The universally familiar tale of Newton and the falling apple was told undramatically by Conduitt, who had it from his wife;

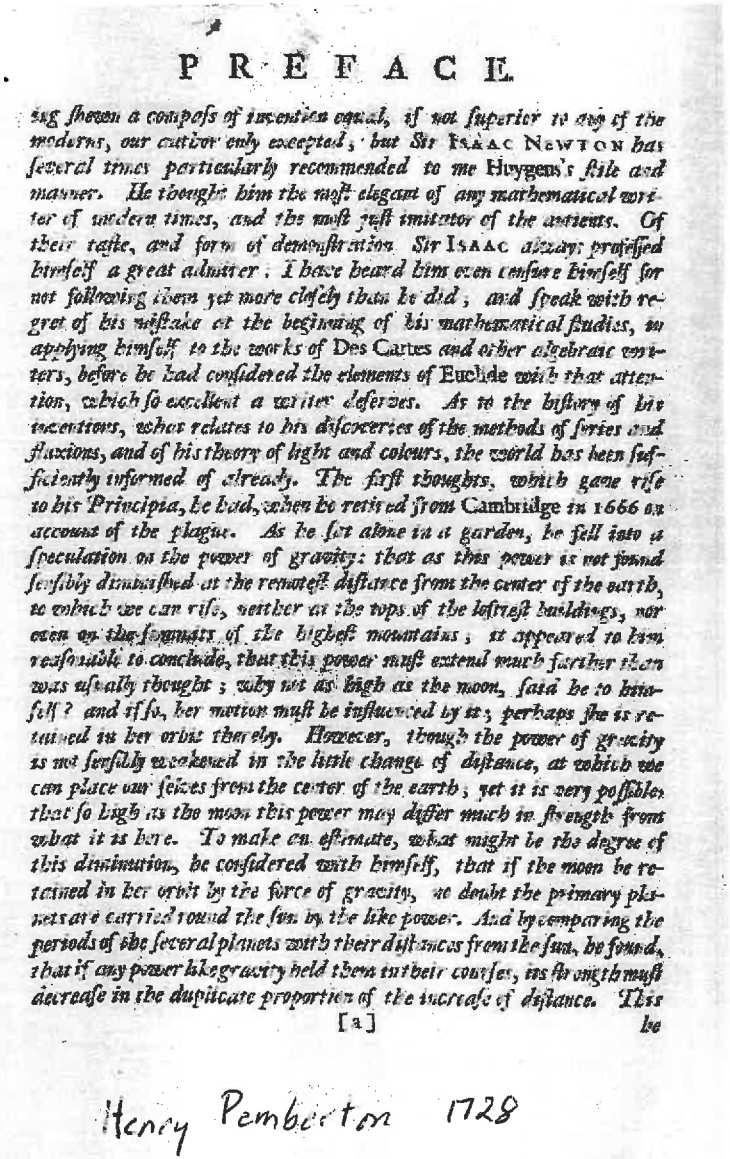
. . . in the year 1665 when he retired to his own [*sc.* his mother's] estate, on account of the plague [in Cambridge], he first thought of his system of gravity, which he hit upon by observing the fall of an apple from a tree.[11]

Some have thought that gravity *hit upon* Newton!

While he was in voluntary exile in England (1726–29) Voltaire had the entrée to a group of men who gathered round the Princess of Wales, Caroline of Anspach, later Queen of England. He met Newton's friend Samuel Clarke, Newton's half-niece Catherine Conduitt and her husband, and Newton's physician William Cheselden. (From the last Voltaire obtained the assurance he gave to readers of his *Letters on the English Nation* (no. XIV) that Newton was certainly a virgin; biographers did not repeat this.) From Mrs Conduitt Voltaire heard the story of Newton and the apple which he told at some length in Letter XV:

being retired in 1666 [*sic*], on account of the plague, to a solitude near Cambridge; as he was walking one day in his garden, and saw some fruits fall from a tree, he fell into a profound meditation on that gravity, the cause of which had so long been sought, but in vain, by all the philosophers . . .. Why may not this power which causes heavy bodies to descend, and is the same without any sensible diminution at the remotest distance from the center of the earth, or on the summits of the highest mountains; why, said Sir Isaac, may not this power extend as high as the moon?[12]

The story accessible in Conduitt's memoir was passed over by Fontenelle, but the next biographer, Thomas Birch, took it from Henry Pemberton (see below).



