How do Newton's laws of gravitation apply to orbital mechanics?

Michael Brenner
Studied Mechanical Engineering & Comparative Linguistics at Vienna University of Technology · Oct 8

At closer inspection they don't, and when they are applied, they are applied incorrectly by none other than Newton himself. The reason for that is that Newton did not investigate free fall and thus did not honour the empirically derived ***law of independency*** of free fall motion, which means that free fall is independent of all other motions a body might have: an object always falls, while it's doing whatever it might be doing otherwise.

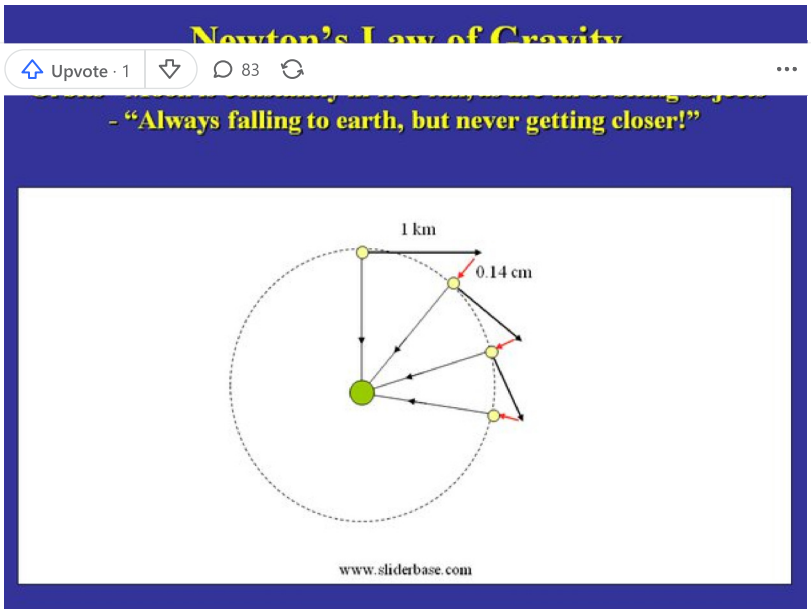
Then, Newton was mostly a philosopher and as such did not find anything wrong with hypothetical thinking, but when it comes to physical reality, you have to stick to what is rational and real, not hypothetical and fictitious.

The next pitfall was that Newton abolished logic and replaced it with math, where identities are reversible, whereas in logic they are not: when you define: *"a cat is a furry animal"* then that does not mean automatically that *"furry animals are cats."* In mathematics, it does, and in a world of only cats as furry animals that may also be true, but you can't just claim that, it does not follow from your first definition, you'd have to go out and check if there are other furry animals first. Newton did not go out and check if free fall acceleration is indeed due to a force, he just reverse concluded it from his first definition of contact force: when he defined ***F=ma*** then he concluded all ***[a]*** must be ***[F/m]*** - and that is not necessarily the case as we will see.

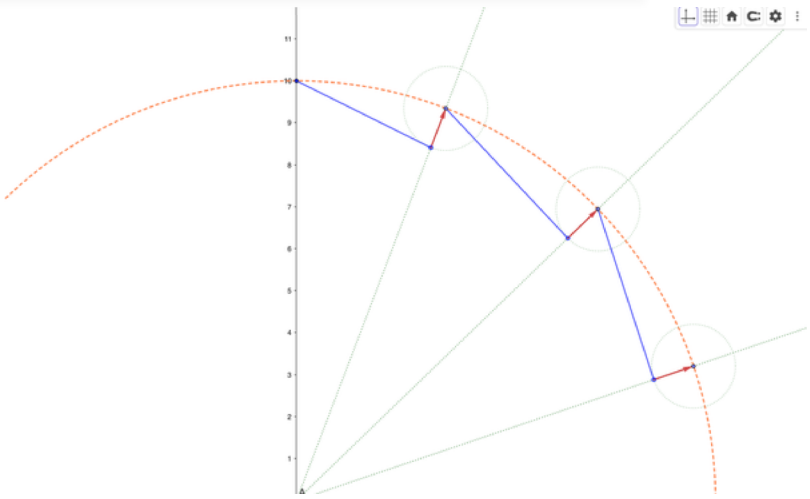
These three errors combine to create the stubborn myth that orbital mechanics is based on empirically derived laws and thus representing physical reality: here is why they don't:

