Detecting the Ether Wind by Doppler Radar

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Two-way Doppler experiments based on electromagnetic waves (EMW) and intrinsic frequency measurements require only one clock. Unlike one-way Doppler experiments, they are not influenced by the compensatory effect of "time dilation" [1]. Thus, it is possible, in principle, to determine motion with respect to a hypothetical ether at rest.

This paper describes an experiment for detecting the hypothetical ether wind. The components for the experiment follow: A table is placed on an axel so it can be positioned at various angles. A 25 GHz radar is placed on the table so it faces an adjustable reflector. This device is designed to give the reflector either a constant or periodic transversal motion. For example, at some radius, R, the linear velocity equal 20 m/s (reflected by either linear, streaming, rotating, or vibrating motion). Because Earth travels towards Leo at 368 km/s, these experiments should reflect a difference of 5 mHz between the 3 kHz beat frequencies towards Leo (CMB dipole) and the perpendicular ether wind direction

1. Introduction

The most famous experiment to detect the medium for electromagnetic waves (EMW) is the experiment of Michelson and Morley. Wesley [1] explained the null result as a classical Doppler Effect (DE).

The DE requires relative motion between a source and a receiver. If relative motion is missing, the experiment produces a null result. This paper shows how the Michelson-Morley experiment can be supplemented with a relative motion, and it explains why experiments with two-way Doppler are required to fully test these effects.

One-way Doppler Effects are influenced by time dilation. Because of time dilation, this paper addresses two cases where one-way DE has limited experimental value:

- **Longitudinal one-way DE on EMW:** This is a combination of the classical DE in a medium and the time dilation from two clocks moving at different velocities. If time dilation is real, as hypothesized from other experiments, then it follows that the physical DE of EMW is analogous to that of sound waves. Thus, there is a medium for EMW, and there must also be a different DE for EMW – dependent on whether the source or the receiver is in motion.
- **Transversal one-way DE on EMW:** This DE, too, is the result from the combination of a classical DE and the absolute time dilation effect on the measurement. As there is classically no transversal physical DE on EMW, the sum of both leaves just the time dilation effect.

In contrast, two-way Doppler Effects only need one clock, and they are not influenced by time dilation. Furthermore, they follow the laws of classical mechanics. This paper addresses two cases where two-way DE enhances experiments:

- **Transversal two-way DE on EMW:** This measurement requires only one clock. Therefore, transversal two-way DE is not observed for EMW [3], [4]. This is contrary to the prediction by special relativity (with special attention given to DE from a reflected wave) [2].
- **Longitudinal two-way DE on EMW:** Here, even for space probes, the radar equation for sound waves is used for the same reason. According to the classical equation for wind, the ether should be detectable by changing the direction of measurement.

The next two sections highlight some aspects of the classical and the relativistic DE. Subsequently, a method is presented to experimentally determine Earth's direction and velocity of movement in a closed laboratory.

2. The Classical and Relativistic Doppler Effect

The frequency shift for the *classic acoustic Doppler Effect* is calculated differently depending on whether the source Q is at rest and the receiver E is moving or whether the receiver is at rest and the source is moving. For convenience, this is demonstrated with the source and receiver moving toward each other in a uniform rectilinear manner. Increasing the distance between the two leads to the opposite signs for the velocity v in Eq. (1) through Eq. (3) that follow. As always, Doppler shift is about the perception of the receiver. The velocities v of the source and the receiver refers to the propagation medium at rest – which is usually still air. c is the speed of sound in still air. The frequencies of the source and receiver are ν_Q and ν_E, respectively.

The following equation describes the DE for a receiver that is approaching a stationary source:

$$\nu_E = \nu_Q\left(1 + \frac{v}{c}\right) \tag{1}$$

And the Eq. (2) describes the DE for a source that is approaching a stationary receiver:

$$\nu_E = \nu_Q \frac{1}{1 - \frac{v}{c}} \tag{2}$$

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[1] "time dilation" = Depending on the frequency of an electromagnetic oscillator by its absolute velocity

However, when the analysis turns from the *acoustic DE* to the *optical DE*, the geometric mean applies to Eq. (1) and Eq. (2). In Eq. (3) below, the *optical DE* is described in an identical manner – regardless of whether the source or receiver is moving. In this equation, v is the relative velocity between the source and receiver; c is the speed of light. This equation describes a source and receiver coming together; however, when they move away from each other, the equation contains the opposite signs:

$$\nu_E = \nu_Q \sqrt{\frac{c+v}{c-v}} \tag{3}$$

On the basis of time dilation, the derivation of Eq. (3) is justified by the different frequency standards of the source and receiver:

In Eq. (1) one takes into account the time dilation between the clock of the moving receiver and the clock at rest. The moving receiver clock ticks slower and reads $\nu_0 / \sqrt{1 - v^2/c^2}$ for transmitted frequency ν_0. Therefore, it follows that the optical DE in an approaching receiver is described by the following equation:

$$\nu_E = \frac{\nu_Q}{\sqrt{1 - \frac{v^2}{c^2}}}\left(1 + \frac{v}{c}\right) = \nu_0 \frac{c+v}{\sqrt{c+v}\cdot\sqrt{c-v}} = \sqrt{\frac{c+v}{c-v}} \tag{4}$$

Next, based on the optical case described by Eq. (2), consider the case where a moving transmitter does not emit a rest frequency, ν_0. Instead, depending of velocity it emits the reduced frequency $\nu_0 \cdot \sqrt{1 - v^2/c^2}$. Therefore, the receiver registers all of its frequency change according to Eq. (3), instead of Eq. (2):

$$\nu_E = \nu_0 \sqrt{1 - \frac{v^2}{c^2}} \cdot \frac{1}{1 - \frac{v}{c}} = \nu_0 \frac{\sqrt{c+v}\cdot\sqrt{c-v}}{\sqrt{c-v}\cdot\sqrt{c-v}} = \sqrt{\frac{c+v}{c-v}} \tag{5}$$

The standard interpretation of optical one-way Doppler Effect states that measured frequency is the same regardless of whether the source or receiver is moving. It is often cited as a reason that there is no propagation medium for light. And therefore, standard theorists conclude that ether does not exist. But, as demonstrated with equations (4) and (5), it may be due to time dilation alone.

3. Doppler-Radar

Radar is based on the two-way Doppler Effect. Because of reflection from the moving target, radar produces a dual frequency change. The simplest classical acoustic case involves a transmitting system and a receiving system. In this case, the propagation medium is still air, and it carries the sound frequency ν_0.

If a car is approaching in a straight line, according to Eq. (1) it would receive a DE frequency of ν', as described below:

$$\nu' = \nu_Q\left(1 + \frac{v}{c}\right) \tag{6}$$

As a reflector, the car emits the above frequency. Additionally, it acts as a transmitter, which produces a reciprocal effect. The stationary unit receives the transmitted signal according to Eq. (2). This produces the following classical radar equation for frequency ν'':

$$\nu'' = \nu'\frac{1}{1 - \frac{v}{c}} = \nu_0\left(1 + \frac{v}{c}\right)\frac{1}{1 - \frac{v}{c}} = \nu_0 \frac{c+v}{c-v} \tag{7}$$

Now, consider the case of an electromagnetic radar measurement for an approaching car. It would receive a DE frequency of ν', corresponding to Eq. (3):

$$\nu' = \nu_0 \sqrt{\frac{c+v}{c-v}} \tag{8}$$

According to SRT, the frequency reflected from the car would be returned unchanged. Applying this to Eq. (3) gives the electromagnetic radar equation for frequency ν'':

$$\nu'' = \nu'\sqrt{\frac{c+v}{c-v}} = \nu_0 \frac{c+v}{c-v} \tag{9}$$

As a result, the optical and acoustic radar equations are identical.

There are reasons for the assumption that the two-way DE for EMW follows the laws of classical mechanics. Time dilation for radar measurements is irrelevant because the frequency standards for the sender and receiver are identical. Another frequency standard for a measuring device on top of a moving car is not of interest. Therefore, a measurement corresponding to Eq. (8) for the car is not needed. A car does not reflect relativistic measurements. Instead, it reflects natural frequencies corresponding to classical Eq. (6).

From the precisely measurable beat frequency, $\nu'' - \nu_0$, in combination with Eq. (7) or (9), the amount of target velocity v in the radial direction in the first order of v/c is calculated as follows:

$$v \cong \frac{c}{2} \cdot \frac{\nu'' - \nu_0}{\nu_0} \tag{10}$$

A more accurate second order calculation of v/c is slightly more complicated:

$$v \cong \mp\frac{c}{2} \pm \frac{c}{2}\sqrt{\frac{2\nu''}{\nu_0} - 1} \tag{11}$$

The upper signs apply when the radial approaches the target. The lower signs are for a retreating target. Thus, it is possible to determine motion with respect to hypothetical ether – based on the assumption that the ether is a reference system at rest.