PREFACE.

ing shewn a compass of invention equal, if not superior to any of the moderns, our author only excepted; but Sir ISAAC NEWTON *has several times particularly recommended to me* Huygens's *stile and manner. He thought him the most elegant of any mathematical writer of modern times, and the most just imitator of the ancients. Of their taste, and form of demonstration Sir* ISAAC *always professed himself a great admirer. I have heard him even censure himself for not following them yet more closely than he did; and speak with regret of his mistake at the beginning of his mathematical studies, in applying himself to the works of* Des Cartes *and other algebraic writers, before he had considered the elements of* Euclide *with that attention, which so excellent a writer deserves. As to the history of his inventions, what relates to his discoveries of the methods of series and fluxions, and of his theory of light and colours, the world has been sufficiently informed of already. The first thoughts, which gave rise to his Principia, he had, when he retired from* Cambridge *in* 1666 *on account of the plague. As he sat alone in a garden, he fell into a speculation on the power of gravity: that as this power is not found sensibly diminished at the remotest distance from the center of the earth, to which we can rise, neither at the tops of the loftiest buildings, nor even on the summits of the highest mountains; it appeared to him reasonable to conclude, that this power must extend much further than was usually thought; why not as high as the moon, said he to himself? and if so, her motion must be influenced by it; perhaps she is retained in her orbit thereby. However, though the power of gravity is not sensibly weakened in the little change of distance, at which we can place our selves from the center of the earth; yet it is very possible, that so high as the moon this power may differ much in strength from what it is here. To make an estimate, what might be the degree of this diminution, he considered with himself, that if the moon be retained in her orbit by the force of gravity, we doubt the primary planets are carried round the sun by the like power. And by comparing the periods of the several planets with their distances from the sun, he found, that if any power like gravity held them in their courses, its strength must decrease in the duplicate proportion of the increase of distance. This*

[a] *be*

Henry Pemberton 1728

REFERENCES to a test of the law of gravitation during the Plague Years occur in the following accounts of Whiston,[1] Pemberton,[2] and Newton[3] himself:

Whiston: What the Occasion of Sir Isaac Newton's leaving the Cartesian Philosophy, and of discovering his amazing Theory of Gravity was, I have heard him long ago, soon after my first Acquaintance with him, which was 1694, thus relate, and of which Dr Pemberton gives the like Account, and somewhat more fully, in the Preface to his Explication of his Philosophy: It was this. An Inclination came into Sir Isaac's Mind to try, whether the same Power did not keep the Moon in her Orbit, notwithstanding her projectile Velocity, which he knew always tended to go along a strait Line the Tangent of that Orbit, which makes Stones and all heavy Bodies with us fall downward, and which we call *Gravity*? Taking this Postulatum, which had been thought of before, that such Power might decrease, in a duplicate Proportion of the Distances from the Earth's Center.[4] Upon Sir Isaac's First Trial, when he took a Degree of a great Circle on the Earth's Surface, whence a Degree at the Distance of the Moon was to be determined also, to be 60 measured Miles only, according to the gross Measures then in Use. He was, in some Degree, disappointed, and the Power that restrained the Moon in her Orbit, measured by the versed Sines of that Orbit,[5] appeared not to be quite the same that was to be expected, had it been the Power of Gravity alone, by which the Moon was there influenc'd. Upon this Disappointment, which made Sir Isaac suspect that this Power was partly that of Gravity, and partly that of Cartesius's Vortices,[6] he threw aside the Paper of his Calculation and went to other Studies.