Newton's leap of faith was to claim that the moon falls the same way an apple falls on earth, but that poses a conundrum: the falling apple reduces distance to gravitational centre proportional to square of time elapsed, whereas the moon remains at constant height. Yet, in a gravitational environment experience tells us that nothing can remain at constant height without experiencing a lift. Let's see how Newton tried to solve this conundrum, while falling into one of the three mind traps mentioned above:

1: hypothetical thinking: here he theorises that the moon ***without*** gravity would travel along a rectilinear path 1km, and then ***with*** gravity it would fall 0.14cm from which point it would again without gravity move tangentially 1km and with gravity fall 0.14cm again producing the saw tooth pattern shown here:



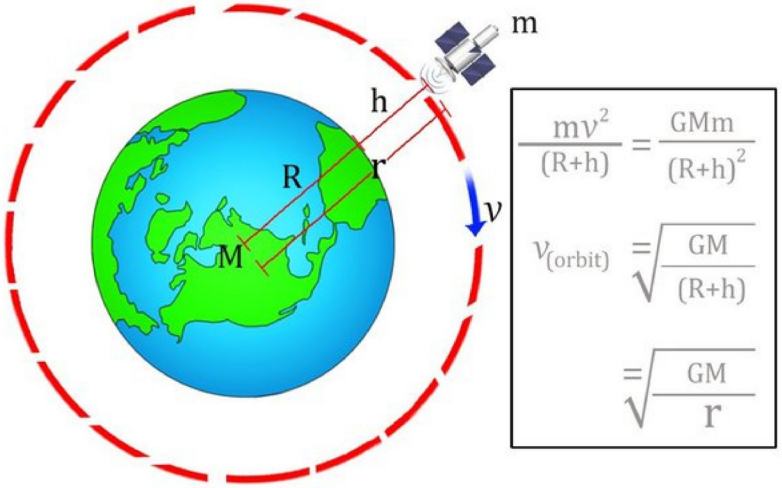
Thus he claims, gravity alone manages to make the moon fall around earth, just like only gravity makes the apple fall to the ground. BUT, that is not reality, as in reality an object falls from the first nanosecond and that changes the situation dramatically: the moon would immediately start to fall 0.14cm while travelling 1km and then something must lift it



If you want to equalise a fall you need a lift, that is elementary, and NASA in due order incorporates that lift in their equation for orbital velocity: ***mv^2/(R+h)*** which "balances out" gravity ***GMm/(R+h)^2*** as per their own words.

> Notice that an orbiting spacecraft has not escaped Earth's gravity, which is very much present --it is giving the mass the centripetal acceleration it needs to stay in orbit. It just happens to be balanced out by the speed that the rocket provided when it placed the spacecraft in orbit. Yes, gravity *is* a little weaker on orbit, simply because you're farther from Earth's center, but it's mostly there. So terms like "weightless" and "micro gravity" have to be taken with a grain of salt... gravity is still dominant, but some of its familiar effects are not apparent on orbit.
>
> For additional information:
>
> NASA:

With this necessity for *"balancing out"* they then arrive at the formula for orbital velocity:



And here most of the hundreds of comments to my other answers about this topic claimed the "identity" of ***mv^2/(R+h)*** and ***GMm/(R+h)^2***, in an attempt to get away from the awkward "lift" problem..... which only emphasises another pitfall of reasoning: the lack of understanding the difference between IDENTITY and EQUALITY.

