

Does the universe have an absolute reference frame?

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Abstract

I claim that there is a universe absolute reference frame. This is the aether or vacuum space. The theories of Newton and Einstein are combined to describe the structure of our universe.

General

The existence/non-existence of a universal absolute reference frame is a profound issue and is a subject of an ongoing debate in physics. At first, there was the aether hypothesis. This hypothesis was proposed by Aristotle as an immovable heavenly fluid in which celestial bodies move. This hypothesis has never lacked critics. On the other hand, it was accepted by many other philosophers and scientists, among them was Newton. Although Newton could not explain the nature of the aether, he founded classical mechanics on the aether. In addition, the aether medium was accepted because it enables the propagation of electromagnetic waves and gravitational forces. The aether hypothesis was discarded by the majority of scientists after the Michelson-Morley (M-M) experiment in 1887. M-M's idea was that the rotating Earth moving through the stationary aether should create a wind of sorts, and light beams moving through it would have a measurable drag. But their result was null, i.e., no difference in light speed was found and the conclusion was that the aether does not exist. This finding was confirmed in subsequent experiments through the 1920s and on.

Secondly, many thought that this issue was resolved theoretically in 1905 by Einstein's special theory of relativity (SR). Einstein claimed in SR that the introduction of aether is superfluous because physics does not require an absolute stationary space. He declared that all inertial frames are equivalent and one cannot prefer one over the other. Nevertheless, this issue was not fully resolved. Einstein himself doubted his claim that aether is superfluous. In a lecture he gave at Leiden university in 1920, (after publishing GR) he stated: "Recapitulating, we may say that according to the general theory of relativity space is endowed with physical qualities; in this sense, therefore, there exists an ether. According to the general theory of relativity space without ether is unthinkable".

Nowadays, with the death of the aether and absolute space, it ceased to be of any interest to most mainstream physicists. Still, there are some, e.g., Nobel prize physicist Robert B. Laughlin that wrote: "It is ironic that Einstein's most creative work, the general theory of relativity, should boil down to conceptualizing space as a medium when his original premise [in special relativity] was that no such medium existed [...] The word 'ether' has extremely negative connotations in theoretical physics because of its past association with opposition to relativity. This is unfortunate because, stripped of these connotations, it rather nicely

captures the way most physicists actually think about the vacuum. . . studies of radioactivity began showing that the empty vacuum of space had spectroscopic structure similar to that of ordinary quantum solids and fluids...”

My conjuncture on the aether

The existence of the aether can be reconsidered if the two reasons for its dismissal (M-M and SR) are disputed.

- 1) The M-M experiment. A known attempt to explain the M-M experiment was done by George Stokes. Stokes hypothesized that the aether is completely dragged by Earth and thus shares its motion at Earth's surface. He claimed that at large distances, in free space, the aether stays at rest. But Stokes's effect of Earth on the aether was discarded because it was found in order of magnitude weaker. More details in [Aether drag hypothesis - Wikipedia](#)

Generally, I agree with Stokes. But my hypothesis differs from Stokes by claiming that frame-dragging is not of the neglectable Earth dragging, but rather dragging of the entire universe. This conjuncture will be explained later when I describe my hypothesis on the structure of the universe.

- 2) SR in the universe. I claim that in general SR does not apply to our matter universe because it is not in accord with the first postulate of SR. Namely, the laws of physics are invariant in all inertial frames of reference (that is, frames of reference with no acceleration).

According to the first postulate, SR is relevant only in places where there is no matter (i.e., no gravity or acceleration), for example in deep space, far away from any celestial body. Therefore, in our matter universe where gravity exists everywhere, SR is not applicable. On the other hand, it is known that SR is used on Earth, e.g., in the Global Positioning System (GPS). In another article, [Is Special Relativity compatible with General Relativity?](#) I suggest an explanation of why SR can be used in GPS.

Another question that arises if the aether does not exist concerns GR. One of GR's results, which was validated by an experiment (Gravity Probe B), is that any spinning celestial body drags space located around it. So, if space is a total void what is dragged?

What is the aether?

