Newton's Invalid Law

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Basic examples show that Newton's "law of universal gravitation" does not correspond with astronomical realities. Most likely, it is fundamentally wrong. Regrettably, today Newton's idea about mass as source of gravity is not anymore counted as a hypothesis, but as a dogma, regardless of its theoretical absurdity and the lack of empirical evidence.

Newton's "law of universal gravitation" claims that there is a force called gravity causing any two bodies to be attracted toward each other, with magnitude proportional to the product of their masses and inversely proportional to the square of the distance between them:

$$F = G\,\frac{m_1 \cdot m_2}{r^2}$$

where F is the force of gravity, m_1 and m_2 are the masses of the objects interacting, r is the distance between the centers of the masses and G is the Newtonian constant of gravitation.

Gravity is considered to determine the motion of planets, stars, and galaxies. However, basic examples show that Newton's law does not correspond with astronomical realities. To convince ourselves of this it is enough applying Newton's "law of universal gravitation" to the system Earth – Moon. Let us do this calculation together.

First we need the big G. CODATA[1] recomments the value:

$$G = 6.6743 \cdot 10^{-11}\ \mathrm{m^3 kg^{-1} s^{-2}}$$

Then we need the mass of the Earth and that of the Moon[2]:

$$m_{earth} = 5.97217 \cdot 10^{24}\ \mathrm{kg} \qquad\qquad m_{moon} = 7.342 \cdot 10^{22}\ \mathrm{kg}$$

Remains only the distance Earth – Moon that lays between the perigee and the apogee of the Moon's orbit:

$$356,400\ \mathrm{km} - 406,700\ \mathrm{km}$$

[1] CODATA recommended 2018 values of the fundamental physical constants: physics.nist.gov/cuu/constants/index.html

[2] NASA planetary fact sheet - metric (2019)

Applying these data to Newton's law, we get the result that the Moon is attracted by the Earth with a gravity force of $1.8 - 2.3 \cdot 10^{20}$ Newton.

Now let us calculate the gravity force between the Moon and the Sun. We need the mass of the Sun and that of the Moon:

$$m_{Sun} = 1.9884 \cdot 10^{30} \text{ kg} \qquad\qquad m_{moon} = 7.342 \cdot 10^{22} \text{ kg}$$

The maximum distance Sun – Moon equals the maximum distance Sun – Earth plus the maximum distance Earth – Moon:

$$152,100,000 \text{ km} + 406,700 \text{ km} = 152,506,700 \text{ km}$$

The minimum distance Sun – Moon equals the minimum distance Sun – Earth minus the maximum distance Earth – Moon:

$$147,095,000 \text{ km} - 406,700 \text{ km} = 146,688,300 \text{ km}$$

Applying these data to Newton's law, we get the result that the Moon is attracted by the Sun with a gravity force of $4.2 - 4.5 \cdot 10^{20}$ Newton.

As we can see, Newton's "law of universal gravitation" suggests that the attraction force of the Sun experienced by the Moon is twice(!) of the attraction force of the Earth.

Consequently, the Moon should have left its orbit around the Earth long time ago. If Newton's "law" were valid, it would have completely destabilized the Moon's orbit. Fortunately, planets and moons don't know Newton's "law of universal gravitation".

One of the standard objections claims that in this calculation Newton's law is applied to a three-body problem (or even N-body problem) while the law describes the interaction between two bodies only.

However, it is believed that gravitation cannot be screened. Because of this, it is virtually impossible to isolate the gravitational interaction between two masses from the presumed perturbative effects created by surrounding masses.

In this case, I would like to know where in the universe can I find a gravitationally isolated space that contains only two masses? And who needs a law that only applies in such an unrealistic scenario?

Obviously, Newton's law must be taken as an unproven hypothesis. Most likely, the connection between gravitation and mass accretion is much more sophisticated than Newton's law would suggest.

Regrettably, today Newton's idea about mass as source of gravity is not anymore counted as a hypothesis, but as a dogma, regardless of its theoretical absurdity and the lack of empirical evidence.

By the way, what's about the famous Einstein's gravity field equations? The sobering point is that in the case of normal gravity and low velocities, Einstein's field equations unpretentiously reduce to Newton's law of gravitation.

