

Can the Michelson-Morley experiment be reconciled with the Sagnac effect?

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Abstract

Michelson-Morley experiment and Sagnac effect were aimed to solve a long debated and crucial question in physics - does the aether exist? But the experiments resulted in two contradictory results –the Michelson-Morley experiment finding was that there is no aether whereas Sagnac showed that the aether exists. Current Physics has no clear answer to this basic and profound conundrum.

Current Status

Newton suggested the existence of an aether in 1704. He claimed that aether fills the infinite space and therefore can serve as an absolute frame of reference. Although he could not define what is the nature of aether, it was the prevailing theory in science until the end of the 19th century. In 1887 Michelson & Morley experimented to prove the existence of the aether, but to their surprise, they found that there is no aether. Their experiment caused the majority of the scientific community to discard the aether theory. However, in modern physics, there is still a debate about the aether existence/non-existence.

Several pieces of evidence support the existence of the aether.

The first - In 1916 Lense & Thirring, based on GR, described a phenomenon designated frame dragging. Frame-dragging was validated by the Gravity Probe B experiment done in 2011. I claim that frame-dragging indicates that an aether must exist, otherwise, if the aether is a total void what is dragged? I quote Einstein from a lecture he gave in 1920 at Leiden University: “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;” https://mathshistory.st-andrews.ac.uk/Extras/Einstein_ether/

The second evidence that vacuum space is not a total void but rather is filled with “something”, comes from quantum physics. Quantum physics describes space as being non-empty at extremely small scales. It contains fluctuating fields of energy from which virtual particle pairs appear and disappear incredibly quickly. In other words, vacuum space is not a total void, but rather “something” as suggested by Einstein. It has been suggested by some such

as Paul Dirac that this quantum vacuum may be the equivalent in modern physics of a particulate aether.

And the third piece of evidence is the Sagnac effect. The Sagnac effect was proposed in 1913, by Sagnac to show that, there is an aether. Sagnac's experiment was repeated by Michelson-Gale (1925) and other similar experiments. All these experiments confirmed the aether's existence, therefore refuting Einstein's SR.

Sagnac built an instrument that rotated on its axis. A source of light was placed on the edge of the instrument. The source sent simultaneously the light in two closed and opposing directions. Both rays of light arrived eventually at one detector. According to Sagnac, without relating to SR, the time difference (Δt) between the light that is traveling in both opposite directions is:

$$\Delta t = \frac{4 \cdot A \cdot \omega}{c^2}$$

Where:

A.....Area of the ring

ωForced angular velocity

c.....Speed of light

Note: The Sagnac effect has stimulated a century-long debate on its meaning and interpretation. Ironically, people used SR for explaining the Sagnac effect, even though Sagnac objected to SR. The first explanation relying on SR was provided by Paul Langevin in 1921. However, between these two opposing theories, the SR theory was accepted by the majority of the physical community as the correct one.

Even though theoretical physics has no accepted explanation, the Sagnac effect has been used by engineers to build devices such as ring-lasers gyroscopes. These gyroscopes are very accurate and are used routinely in navigation systems of satellites, aircraft, ships, submarines, etc.

I claim that using SR to prove the Sagnac effect is a mistake. The error of those who tried to explain the Sagnac effect using SR lies in the fact that they have

been using SR contrary to its first postulate.
SR is based on two main postulates:

1. The laws of physics are invariant in all inertial frames of reference (that is, frames of reference with no acceleration or gravity).
2. The speed of light in the vacuum is the same for all observers, regardless of the motion of the light source or observer.

From postulate one of SR, it can be concluded that SR is applicable only where there is no gravity or acceleration thus that the reference frames do not change their relative position, or in other words, stay parallel all the time. This is not the case with the Sagnac effect. Fig. 1 shows that at the lower part the reference frames are parallel, but along the path, the frames are not parallel anymore. Therefore, using SR to solve problems in the universe where gravity or acceleration exists is not applicable.

Note: Nevertheless, SR is used in places that are influenced by gravity, e.g., in the vicinity of Earth. An example is the global positioning system (GPS), which is used many million times a day. In my paper https://www.academia.edu/78702799/Is_Special_Relativity_compatible_with_General_Relativity, I give the reasoning for using SR in GPS.