4. Principle and Experimental Proposal to Measure the Ether Wind by Doppler Radar

In the case of acoustics, it is possible to measure the anisotropic speed of sound in a moving open system in the medium of air. For example, against a wind of velocity v sound travels at *c-v*. Today, most mechanical anemometers operate with acoustics. From this, the directional signal propagation speed of sound is determined. From their deviation from *c* in a still-air reference system, the wind's speed and direction are determined. The wind velocity vector corresponds to the absolute velocity vector of the measuring device – measured with the still-air reference system. This is possible, because sound has a propagation medium (air).

While air serves as the well-established propagation medium for sound, this paper calls into question the hypothesis that elec-

tromagnetic waves propagate without a transfer medium. The difference between sound and electromagnetic propagation may be due solely to the time measurements with clocks whose frequency is dependent on absolute velocity with respect to the propagation medium.

The one-way DE for EMW is a conglomeration of two different physical effects: Classical DE plus time dilation. The derivation of equations (3) to (5) shows that. Experiments with one-way Doppler measurements cannot provide information about a medium for EMW.

The acoustic and electromagnetic radar equations (7) and (9) lead to the conclusion that this restriction on the two-way Doppler method does not exist. This is confirmed by the inability to demonstrate a transverse Doppler effect in the reflection process of light [3] or microwaves [4].

Based on these assumptions, it might be possible, through experiments with Doppler radar, to demonstrate the existence of a propagation medium for electromagnetic waves and movements within it. For this purpose, it is only necessary to put a reflector in relative translational motion to a unit that transmits and receives electromagnetic waves. Then, the signals require evaluation according to the classical Doppler formula.

The basic equations (1) and (2) are inappropriate for this. That is because they only describe the simplest Doppler case. A more general, classical Doppler formula takes into account the components of absolute velocities, u, of the source and the receiver in the direction of propagation. Below, Fig. 1 depicts a radar system, A, which serves as the source for sending the frequency ν_0
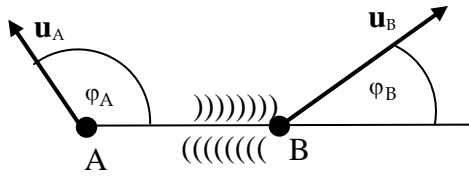

Fig. 1. A=Radar unit, B= Reflector, without wind

The reflector B receives the following frequency:

$$\nu_B' = \nu_0 \frac{c - u_B \cos\phi_B}{c - u_A \cos\phi_A} \tag{12}$$

After the signal is reflected from B, B becomes the source. This changes the indices. The new direction of propagation becomes the complement to 180°. Because of this, the relationship can be represented as follows:

$$\cos(180° - \phi) = -\cos\phi$$

However, by changing only the sign of the angular terms, the amounts remain the same. The radar system A receives the frequency ν'', which is described with the following equation:

$$\nu'' = \nu_B' \frac{c + u_A \cos\phi_A}{c + u_B \cos\phi_B} = \nu_0 \frac{c - u_B \cos\phi_B}{c - u_A \cos\phi_A} \cdot \frac{c + u_A \cos\phi_A}{c + u_B \cos\phi_B} \tag{13}$$

This calculation is equivalent to the classical use of relative velocity v within an inertial system moving in the medium. This takes into account wind velocity v_W in the direction of propagation of waves. In the inertial system, wind speed is measured inversely to the absolute velocity u of the inertial system.
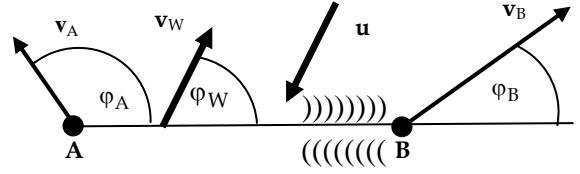

Fig. 2. A=Radar unit, B=Reflector, W=Ether wind

The reflector B in Fig. 2 receives the following Doppler shifted frequency:

$$\nu_B' = \nu_0 \frac{c + v_W \cos\phi_W - v_B \cos\phi_B}{c + v_W \cos\phi_W - v_A \cos\phi_A} \tag{14}$$

To calculate the reflected DE, change the subscripts A and B and the sign of the angular terms. The radar system tunes the frequency as follows:

$$\nu'' = \nu_0 \frac{c + v_W \cos\phi_W - v_B \cos\phi_B}{c + v_W \cos\phi_W - v_A \cos\phi_A} \cdot \frac{c - v_W \cos\phi_W + v_A \cos\phi_A}{c - v_w \cos\phi_W + v_B \cos\phi_B} \tag{15}$$

Note: The terms $c \pm v_W \cos\phi_W$ correspond to anisotropic propagation velocities in the moving system.