Here's what IDENTITY looks like mathematically:

a = a → a-a = a-a → 0 = 0

and here's what EQUALITY looks like mathematically

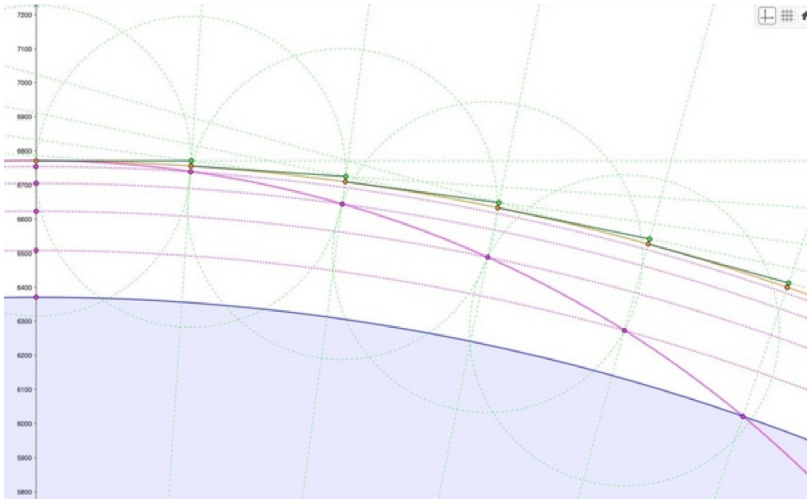
a = b → a-a = b-a → 0=b-a

The velocity dependent ***mv^2/(R+h)*** is NOT IDENTICAL with the positional ***GMm/(R+h)^2***, it is EQUAL, and that only in the specific case that [v] takes on the value

Sooo? Newton was not correct in claiming the moon falls like apples fall on earth, because apples fall independently from whatever motion we impart on them by throwing them, they will hit ground in $t=\sqrt{2h/g}$ seconds. Whereas for an orbiting body it is claimed that $t=\sqrt{2h/(g-v^2/R)}$, which means the faster I throw, the less effective gravity becomes as per $g-v^2/R$ until [v] reaches the value $v=\sqrt{GM/R}$ when effective gravity is zero and the object does not fall any longer, i.e. it remains on constant distance to ground.

If we would want to get an apple into orbit, that is, an object that falls the way it is actually observed on earth, we would have to give it infinite velocity, because only then the range becomes infinite - which is what constitutes an orbit: an object that never reaches ground is an object with infinite range: $s=vt=v\sqrt{2h/g}=\infty$ only for $v=\infty$.

Thus the path of the ISS with a speed of 7.6km/s starting at 400km altitude would look like this (crashing after around 5 minutes as per magenta curve - as opposed to the green sawtooth curve)



And that brings us to the core of Newton's problem with gravity: the *"furry animal problem"* or *"is gravity indeed a force?"* He felt the full weight of the problem without being able to solve it, wherefore he first, hated it: *"That **gravity** should be innate, inherent and essential to matter, so that one body may act upon another at-a-distance, through a vacuum, without the mediation of anything else by and through which their action may be conveyed from one to another, **is to me so great an absurdity** that I believe no man, who has in philosophical matters a competent faculty of thinking, can ever fall into it."*

... and then fled into false humility and theology: "*So far I have explained the phenomena by the force of gravity, but I have not yet ascertained the cause of gravity itself. ... and I do not arbitrarily invent hypotheses.*"

We know this humility to be false, because up to his time Newton was the least humble person in the entire universe, and because he was mostly theologian his solution was a theological one: gravity as the *"immensity of the Lord God Pantocrator in space"* which makes bodies move ***as if*** they attracted each other.

With this *"as if"* Newton was on to something though, and would he have allowed himself to follow up this hunch with sceintific thinking instead of theological thinking, he would indeed have made the greatest stride in science history: free fall like uniform rectilinear motion is indistinguishable from being at rest and therefore, like uniform motion, free fall cannot be associated with the application of a force - but because Newton laws are force-laws they cannot be applied to gravity.