Pemberton: The first thoughts, which gave rise to his Principia, he had, when he retired from Cambridge in 1666 on account of the plague. As he sat alone in a garden,[7] he fell into a speculation on the power of gravity: that as this power is not found sensibly diminished at the remotest distance from the center of the earth, to which we can rise, neither at the tops of the loftiest buildings, nor even on the summits of the highest mountains; it appeared to him reasonable to conclude, that this power must extend much farther than was usually thought; why not as high as the moon, said he to himself? and if so, her motion must be influenced by it; perhaps she is retained in her orbit thereby. However, though the power of gravity is not sensibly weakened in the little change of distance, at which we can place ourselves from the center of the earth, yet it is very possible that, so high as the moon this power may differ much in strength from what it is here. To make an estimate, what might be the degree of this diminution, he considered with himself, that if the moon be retained in her orbit by the force of gravity, no doubt the primary planets are carried round the sun by the like power. And by comparing the periods of the several planets with their distances from the sun,[1] he found, that if any power like gravity held them in their courses, its strength must decrease in the duplicate proportion of the increase of distance. This he concluded by supposing them to move in perfect circles concentrical to the sun, from which the orbits of the greatest part of them do not much differ. Supposing therefore the power of gravity, when extended to the moon, to decrease in the same manner, he computed whether that force would be sufficient to keep the moon in her orbit. In this computation, being absent from books, he took the common estimate in use among geographers and our seamen, before Norwood had measured the earth, that 60 English miles were contained in one degree of latitude on the surface of the earth. But as this is a very faulty supposition, each degree containing about 69½ of our miles,[2] his computation did not answer expectation; whence he concluded, that some other cause[3] must at least join with the action of the power of gravity on the moon. On this account he laid aside for that time any farther thoughts upon this matter.

Newton: I found the method [of fluxions] by degrees in the years 1665 and 1666. In the beginning of the year 1665 I found the method of approximating Series and the Rule for reducing any dignity of any Binomial into such a series. The same year in May I found the method of tangents of Gregory and Slusius, and in November had the direct method of fluxions, and the next year in January had the Theory of colours, and in May following I had entrance into the inverse method of fluxions. And the same year[1] I began to think of gravity extending to the orb of the Moon, and having found out how to estimate the force with which [a] globe revolving within a sphere presses the surface of the sphere, from Kepler's Rule of the periodical times of the Planets being in a sesquialterate proportion of their distances from the centers of their Orbs I deduced that the forces which keep the Planets in their Orbs must [be] reciprocally as the squares of their distances from the centers about which they revolve: and thereby compared the force requisite to keep the Moon in her Orb with the force of gravity at the surface of the earth, and found them answer pretty nearly. All this was in the two plague years of 1665 and 1666, for in those days I was in the prime of my age for invention, and minded Mathematicks and Philosophy more than at any time since.

From Streete's *Astronomia Carolina*, 1661, p. 11

"But further to cleer the truth from all seeming contradictions; Whereas we see that all Corporeal Substances appertaining to this our Earthly Globe do (proportionably to their quantities) tend downward towards the Earths center; let us observe that this comes to pass by the Natural Magnetick power of the Earth, attracting its parts, a property common to every one of the Planets, whereby (according to the Creators will) they became compact bodies and do retain their constant Form; The Sun also and Fixt Starres (though of a different Principle) having the like retentive Faculty.

"And that the Aire, the Clowds, a bird flying, a stone falling from any height, an arrow or bullet shot or driven in any way, and all things else within the Sphere of the Earths activity (whether otherwise moved or not) do Naturally and exactly follow her Annual and Diurnal Motion, so that we the Earths Inhabitants cannot possibly perceive or be made sensible thereof, any other way then by such real demonstrations as are here given; We shall exemplify this in the Planets *Jupiter* and *Saturn*, whose attendants (at a farre larger distance) do not only keep their constant revolutions about them, but together with them about the Sun; the like doth our Moon about the Earth, and both about the Sun. So that by the impulse and universal consent of Nature (whether accidentall motion be annexed or not) all things so neere the Earth do precisely keep the same motion with it."

My View of the Original "Moon Test"

A collection of bodies moving uniformly in concentric circular orbits about a central body – e.g. the six planets about the Sun – have periods and radii satisfying Kepler's 3/2 power rule if and only if their respective *conati a centro* vary in an inverse-square ratio with respect to their distance from the Sun.

Suppose we could show that any body orbiting the Earth is retained in orbit by inverse-square terrestrial gravity e.g. by showing that the *conatus a centro* of the Moon at a distance of 60 Earth-radii is 1/3600 of the strength of surface gravity.

Then the Tychonic system could be rejected on the grounds that the Moon and Sun together, assumed to be in orbit around the Earth, would markedly violate the 3/2 power rule.

In other words, the point of the original "Moon test" was to fashion a defense of the Copernican system, just as was the point of the paragraph preceding it in the manuscript.

{*Open question*: What would Newton have done next if the original "Moon test" had succeeded – i.e. if it had not been done in by an inaccurate value for the radius of the Earth taken from Galileo's *Two World Systems*?}