In general, the transmitting and receiving station A is anchored in the moving inertial system. This means that the velocity component is $v_A \cos\phi_A = 0$. This produces the simpler equation:

$$\nu'' = \nu_0 \frac{c - v_B \cos\phi_B + v_W \cos\phi_W}{c + v_B \cos\phi_B - v_W \cos\phi_W} \cdot \frac{c - v_W \cos\phi_W}{c + v_w \cos\phi_W} \tag{16}$$

The angles continue to refer to the propagation direction of the output signal. In the case of the radial approach of B towards A, with $\cos\phi_B = -1$, and by neglecting the wind component, then Eq. (16) can be simplified with the Radar equations (7) or (9).

Eq. (15) and (16) show that two-way Doppler measurements can be flawed without taking into account the wind component. Such measurements, with known relative velocities within the inertial system, can be used to calculate the absolute velocity u and the ether wind velocity v_w.
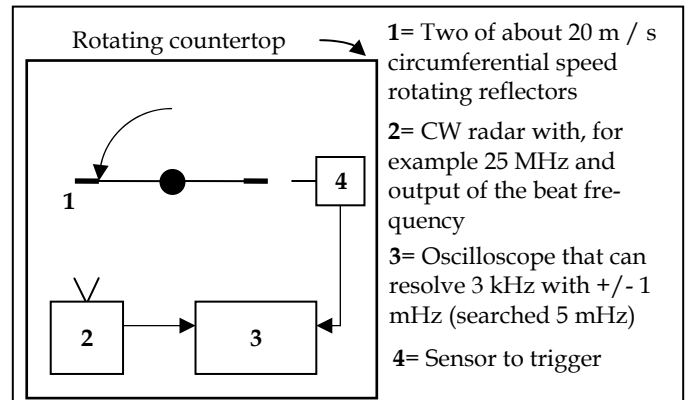

Fig. 3. Schematic diagram of CW-Doppler radar experiment

Verification of Eq. (16) for the electromagnetic case can be performed experimentally in a closed laboratory. A table is placed on an axel so it can be positioned at various angles. A 25 GHz radar is placed on the table so it faces an adjustable reflector. This device is designed to give the reflector either a constant or periodic transversal motion. For example, at some radius, R, the linear velocity equals 20 m/s (reflected by either linear,

streaming, rotating, or vibrating motion). Fig. 3 shows an embodiment of this potential experiment. In principle, this is a Michelson-Morley experiment with an active Doppler Effect. It needs only one arm because, in each direction, it yields individually identifiable, numeric, measureable results.

Because of Earth's travel toward Leo at 368 km/s, this movement should produce a difference of 5 mHz between the 3 kHz beat frequencies towards Leo (CMB dipole) and the perpendicular wind direction. Subsequent calculations, as well as Fig. 4, show that.

In the phase in which the reflector is moving towards the radar, should reflect the usual political radar equation (9) independently arising from the orientation in space following Doppler frequency:

c = 300 000 000 m/s

v = 20 m/s

ν_0 = 25 000 000 000 Hz

$$\nu'' = \nu_0 \frac{c+v}{c-v} = 25000000000 \cdot \frac{300000020}{299999980} \text{ Hz}$$

ν'' = 25000003333,333556 Hz

Because of the anisotropy of the CMB but could an ether wind of size 368 000 m / s from the direction of the constellation Leo blow. If the device in this direction, should according to Eq. (16) results in the following Doppler frequency:

c = 300 000 000 m/s

v_B = 20 m/s

ϕ_B = 180°

v_W = 368 000 m/s

ϕ_W = 180°

ν_0 = 25 000 000 000 Hz

$$\nu''_A = 25000000000 \frac{300000020 - 368000}{299999980 + 368000} \cdot \frac{300368000}{299632000} \text{ Hz}$$

ν''_A = 25000003333.338570995 Hz

The calculations reveal about 5 mHz more than expected without an ether wind component -- or received equivalently by orientation of the apparatus across the CMB dipole. For the real data, ν_0, ν'', and the known relative target velocity, v_B, the wind speed is calculated to 368,000 m/s:

$$v_W = \frac{v_B}{2} \pm \sqrt{\frac{v_B^2}{4} + c^2 - cv_B \frac{\nu''/\nu_0 + 1}{\nu''/\nu_0 - 1}} \qquad (17)$$

The speed of the target could and should be accurate using Eq. (11) from the minimum value of ν''. It can be calculated if the direction of the device is perpendicular to the wind direction.

