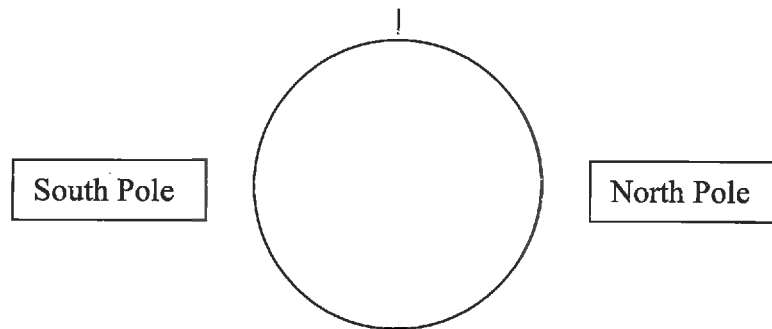


## Newton's Proposed Proof of the Rotation of the Earth



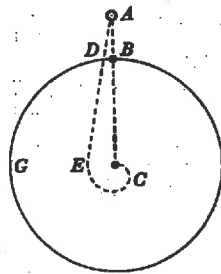
If the Earth rotates, then the translational velocity at the top of the tower is greater than the translational velocity at the bottom by an amount  $\Delta r$  times the angular speed of the Earth.

But then, an object dropped from the top of the tower, instead of landing to the west at the bottom (as the defenders of the motionless Earth would have it) or at the base of the tower (as Galileo and Gassendi would have it), must land to the east of the tower, by an amount equal to  $\omega\Delta r$  times the time of descent.

Indeed, if the falling object is heavy enough to minimize the effects of air resistance, the displacement to the east can yield a value for the rotational speed of the Earth that must agree with its known value ( $15^\circ$  per hour).

(The phenomenon became known in the 19<sup>th</sup> century as an instance of Coriolis forces.)

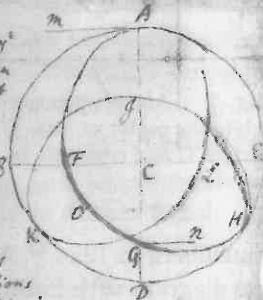
London. I am glad to heare that so considerable a discovery as you made of ye earth's annual parallax is seconded by Mr Flamstead's Observations. In requital of this advertisement I shall communicate to you a fancy of my own about discovering the earth's diurnal motion. In order thereto I will consider ye Earth's diurnal motion alone without ye annual, that having little influence on ye experimt I shall here propound. Suppose then  $BDG$  represents the Globe of ye Earth carried round once a day about its center  $C$  from west to east according to ye order of ye letters  $BDG$ ; & let  $A$  be a heavy body suspended in the Air & moving round with the earth so as perpetually to hang over ye same point thereof  $B$ . Then imagin this body  $B$  let fall & it's gravity will give it a new motion towards ye center of ye Earth without diminishing ye old one from west to east. Whence the motion of this body from west to east, by reason that before it fell it was more distant from ye center of ye earth then the parts of ye earth at wch it arrives in its fall, will be greater then the motion from west to east of ye parts of ye earth at wch ye body arrives in it's fall: & therefore it will not descend in ye perpendicular  $AC$ , but outrunning ye parts of ye earth will shoot forward to ye east side of the perpendicular describing<sup>(6)</sup> in it's fall a spiral line  $ADEC$ , quite contrary to ye opinion of ye vulgar who think that if ye earth moved, heavy bodies in falling would be outrun by its parts & fall on the west side of ye perpendicular. The advance of ye body from ye perpendicular east-



ward will in a descent of but 20 or 30 yards be very small & yet I am apt to think it may be enough to determin the matter of fact. Suppose then in a very calm day a Pistol Bullet were let down by a silk line from the top of a high Building or Well, the line going through a small hole made in a plate of Brass or Tinn fastened to ye top of ye Building or Well & yt ye bullet when let down almost to ye bottom were settled in water so as to cease from swinging & then let down further on an edge of steel lying north & south to try if ye bullet in settling thereon will almost stand *in equilibrio* but yet with some small propensity (the smaller ye better) decline to ye west side of ye steel as often as it is so let down thereon. The steel being so placed underneath, suppose the bullet be then drawn up to ye top & let fall by cutting clipping or burning the line of silk, & if it fall constantly on ye east side of ye steel it will argue ye diurnall motion of ye earth. But what ye event will be I know not having never attempted to try it. If any body may think this worth their triall the best way in my opinion would be to try it in a high church or wide steeple the windows being first well stopt. For in a narrow well ye bullet possibly may be apt to receive a ply<sup>(6)</sup> from ye straitned Air neare ye sides of ye Well, if in its fall it come nearer to one side then to another. It would be convenient also that ye water into wch ye bullet falls be a yard or two deep or more partly that ye bullet may fall more gently on ye steel, partly that ye motion wch it has from west to east at its entring into ye water by meanes of ye longer time of descent through ye water, carry it on further eastward & so make ye experiment more manifest.

