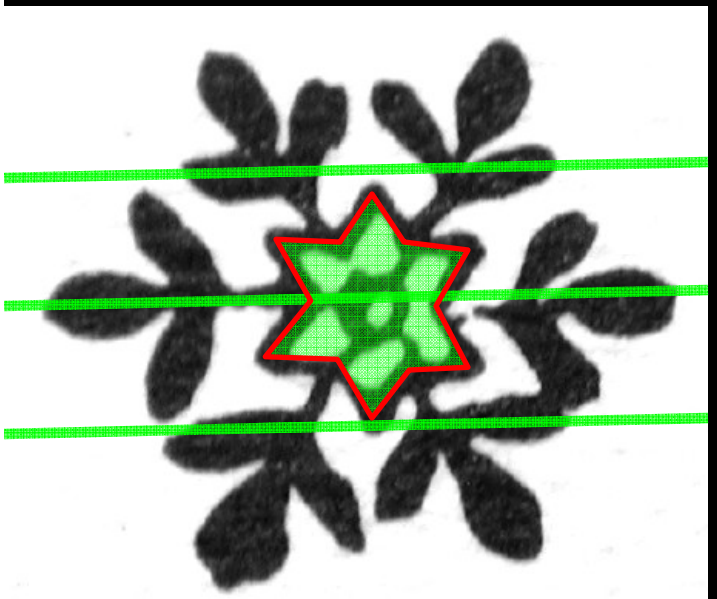


Descartes
(1637)

Bartholinus
(1661)

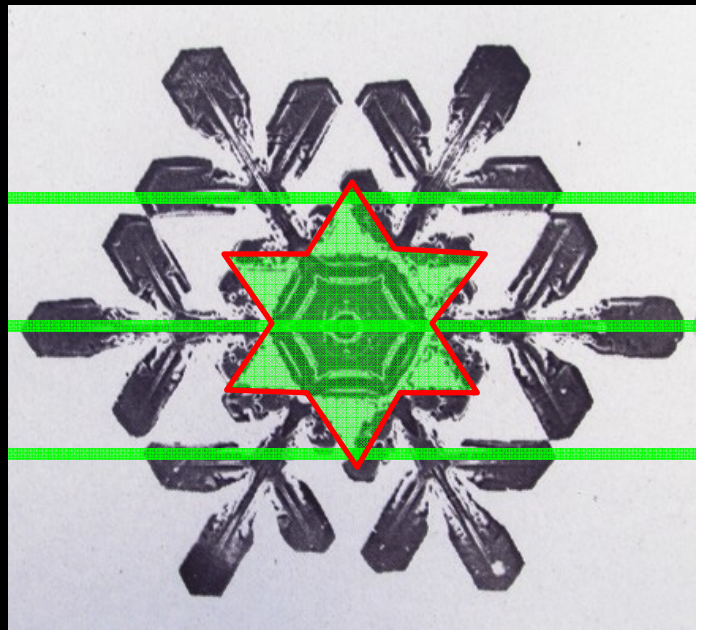


Fleur de Lys



Hooke
(1665)

Nature *via*
"Snowflake"
Bentley
(1931)

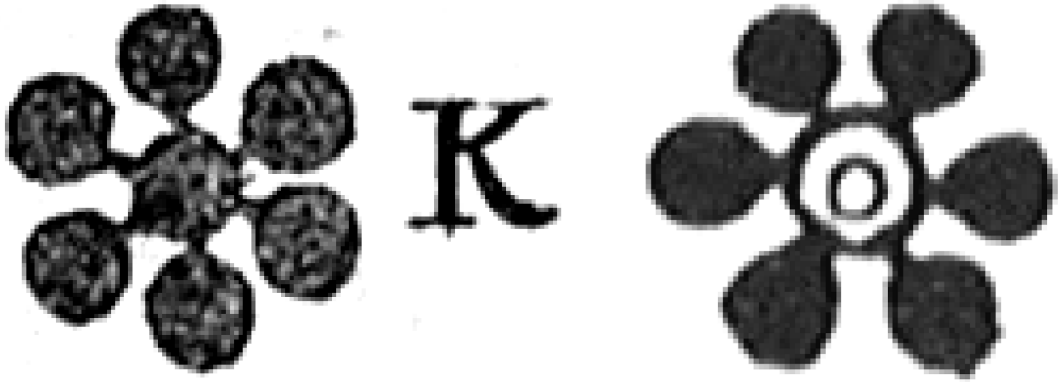


Hooke
was copying
Nature,
not Bartholinus,
nor Descartes.

B. J. Ford to J.M.M. (6/15/05)

"The flakes you chose to analyze aren't the definitive examples, I fear. The clincher is the flake labelled K."

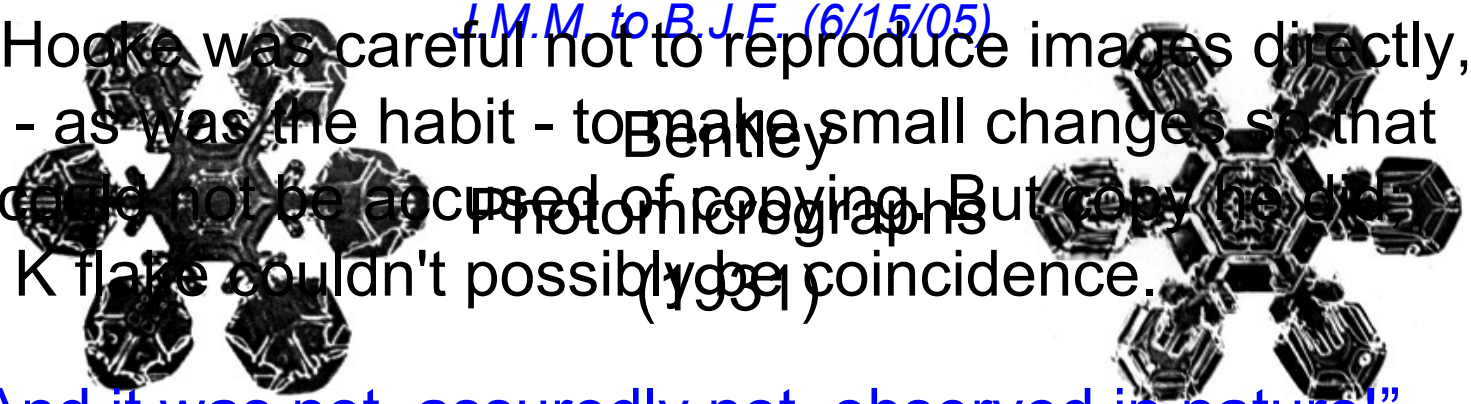
Bartholinus (1661)



Hooke (1665)

J.M.M. to B.J.F. (6/15/05)

"Hooke was careful not to reproduce images directly, but - as was the habit - to make small changes so that he could not be accused of copying. But copy he did: the K flake couldn't possibly be a coincidence.



Bentley Photomicrographs (1931)

And it was not, assuredly not, observed in nature!"

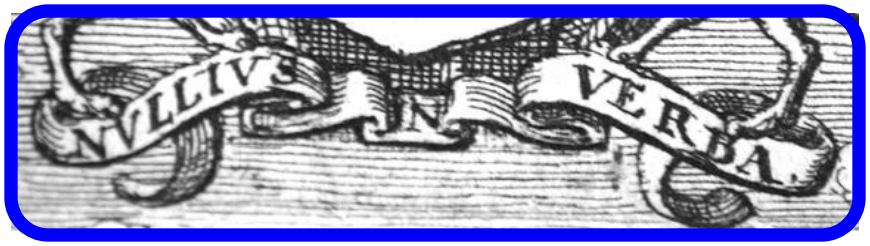
B.J.F. to J.M.M. (6/16/05)

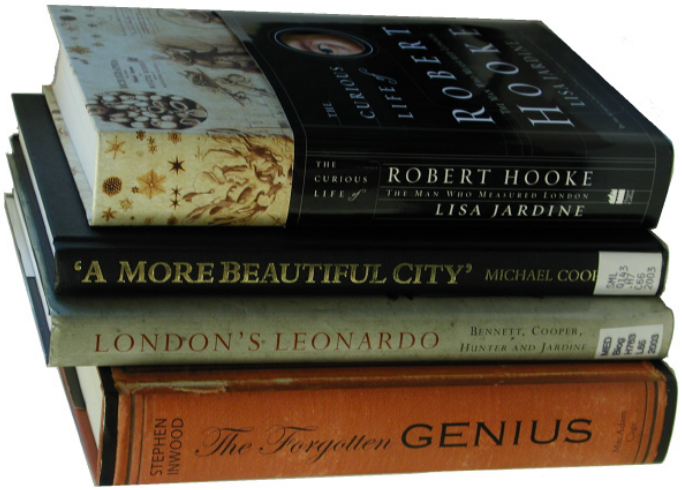
"elegant argument…though, having looked at a great many snowflakes under the microscope, I am not persuaded."

“Hooke was a particularly pushy and strident character, a man for whom I have unlimited admiration. But I don't doubt that he took Bartholin's pictures as his source.”

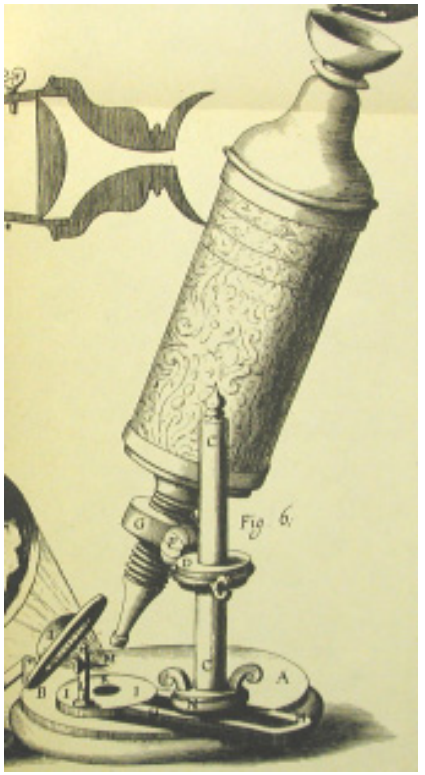
Who was Robert Hooke,
and what did he do
to deserve this reputation?

Background:
Bacon, the Royal Society & the "Scientific Method"

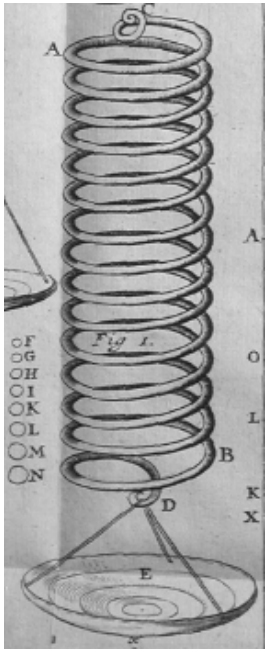




Who was Robert Hooke?



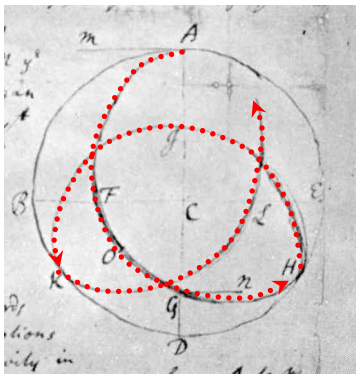
Micrographia
Mushrooms &
Self Assembly
(1665)



Hooke's
Coded
Top Ten List
(1676)

ceiiinosssttuu.

Hooke's Law
& Its Utility
(1678)

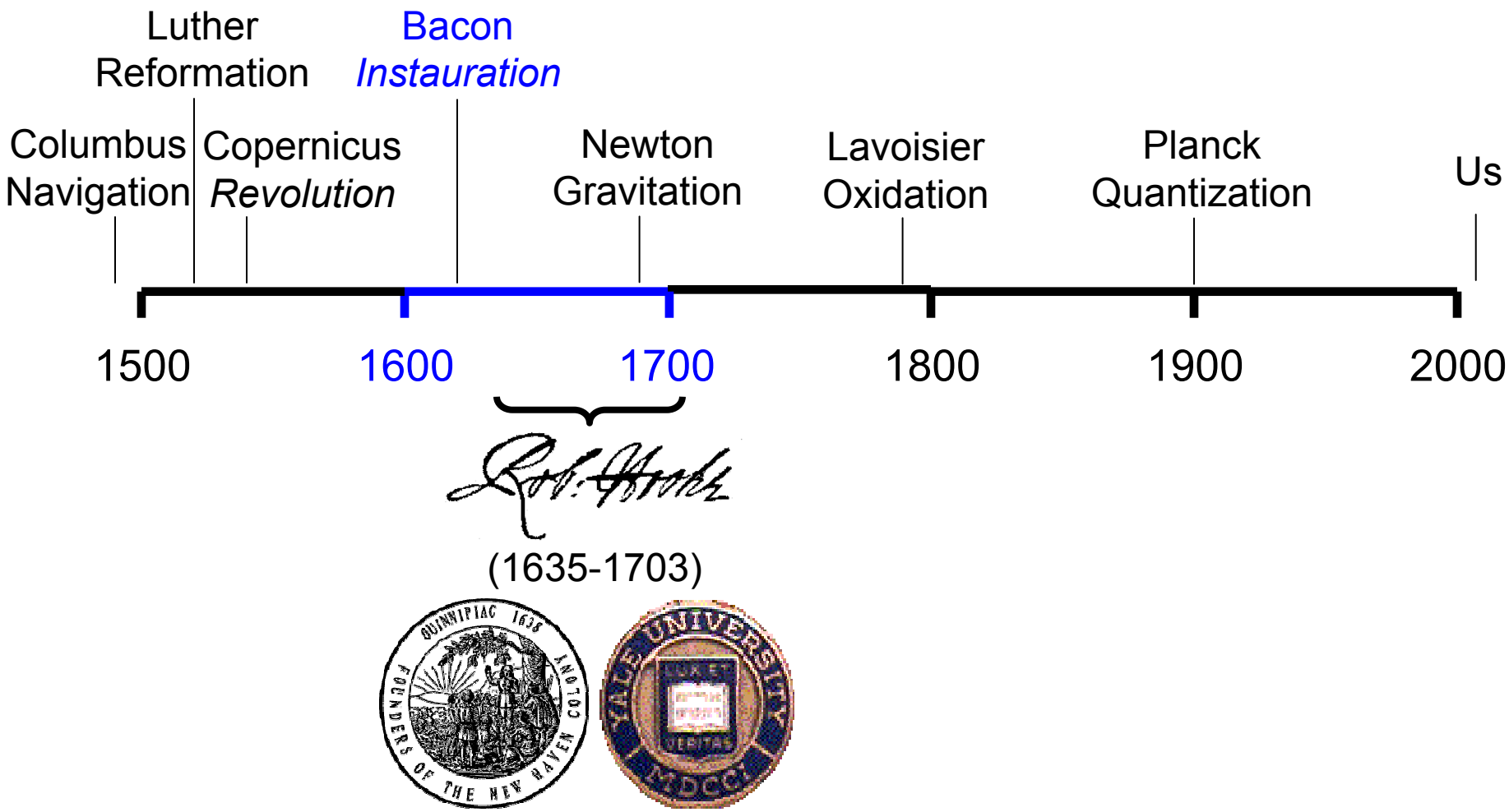


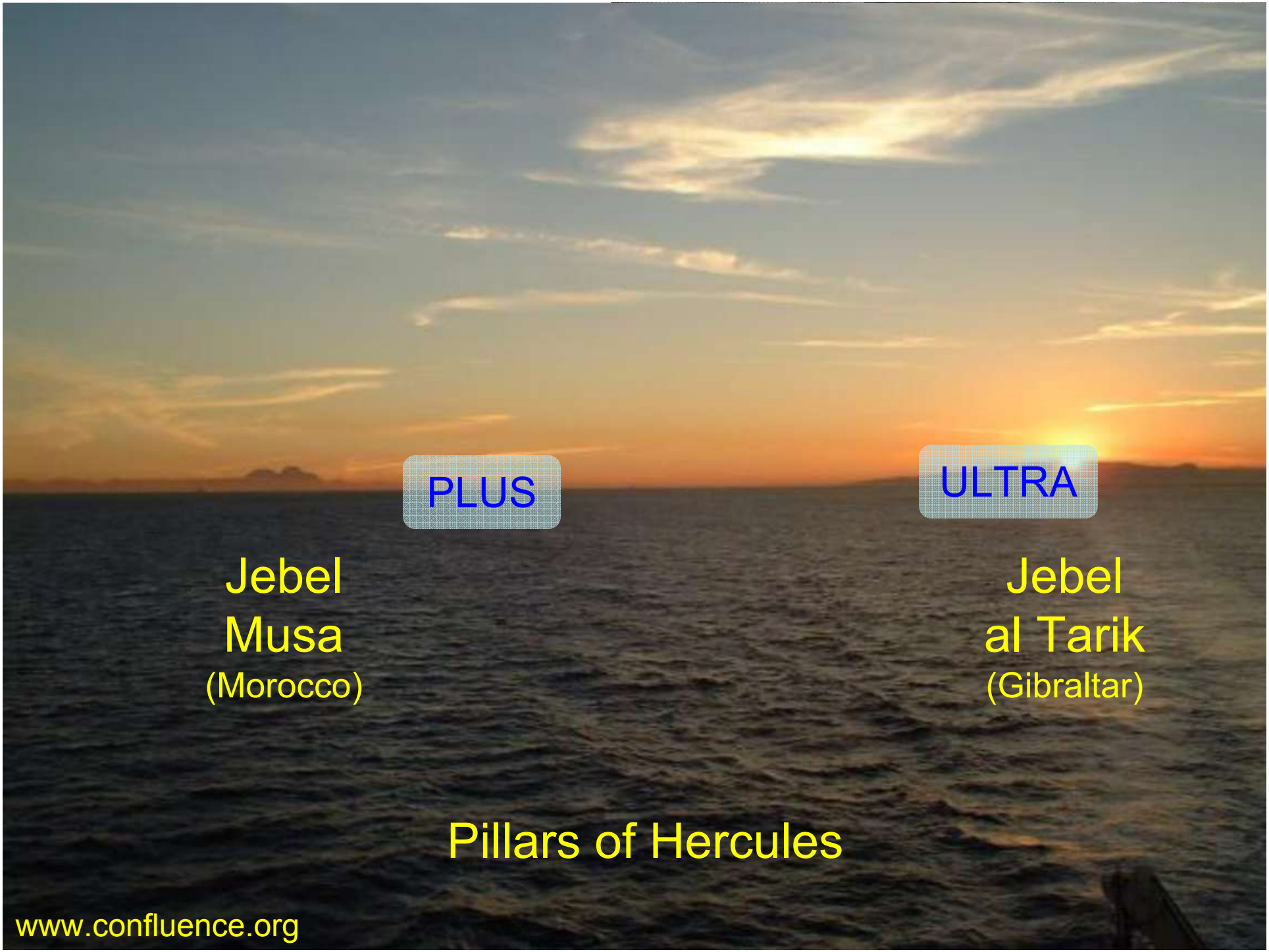
Gravity,
Geometry
& Newton
(1679-1687)

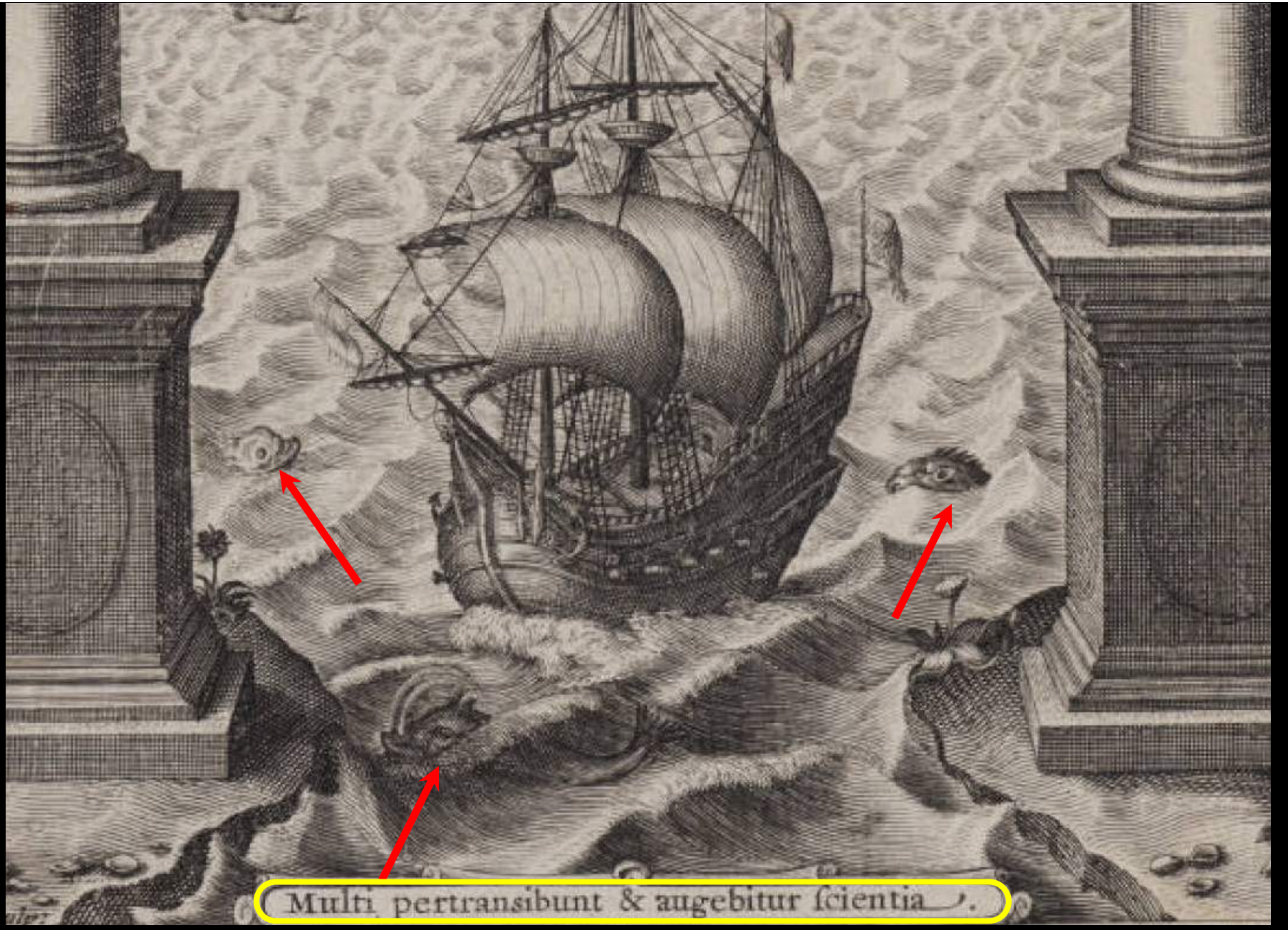
17th Century

an Age of all others the most inquisitive

Hooke (1665)




PLUS
ULTRA
Jebel
Musa
(Morocco)
Jebel
al Tarik
(Gibraltar)
Pillars of Hercules
www.confluence.org



"Many will pass through and knowledge will be increased."

