How Newton could have developed his law of gravitation.

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Abstract

The main idea in this paper is that physicists should have either explored the universe to discover a 'solar system' in which Newton's law of gravitation applied exactly or should have explained the discrepancy between the implication of the simple Newton's law of gravitation (circular orbits) and actual observation (non circular or 'elliptic') orbits, with sound logical consistency and validity. Discrepancies between a theory and actual observation should never be tolerated or given ad hoc explanations and carried forward. The discrepancy between Newton's law of gravitation and actual observation turned out to be of fundamental importance as presented in my previous paper:
" 'Elliptic' Orbits and Mercury Perihelion Advance as Evidence for Absolute Motion "

Discussion

Before developing his law of gravitation, Newton knew Galileo's law of gravity. Then he connected two phenomena : a falling apple fruit from an apple tree and the revolution of planets around the sun! How could one imagine of any connection between a falling apple fruit with revolution of a planet around the sun! So big distance between the two phenomena.

Once Newton made this great discovery on the underlying cause of revolution of planets around the sun, he had to develop his law of gravitation. At this point he had to use abstraction.

The next discussion is not meant to explain how Newton actually formulated his law of gravitation, but we only imagine how he could have developed it. This approach is taken because it has been considered to be a better way to convey the main idea : formulate (laws of physics) as observed, observe as formulated.

Say, Newton imagined a sun with one planet (for simplicity) revolving around it, in free space. Then he imagined that the orbit should be circular. He thought there was no reason for the orbit to be non circular. He formulated his simple law (equation) of gravitation. The simple law predicted a simple orbital shape: circular.

However, Newton knew that his simple law of gravitation worked exactly only in his imagination. He observed that his law of gravitation didn't apply exactly in our solar system. The non circular orbits couldn't simply be attributed to interaction of many planets with each other or to other ad hoc explanation. Newton would then seek a more fundamental explanation.

Ideally, what Newton would do?

We imagine that Newton explored the universe in search for a solar system in which his law of gravitation was observed exactly.

Newton actually, physically (not in his imagination) travelled through the universe until he found his law happen exactly as predicted: circular orbits. Imagine that Newton finally found such a solar system, one sun with one planet (for simplicity). He would certainly be very happy. Then Newton wanted to further check his law in this solar system. Imagine he threw a stone horizontally (slightly upwards) with sufficient velocity so that the stone would finally settle in a fixed orbit around the sun. Then Newton checked the shape of the orbit. It was exactly circular! But Newton later thought that, of course there was no reason for the orbit of the stone to be non circular, as the orbit of the planet is also circular in that system.
Then Newton enjoyed the correctness of his law (equation) by varying the tangential velocity, the radius of the orbit from the center of the sun, etc … He repeatedly observed his law apply exactly in that solar system. He even predicted the mass of the sun.

This solar system is mentioned as 'Newton's solar system' in the following discussions.

Even though Newton was happy to find a solar system in which his law applied exactly, he was not very happy because his law appeared not to apply exactly to other solar systems.

Newton then started thinking: 'Why my law of gravitation doesn't apply exactly to other solar systems?' He thought a lot, for several days, but he could conceive of no way why those orbits were non circular. Finally he was exhausted and abandoned this problem. On the next day he decided to take rest and passed the day by playing games. But, the next day, while he was playing, ' .. ………wait ……wait ….a new idea?! ……… what if I pushed and set the sun in motion ?! the orbit would be disturbed! at least for a moment! If the planet is, say, at the rear of the sun when the sun started accelerating, it will be left behind slightly. If it is just at the front of the sun at the moment the sun started accelerating, the sun will come closer to it slightly. If it is at the left side, then ………. If it is at the right side, then ……. What if the acceleration continued for several revolutions? What if the acceleration ceased after setting the sun in motion and the sun continued with some constant velocity? Will the original stable circular orbit be restored? Or will it be a stable but non circular orbit? Or will the orbit continue to be non stable?'

Newton hypothesized:
'Accelerating the sun will disturb the orbit, both a circular and non circular orbit.'
'If the acceleration continued, the orbit changes continuously."
' If acceleration ceases, the orbit will settle in a stable shape.'

Newton summarized his findings as follows:
Acceleration results in: non stable, non circular orbit
Constant rectilinear velocity results in: stable, but non circular orbit
Rest results in: stable and circular orbit

‘ But acceleration relative to what? Constant rectilinear velocity relative to what? Rest relative to what? ’

After some thought, Newton would come across an idea and make reasoning as follows.
‘If two identical solar systems with stable orbits are at rest relative to each other, then their orbits will be identical (assuming the same initial conditions). There is no reason for the two orbits to be different. Therefore, if we apply a force (hence acceleration) to the sun of one of the two solar systems, the orbit of the moving solar system will be disturbed. So we can take the ‘stationary’ solar system as the reference.

The center of the sun of any other solar system with stable orbit can be the reference. Any other solar system with stable orbits will be valid to be taken as reference, but a solar system with stable and circular orbit seems to be universal and more convenient.’

Newton was very happy with this intuitive idea because it was a great hint to solve the problem.

‘So, if I accelerated this solar system and removed the force after some time, the orbit must be stable, but non-circular.’