It was noted above that the proponents of the aether theory, including Newton, could not explain the nature of the aether.

I claim that there is an aether. It relies on quantum physics. Quantum Field Theory (QFT) describes space as being non-empty at extremely small scales, even if all matter particles are removed. It is endowed with fluctuating fields of energy such as electrical and magnetic fields. QFT teaches that any point in this vacuum space contains energy that has a minimum value designated the vacuum energy. Its behavior is codified in Heisenberg's energy-time uncertainty principle. From the energy of the vacuum space, pairs of matter and antimatter particles are perpetually generated, e.g., an up quark and its up antiquark, a down quark, and its down antiquark, electron, and positron, etc. These pairs pop out in the vacuum, exist for a short time, and then annihilate each other. Vacuum space has measurable physical properties such as electrical permittivity and magnetic permeability. Maxwell used these parameters to calculate the speed of light in a vacuum. I hypothesize that space has additional properties e.g., viscosity. I claim this because it enables space to be dragged by matter. In other words, vacuum space is not a total void but is rather "something" as suggested by the aether theory. It has been suggested by some such as [Paul Dirac](#) that this quantum vacuum may be the equivalent in modern physics of the aether.

My conjuncture on the structure of the universe

My conjuncture on the structure of the universe is based on Newton's ideas on space, time, motion, and matter. It is also based on GR.

Newton postulated that:

1. Time is absolute, eternal, and passes uniformly without relation to anything external.
2. Space is absolute, eternal, infinite, permeates everywhere, and remains similar and immovable without relation to anything external.
3. Space is filled with a "stuff" called aether. The aether provides an absolute frame of reference for the motion of celestial bodies.
4. The matter is a finite island in space and is distinct from it.
5. Motion is the translation of a body from one absolute place to another; relative motion is the translation from one relative place to another.

But there is a discrepancy between GR and Newton. I concur with part of Newton's postulate 2, namely, "Space is absolute, eternal, infinite and it permeates everywhere". But the part in his claim that "space remains similar and immovable without relation to anything external" is not correct. It is predicted by GR and validated by experiments that any spinning celestial body drags space, thus space is movable.

Starting with Newton's gravitational law (see Fig. 1): The gravitational field outside any celestial body has a maximum value at the surface of the body and is reduced as the distance gets bigger and is zero at infinity. However, gravity exists also inside any celestial body. Inside the celestial body, the value of g is reduced linearly from its surface value to zero at the center of the body. As the aether permeates everywhere it is stationary at the center of this body and infinity distance from a celestial body. This gives rise that time at these points passes uniformly as the entire undisturbed stationary aether.

As an example, gravitational field of Earth

$$M_E = 5.97 \cdot 10^{24} \cdot \text{kg} \dots \text{Earth mass}$$

$$R_E = 6371 \cdot \text{km} \dots \text{Earth radius}$$

$$G = 6.67 \cdot 10^{-11} \frac{\text{m}^3}{\text{kg} \cdot \text{sec}^2}$$

$$g(r) = \frac{G \cdot M_E}{r^2} \dots \dots \text{If } R_E \leq r \dots \dots \text{Gravity outside Earth}$$

$$g(r) = \frac{G \cdot M_E}{R_E^3} \cdot r \dots \dots \text{If } 0 \cdot \text{km} \leq r \leq R_E \dots \dots \text{Gravity Inside Earth}$$