Daniel 12:4

Instauratio Magna (1620)

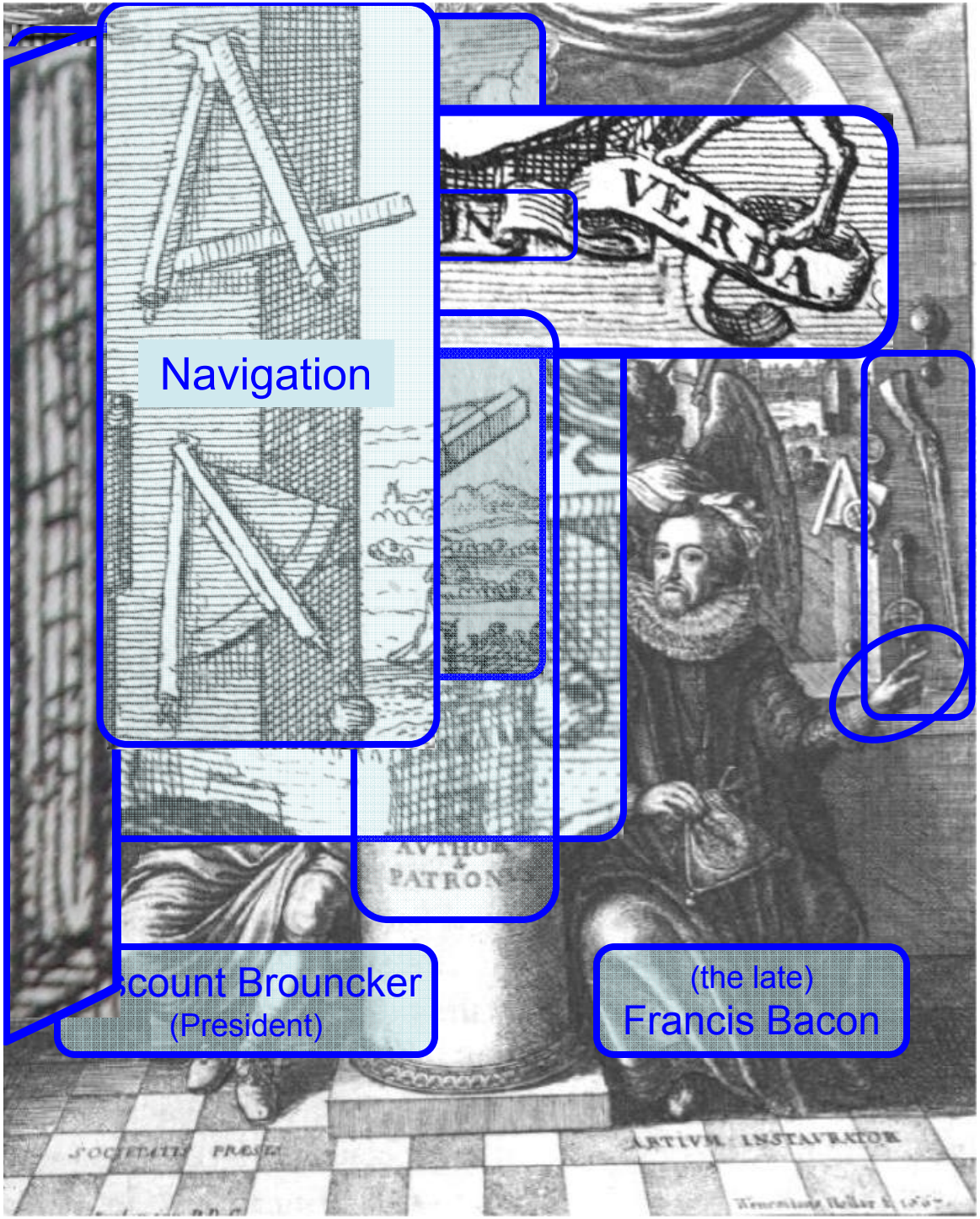
"…that wisdom which we have derived principally from the Greeks is but like the boyhood of knowledge, and has the characteristic property of boys: it can talk, but it cannot generate;"

"…it is but a device for exempting ignorance from ignominy."

"…the end which this science of mine proposes is the invention not of arguments but of arts."

"…not so much by instruments as by experiments …skilfully and artificially devised for the express purpose of determining the point in question."

"restoration of learning and knowledge"



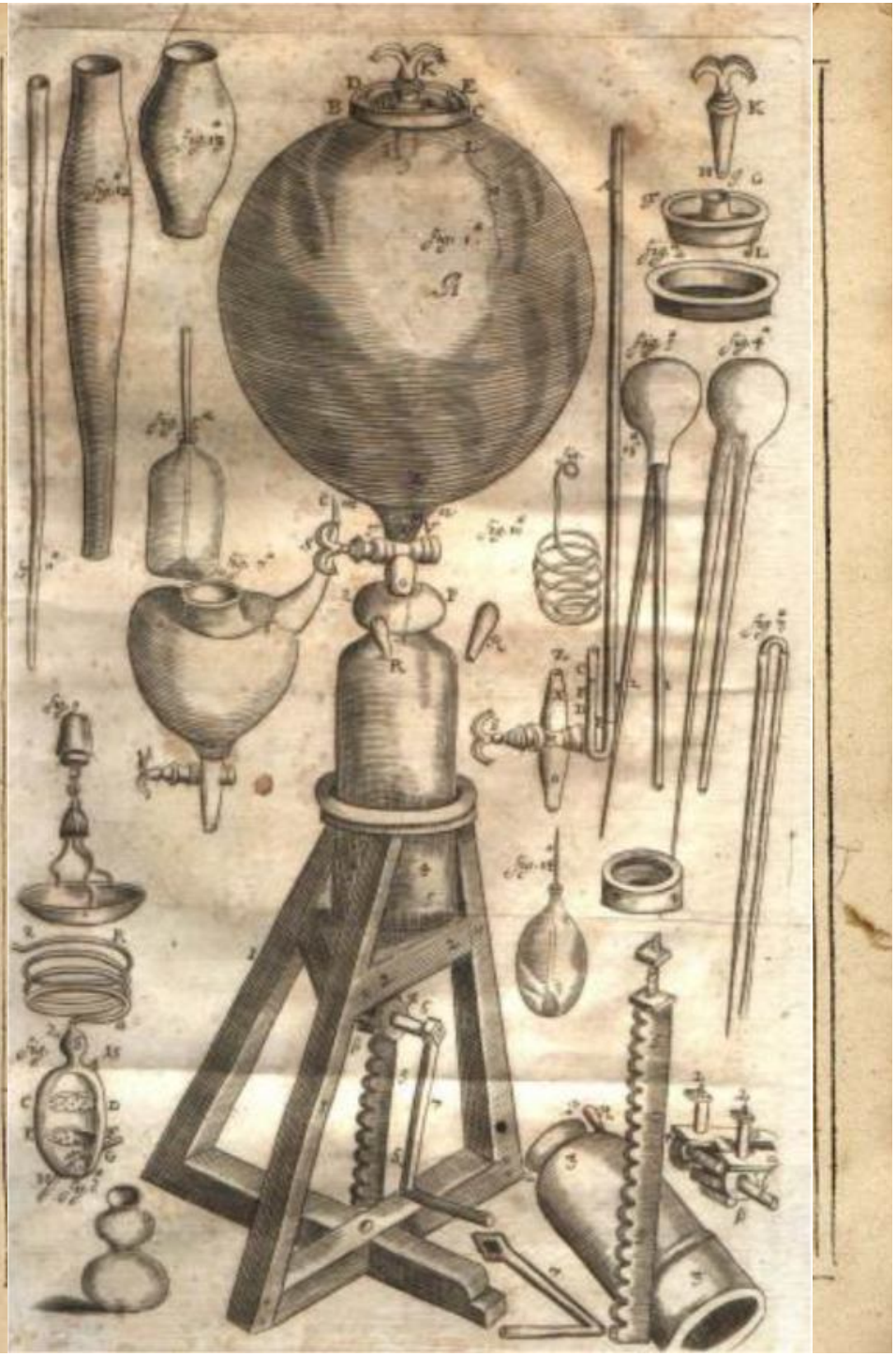
Ac ne forte roges, quo me duce, quo lare tuter,
Nullius addictus jurare in verba magistri
Quo me cumque rapit tempestas, deferor hospes.

Horace (15 B.C.)

Lest you ask who leads me, in what household I lodge,
There is no master in whose words I am bound to take an oath,
Wherever the storm forces me, there I put in as a guest.

Forerunner of
Institute for Soldier Nanotechnologies

"The Royal Society for the Improving of Natural Knowledge by Experiments"



Focus on Mechanics and Mechanism

…I had call'd to mind what my Curiosity for Dissections has shown me, and remembred how many Bones, and Muscles, and Veins, and Arteries, and Grisles, and Ligaments, and Nerves, and Membranes, and Juices, a humane Body is made up of…

Upon the Accidents of an Ague

Robert Boyle (1665)

…it being no more strange that a Man's Body should be subject to Pain, or Sickness, than that an Instrument with above a thousand Strings (if there were any such) should frequently be out of Tune…

the inimitable Structure of humane Bodies is scarce more admirable, than that such curious and elaborate Engines can be so contriv'd, as not to be oftner out of order than they are…

Robert Boyle (1665)

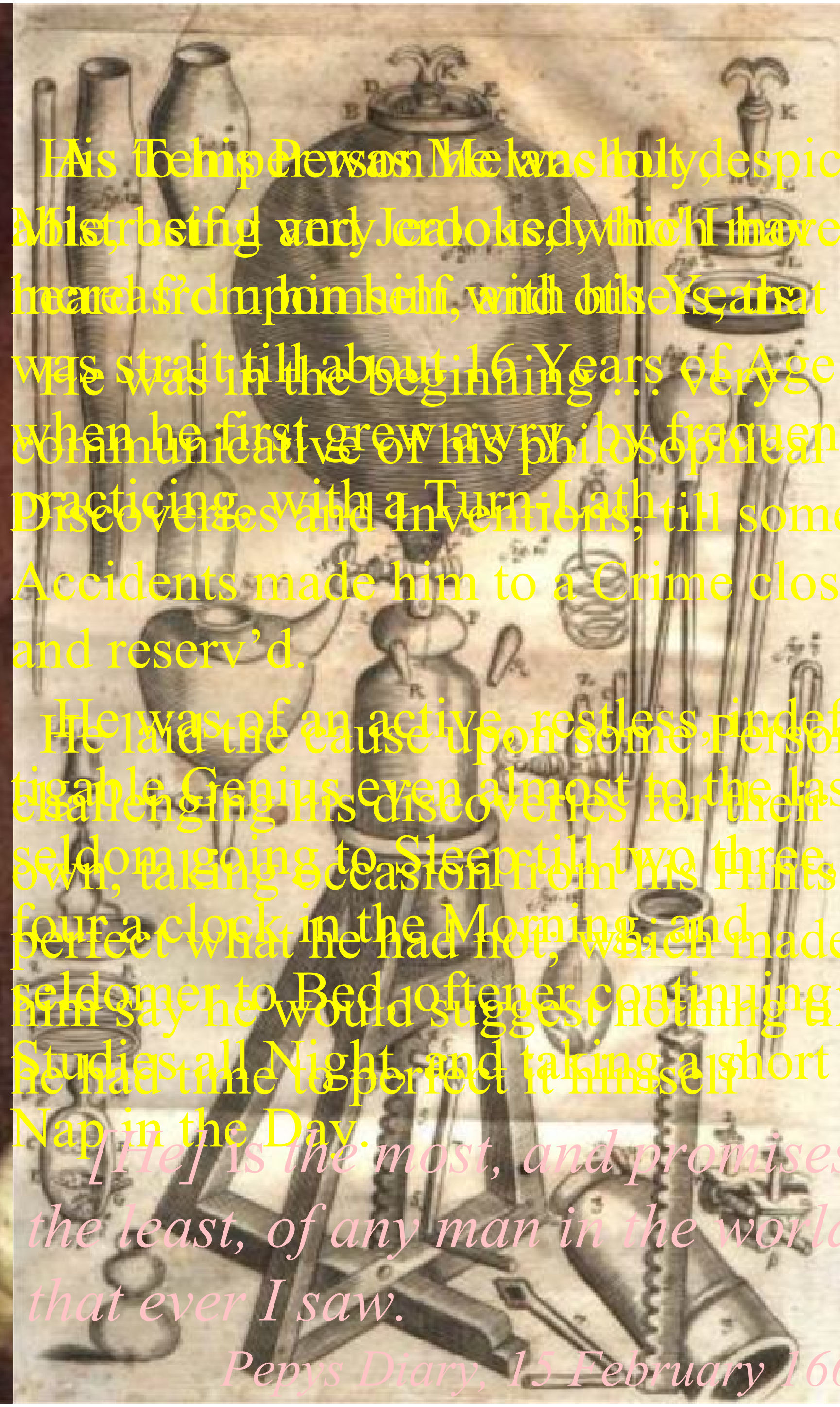
Our Life contains a thouſand Springs,
And dies if one be gone;
Strange! that a Harp of thouſand ſtrings
Should keep in Tune ſo long.

Isaac Watts (1707)

Mechanical Understanding is a Venerable Tradition in British Science

I am never content until I have
constructed a mechanical model
of what I am studying.
If I succeed in making one,
I understand;
otherwise I do not.

Lord Kelvin, *Baltimore Lectures (1884)*



As to his Person he was but despicable, being very crooked, tho' I have heard from himself, and others, that he was strait till about 16 Years of Age when he first grew awry, by frequent practicing, with a Turn-Lath…

His Temper was Melancholy, Mistrustful and Jealous, which more increas'd upon him with his Years.

He was in the beginning … very communicative of his philosophical Discoveries and Inventions, till some Accidents made him to a Crime close and reserv'd.

He laid the cause upon some Persons, challenging his discoveries for their own, taking occasion from his Hints to perfect what he had not; which made him say he would suggest nothing till he had time to perfect it himself

He was of an active, restless, indefatigable Genius even almost to the last,.. seldom going to Sleep till two, three, or four a clock in the Morning, and seldomer to Bed, oftener continuing his Studies all Night, and taking a short Nap in the Day.

[He] is the most, and promises the least, of any man in the world that ever I saw.

Pepys Diary, 15 February 1665

Robert Hooke

1635 Born youngest son of Isle of Wight curate

1648 Father dies

To London , apprenticed to Peter Lely

1653 “Choral” Scholarship,

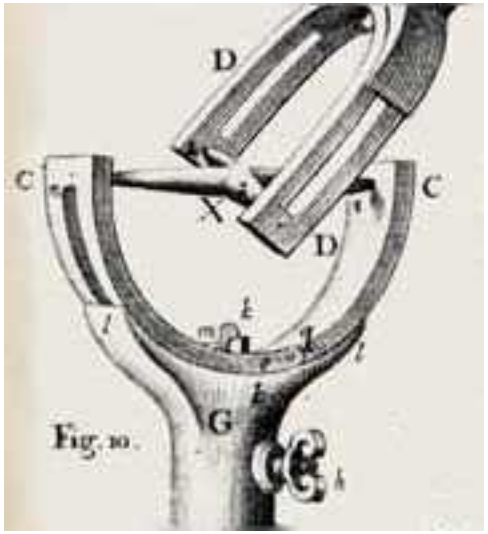
1655 Lab Assistant to Robt

1662 Curator of Experimen

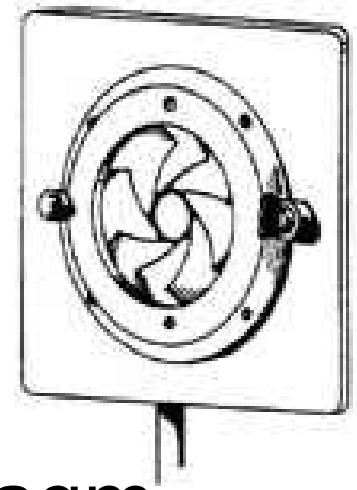
(unsalaried)

Fre
~1637

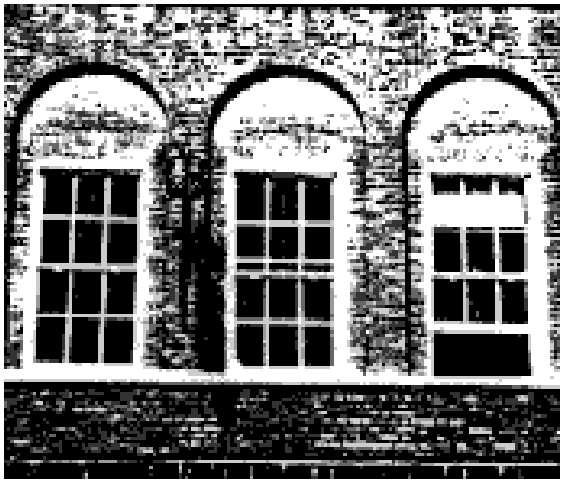
Some Hooke Inventions



Universal Joint



Iris Diaphragm

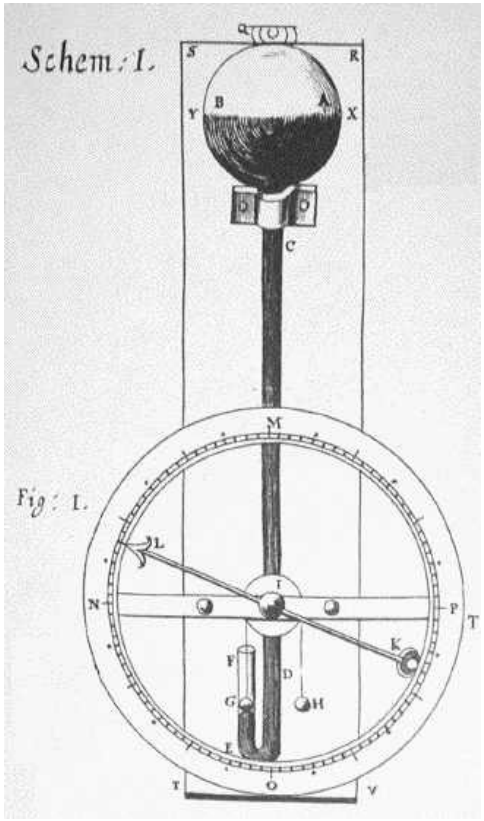


Double-Hung Sash Window

"Telephone"

"I have, by the help of a distended wire, propagated the sound to a very consi-derable distance in an instant, or with as seemingly quick a motion as that of light"

Some Hooke Instruments



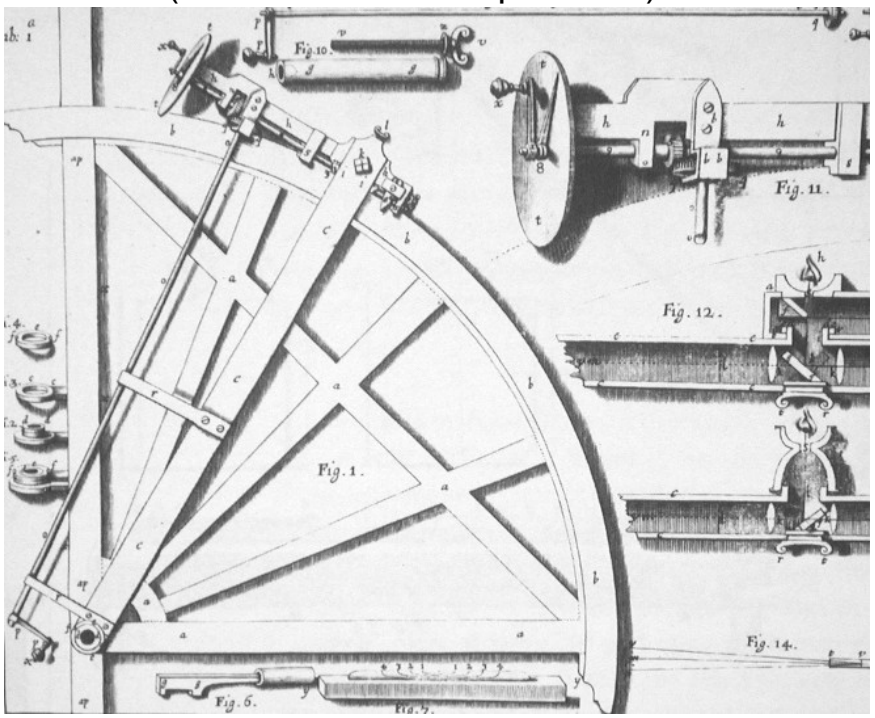
Index Barometer

Oat Beard Hygrometer, Weather 'Clock' & Many Other Meterological Instruments

Reflecting Quadrant

Micrometer Screw, Telescopic Sight

(clockwork drive & spirit level)



Compound Microscope

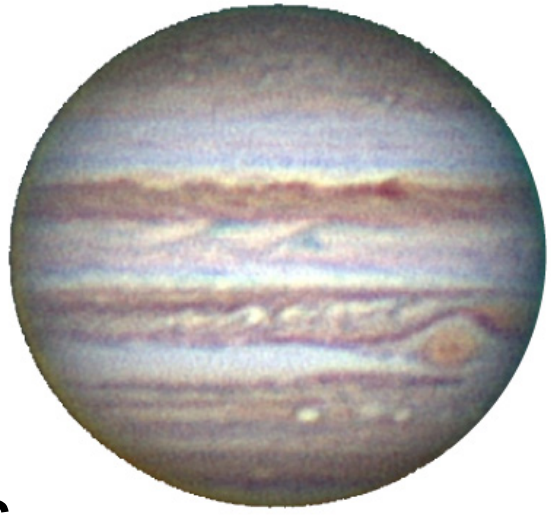
Device to Measure Frequency of Fly Wingbeats

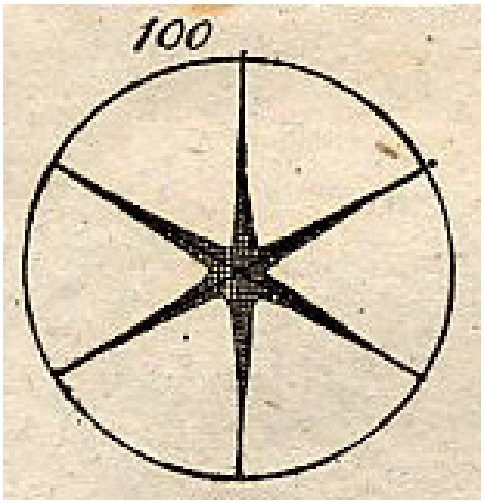
"By the addition of such artificial Instruments and methods, there may be, in some manner, a repayment made for the mischiefs, and imperfection, mankind has drawn upon it self."

Micrographia Preface *(1665)*

Some Hooke Discoveries

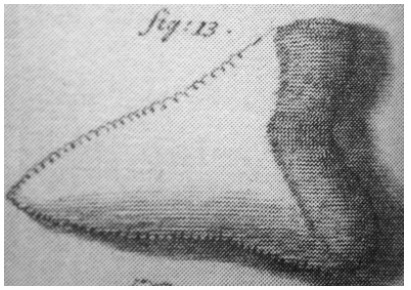
Spots and Rotation
of Jupiter & Mars





"Chladni" Figures

Fossil record of
mutability of Earth and species



Role of the lungs in aerating blood

Consumption of "nitrous air" by combustion

Three Weeks for Hooke (October,1663)

Prepare a paper on what should be observed
and recorded for a history of weather

Make and demonstrate a hygroscope
from the beard of a wild oat, with an index

Prepare two thermometers (tin and glass, invented by Wren)

Make an artificial eye.