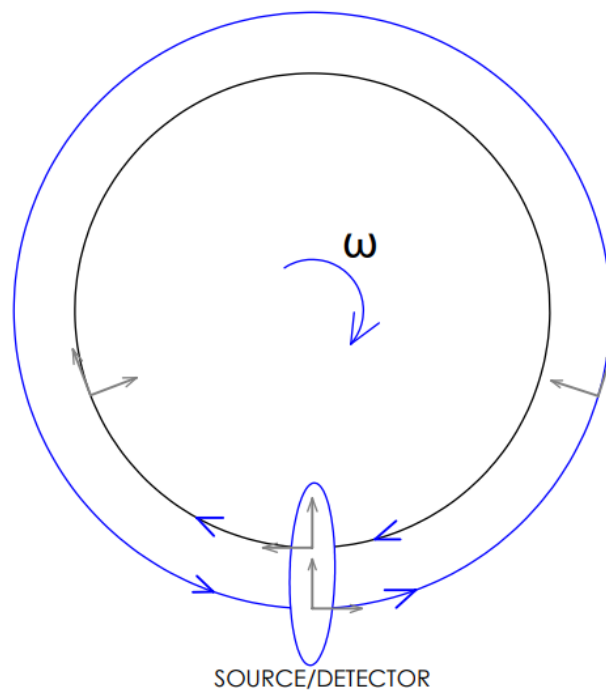


Fig. 1 - Sagnac effect

On the other side of the debate, the aether existence has a powerful observation. This is the Michelson-Morley experiment (MMX) (1897). MMX gained acceptance in the scientific community and was the basis of special relativity (SR). MMX was the reason why Newton's aether hypothesis that reigned for hundreds of years was discarded. Because of the importance of its findings, MMX has been repeated by many scientists at different times, that used various techniques of measurements. The result has been always the same - there is no aether.

So, the question remains. Is there an aether? GR, quantum physics, and the Sagnac effect claim that there is an aether, whereas MMX claims that there is no aether. In other words, the question is:

Is it possible to reconcile MMX and Sagnac effect?

I claim that this is possible.

My explanation is based on another paper:

https://www.academia.edu/81829188/Does_the_universe_have_an_absolute_reference_frame

I claim that there is an aether (or vacuum space), that has physical properties. I claim that MMX data is correct, but not its interpretation. The reason for the null result is not that aether does not exist but results from the frame dragging of the aether. A similar idea was suggested by Stokes. However, Stokes's hypothesis was proven wrong, because he related only to the frame-dragging of Earth. I claim that the entire space in our universe is frame dragged by a huge neutron star, I designate the Pivot, located at the center of our universe.

I described the structure of the Pivot universe. Our matter universe is located in space. I conjecture that our matter universe composes of a spinning neutron star that drags the space around it. All celestial bodies (from dust to galaxies) are located in the dragged space and move together with it. In the above paper, I related only to MMX and explain how MMX results in a null result.

I briefly mention in the paper that in addition to dragging all celestial bodies with space, they simultaneously also spin on their axis. Now I would like to elaborate on the Sagnac effect.

Fig. 2 shows the structure of our matter universe. (More details in the paper mentioned above). It shows the disk shape of the universe with spirals representing dragged space. The area that is within the event horizon is not considered because our matter universe cannot exist there. A rigid disk is placed in the dragged space. In addition to dragging the disk in the direction of space rotation, it also spins on its axis in a direction contrary to space direction.

Detail A shows the rigid disk. The velocities at points “a” and “b” differ. The velocity of point a – V_2 is bigger than the velocity V_1 at point b. Therefore, the rigid disk must rotate at its “natural” angular velocity $\omega_{disk} = \frac{V_2 - V_1}{R_{Disk}}$

The size of the rigid disk can differ. Its radius can vary from centimeters up to the sizes of celestial bodies. If the rigid disk is forced to rotate by an external moment (either clockwise or counter-clockwise) there is a deviation from the natural angular velocity ω_{Disk} . This deviation is expressed in the Sagnac effect. Fig.-2 also shows why the Sagnac effect is dependent on the area of disk A.

The reader is also referred 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 and solid objects that are placed in the fluid. What is important to the current discussion is how, simultaneously, the motion of the viscous fluid causes the rotation of a solid ring that is immersed in the fluid. The direction of rotation of the ring is contrary to the direction of the entire fluid.