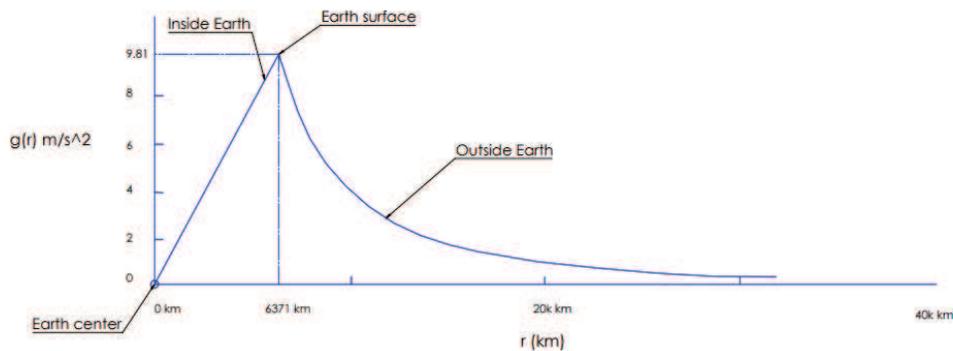


Fig. 1 – Newton's gravitational field

Today science teaches that this is not the whole picture. Newton was not aware that all celestial bodies rotate on their axis, and while doing that, vacuum space (or aether) is dragged by them. Frame dragging is a validated phenomenon predicted by GR. A celestial body rotating on its axis drags vacuum space in the manner shown in Fig. 2. It has a disk at its equatorial plane and longitudinal-shaped spirals extending from each of its poles. Structures like this are observed in the universe. For example, black holes that have accretion disks and jets extending from their poles. Gravity (g) and velocity are both zero relative to the stationary space at infinity and at the center of the celestial body.

It is to be noted that Fig 2 is a computer simulation of a sphere rotating in a viscous fluid, based on Navier- Stokes fluid dynamics. I concur with the conjuncture, people have suggested, that if vacuum space is considered a viscous fluid, then this phenomenon can be explained by fluid dynamics, as well as GR. See, for example, Delplace: Liquid spacetime (Aether) viscosity.

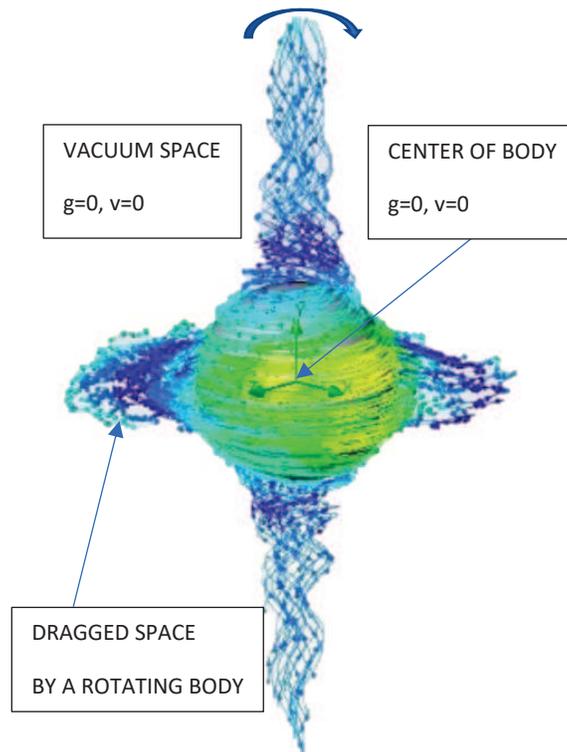


Fig. 2 – Frame dragging by a celestial body

Previously I related to the way celestial bodies affect space around them. Is it possible that space can affect celestial bodies? My answer is yes. For easy explanation, I refer the reader to the experiment done by Prof. Taylor <https://www.youtube.com/watch?v=QcBpDVzBPMk> (start time: 3:38 min). In this experiment, it is shown how a rotating cylinder immersed in viscous fluid drags the fluid around it, but also how, simultaneously, the viscous fluid causes the rotation of a solid body that is immersed in the fluid. The theoretical explanation is given by Stokes flow.

The structure of our universe I suggest is shown in Fig. 3. At the center of our matter universe, there is a rotating neutron star I designate the Pivot. The Pivot drags space around it. Galaxies as well as other celestial bodies that are located on the equatorial plane move together with the space dragged by the Pivot. At the same time, all celestial bodies also spin around on their axis. John Wheeler summarized it: “matter tells spacetime how to curve, and spacetime tells matter how to move”. This explains the M-M experiment. Although there is no relative velocity between all celestial bodies and the space that is dragged by the Pivot, there is also local dragging of celestial bodies. The sum of dragging is not exactly zero.