Prepare a suitable concave glass
for projecting a picture in a lighted room

Remove and restitch a piece of a dog's skin to see if it will regrow

Move in at Gresham College

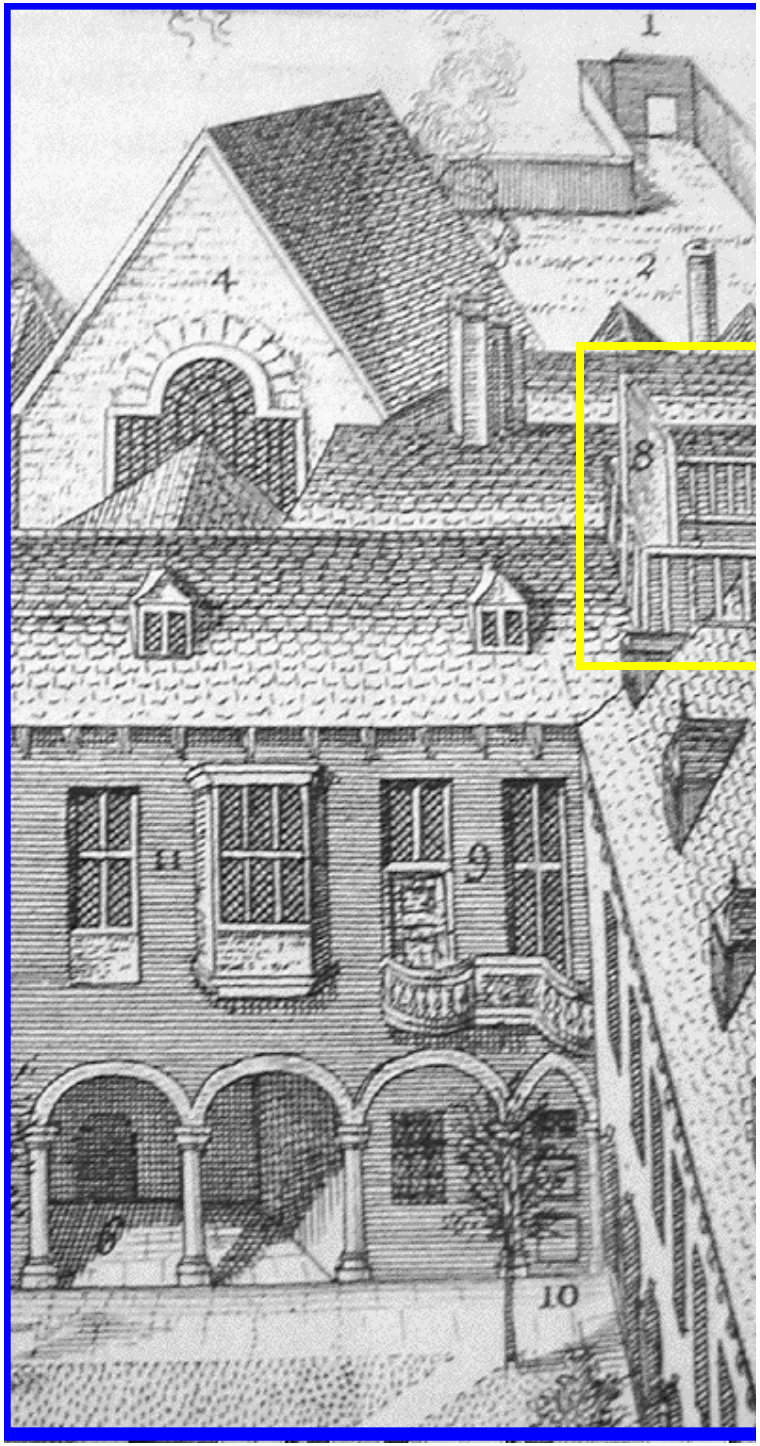
Supervise making a new air pump
and a machine for measuring the force of gunpowder

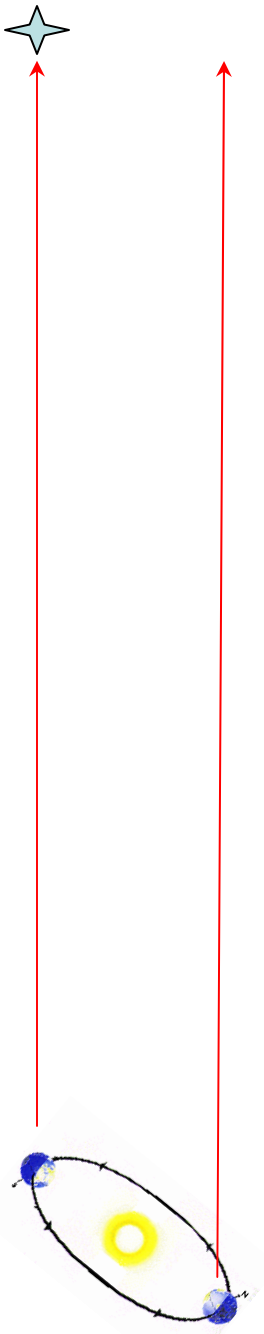
Prepare micrographs of common fly and moss growing on brick

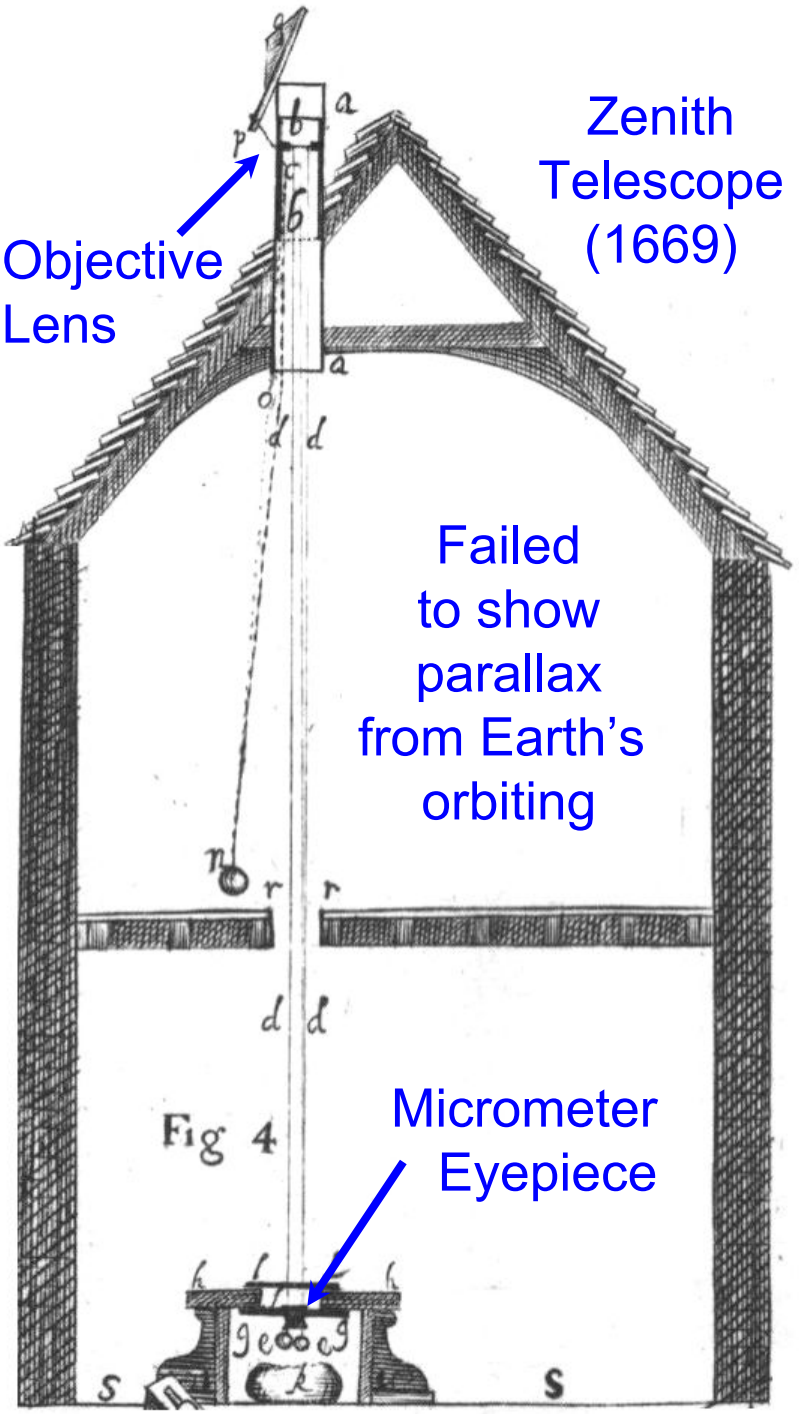
Care for Society Repository - labeling objects (with provenance)

Prepare demo of lineless depth sounder to show King Charles

Graft feathers onto a cock's comb






Zenith
Telescope
(1669)
Objective
Lens
Failed
to show
parallax
from Earth's
orbiting
Micrometer
Eyepiece
Fig 4

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. 1.

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 LX V.

1665

TO THE

ROYAL SOCIETY

...I have added some *Conjectures*...And therefore ... I must also beg YOUR *pardon*. The Rules YOU have prescrib'd YOURselves in YOUR Philosophical Progress do seem the best that have ever yet been practis'd. And particularly that of avoiding *Dogmatizing*, and the *espousal* of any *Hypothesis* not sufficiently grounded and confirm'd by *Experiments*.

...I desire them to be understood only as *Conjectures* and *Quaeries.*

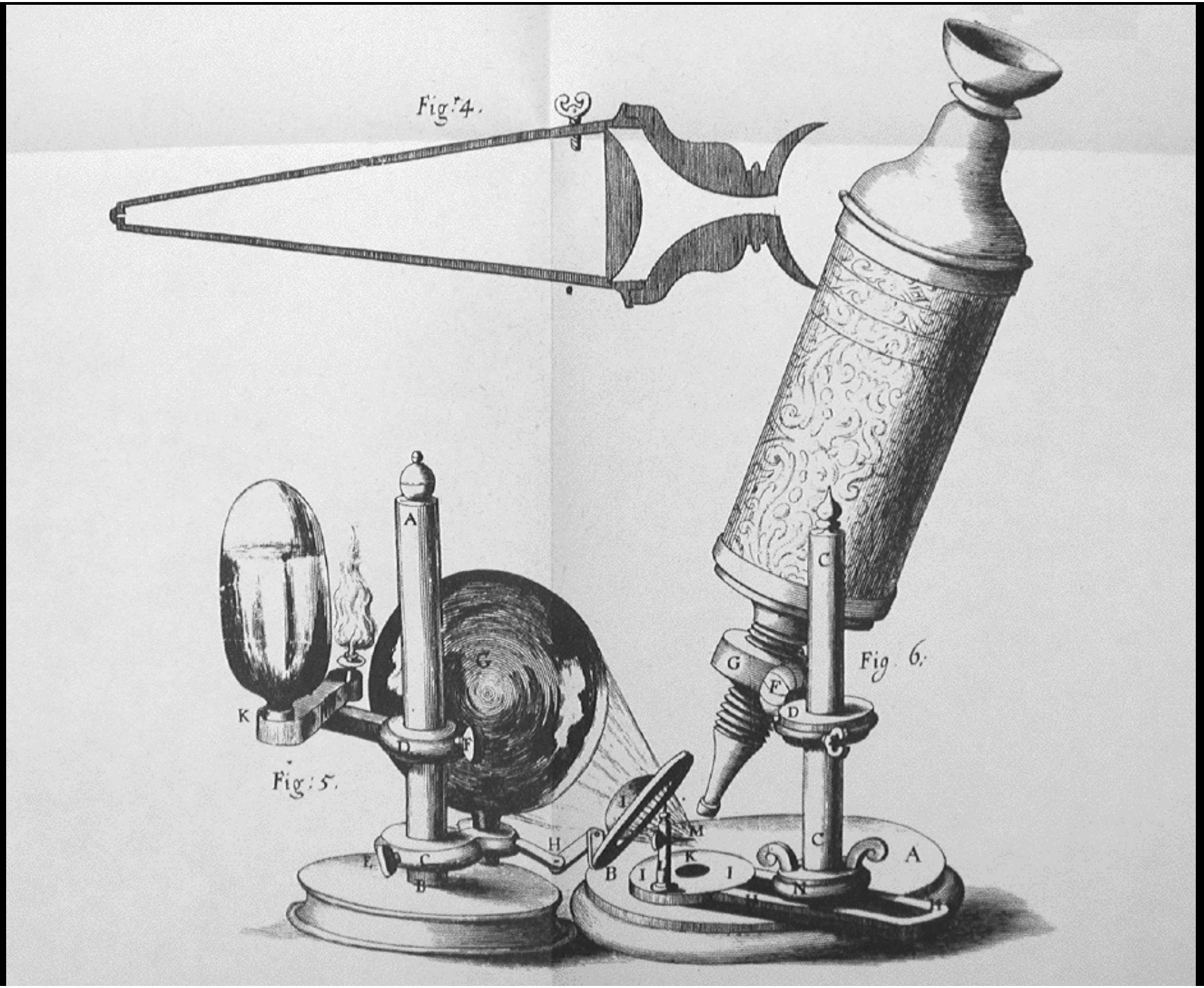
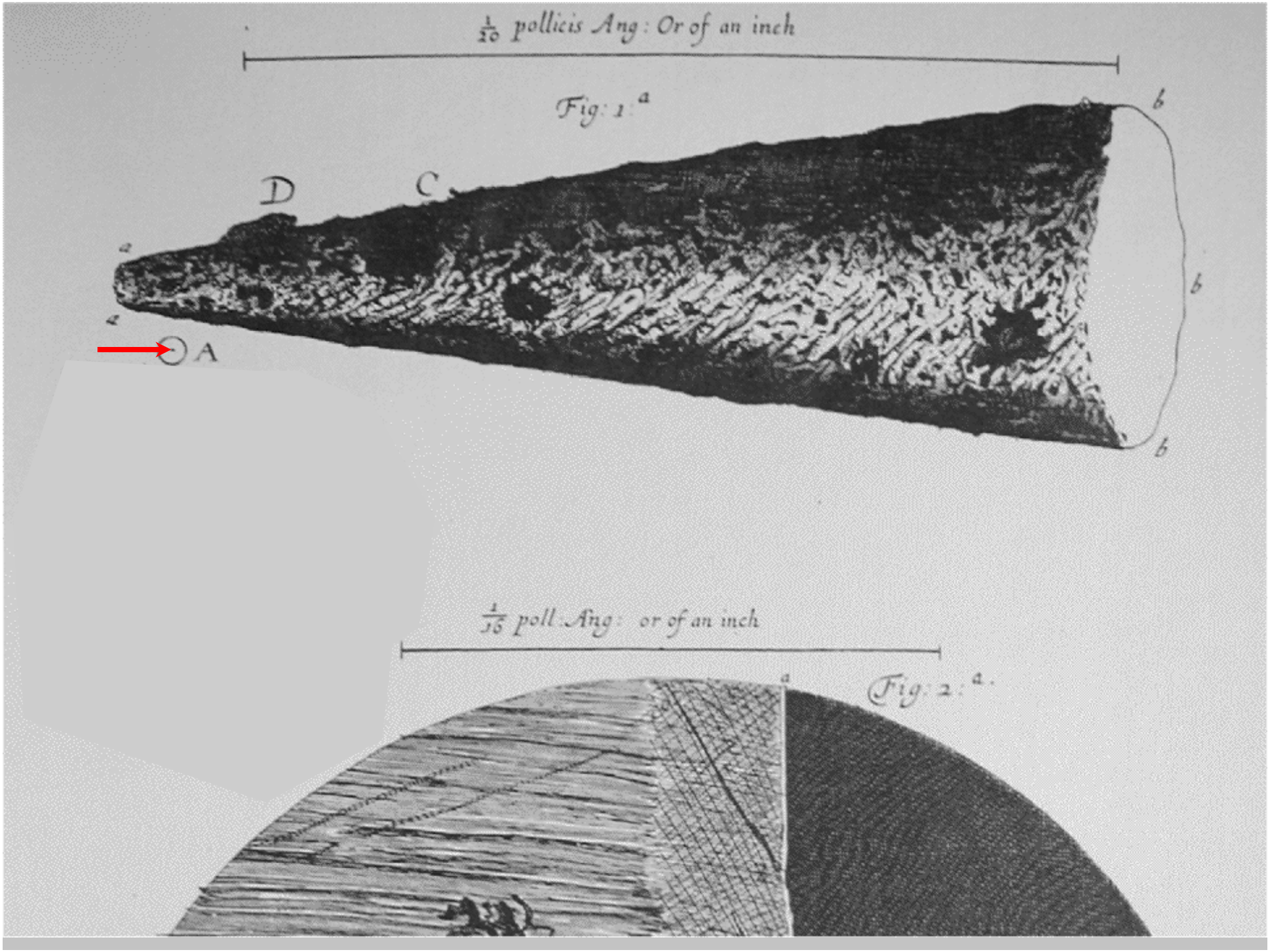


Fig: 5.

Fig. 6.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a
A
b
b
b
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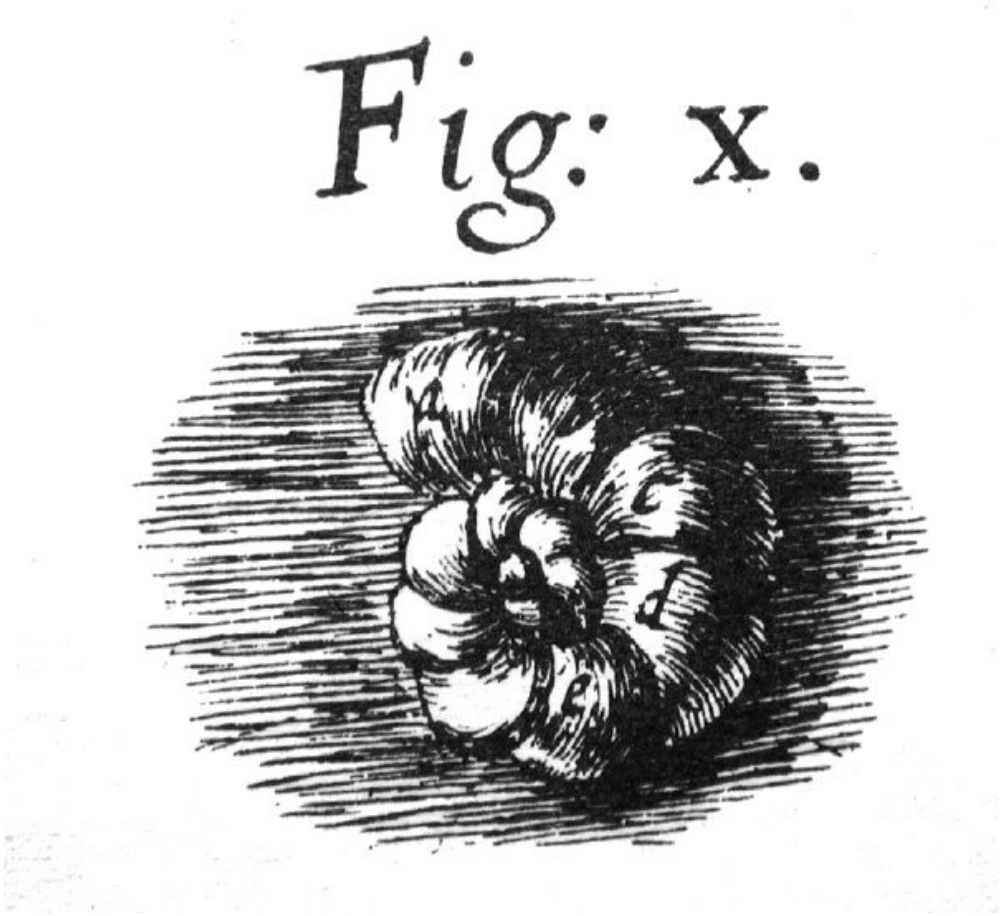
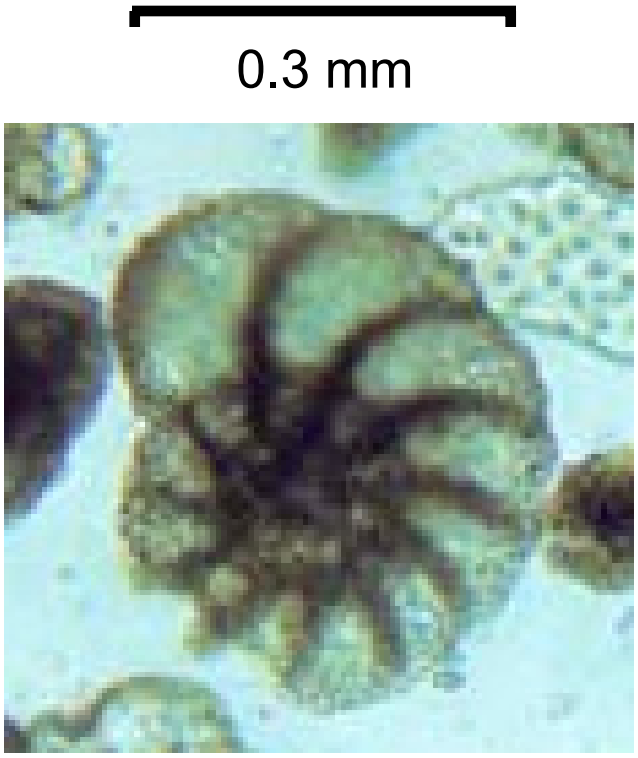
a
Fig: 2: a.