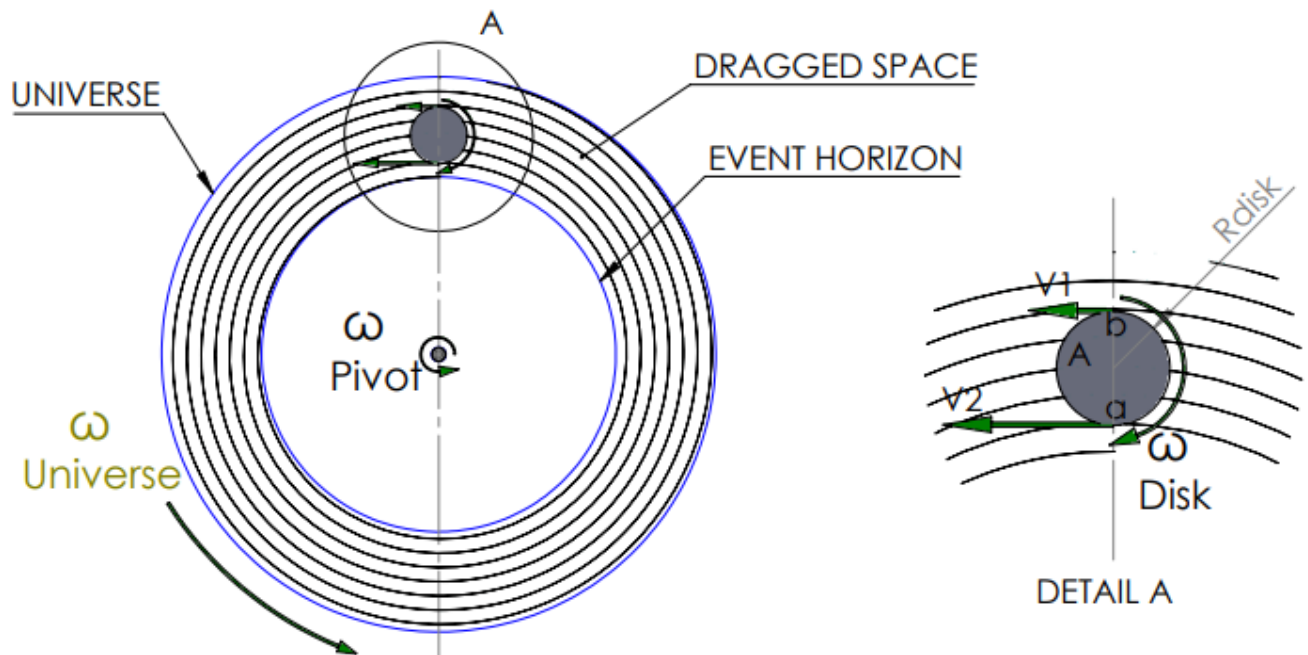


Fig. 2 – Sagnac effect in the universe

I would also like to relate to an additional long-debated experiment designated “Newton’s bucket”. In Newton’s experiment, a bucket is filled with water and hung by a rope. If the rope is twisted around and around until it is tight and then released, the bucket begins to spin rapidly, not only with respect to the observers watching it, but also with respect to the water in the bucket, which at first doesn’t move and remains flat on its surface. Eventually, as the bucket continues to spin, the water starts to rotate as well, as can be seen from the concave shape of its surface. This concaving of the water shows that it is rotating, even though it is now at rest with respect to the co-rotating bucket. Newton pointed out it is not the relative motion of the bucket and water that causes the concavity of the water. The concaving of the water suggests that it is rotating with respect to something else, far more remote. In Newton’s thinking, this showed rotation relative to absolute space.

This explanation of Newton was disputed by Mach. Mach wrote that Newton’s experiment merely shows that the relative rotation of the water with respect to the sides of the vessel produces no noticeable centrifugal forces and that such forces are instead produced by its relative rotation with respect to Earth and the other celestial bodies.

I concur with Newton. The disk in Fig. 2 can represent the surface of the water in the bucket. In a steady state, the bucket and the water are spinning at the natural frequency ω_{Disk} . When the bucket is forced by an external moment to rotate, it deviates from the natural frequency and its surface become concave.