This was only a hypothesis and Newton decided to do an experiment.

But he didn’t want to disturb his solar system which demonstrated the circular orbit that was predicted by his law because he was afraid that he might not be able to restore it back to its original state.

So he decided to do the experiment with another similar solar system, by using his solar system as reference, as discussed above. He went far away in the universe from his solar system to search and finally found a similar solar system, but with a non circular orbit. Then he pulled the solar system in space to nearby his home solar system (he just pulled the sun and the planet just followed the sun). We call this the experimental solar system from now onwards. He put the experimental solar system at rest relative to his solar system. After taking rest for a few days, Newton decided to do the experiment.

But when he looked at the experimental solar system, he observed that its orbit was circular!
He remembered that it was initially non circular when it was at its original location!
Of course, Newton hypothesized this already (that any two identical solar systems at rest relative to each other will have the same orbit shape, assuming the same initial conditions), but he was surprised to see it happen actually.
If a solar system has any specific stable shape, then any identical solar system that is at rest relative to it will also have exactly the same specific shape of orbit. (again assuming the same initial conditions in both).

Although Newton then decisively proved his hypothesis even before doing the experiment, he did the experiment by moving the experimental solar system relative to his solar system at different velocities and he found the orbit to be non circular with the exact shape and size depending on the value of the velocity. He repeated this several times by varying the relative velocity and found a specific size and shape of orbit for different velocities.

Now that he had discovered the fundamental cause of non-circular orbits he decided to work on how to predict the shape exactly, mathematically.

From his experience and his experiment, he observed that the simple law of gravitation didn't apply correctly in the reference frame of the moving solar system.

Then Newton hypothesized that if the law of gravitation works correctly for his solar system (in the reference frame of his solar system), it should be possible to predict correctly the shape of any other identical moving solar system in this reference frame. He developed the equations for a solar system moving in the reference frame of his solar system. He solved the differential equations, by using initial conditions: initial position of the sun, initial position of the planet, translational velocity V_{tr} of the sun (this is constant) , initial velocity of the planet. He measured these at a specific time and used them as initial conditions (Note again that all positions and velocities are defined and measured in the reference frame of Newton's solar system, i. e the reference frame fixed to the center of the sun of Newton's solar system). He solved the differential equations for the path of the planet in this reference frame.

The solution of the differential equations was then transformed to the reference frame of the moving solar system to see what an orbital shape an observer there would observe. Note that the path of the planet typically looks like a sketch of a coil spring? in the reference frame of Newton's solar system, for small velocities, or a wave along the path of motion of the sun ?, periodically crossing the path from one side to the other, for higher velocities. The exact shape of the path varies with translational speed of the sun. Thus the transformation transforms this open path into a closed orbit.

Then Newton went to the experimental solar system and observed the orbit in every direction. The observed orbit was accurately predicted by the mathematical model!
Note that the orbit is stable because there is no acceleration.

Newton remembered the time when he was afraid of disturbing his home solar system in which he observed his simple law of gravitation because he thought he might not be able to restore it back to its initial state (circular orbit). Now he knows that he can restore it by simply varying its motion in space until the orbits become circular.

Newton would then call the state in which the orbit of his solar system was circular: absolute rest. At absolute rest, the law of gravitation is observed in its simplest form: circular orbit. He would call a reference frame attached to the sun of his solar system absolute reference frame. Newton proved that his law of gravitation applied correctly only in this reference frame or in any reference frame that is at rest relative to it. Newton's simple law of gravitation applied correctly only in an absolute reference frame.

Therefore Newton would have come back to earth and redefined his law of gravitation (and his laws of motion) with respect to the absolute reference frame.

Absolute reference frame is the frame in which the laws of gravitation and motion are observed in their simplest forms.

Conclusion

The discussion made so far is meant to stress the point that we should strictly test the laws of physics against nature and go to great lengths to do this and is not meant to state that Newton could actually explore the universe to test his law of gravitation. As we can't actually explore the universe to test Newton's law of gravitation, then he/we are left with only one alternative: explanation of the discrepancy between Newton's law of gravitation and actual observations with sound logical consistency and validity.

The laws of nature should be formulated as observed and observed as formulated. The laws of physics should predict and explain natural phenomena correctly and accurately. We should observe the laws we formulate happen exactly or be able to explain discrepancies with sound logical consistency, not with adhoc explanations. Unexplained discrepancies should never be tolerated and carried forward.

The mistake made in physics so far was that the discrepancy between Newton's law of gravitation and observations was tolerated and was never investigated with the rigor it deserved. But, as it turned out in the theory of absolute motion proposed in my third post, this discrepancy turned out to be of fundamental importance.

Physicists could have solved the problem in their imagination, by using the two hypothetical solar systems argument presented in the previous post ("Evidence of Absolute Motion: Elliptic Orbits ; Perihelion advance is the other evidence."), without actually exploring the universe.

Finally,

I always thank God and His Mother, Our Lady Saint Virgin Mary. I know that these new theories are divine revelations with the same certainty that I know a given color to be red or blue.

God devastates the most cherished theory with three cosmic 'lightening strikes' sent in succession from the heavens.

Perhaps He wants to send to us some message because we have been too proud of the advance of scientific knowledge.