Observ. XI.
Of Figures *observ'd in small Sand*



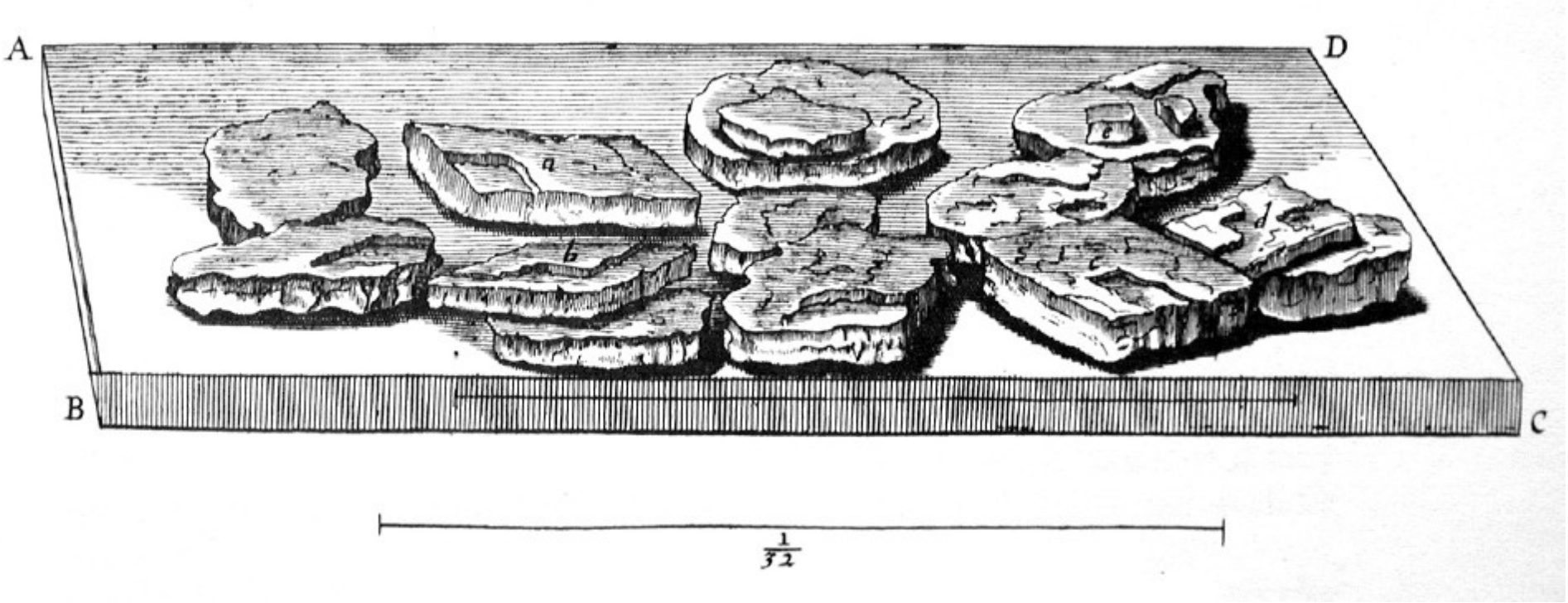
First Protozoan Picture



http://www.fathom.com

Foraminifer from
Dover Cliffs

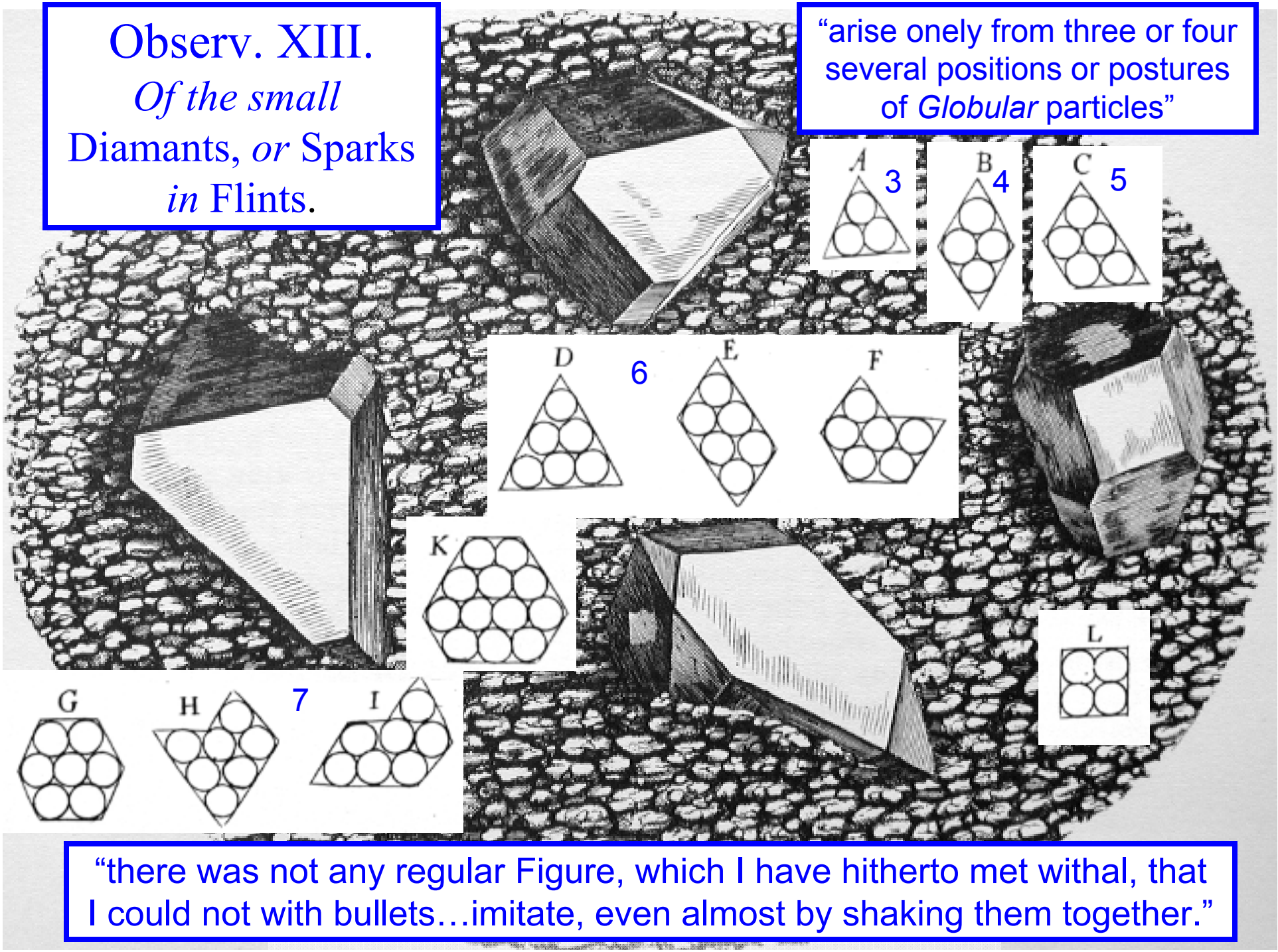
Observ. XII. *Of* Gravel *in Urine*



"How great an advantage it would be to such as are troubled with the Stone, to find some *menstruum* that might dissolve them without hurting the bladder."

Observ. XIII.
Of the small Diamants, *or* Sparks *in* Flints.

"arise onely from three or four several positions or postures of *Globular* particles"



"there was not any regular Figure, which I have hitherto met withal, that I could not with bullets…imitate, even almost by shaking them together."

"…the Philosophers hitherto… conclude nature in these things to play the Geometrician, according to that saying of *Plato*

God does geometry

"impossible to imitate exactly the curious and Geometrical *Mechanism* of Nature in any [snowflake]"

"Nor have I hitherto found indeed an opportunity of prosecuting the inquiry "…I designed…to get as exact and full a collection as I could, of all the differing kinds of Geometrical figur'd bodies…

OED's 1st use of "*crystallization*" in the English Language

Having such a multitude of instances to compare…as in the Solution and Crystallization of Salts, we cannot but learn plentifull information…of the Principle which Nature has made use of almost in all inanimate bodies."

Hooke's Mechanism of Growth

Imagination

Sensation

Amination

Plantamination

Vegetation

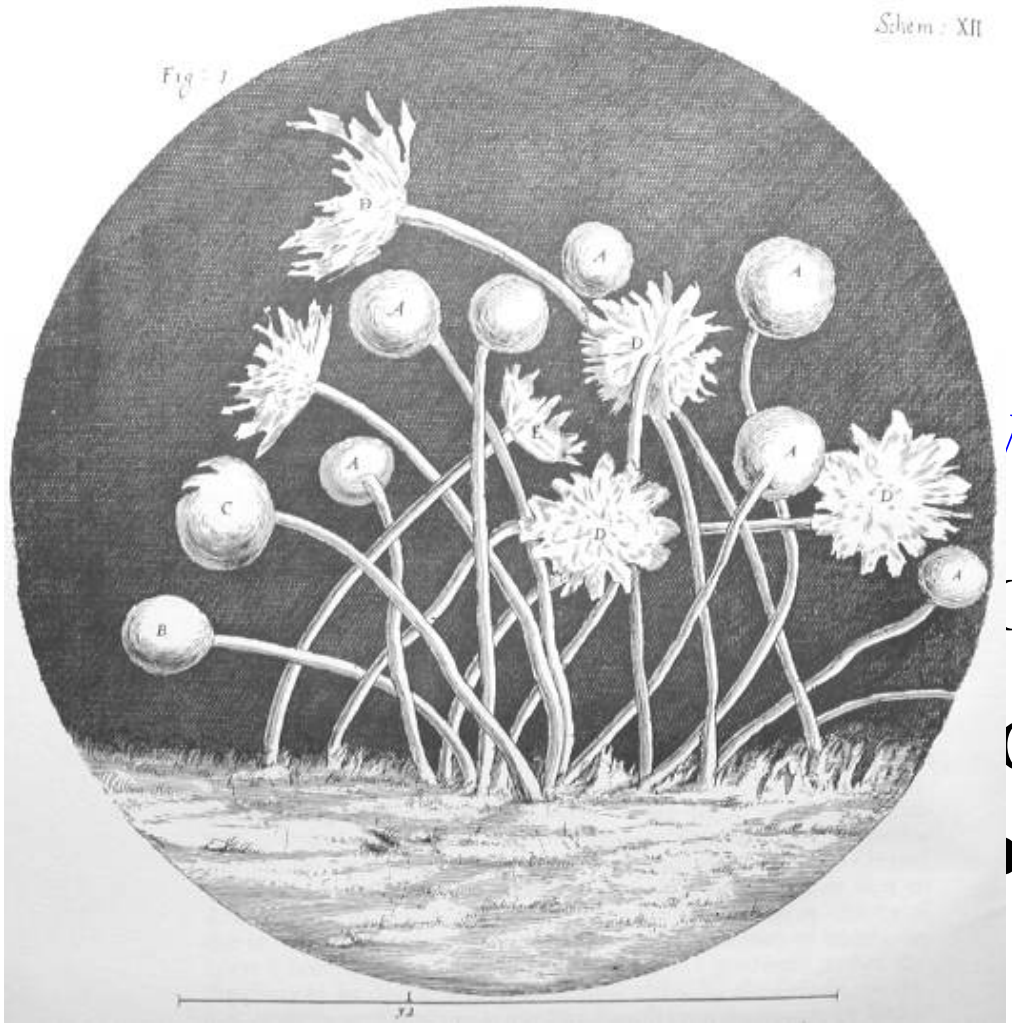
Germination or Ebullition

Angulization or Crystallization

Fixation

Orbiculation

Fluidity



“The several kinds of hairy mouldy spots… are all of them nothing else but several kinds of small and variously figur’d Mushrooms

V does not as yet appear (that I know of) that Mushrooms may be generated from a seed,

but they rather seem to depend merely upon a convenient constitution of the matter out of which they are made, and a concurrence of either natural or artificial heat.”

“concreeted by mechanical principles”

"Mushrooms" in Candle Wick


“Diana Tree”
($AgNO_3$+Hg)

celosvetovy.webz.cz/velkekras2

Petrifying Water

"I have seen some knobb'd a little at the lower end, though, for the most part, indeed, they are otherwise."

Growth by Self-Assembly

"…as far as I have been able to look into the nature of this Primary kind of life and vegetation, I cannot find the least probable argument to perswade me there is any other concurrent cause then such as is purely Mechanical…"

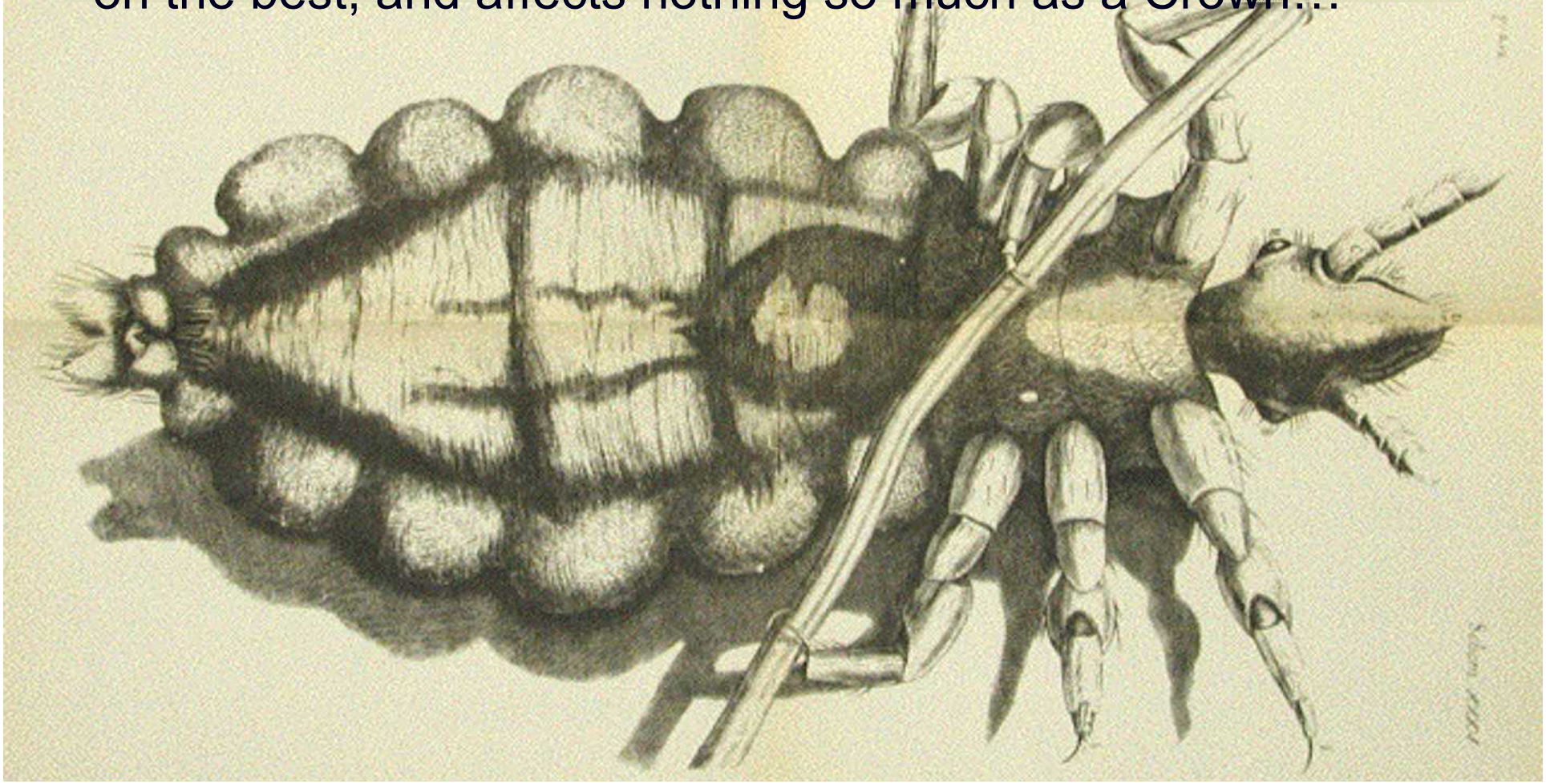
Observ. 17:

Of Petrify'd wood, and other Petrify'd bodies

Observ. 18:

Of the Schematisme *or* Texture *of* Cork, *and of the Cells and Pores of some other such frothy Bodies*

“This is a Creature so officious that ‘twill be known to every one at one time or other,
so busie, and so impudent, that it will be intruding itself in every ones company,
and so proud and aspiring withall, that it fears not to trample on the best, and affects nothing so much as a Crown…”

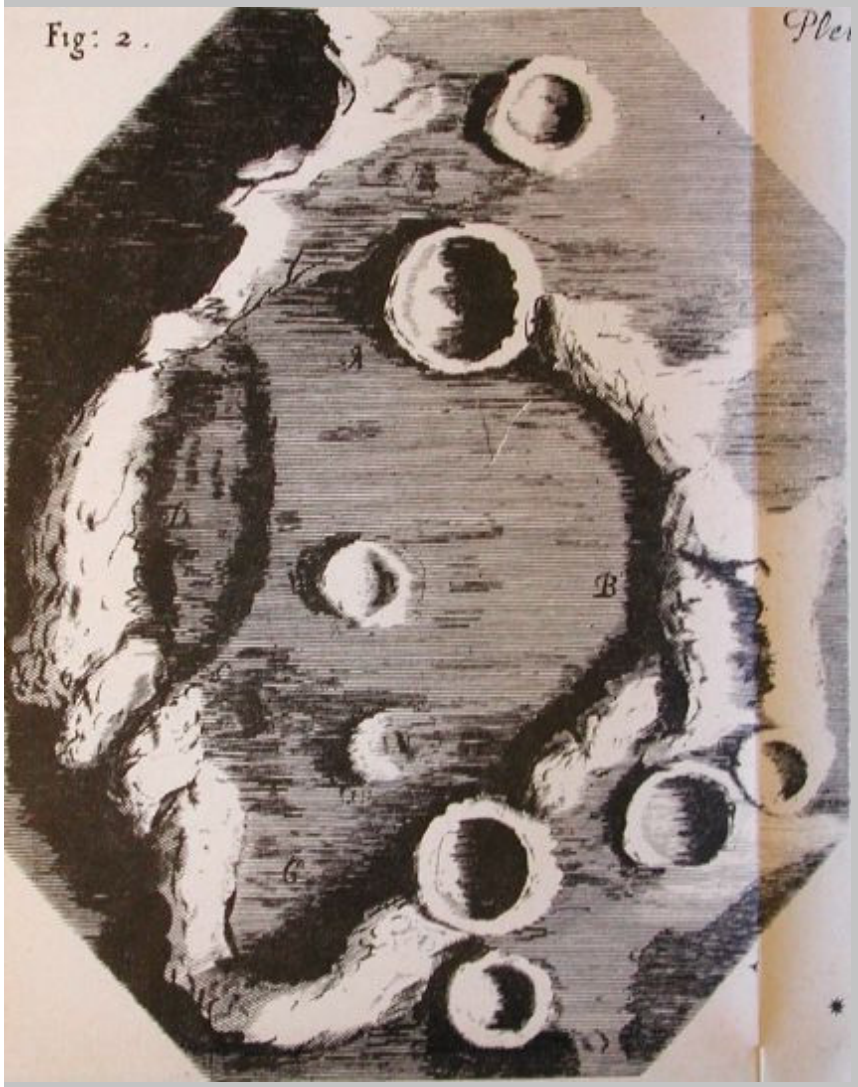


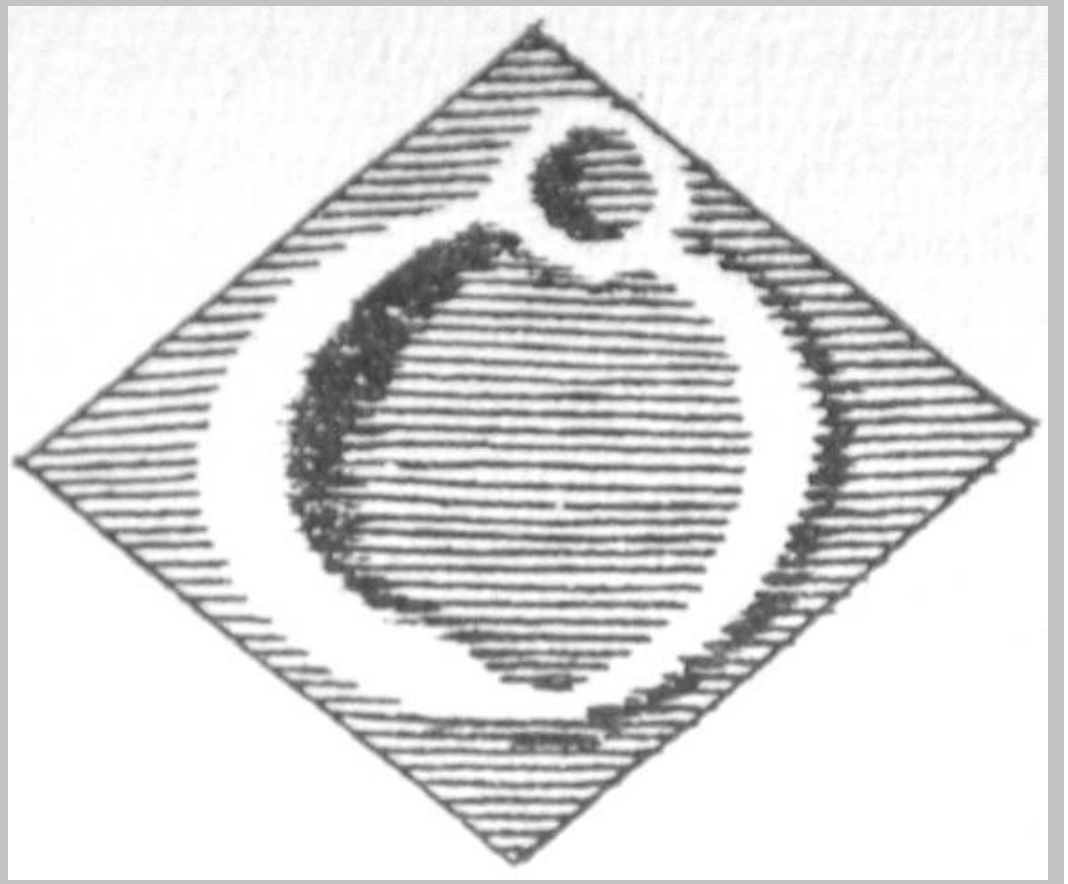
So, naturalists observe, a flea
Has smaller fleas that on him prey;
And these have smaller still to bite ‘em;
And so proceed *ad infinitum.*

Jonathan Swift (1667-1745)

Yersinia pestis (1894)

To conclude therefore, it being very probable, that the Moon has a principle of gravitation, it affords an excellent diſtinguiſhing Inſtance in the ſearch after the cauſe of gravitation, or attraction, to hint, that it does not depend upon the diurnal or turbinated motion of the Earth

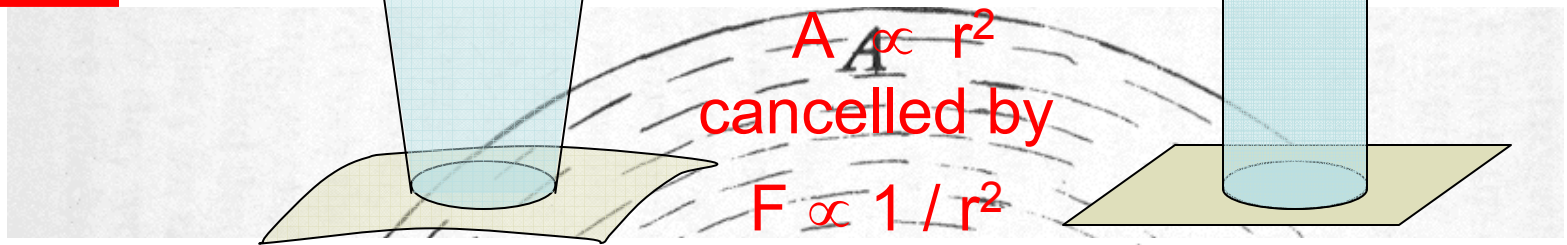




Cf. 'Mons' Olympus of "Excellent Hevelius"

Obs. 58. Of the Inflection of the Rays of Light in the Air

But it being more likely, that there is a continual increaſe of rarity in the parts of the Air, the further they are removed from the ſurface of the Earth: It will hence neceſſarily follow, that (as in the Experiment of the ſalt and freſh Water) the ray of Light paſſing obliquely through the Air alſo, which is of very different denſity, will be continually, and infinitely inflected, or bended, from a ſtreight, or direct motion.