And what's about Kepler's laws of planetary motion? They do not contain masses and do not contain the big G. Hence, the proven reality of Kepler's laws of planetary motion cannot serve as a confirmation of Newton's law of gravitation.

Let's take a closer look at Kepler's third law. Johannes Kepler discovered that for every planet in the solar system, the ratio of the cube of its orbital distance (semi-major axis) R_{planet} and the square of its orbital period T_{planet} has the same value.

In units of the semi-major axis of Earth's orbit (astronomical units) and units of the sidereal orbital period of the Earth (sidereal years), this ratio equals 1 for all planets of the solar system. For instance, the semi-major axis of Venus' orbit equals 0.723332 astronomical units, and its orbital period is 0.615198 years:

$$\frac{R^3_{venus}}{T^2_{venus}} = \frac{0.723332^3}{0.615198^2} = 1$$

In units of meters and seconds, this ratio defines the heliocentric gravitational constant μ_{sun}:

$$\mu_{sun} = 4\pi^2 \frac{R^3_{planet}}{T^2_{planet}} = 1.3271244 \cdot 10^{20}\,\mathrm{m}^3/\mathrm{s}^2$$

Kepler's law is also valid for moons orbiting a planet. In the case of the Earth, this ratio defines the geocentric gravitational constant μ_{earth}:

$$\mu_{earth} = 4\pi^2 \frac{R^3_{moon}}{T^2_{moon}} = 3.9860044 \cdot 10^{14}\,\mathrm{m}^3/\mathrm{s}^2$$

For deriving the geocentric gravitational constant μ, the semi-major axis $R = 384,400$ km of the Moon's orbit and the orbital period $T = 27.3217$ days of the Moon can be used. For deriving the gravitational constant of Jupiter, the orbital elements of Jupiter's Galilean moons can be used.

As we can see, Kepler's law of planetary motion works precisely and, unlike Newton's law of gravitation, Kepler's law does not have any N-body problem.

Kepler's law does not deal with masses because gravity does not depend on masses and therefore cannot be caused by mass. All what we need to know for deriving Earth's surface gravity acceleration g is the geocentric gravitational constant μ and the radius r of the Earth:

$$g = \frac{\mu}{r^2} = \frac{\mu}{(6,378,000\ \mathrm{m})^2} = 9.81\ \mathrm{m/s}^2$$

As we can see, no data about the mass or chemical composition of the Earth is needed for calculating Earth's gravity, in full agreement with Galileo Galilei's discovery that the acceleration of a free falling body does not depend on its mass, physical state or chemical composition. Modern measurements[1] confirm Galilei's discovery with the precision of a trillionth.

Actually, the question is not, does the *force* caused by the gravity acceleration of the Earth depend on the mass of the free falling body. The question is rather, does the mass M of the Earth *cause* the acceleration of free fall. The formal expression of Newton's idea that mass causes gravity is the equation $\mu = GM$, an arbitrary interpretation of μ that introduces the big G as "universal" gravitational constant. The gravitational constant μ does not contain the dimension of mass, as we have seen above. Consequently, the true function of G is simply to eliminate the dimension of mass artificially introduced by M. It is very unlikely that G has a physical sense at all.

One of the basic principles of scientific research is the falsifiability of a theory. Obviously, any theory that postulates gravitation of mass as forming factor of the solar system is not falsifiable, because there is no method to *measure* the mass of a planet. Actually, no mass of any planet, planetoid or moon is measured, but only calculated based on the theoretical presumption $\mu = GM$. Consequently, if G would be estimated to be 10 times larger than the currently recommended value, this would simply mean that the masses of celestial bodies automatically would be estimated to be 10 times smaller. However, this change would not have any impact on astronomical calculations.

Honestly, physicists should realize that they do not know the true masses of the Sun, the Earth, the Moon and other planets or stars. They still have to find out how to measure them.

So, why then is Newton's formula still considered as a law of physics? Is that some strange kind of nostalgia? Why do school teachers still explain this nonsense to children?

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[1] Schlamminger S. et al. Test of the Equivalence Principle Using a Rotating Torsion Balance. *arXiv*: 0712.0607v1 [gr-qc] 4 Dec 2007