4. Stronger implication: undermine the evidential value of discrepancies between observation and theory, for may be mere transient perturbations!
    a. Version 1: all such discrepancies informative, for provide a basis for identifying and characterizing further forces at work
    b. Version 3: only select discrepancies informative, and burden of argument on anyone drawing inferences from a small discrepancy, for perhaps just do not have mean orbit correct yet
5. Version 3 thus represents a retreat in evidential prospects, and hence standards, to ones more akin to those of Galileo and Huygens
    a. Just as resistance effects may be beyond science, orbital perturbations may be beyond science
    b. Therefore there are limits on empirical evidence -- there will always be room to explain away small discrepancies
    c. Newton in effect being pushed into a position more akin to that of rational mechanics, though what is pushing him into it is a sequence of (theory-mediated) inferences from phenomena
6. The key thing to notice is that all these points in the "Copernican Scholium" are coming from Laws 3 and 4 (and two conclusions of Version 1: multiple centers, and a^3/P^2 as a measure of the underlying attractive strength of each center)
    a. Not from universal gravity, for reasoning neutral with respect to mechanism of centripetal force
    b. Nor from an especially tenuous chain of reasoning; the weakest link in the chain would appear to be Laws 3 and 4 themselves, which is why I say that they are doing the main work

D. Resistance and Planetary Motion
1. The other addition to Version 3, here called the "Resistance Scholium", outwardly appears to be nothing more than a way of smoothing the transition from Problem 5 to Problem 6
    a. First paragraph says that up to this point he has been considering motion in non-resisting media as a basis for drawing conclusions about the motion of celestial bodies in the aether
    b. Aether either non-resisting or insensibly resisting
    c. Notice the Cartesian tie between density and quantity of solid matter: Newton has not yet got his concept of mass!
2. Bottom line of argument of first paragraph: results so far are applicable to planets and comets, for no grounds whatever to conclude that aether offering any resistance
    a. Conclusion stated at beginning of second paragraph: "Motions in the heavens are ruled therefore by the laws demonstrated"
    b. Note: propositions here being termed "laws" in original, not after a revision by Newton
3. Argument: no observed "dissipative" effects, which would have to be present were the medium offering any resistance at all
    a. Argument appealing to claim that resistance proportional to density presupposes that density of aether small -- perhaps justified by negligible effects in measuring densities of bodies

b. Comet argument amounts to saying no need to invoke resistance at all; notice, however, the increasing burden being put on success with comet trajectories
c. Persistance of basic orbital motion argument also saying no sign of resistance effects

4. Notice that Newton can no longer argue from the absence of minor discrepancies in Keplerian motion to the conclusion that no resistance forces are at work, for now having to concede that discrepancies that have not been strictly accounted for are present
   a. I.e. cannot reason from preceding 9 propositions, and hence must offer independent reasoning
   b. Perhaps part of the reason for the addition: a further consequence of the Copernican Scholium
5. Reasoning in the first paragraph is largely neutral with respect to a vortex theory of planetary motion versus other mechanisms
   a. Resistance from relative motion, and hence no resistance if planets carried along by vortices
   b. But comments about comets do present a challenge to Descartes' account since comets, especially retrograde comets, not being carried along by vortices

E. Projectile Motion on the Earth

1. Second paragraph of the added "Resistance Scholium" claims that Problems 4 and 5 cover motion "in our air" in the absence of resistance effects
   a. I.e. a correction to Galileo's laws of free fall and projectile motion in the absence of resistance
   b. "Given of course that gravity is inversely proportional to the square of the distance from the centre of the earth"
2. First argument that gravity is an inverse-square centripetal force invokes the "Moon test"
   a. Ratio of moon acceleration to *g* very nearly inverse-square -- a calculation that anyone could do
   b. (For details of the revised "Moon test" using Picard's or Cassini's determinations of the radius of the earth, see the Appendix or Notes for Class 13)
   c. Note Newton's phrasing: he does not expressly conclude that gravity holds the moon in orbit
   d. But it is unclear how the argument is supposed to yield the conclusion without the added claim that the centripetal force on the moon and the centripetal force of gravity are one and the same
3. Second argument invokes Halley's observations at St. Helena (15 deg S latitude)
   a. Newton could be taking Halley's measurements from Hooke's letter, or perhaps from conversations with Halley -- e.g. in the second, November meeting
   b. The argument involves a mistaken explanation of the measurements, a mistake carried over from Hooke's letter and Halley's subsequent report in the 1686/7 *Philosophical Transactions*
      (1) Newton could readily have confirmed that this was a mistake
      (2) For a 2570 ft mountain would have only a 0.12 line effect on the length of a seconds pendulum and a 0.013 percent effect on the period of a pendulum clock (resulting in only a 10.6 sec discrepancy per 24 hours)
   c. (Richer's measurements not known to Newton at the time because Richer's 1679 report issued

only in French and Cassini's report on the expedition to Cayenne was not published until 1684; Richer's measurements were nevertheless known to those at the Academy and Halley)

4. The basic point of the final paragraph concerns the need to refer projectile motion to a proper frame, and not a frame rotating with the earth (as in Galileo)
    a. (Note the concern with frames of reference here in the light of my proposal that this was the provocation for all of Version 3)
    b. The essence of Newton's "experiment" is the difference between a truly inertial frame and a rotating frame in free fall
    c. The insight underlying Coriolis forces generally, and why they are not real forces
5. Newton finally claims that the experiment works to prove diurnal motion, in effect completing the proof of the Copernican system
    a. No mention made of the vagaries in Hooke's measurements
    b. But Problems 4 through 7 and the following Scholium are just what is needed to address these vagaries, for they allow one to calculate a magnitude of the displacement
    c. That magnitude would have raised worries about Hooke's experimental results

IV. In the Aftermath of De Motu, Version 3

A. The Initial Exchange with Flamsteed

1. Sometime in mid or late December Newton initiates a correspondence with Flamsteed, pursuing reliable astronomical information; it ends abruptly with Flamsteed's letter of January 27
    a. First letter missing, and so exact date and contents unknown
    b. Flamsteed already aware that a document on orbital motion by Newton has been registered at the Royal Society, from the grapevine if not from Newton's letter
2. Based on Flamsteed's December 27 reply, Newton's primary concerns in his initial letter appear to have been with (1) the comet of 1680-81 and (2) whether the satellites of Jupiter (and Saturn) conform with the 3/2 power rule
    a. Strongly affirmative answer to latter from Flamsteed, in no small part because of Roemer's speed of light correction; notice too that Cassini's earlier predicted eclipses wrong by almost an hour (not a speed of light effect, but from vagaries in the motion of Jupiter)
    b. But Flamsteed unable to confirm Cassini's satellites of Saturn
    c. In effect, Flamsteed telling Newton that there is no reason to think that the 3/2 power rule does not hold to full precision for the satellites
    d. Notice also Flamsteed's remark about the complexity of our moon's motion versus the well-behaved motions of Jupiter's satellites!
3. Newton's December 30 reply: "your information about the Satellites of Jupiter gives me very much satisfaction;" shifts then to questions about anomalies in Saturn and Jupiter orbits when they are in conjunction with one another