$A \propto r^2$

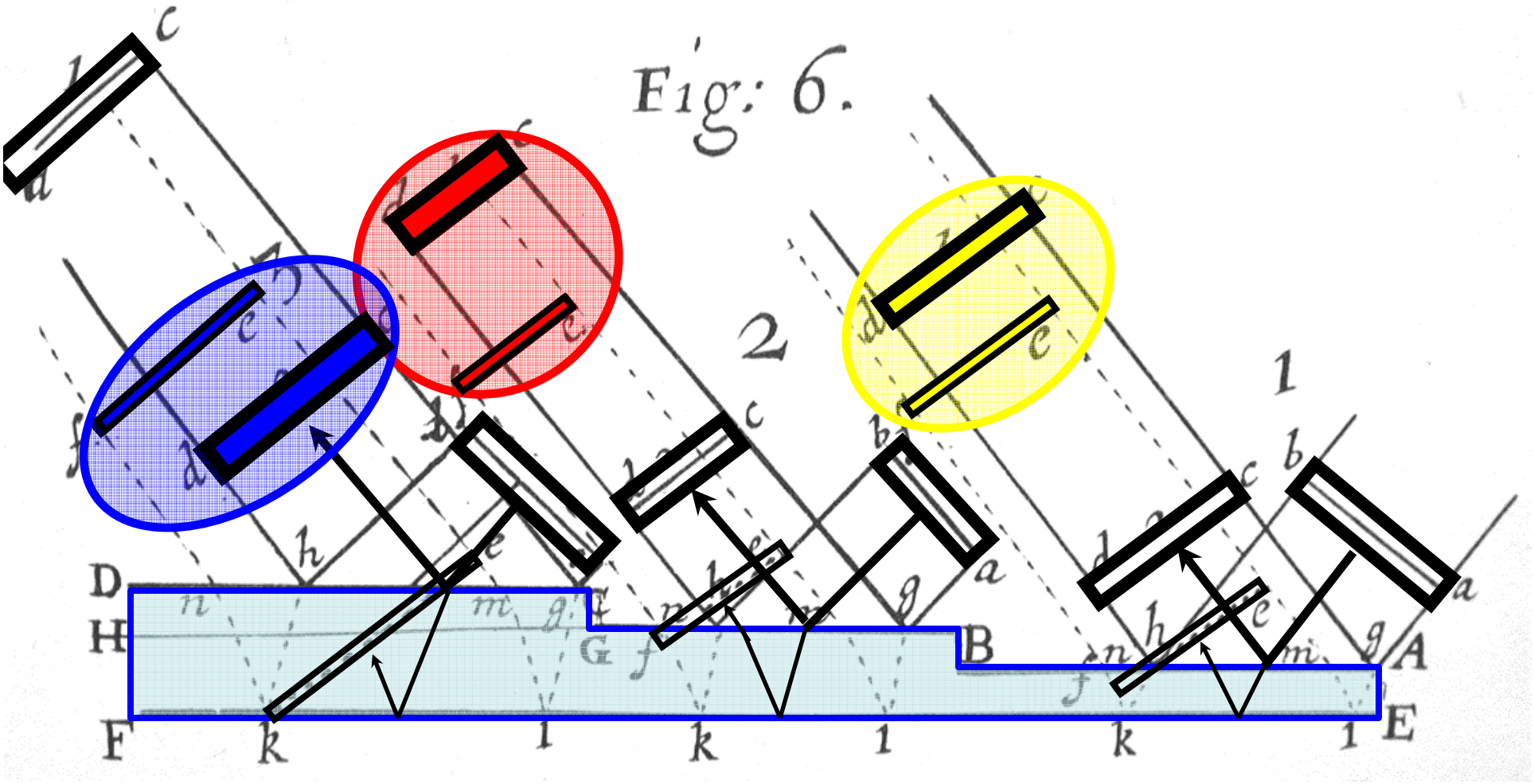
cancelled by

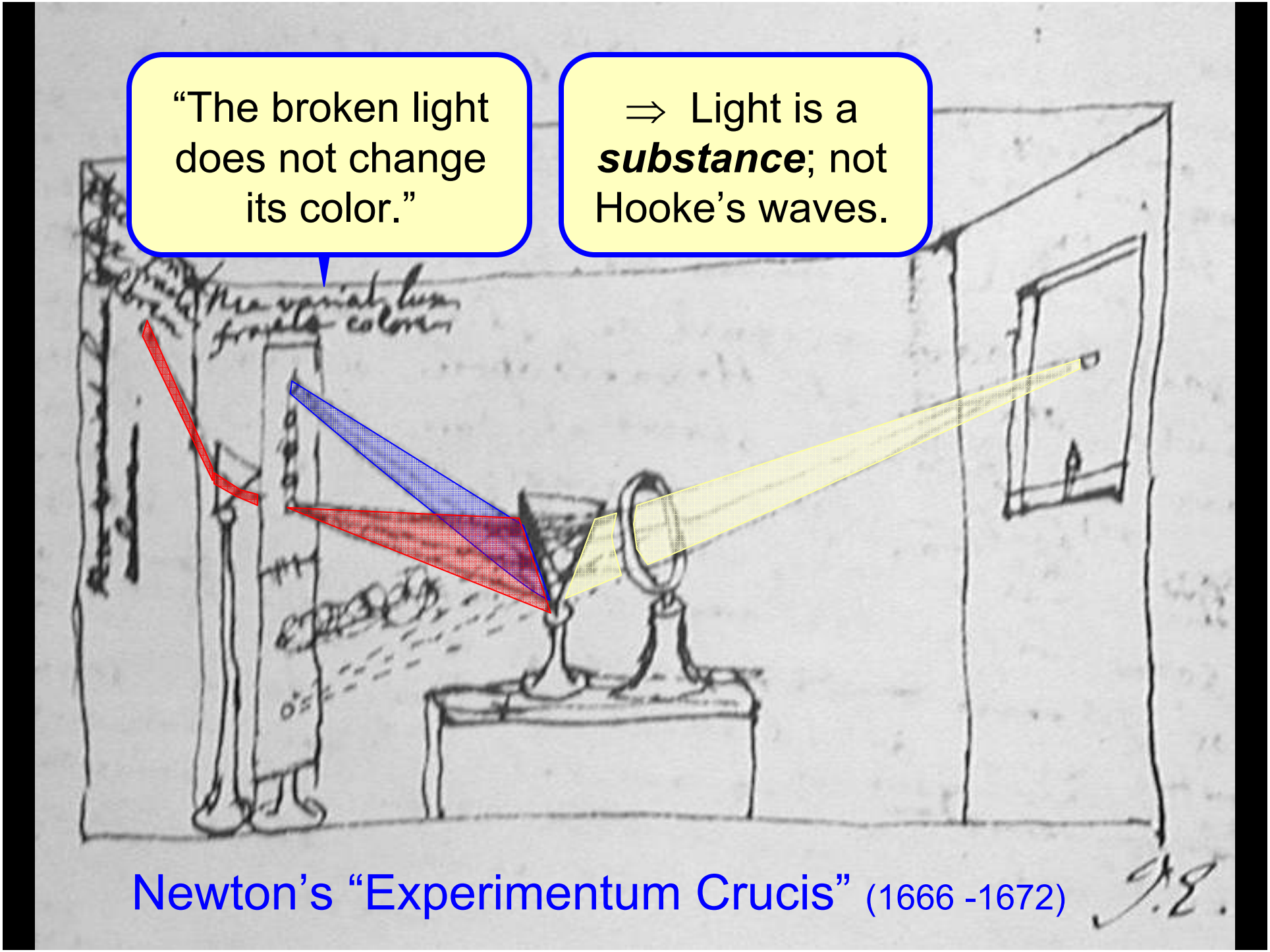
$F \propto 1 / r^2$

we will ſuppoſe a *Cylinder* indefinitely extended upwards,


American mathematicians
visit Newton's apple tree
W
Oct. 1665 - April 1667
Lisa Kolbe www.maa.org/england/

Confus'd Pulses of Light





Newton's "Experimentum Crucis" (1666 -1672)

Newton to Hooke Feb. 5, 1676

"What Des-Cartes did was a good step. You have added much several ways, & especially in taking y^{e} colours of thin plates into philosophical consideration.

If I have seen further
it is by standing on
y^{e} shoulders of giants."

From Lucan's Civil War (~62 A.D.) via Robt. Burton (1624)

(Hooke was hunchbacked!)

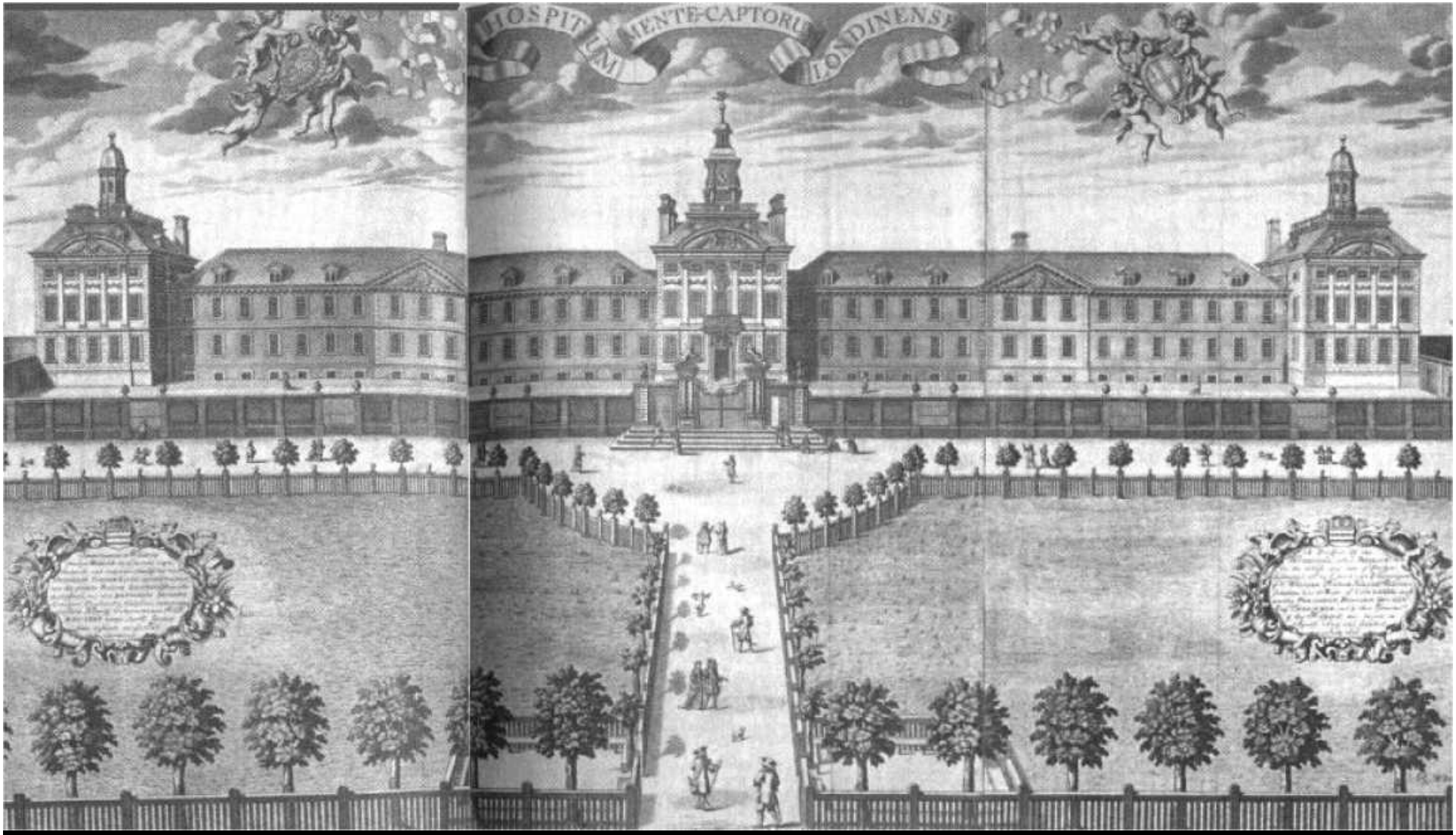
London 1666

Gresham College

Moorfields

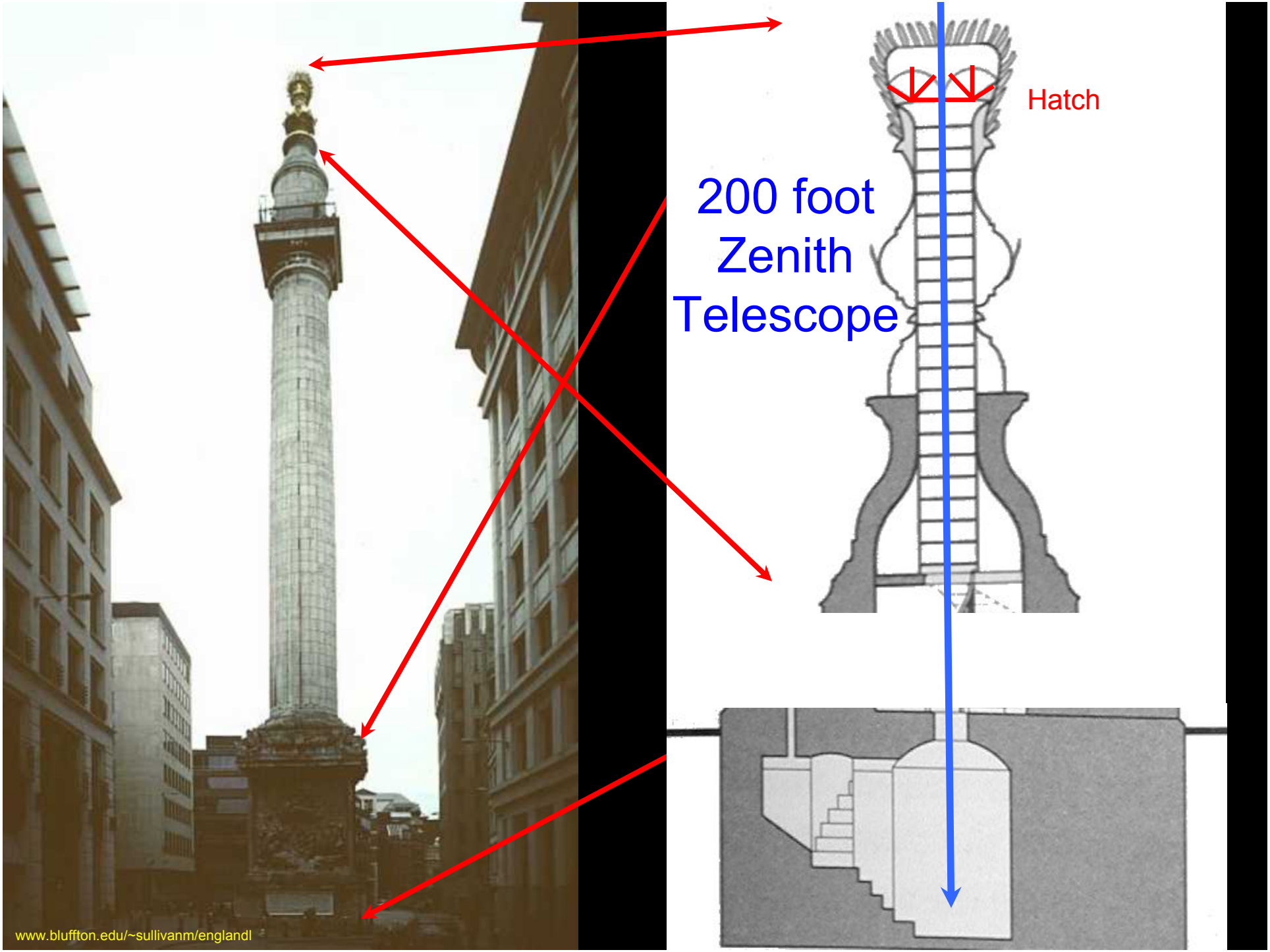
Ward for Christopher Wren, City Surveyor of New Buildings)

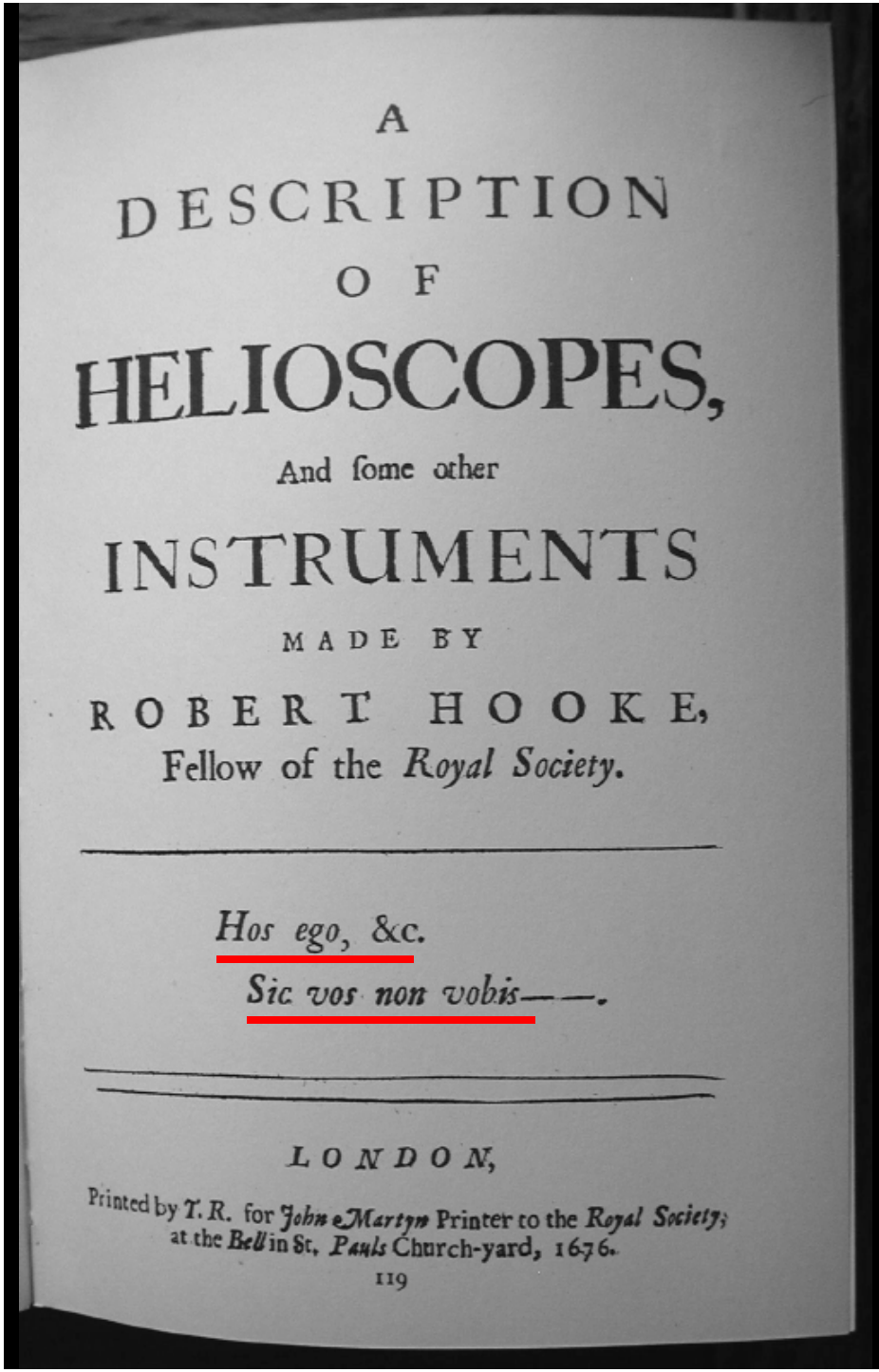
Ward for Robert Hooke, City Surveyor of New Buildings)



Hooke's Bethlehem Hospital (1675)

(Bedlam)


Hatch
200 foot
Zenith
Telescope
www.bluffton.edu/~sullivanm/englandl



A

DESCRIPTION

OF

HELIOSCOPES,

And some other

INSTRUMENTS

MADE BY

ROBERT HOOKE,

Fellow of the *Royal Society*.

Hos ego, &c.

Sic vos non vobis——.

LONDON,

Printed by T. R. for John e Martyn Printer to the *Royal Society*; at the *Bell* in St. *Pauls* Church-yard, 1676.

119

Hos ego versiculos feci,
tulit alter honores:
Sic vos non vobis nidificatis aves;
Sic vos non vobis vellera fertis oves;
Sic vos non vobis mellificatis apes;
Sic vos non vobis fertis aratra boves.

Of these short verses I composed,
another person had the honour:
So you not for yourself build a nest,o birds;
So you not for yourself bear the wool,o sheep;
So you not for yourself make honey,o bees;
So you not for yourself pull the plough,o oxen

ALTRUISM

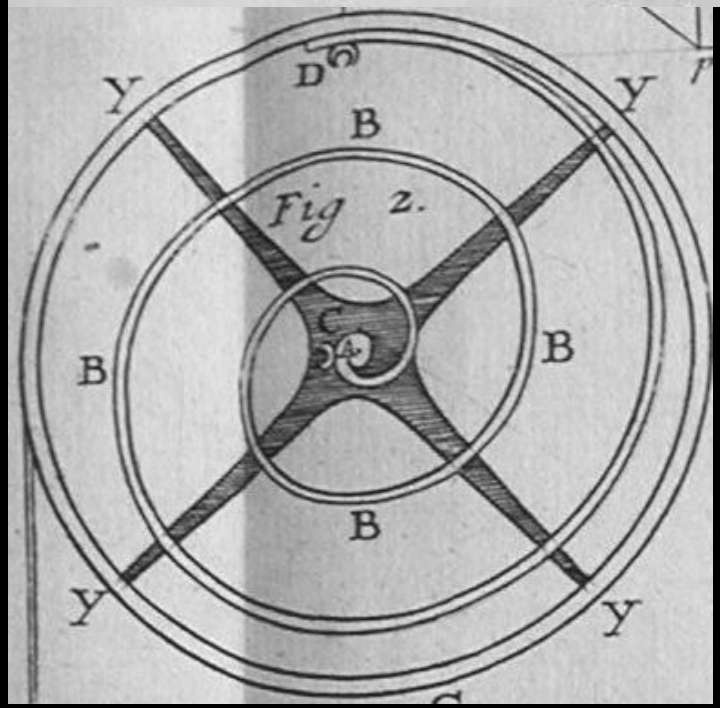
PLAGIARISM

1676

To fill the vacancy of the enſuing page, I have here added a *decimate* of the *centeſme* of the Inventions I intend to publiſh, t[illegible], but as I can get opportunity and leaſure; moſt of which, I hope, will be as uſeful to Mankind, as they are yet unknown and new.

0.1% = 10 ⇒ 10,000 Inventions

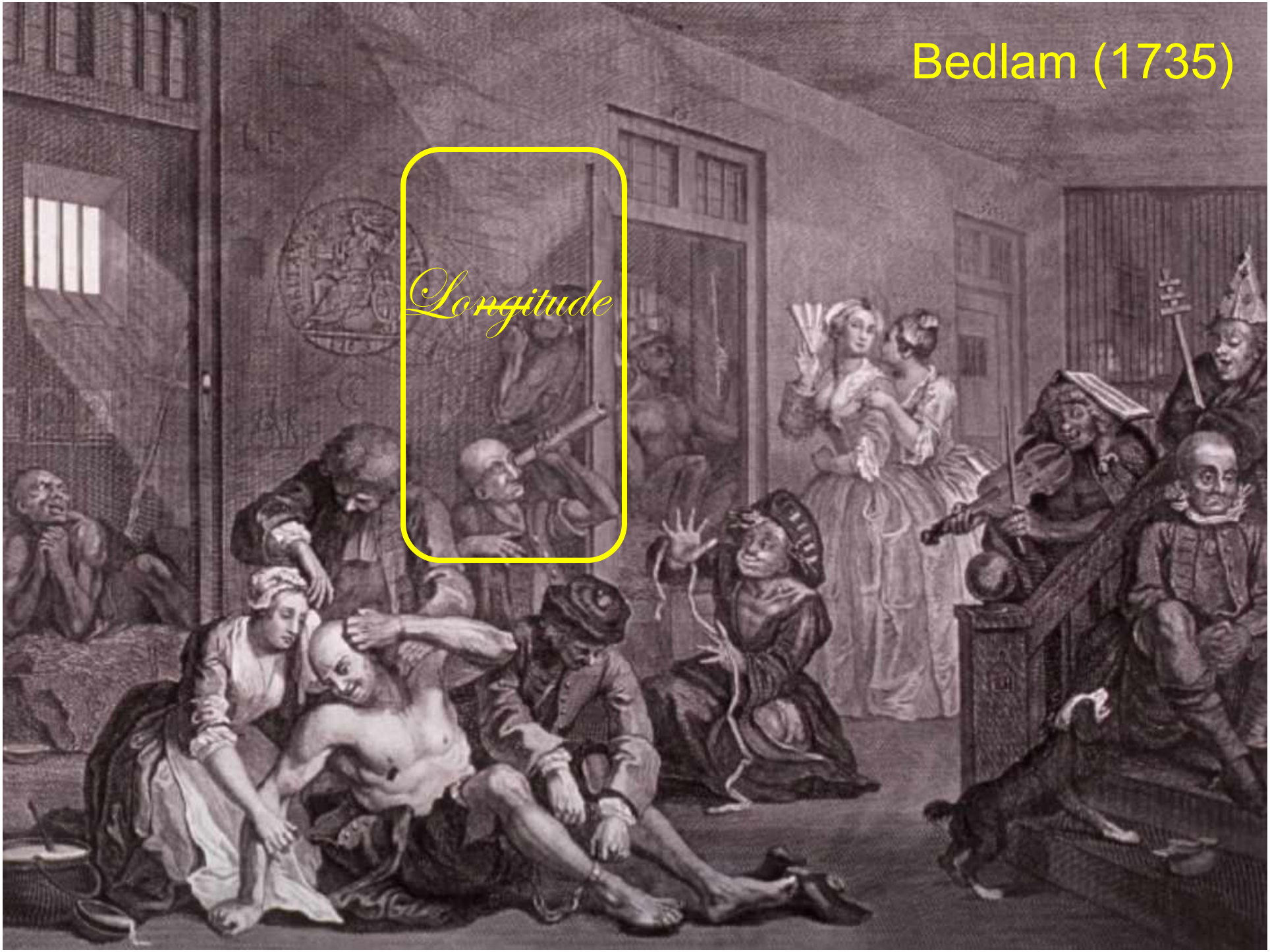
1. *A way of Regulating all ſorts of* Watches *or* Time-keepers, *ſo as to make any way to equalize, if not exceed the* Pendulum-Clocks *now uſed.*



Hooke
(1660)

Henry Oldenburg

Christiaan Huygens


Bedlam (1735)
Longitude

$3,000,000 Longitude Prize (1714)

"*Association*" Disaster (1707)

"…for determining the longitude at sea, there have been several projects, true in theory but difficult to execute…

one is by a watch…but by reason of the motion of the ship…variation of heat and cold…such a watch hath not yet been made…"

Issac Newton (1714)

±25 miles to West Indies required

±2 sec/day at sea!