Set up the apparatus from the opposite direction so that the ether wind is blowing in the direction of the transmitted signal. Also ϕ_W must be 0 °, giving the following frequency:

$$\nu''_A = 25000000000 \frac{300000020 + 368000}{299999980 - 368000} \cdot \frac{299632000}{300368000} \text{ Hz}$$

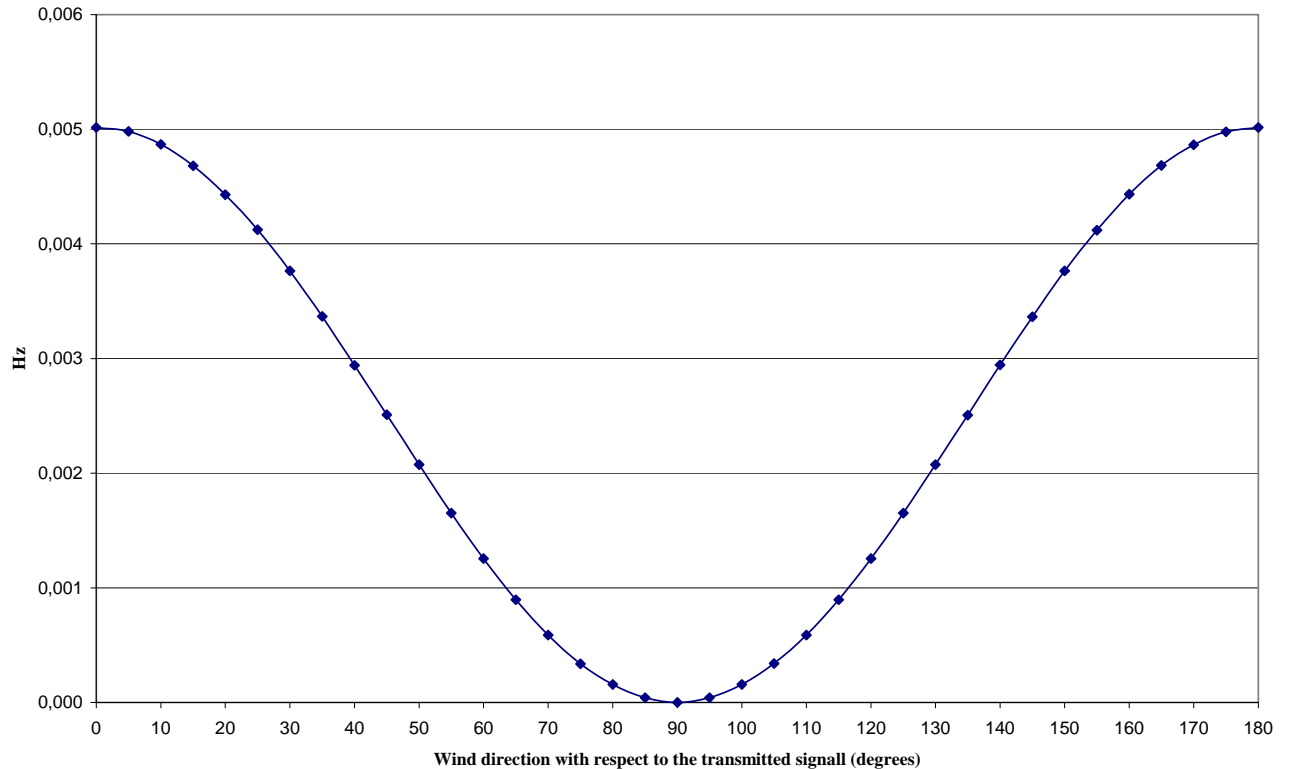ν''_A = 25000003333.338571540 Hz

Fig. 4. Calculations for a proposed 25-GHz Doppler radar experiment. The reflector is approaching 20 m / s. Adoption: Ether wind with 368 km / s. Difference on the beat frequency without wind or perpendicular to the wind direction.

Once again, this is approximately 5 mHz more than one would measure across the CMB Diopol. The difference between the beat frequency perpendicular to the CMB dipole is nearly symmetrical, as the following graph shows. The direction maxima at 0° and 180 ° of about 5 mHz differs by only by 0.5 µHz.

Technically, this measurement is difficult to achieve. Perhaps the effect is contained within unexplained variations in Doppler tracking of space probe navigation. Alternatively, this measurement can be tested via an experiment with sound in flowing air.

5. Conclusions

Doppler measurements with direct reflection only need one clock. In this instance, it is assumed that the classical calculation of the Doppler Effect (for the propagation in a medium) is also valid for electromagnetic waves. Old, as well as new, measurements could reveal a violation of Lorentz invariance. According to the experiment proposed in this paper, basic conditions were outlined for determining the direction and velocity of Earth.

This experiment is best suited for the proof of the existence of a preferred reference frame in a closed laboratory.

Acknowledgements

References

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