The Pivot rotates at ω_{pivot} , however, the center of the Pivot is not moving ($g=0, v=0$ relatively to stationary space). Time at this point passes uniformly without relation to anything external. But, within the region of influence of the Pivot, GR must be applied to calculate gravity, velocity, and time. Frame dragging equation according to GR is given by:

$$\Omega(r, \theta) = \frac{R_H \cdot \alpha \cdot r \cdot C}{(r^2 + \alpha^2 \cdot \cos^2 \theta)(r^2 + \alpha^2) + R_H \cdot \alpha^2 \cdot r \cdot \sin^2 \theta}$$

See [Frame-dragging](#). Fig. 3 is based on this equation.

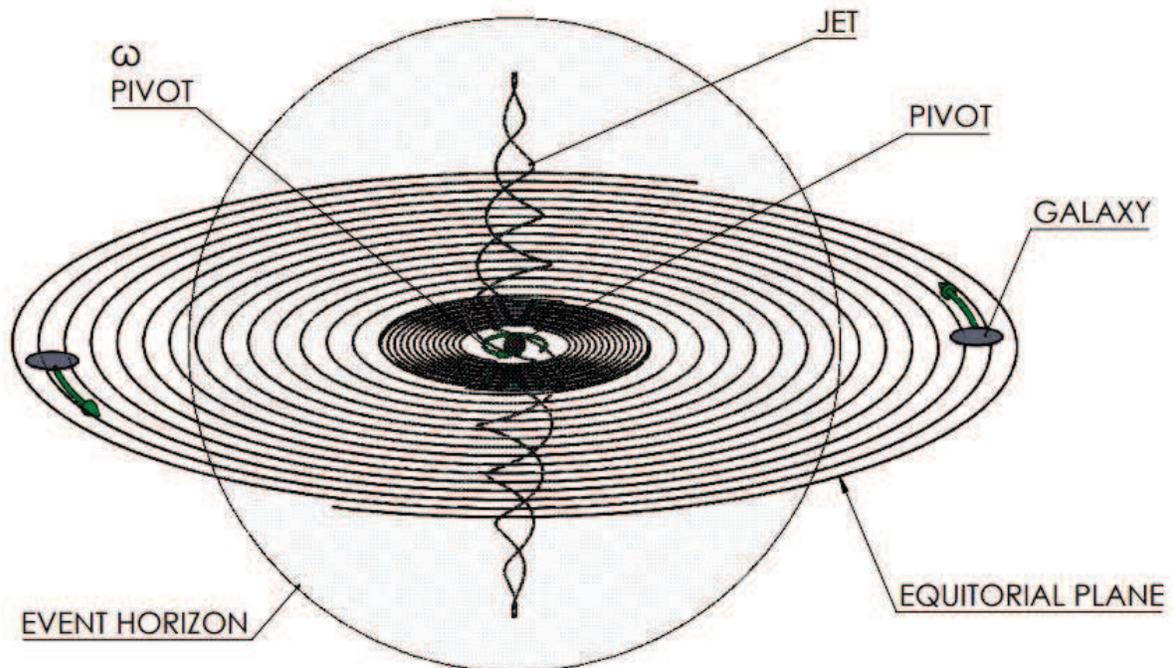


Fig. 3 – The Pivot universe

What about SR?

It was mentioned earlier that SR is valid only in places where there is no matter (i.e., no gravity or acceleration), for example in deep space, far away from the influence of any celestial body. In our matter universe where gravity exists everywhere, SR is not applicable, except for cases where the reference frame does not change its position during the measurement. Hypothetically, it is possible that in the infinite space many finite universes exist. In this case, SR is valid in the space between universes.

Conclusion

The aether (or vacuum space) is real. It can serve as an absolute reference frame. Newton and Einstein's theories can be combined to describe the universe. They differ in their claims about the mobility of the aether. According to Newton there is an aether that is absolute, eternal, infinite, permeates everywhere, and remains similar and **immovable without relation to anything external**. Einstein, eventually, also claimed that aether exists. However, according to GR space does relate to matter. **In the vicinity of celestial bodies, space is moveable**: it is dragged by the celestial body. There are two points – at the center of the celestial body and far away from it that space is immovable.