$3,000,000 Longitude Prize (1714)

"*Association*" Disaster (1707)

Won 45 years later
by
John Harrison
(1759)

Pendulum-Clocks *now uſed.*

2. *The true Mathematical and Mechanichal form of all manner of* Arches *for Building, with the true butment neceſſary to each of them.* A Problem which no *Architectonick* Writer hath ever yet attempted, much leſs performed. abcccc ddeeeeee f gg iiiiiiii llmmmmnnnnnnoooprr sssttttttuuuuuuuuux.

Coded as an Anagram

Solution revealed 29 years later by Hooke's executor

"Ut pendet continuum flexile, sic stabit contiguum rigidum inversum"

"As a flexible cable hangs, thus, inverted, stand touching pieces of a rigid arch.

Pendulum-Clocks *now used.*

2. *The true Mathematical and Mechanichal form of all manner of* Arches *for Building, with the true butment necessary to each of them.* A Problem which no *Architectonick* Writer hath ever yet attempted, much less performed. abccc ddeeeee f gg iiiiiiii llmmmmnnnnnnoooprr sssttttttuuuuuuuuux.

3. *The true Theory of* Elasticity *or* Springiness, *and a particular Explication thereof in several Subjects in which it is to be found: And the way of computing the velocity of Bodies moved by them.* ceiiinosssttuu.

4. *A very plain and practical way of counterpoising Liquors, of great use in* Hydraulicks. Discovered.

5. *A new sort of* Object-Glasses *for* Telescopes *and* Microscopes, *much outdoing any yet used.* Discovered.

6. *A new* Selenoſcope, *eaſie enough to be made and uſed, whereby the ſmalleſt inequality of the Moons ſurface and limb may be moſt plainly diſtinguiſhed.* Diſcovered.

7. *A new ſort of* Horizontal-Sayls *for a* Mill, *performing the moſt that any Horizontal Sayls of that bigneſs are capable of; and the various uſe of that principle on divers other occaſions.* Diſcovered.

8. *A new way of* Poſt-Charriot *for travelling far, without much wearying Horſe or Rider.* Diſcovered.

9. *A new ſort of* Philoſophical-Scales, *of great uſe in Experimental Philoſophy.* c d e i i n n o o p s s s t t u u.

10. *A new Invention in* Mechanicks *of prodigious uſe, exceeding the* chimera's *of perpetual motions for ſeveral uſes.* a a a æ b c c d d e e e e e e e g i i i l m m m n n o o p p q r r r r s t t t u u u u u u. "Pondere praemit aer vacuum quod ab igne relictum est" a a e f f h i i i i l l n r r s s t u u. ?

"By its weight air presses on the vacuum left by fire"

LECTURES
De Potentia Reſtitutiva,
OR OF
SPRING
Explaining the Power of Springing Bodies.

To which are added ſome
COLLECTIONS
Viz.

A Deſcription of Dr. Pappins *Wind-Fountain and Force-Pump.*
Mr. Young's [illegible]*formation concerning natural Fountains.*
Some other Conſi[illegible]ning that Subject.
Captain Sturmy's *remarks of a Subterraneous Cave and Ciſtern.*
Mr. G. T. *Obſervations made on the Pike of* Teneriff, 1674.
Some Reflections and Conjectures occaſioned thereupon.
A Relation of a late Eruption in the Iſle of Palma.

By *ROBERT HOOKE.* S.R.S.

LONDON,
Printed for *John Martyn* Printer to the *Royal Society*,
at the Bell in St. *Pauls* Church-Yard, 1678.

1678

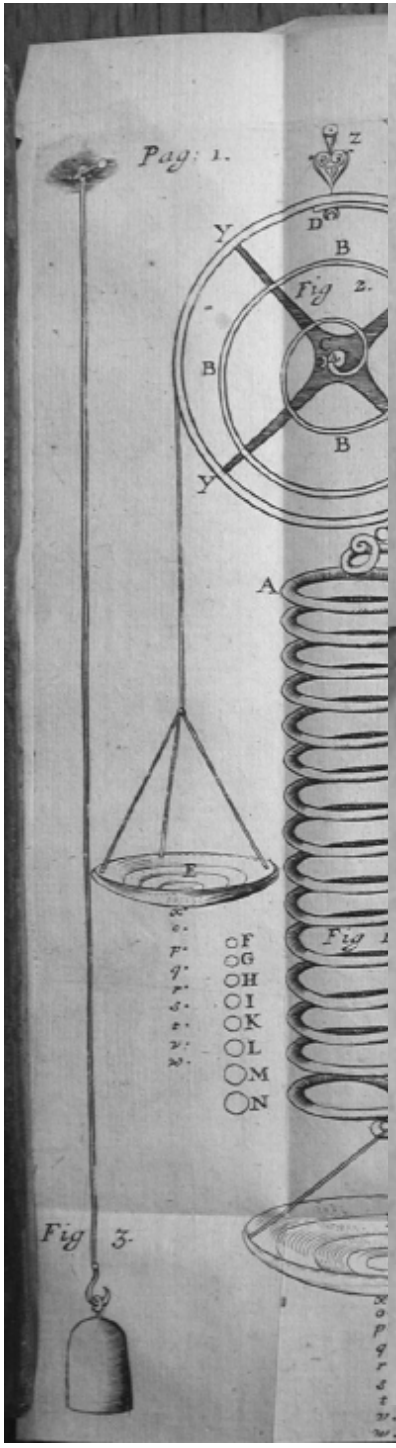
Potentia Reſtitutiva,

OR

SPRING.

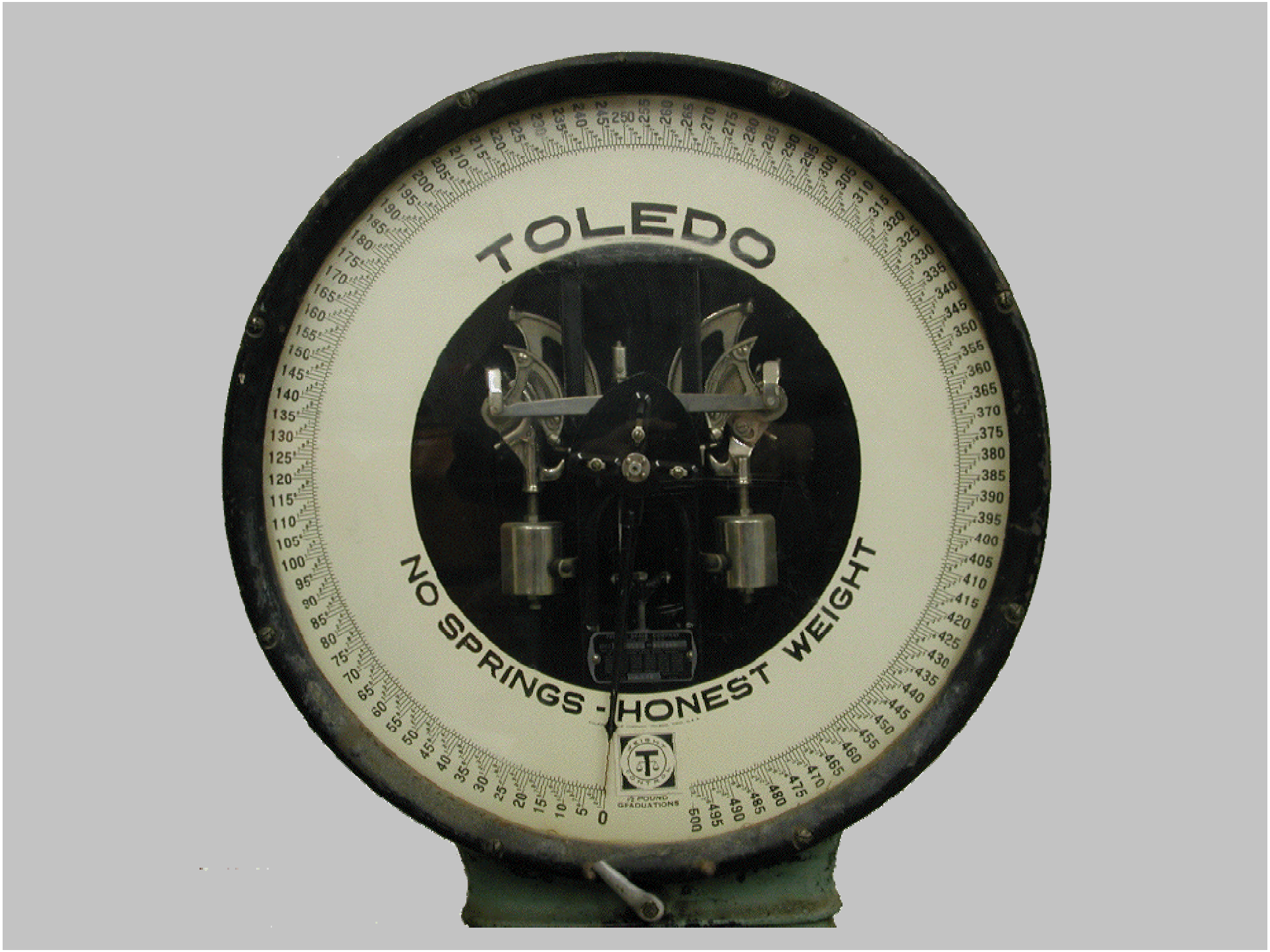
THe Theory of Springs, though attempted by divers eminent Mathematicians of this Age has hitherto not been Publiſhed by any. It it now about eighteen years ſince I firſt found it out, but deſigning to apply it to ſome particular uſe, I omitted the publiſhing thereof.

About three years ſince His Majeſty was pleaſed to ſee the Experiment that made out this Theory tried at *White-Hall*, as alſo my Spring Watch.



From this it will be easie to make a Philosophical Scale to examine the weight of any body without putting in weights, which was that which I mentioned at the end of my description of Helioscopes, the ground of which was veiled under this Anagram, *c e d i i n n o o p s s s t t u u*, namely, *Ut pondus sic tensio*. The fabrick of which see in the three first figures.

This Scale I contrived in order to examine the gravitation of bodies towards the Center of the Earth, *viz.* to examine whether bodies at a further distance from the Center of the Earth did not lose somewhat of their power or tendency towards it. And propounded it as one of the Experiments to be tried at the top of the Pike of *Teneriff*, and attempted the same at the top of the Tower of St. *Pauls* before the burning of it in the late great Fire; as also at the top and bottom of the Abby of St. *Peters* in *Westminster* though these being by but small distances removed from the Surface, I was not able certainly to perceive any manifest difference. I propounded the same also to


TOLEDO
NO SPRINGS - HONEST WEIGHT
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It now remains, that I ſhew how the conſtitutions of ſpringy bodies being ſuch, the Vibrations of a Spring, or a Body moved by a Spring, equally and uniformly ſhall be of equal duration whether they be greater or leſs.

I have here already ſhewed then that the power of all Springs is proportionate to the degree of flexure, *viz.* one degree of flexure, or one ſpace bended hath one power, two hath two, and three hath three, and ſo forward. And every point of the ſpace of flexure hath a peculiar power, and conſequently there being infinite points of the ſpace, there muſt be infinite degrees of power.

$$E \propto d^2$$

in the ninth, and one in the

Now the comparative Velocities of any body moved are in ſubduplicate proportion to the aggregates or ſums of the powers by which it is moved

$$V \propto \sqrt{E}$$

$$(E \propto V^2)$$

Stiffer Spring

First Use of Conservation of Energy !

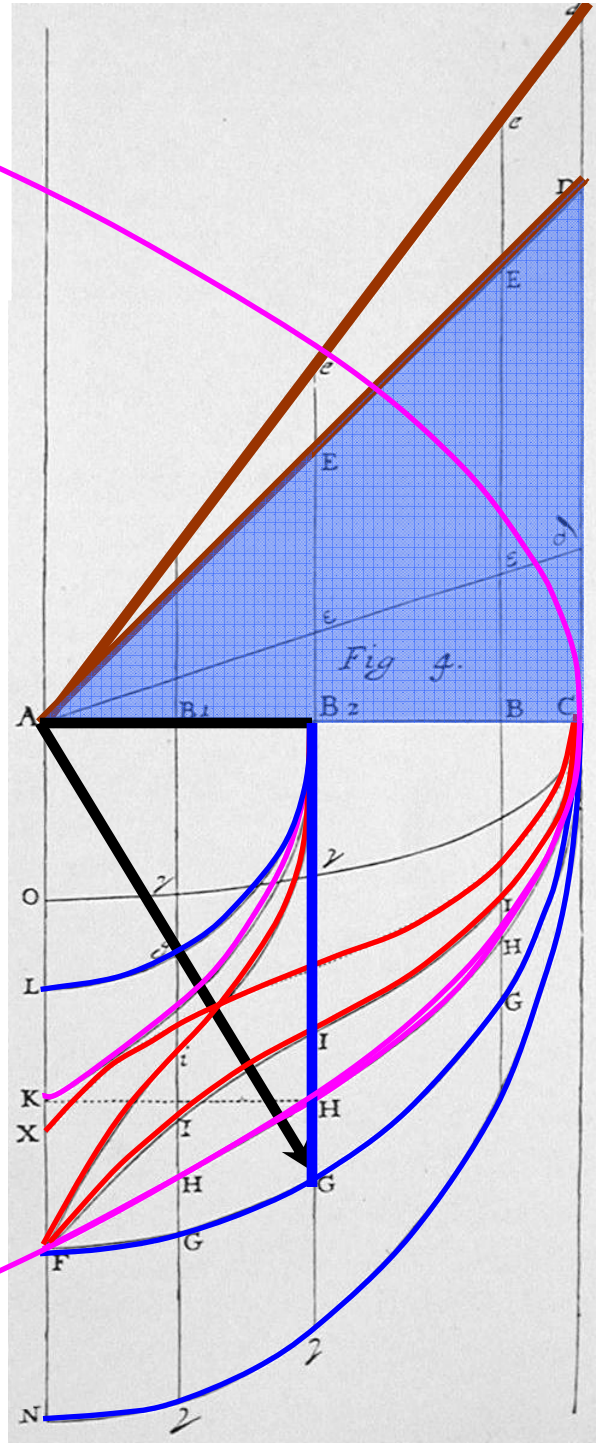
Smaller Amplitude

"Let there be Light"

(motion)

Shorter Time

Same Time



"Power" (Force)

"Aggregate of Powers" (Energy)

Displacement

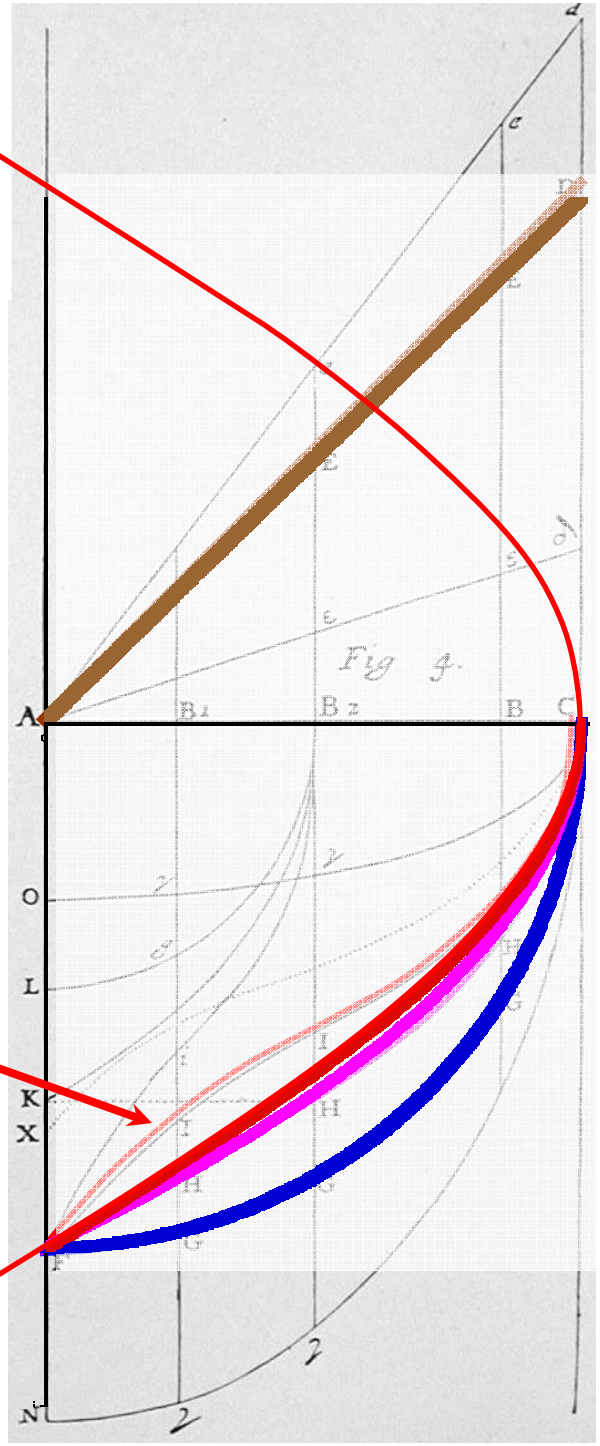
Velocity

√(Return)

Time

$$\frac{t}{\sqrt{R}} = \frac{\sqrt{R}}{v} \qquad v\,t = R$$

Hooke made this correction *using only geometry* in 1685

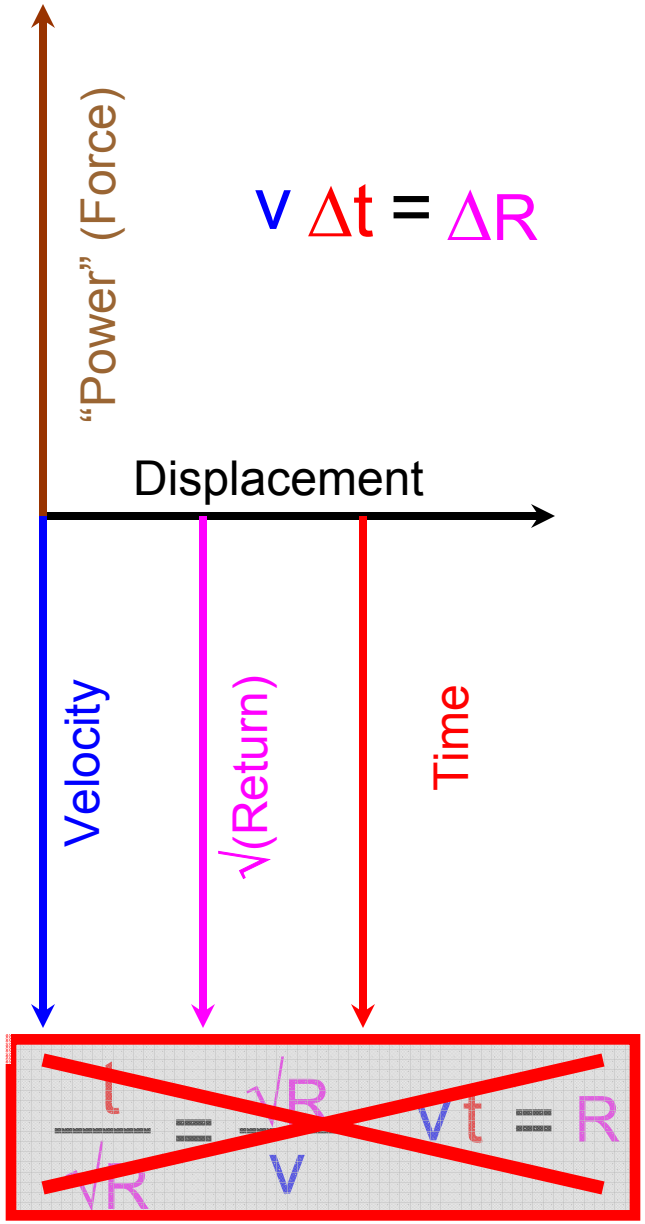


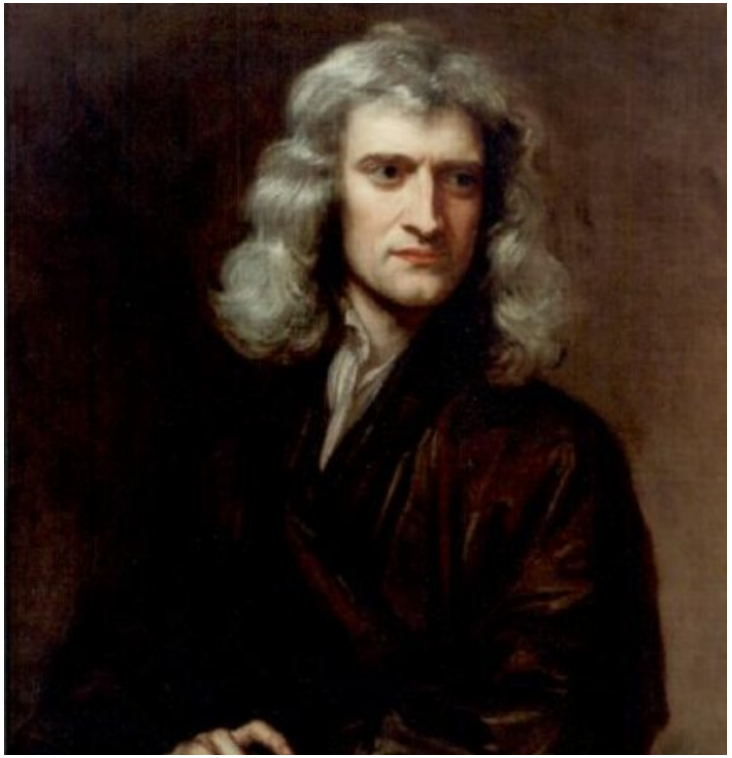
Slowing Down?