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Ewan Brown · Oct 8

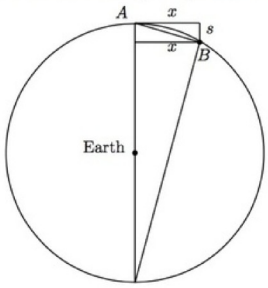
"hypothetical thinking: here he theorises that the moon without gravity would travel along a rectilinear path 1km, and then with gravity it would fall 0.14cm from which point it would again without gravity move tangentially 1km and with gravity f (more)

Quora

Michael Brenner · Oct 8

It's not my analysis, it's Newton's, the numbers are not important, the principle is, and it doesn't work: here from a physics text book

FIGURE 1. The moon starts at A. In one second it moves to B, falling a distance s while moving horizontally a distance x. The diameter of the orbit is D so the vertical side of the big triangle is $D - s$.



One-twentieth of an inch. That's how far the moon falls per second.

Now how far would we expect the Moon to fall if it is acted upon by the same force that makes apples fall? The moon is 60 times as far from the center of the Earth as the apple; let us suppose the Earth attracts the apple as if all the mass was concentrated at the center. Then we would expect the force on the Moon to be smaller by a factor of 60^2, which is 3600. We know that the apple falls $\frac{1}{2}gt^2 = g/2$ feet on Earth; since $g = 32$ that is 16 feet, or 192 inches. if g goes down by a factor of 3600, the Moon should fall 0.053 inches in one second. One-twentieth of an inch. As Newton said, the two calculations "answer pretty nearly."

Reply

Ewan Brown The numbers are important. And your only saying otherwise because you don'...

Tim Good · Oct 8

How many times can you answer the same question incorrectly without taking into consideration all the feedback being given to you that you are completely flawed? A scientist doesn't write a paper, receive criticism, and then go write the same p (more)

1 Reply

Michael Brenner · Oct 8

But it's not feedback, it's stubborn clinging to a myth. Neither Newton nor anybody after him who blindly repeats his gospel of orbits has ever pointed out where exactly earth's curvature begins to feature in the equations: first it (more)

Reply

Ewan Brown No one ever claimed the earth was flat over any distance....

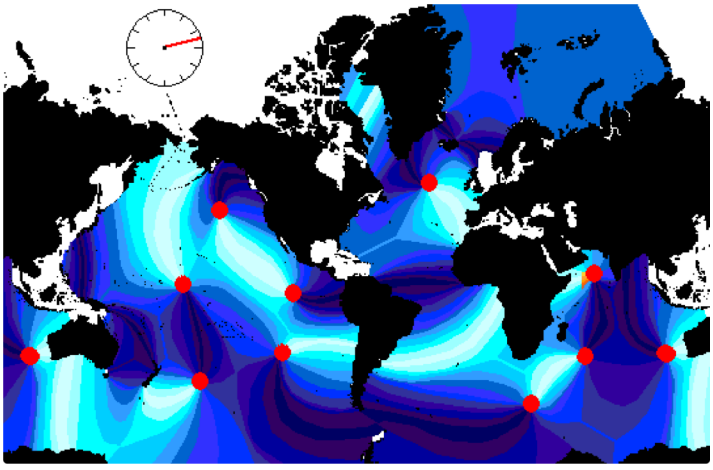
Quora

Barycentre around 4000km below the earth surface. Hereby explaining the twice a day sea tides including an explanation of the geo-dynamic inertia. Hence the high tide of the “far side” being caused by centrifugal force.

Reply

Michael Brenner · Oct 10

You and I know that this is nonsense, because tides do not work like you pretend they do: they rotate around omphidromic points which cannot be related to neither rotation nor moon.



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Gert Van Der Walt So your omphidromic points are not “La Grange” points created by a...

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About the Author

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