I agree all you of y<sup>e</sup> body in a circle will fall more to y<sup>e</sup> south then east if y<sup>e</sup> weight it falls from be any thing great, & it is said that if its gravity be supposed uniform it will not descend in a spiral to y<sup>e</sup> very center but circulate all an alternate ascent & descent made by its centrifuge & gravity alternately overbalancing one another. Yet I imagine y<sup>e</sup> body will not describe an Ellipsoid but rather such a figure as is represented by AFGHJK &c. Suppose A y<sup>e</sup> body, C y<sup>e</sup> center of y<sup>e</sup> circle

ABDE quadrant with perpendicular diameters  
 ABDE, the cut of said curve is F & G; All y<sup>e</sup> tang<sup>t</sup> in west of body inward before it begins to fall to GN a line drawn parallel to y<sup>e</sup> tang<sup>t</sup>. When y<sup>e</sup> body descending through y<sup>e</sup> world (supposed perisus) arrives at G, the determination of its motion shall not be towards H but towards y<sup>e</sup> east between H & D. for y<sup>e</sup> motion of y<sup>e</sup> body at G is compounded of y<sup>e</sup> motion it had at A towards M & of all y<sup>e</sup> innumerable converging motions successively generated by y<sup>e</sup> impulses of gravity in every moment of its passage from A to G: The motion from A to M being in a parallel to GN inclines not y<sup>e</sup> body to verge from y<sup>e</sup> line GN. The innumerable & infinitely little motions (for I here consider motion according to y<sup>e</sup> method of indivisibles) continually generated by gravity in its passage from A to F inclines it to verge from GN towards D, & y<sup>e</sup> like motions generated in its passage from F to G incline it to verge from GN towards B C. But these motions are proportional to y<sup>e</sup> length they are generated in, & the time of passing from A to F (By reason of y<sup>e</sup> longer journey & slower going) is greater then y<sup>e</sup> time of passing from F to G. And therefore y<sup>e</sup> motions generated in AF shall exceed those generated in FG & so make y<sup>e</sup> body verge from GN too some east between H & D.



The nearer approach therefore of y<sup>e</sup> body to y<sup>e</sup> center is not at G but somewhere between G & F as at O. CD is said to be according to y<sup>e</sup> various proportions of gravity to y<sup>e</sup> impulse of y<sup>e</sup> body at A towards M, may fall any where in y<sup>e</sup> angle BCD in a certain curve will touch y<sup>e</sup> line BC at C & pass on to D. Thus I conceive it would be y<sup>e</sup> gravity curve of some actual distances from y<sup>e</sup> center. But if it be supposed greater nearer y<sup>e</sup> center y<sup>e</sup> point O may fall in y<sup>e</sup> line CD or in y<sup>e</sup> angle BCD or in other angles y<sup>e</sup> follow, or even nowhere. For the increase of gravity in descent may be supposed such y<sup>e</sup> body shall by an infinite

## Hooke's Challenge to Newton

... particularly if you would let me know your thoughts of that [hypothesis of mine] of compounding the celestial motions of the planets of a direct motion by the tangent and an attractive motion towards the central body.

24 November 1679

But as to the curve Line which you seem to suppose it to Descend by (though that was not then at all Discoursed of) Vizt a kind of spirall which after some few revolutions Leave it in the Center of the Earth my theory of circular motion makes me suppose it would be very differing and nothing at all akin to a spiral but rather a kind Elletueid....

9 December 1679

Your Calculation of the Curve by a body attracted by an aequall power at all Distances from the center Such as that of a ball Rouling in an inverted Concave Cone is right and the two auges will not unite by about a third of a Revolution. But my supposition is that the Attraction always is in a duplicate proportion to the Distance from the Center Reciprocall, and Consequently that the Velocity will be in a subduplicate proportion to the Attraction and Consequently as Kepler Supposes Reciprocall to the Distance. And that with Such an attraction the auges will unite in the same part of the Circle and that the nearest point of accesse to the center will be opposite to the furthest Distance. ... What I mentioned in my last concerning the Descent within ye body of the Earth was But upon the Supposal of such an attraction, not that I believe there really is an attraction to the very Center of the Earth, but on the Contrary I rather Conceive that the more the body approaches the Center, the lesse will it be Urged by the attraction.... But in the Celestiall Motions the Sun Earth or Centrall body are the cause of the Attraction, and though they cannot be supposed mathematicall points yet they may be Conceived as physicall and the attraction at a Considerable Distance may be computed according to the former proportion as from the very Center. This Curve truly Calculated will shew the error of those many lame shifts made use of by astronomers to approach the true motions of the planets with their tables.

6 January 1680

It now remaines to know the propriety of a curve line (not circular not concentricall) made by a centrall attractive power which makes the velocity of Descent from the tangent Line or equall straight motion at all Distances in a Duplicate proportion to the Distances Reciprocally taken. I doubt not but that by your excellent method you will easily find out what that Curve must be, and its propriety, and suggest a physicall Reason of this proportion.

17 January 1680