Calculus

⇓

R ∝ sin(t)





Hooke to Newton

Nov. 24,1679

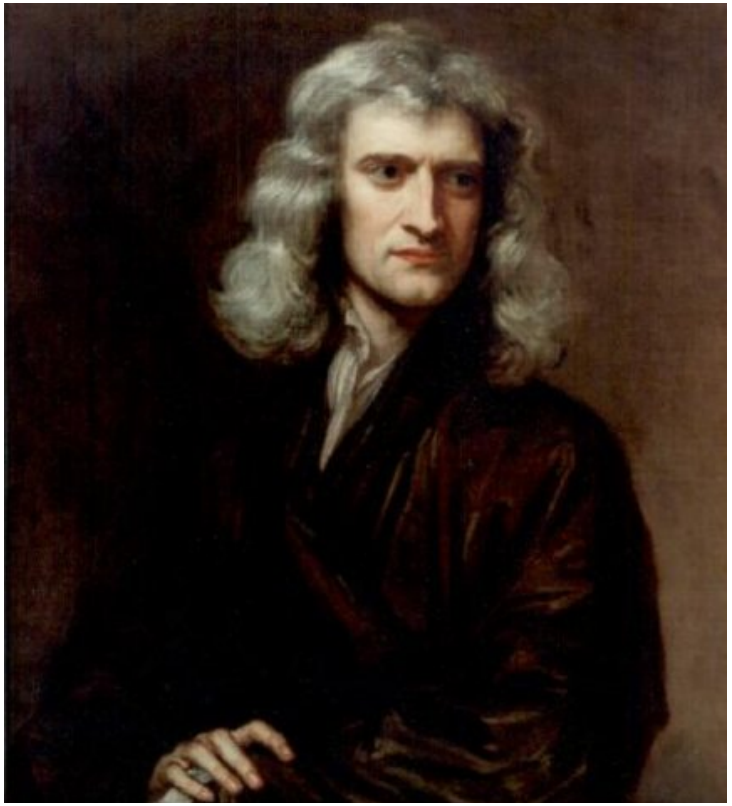
I hope…that you will please to continue your former favours to the Society by communicating

…you may be assured that whatever shall be soe communicated shall be noe otherwise further imparted or disposed of than you yourself shall praescribe.

I am not ignorant that both heretofore, and not long since also, there have been some who have indeavoured to misrepresent me to you…but difference of opinion, if such there be (especially in philosophical matters where interest hath little concerne) methinks should not be the occasion of enmity…

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…that of compounding the celestiall motions of the planetts of a direct motion…and an attractive motion towards the centrall body

I should be glad if by perpendicular observations, we could determine the difference of latitude between London and Cambridge…

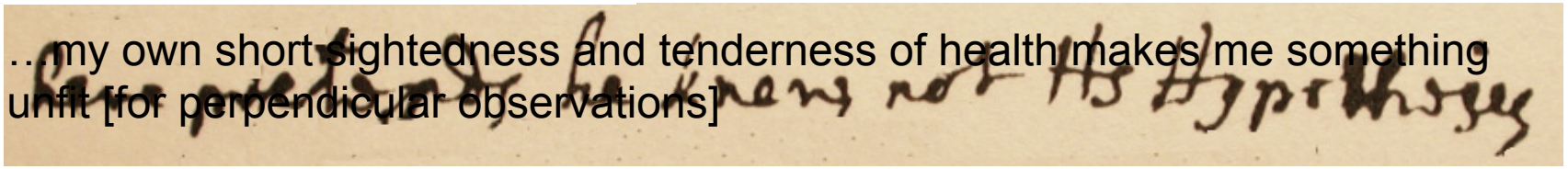


Newton to Hooke

Nov. 28,1679

I cannot but acknowledge my self every way by the kindness of your letter tempted to concur with your desires…heartily sorry I am that…I had for some years last been endeavouring to bend myself from philosophy to other studies …unless it be perhaps at idle hours sometimes for a diversion.

…I did not, before the receipt of your last letter, so much as heare (that I remember) of your hypothesis of compounding the celestial motions of the planets, of a direct motion by the tangent to the curve and of the laws and causes of springyness, though these no doubt are well known to the philosophical world.

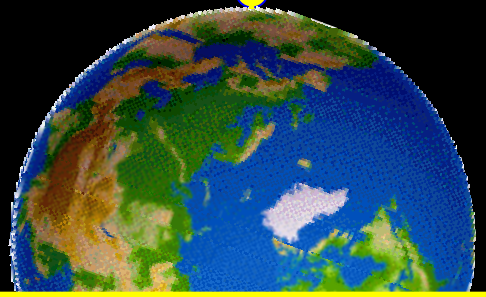


…my own short-sightedness and tenderness of health makes me something unfit [for perpendicular observations]

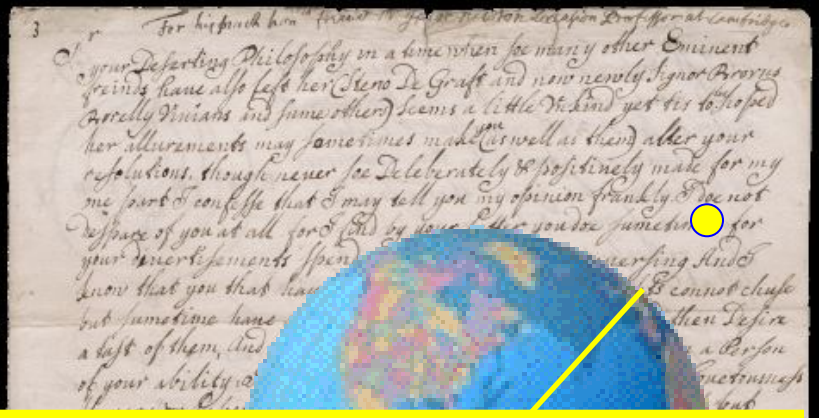
In requital of this advertisement I shall communicate to you a fancy of my own about discovering the earth's diurnal motion.

Newton Falling Body "Fancy" (11/28/79)

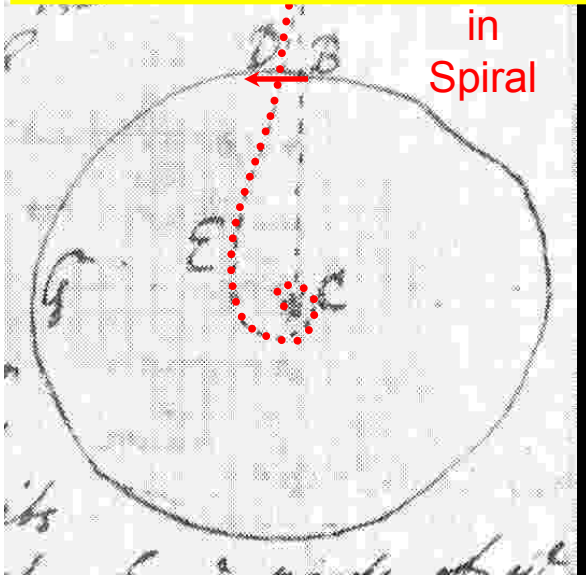
"opinion of the vulgar"
(& Kepler)
fall West

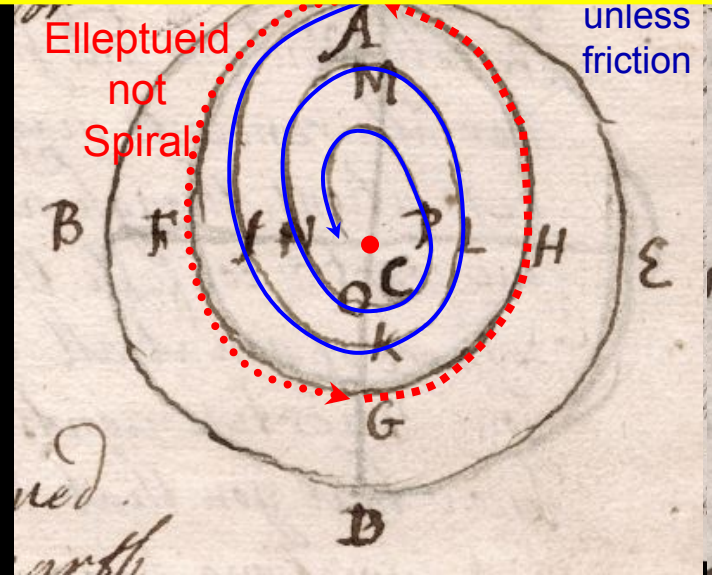


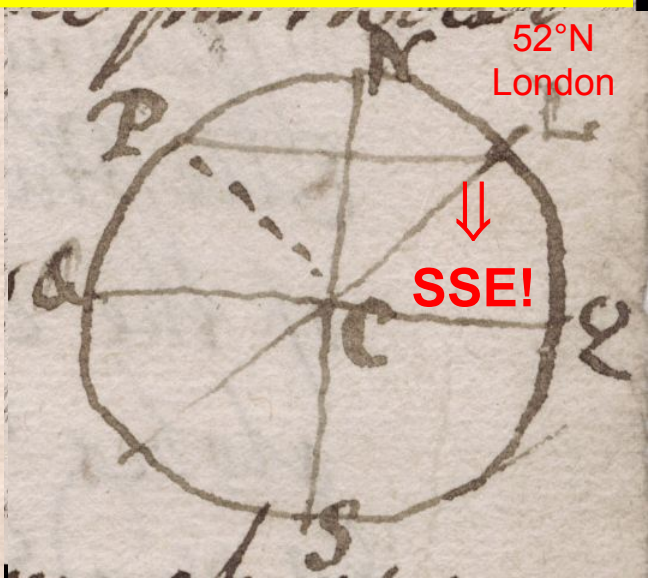
Hooke to Newton
Dec. 9, 1679



I wish I
were as sure of your Correspondence and Communicating as I am
of your Yet remaining affection to Philosophy





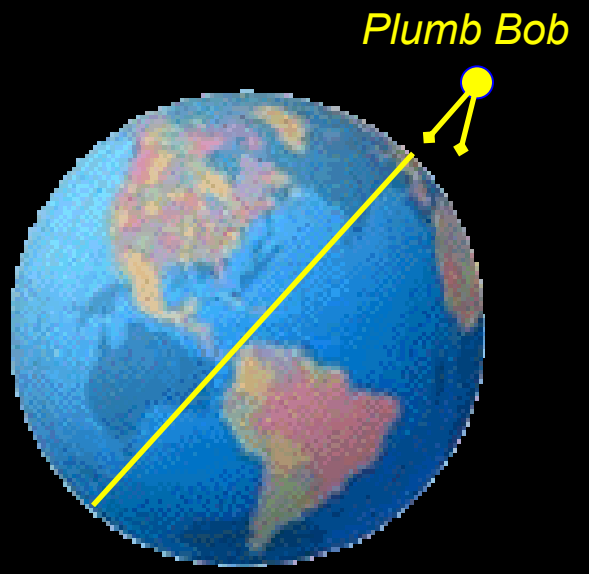


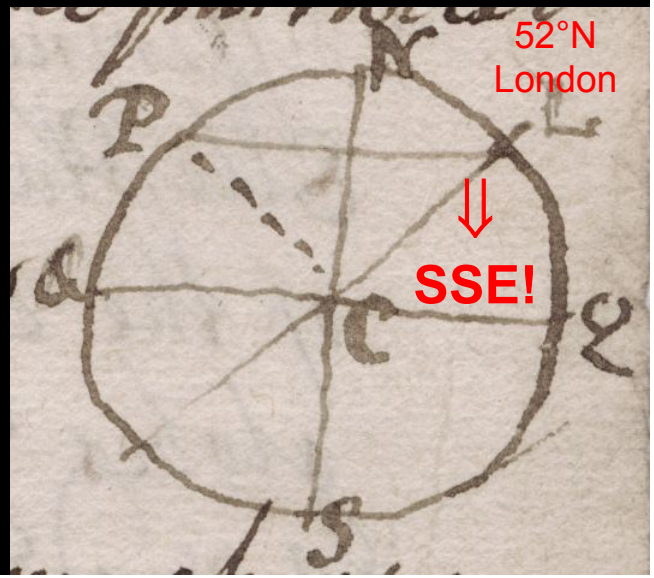
Newton Falling Body "Fancy" (11/28/79)

Experiment

Year	South/East (%)
1680	>100
1791	63
1802	37
1831	15
1902	3

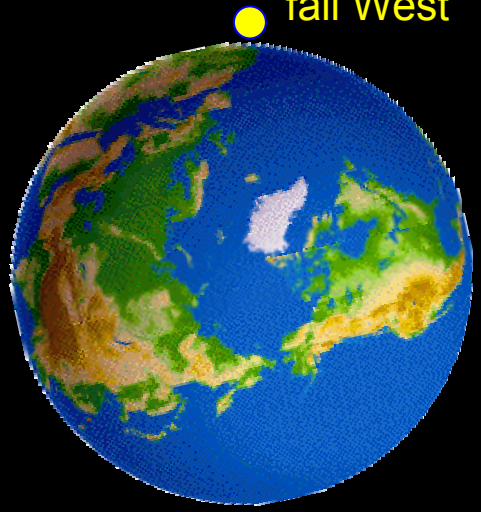
J. Lohne (1960)

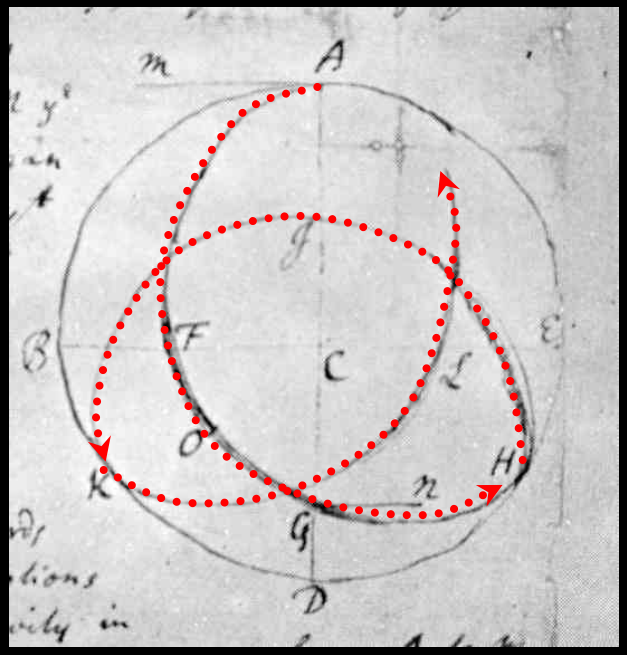




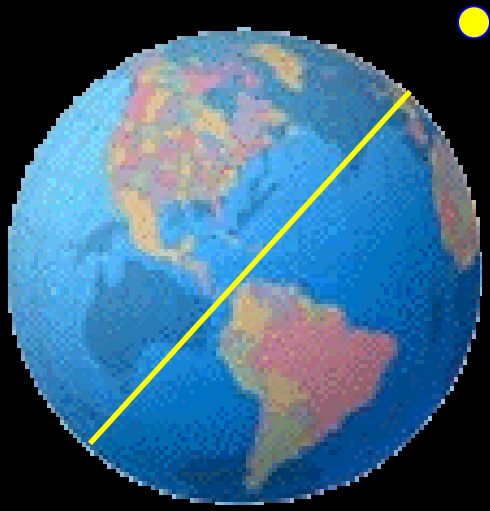
Newton Falling Body "Fancy" (11/28/79)

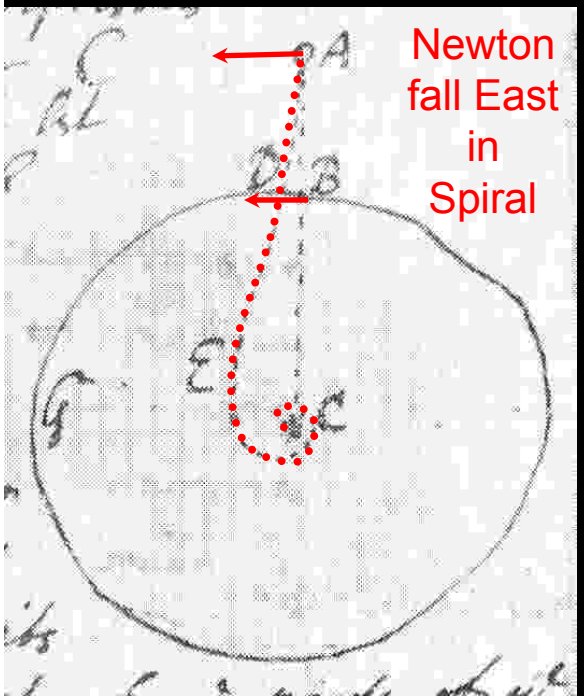
"opinion of the vulgar"
(& Kepler)
fall West



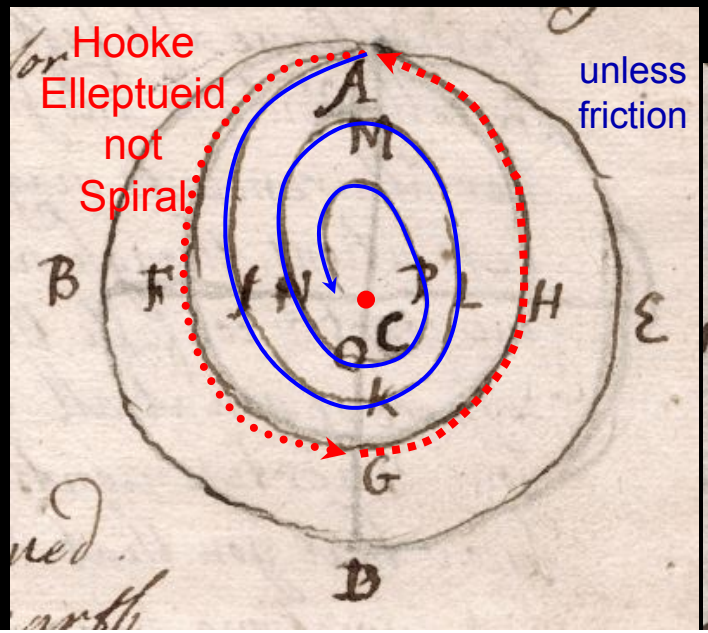


Newton to Hooke
Dec. 13, 1679



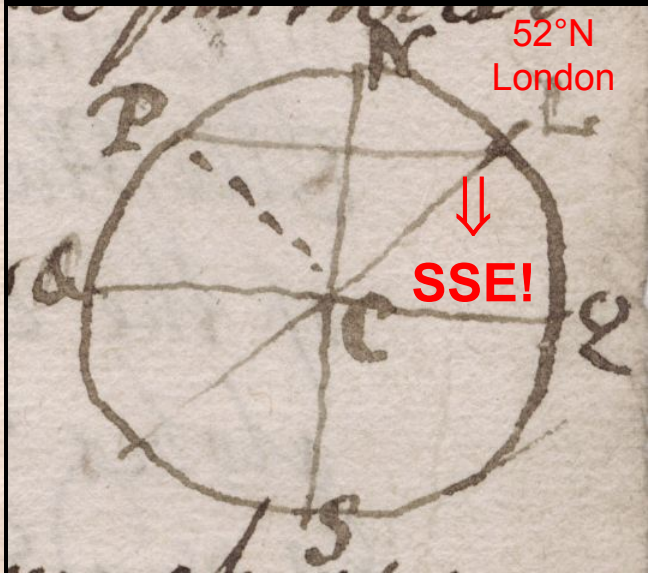


Newton
fall East
in
Spiral



Hooke
Elleptueid
not
Spiral

unless
friction



52°N
London

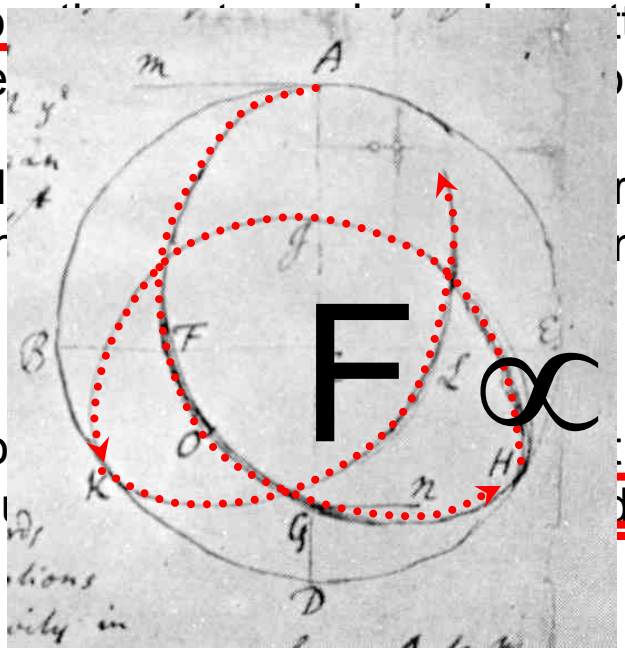
SSE!

Hooke to Newton January 1680

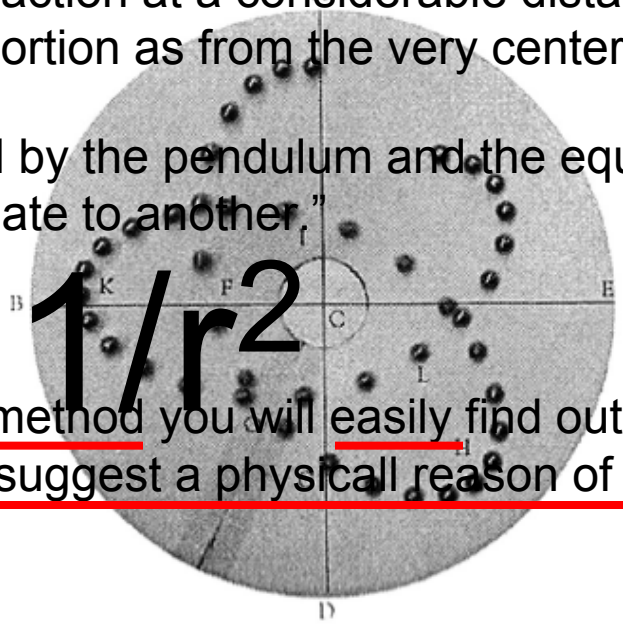
Jan 6: Your calculation of the curve described by a body attracted by an aequall power at all distances from the center

but my supposition is that the attraction always is in duplicate proportion to the distance fro… …traction at a considerable distance may be compute… …portion as from the very center."

"This will … …rd by the pendulum and the equality of pendulur… …mate to another."



$F \propto 1/r^2$



Jan 17: I do … …: method you will easily find out what that curve mu… …d suggest a physicall reason of this proportion.

December 3, 1680

Newton: "I am indebted to you thanks."

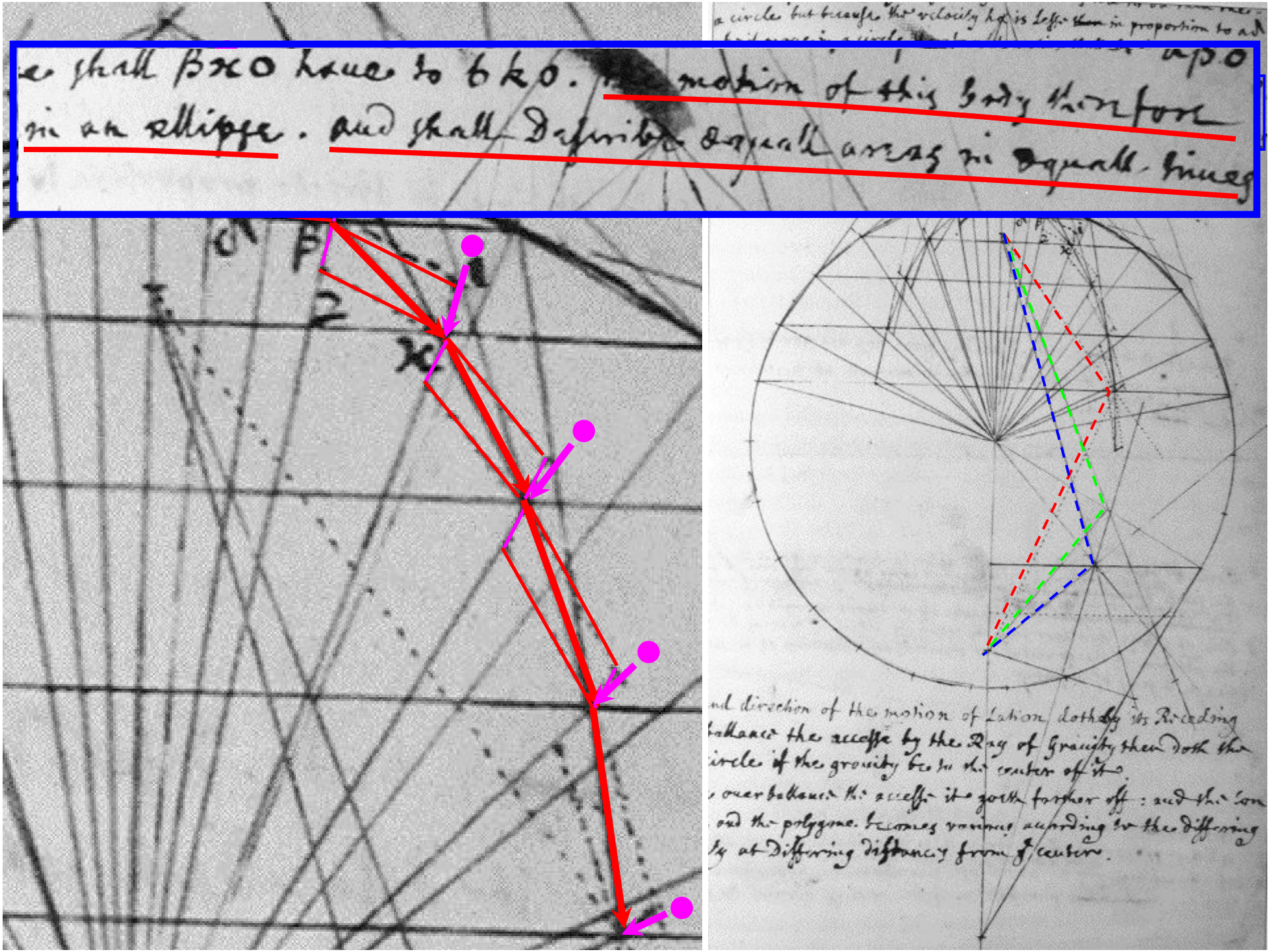
Michael Nauenberg (2015)

Halley to Newton May 22, 1686

Mr. Hook has some pretensions upon the invention of y^e^ rule of the decrease of Gravity, being reciprocally as the squares of the distances from the Center. He sais you had the notion from him, though he owns the Demonstration of the Curves generated thereby to be wholly yours: whereas he should rather have excused himself by reason of his inability. For tis plain by his words he knew not how to go about it.

Now is not this very fine? Mathematicians that find out, settle & do all the business must content themselves with being nothing but dry calculators & drudges & another that does nothing but pretend & grasp at all things must carry away all the invention

Newton dropped some references to Hooke, and downgraded others "*Clarissimus Hookius*"


e shall BXO have to bKO. the motion of this body therefore
in an ellipse. and shall describe equall areas in equall times
a circle but because the velocity hee is lesse then in proportion to ad
apo
nd direction of the motion of Lation doth by its Receding
ballance the accesse by the Ray of Gravity then doth the
circle if the gravity be in the center of it
overballance the accesse it goeth further off : and the Lon
and the polygone becomes varying according to the differing
ty at Differing Distances from ye Centers.

Hooke almost Did It Geometrically!

and with a "*physicall reason*" for $1/r^2$

Hooke Iatrochemistry

1672

Aug.1 (also 2,3,4) "Drank U [iron] and S [mercury]" …"was ill"

Aug. 31 "Slept ill by reason of tart at noon. Gott up a little and rectifyd my stomack with white aniseed N [distillate]."

Sept. 1 "Drank steel. benummd my head…"

Sept. 2 "At Dr. Godderds tastd tinture of wormwood…"

Sept. 3 "took ,ii [2 oz.] of infusion of Crocus metall [Na_3SbS_3 ?], vomited."

Sept. 22 "took syrup of popys, slept little with sweat and wild frightfull dreames."

Oct. 1 "took spirit of urine and laudanum with milk for the three preceeding nights. Slept pretty well."

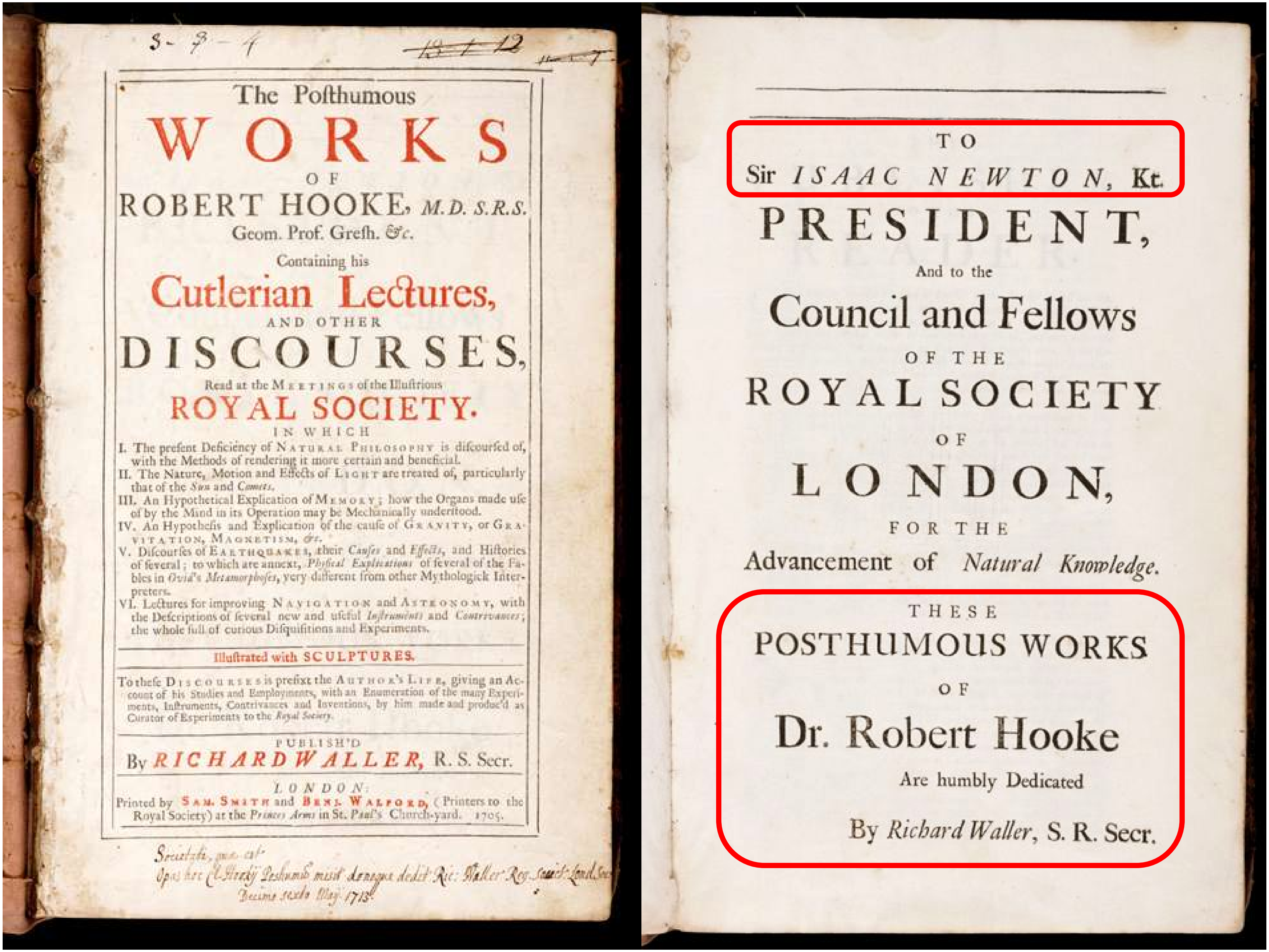
Oct. 25 "took conserves and flowers of Q [sulfur] after which I slept well, but had a bloody dysentry the next day soe that I swooned and was violently griped, but I judge it did me good for my Rhume."

Dec. 27 "made oyle of bitter almonds, put some in right ear…slept ill.

Lived another 31 years!

Died 1703 aged 67
with £10,000 estate
and no will

An illiterate distant cousin
soon went through his estate.



The Posthumous

WORKS

OF

ROBERT HOOKE, *M.D. S.R.S.*

Geom. Prof. Gresh. &c.

Containing his

Cutlerian Lectures,

AND OTHER

DISCOURSES,

Read at the MEETINGS of the Illustrious

ROYAL SOCIETY.

IN WHICH

I. The present Deficiency of NATURAL PHILOSOPHY is discoursed of, with the Methods of rendering it more certain and beneficial.

II. The Nature, Motion and Effects of LIGHT are treated of, particularly that of the *Sun* and *Comets*.

III. An Hypothetical Explication of MEMORY; how the Organs made use of by the Mind in its Operation may be Mechanically understood.

IV. An Hypothesis and Explication of the cause of GRAVITY, or GRAVITATION, MAGNETISM, &c.

V. Discourses of EARTHQUAKES, their *Causes* and *Effects*, and Histories of several; to which are annext, *Physical Explications* of several of the Fables in *Ovid's Metamorphoses*, very different from other Mythologick Interpreters.

VI. Lectures for improving NAVIGATION and ASTRONOMY, with the Descriptions of several new and useful *Instruments* and *Contrivances*; the whole full of curious Disquisitions and Experiments.

Illustrated with SCULPTURES.

To these DISCOURSES is prefixt the AUTHOR'S LIFE, giving an Account of his Studies and Employments, with an Enumeration of the many Experiments, Instruments, Contrivances and Inventions, by him made and produc'd as Curator of Experiments to the *Royal Society*.

PUBLISH'D

By *RICHARD WALLER*, R. S. Secr.

LONDON:

Printed by SAM. SMITH and BENJ. WALFORD, (Printers to the Royal Society) at the *Princes Arms* in St. *Paul's* Church-yard. 1705.

TO

Sir *ISAAC NEWTON*, Kt.

PRESIDENT,

And to the

Council and Fellows

OF THE

ROYAL SOCIETY

OF

LONDON,

FOR THE

Advancement of *Natural Knowledge*.

THESE

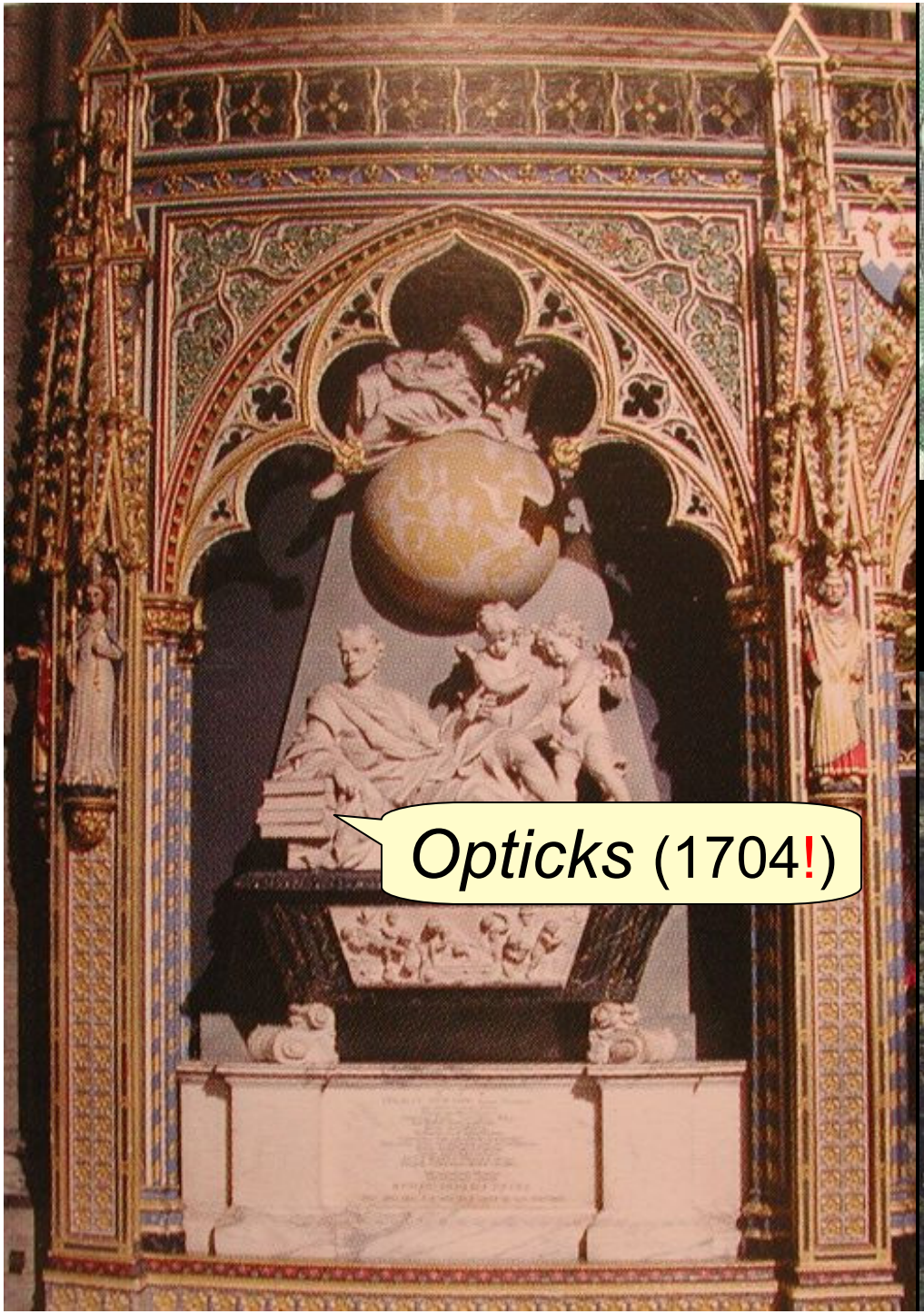
POSTHUMOUS WORKS

OF

Dr. Robert Hooke

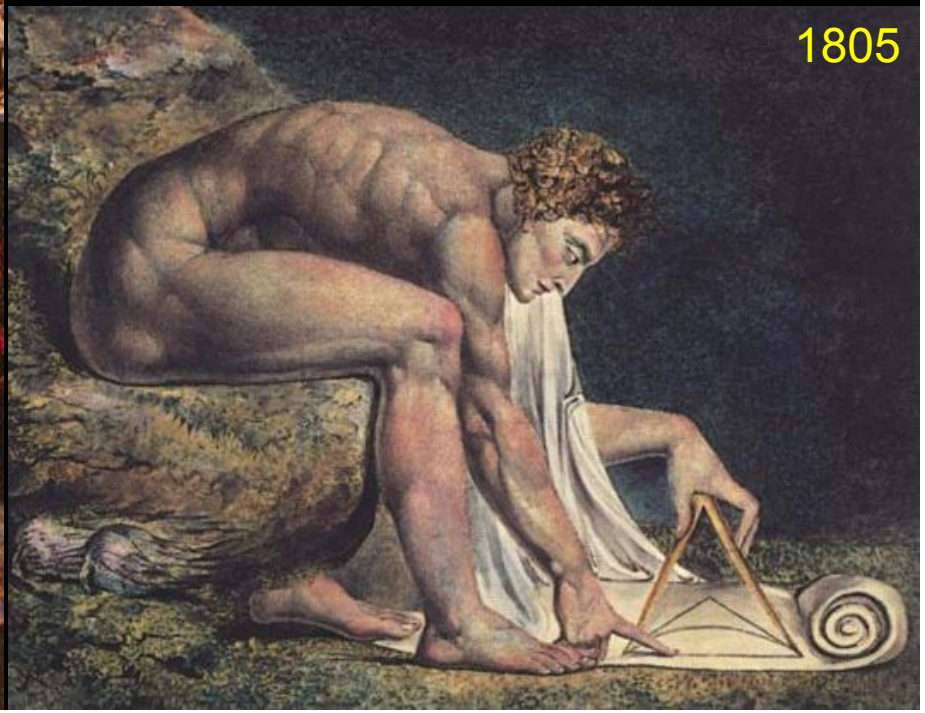
Are humbly Dedicated

By *Richard Waller*, S. R. Secr.



Newton d. 1727

(President, Royal Society 1703-27)



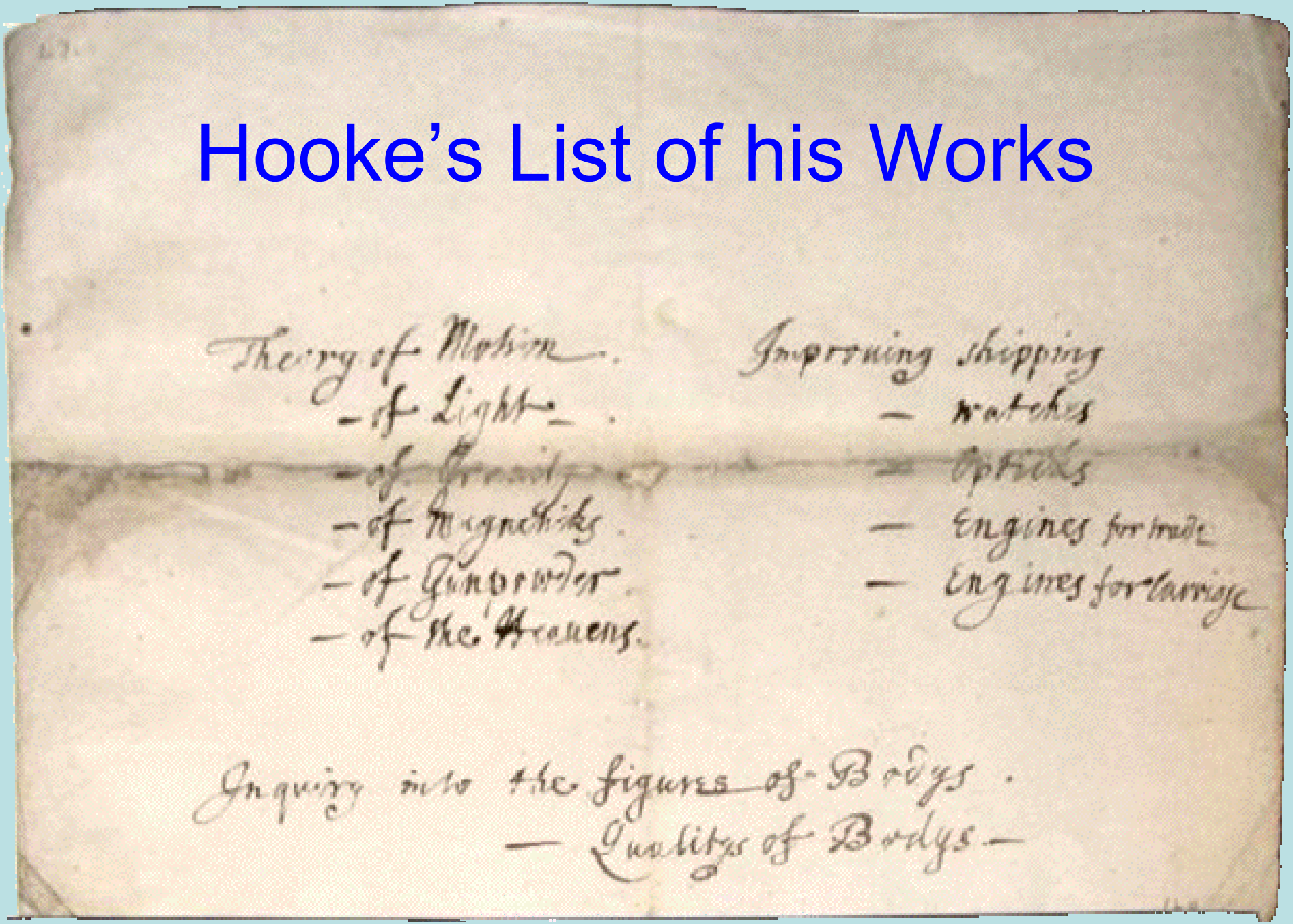
Hooke's Mass Grave?

(1892)

Photo
M. Cooper

NatWest
Tower 42
⇑
Gresham
College

Hooke's List of his Works


Theory of Motion.
— of Light.
— of Gravity.
— of Magnetiks.
— of Gunpowder.
— of the Heavens.

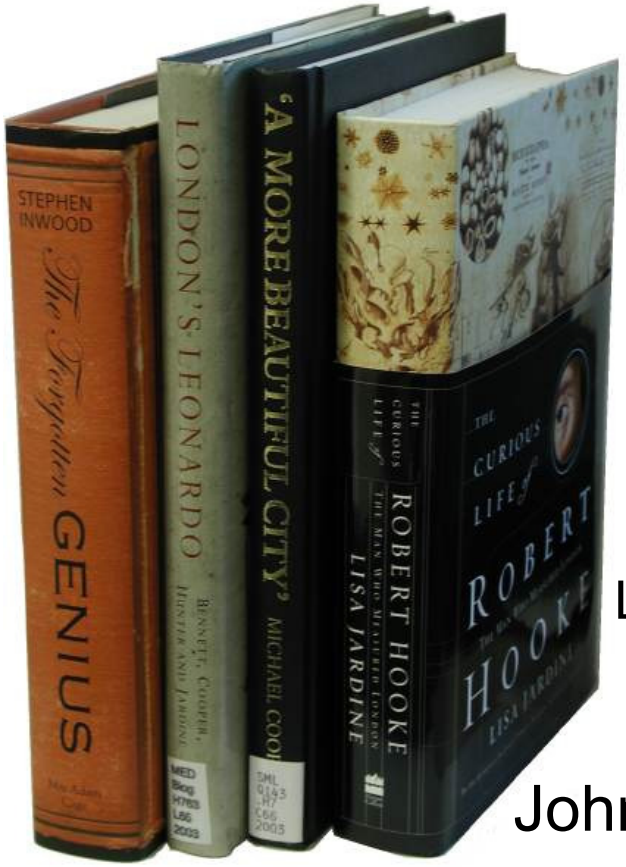
Improving Shipping
— Watches
— Opticks
— Engines for trade
— Engines for carriage

Enquiry into the figures of Bodys.
— Qualitys of Bodys.

Westminster Abbey

March 3, 2005

roberthooke.org.uk



Thanks

Stephen Inwood, *The Forgotten Genius* (2002)

Bennett, Cooper, Hunter, Jardine,
London's Leonardo (2003)

Michael Cooper, *A More Beautiful City* (2003)

Lisa Jardine, *The Curious Life of Robert Hooke* (2004)

John Heilbron, Ted Davis

Michael Cooper, Patri Pugliese

Michael Nauenberg

Beinecke Library

Yale Medical Historical Library

John F. Fulton
(1899-1960)

Preface to *Micrographia* (1665)

The good ſucceſs of all theſe great Men, *and many* others, *and the now ſeemingly great* obviouſneſs *of moſt of their and divers other Inventions, which from the beginning of the world have been, as 'twere, trod on, and yet not minded till theſe laſt* inquiſitive *Ages* (*an Argument that there may be yet behind multitudes of the like*) *puts me in mind to recommend ſuch Studies, and the proſecution of them by ſuch methods, to the* Gentlemen *of our Nation, whoſe* leiſure *makes them fit to* undertake, *and the* plenty *of their fortunes to* accompliſh, *extraordinary things in this way. And I do not only propoſe this kind of* Experimental Philoſophy *as a matter of high* rapture *and* delight *of the mind, but even as a* material *and* ſenſible Pleaſure. *So vaſt is the* variety of Objects *which will come under their Inſpections, ſo many* different wayes *there are of* handling *them, ſo great is the* ſatisfaction *of* finding *out* new things, *that I dare compare the* contentment *which they will injoy, not only to that of* contemplation, *but even to that which moſt men prefer of* the very Senſes themſelves.