Daily variations of the amplitude of the fringe shifts observed when an air-glass Mach-Zehnder type interferometer is rotated - a preliminary report

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We study the daily variations of the amplitude of the fringe shifts observed in the interference pattern of a Mach-Zenhder-type interferometer in which one arm is traversed in air while the other traverses a glass slab. The study is based on data collected over a period of years (2018-present), with digital pictures of the interference pattern taken every 3 seconds, while the interferometer is being slowly rotated (120°/min) around an axis perpendicular to the ground. Fringe shifts in the interference pattern are observed and are correlated to the angle of rotation. Furthermore, we also measure daily variations in the amplitude of these fringe shifts. The frequency of the daily variation seems correlated with the sidereal day. Our findings do not seem to contradict, at least to slow speed approximation, either Special Relativity nor the Lorentzian Theories. We discuss our interpretation of these variations. Further independent studies are required to confirm our findings and to explore their implications.

I. INTRODUCTION

Interferometers are widely used in precision measurements of the speed of light and other physical quantities. So-called one-way interferometers are interferometers in which light only travels in one direction from the source to the receiver. The interference pattern is affected by various factors that can cause a shift in the interference fringes.

In our experiment, light travels through air in one of the arms of the interferometer while on the other arm light travels through a glass slab of refractive index $n \approx 1.6$, and length 0.6m.

Some years ago, we wrote a lenghtier introduction for a research similar to this that the reader might find informative [1]. This same publication treats a similar topic from a simpler point of view.

In this study, we focus on the daily variations of the amplitude of the fringe shifts observed when the interferometer is rotated. The amplitude of the fringe shift is correlated to the angle of rotation of the interferometer.

We aimed to investigate if whether there were any fringe shifts upon rotation, and if the amplitude of the fringe shifts would vary over time with a sidereal period. Any signal not meeting these requirements would have to be interpreted as noise.

We find that, additionally, different amplitudes of the fringe shifts are predictably expected for different configurations of the interferometer: air-glass, air-air, glass-glass, air-2xglass [2]

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II. METHODOLOGY

A. Experimental setup

We conducted our study using a one-way interferometer at rest in a laboratory. A diagram of the experimental set up can be seen in Fig. 1.

We used a non-frequency-stabilized HeNe laser (wavelength of 632.8nm) as the light source and a digital photographic camera as the receiver.

B. Digital pictures

The camera takes HD (720x1280p) digital photos of the interference pattern every 3 seconds while the interferometer is being slowly rotated with respect to an axis perpendicular to the ground.

The metadata of each photo contains the cardinal orientation of the camera as well as a timestamp, among other information. Since all elements of the experimental set-up are fixed relative to each other, the orientation of the camera reveals the cardinal orientation of the beam of light that comes out of the laser.

Using this information (fringe position in the picture, timestamp and cardinal orientation of the beam of light) for each picture, we are able to study correlations between the angle of rotation of the interferometer and the observed fringe shifts.

C. Precision of the method

In each picture, fringes are usually resolved at a width of approximately 70px, so at the bare minimum we can resolve a fringe with $1.4\% = 1px/70px \times 100\%$

However, the statistical error can go as low as 0.1px.

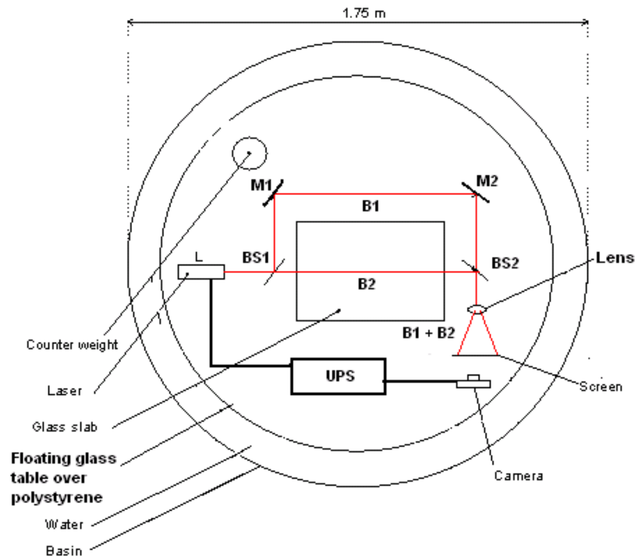

FIG. 1. Diagram of experimental setup. Light is emitted by a HeNe laser seen in the middle left of the figure. The beam is divided by Beam Splitter 1 (BS1) into beams B1 and B2. B1 traverses air while being reflected by M1 and M2 to meet B2 at BS2. B2 traverses a glass slab n=1.6 and meets B1 in BS2, and both beams form an interference pattern that is registered by the camera. The interferometer is floating over water, and rotaing slowly 120°/min while pictures are taken of the interference pattern every three seconds. This is the basic, initial configuration of the apparatus. Multiple variations were also studied (air-air, glass-glass, air-2xglass [2]).

As seen in Figure 1, in one of the arms of the interferometer (B2, aka Beam 2, in the diagram) light traverses a glass slab ($n \approx 1.6$, length=0.6m). In the other arm (B1 in the diagram) light traverses air.

We collected data, mostly continuously, since Aug-2018 to present. Pictures of the interference pattern were taken every 3s for different configurations of the interferometer (air-glass, as described above, we also measured other configuration like air-air, glass-glass and air-2xglass [2]).

The analysis starts with a typical picture like Fig. 2.

For each picture, we identify the position of each interference maxima (see Fig. 3). Notice the red vertical bars that indicate rotations of the interferometer.

We then identify the position of only one fringe, and separate into a series of rotations. A plot of individual rotation can be seen in Fig. 4. Notice that in this figure the scale on the vertical axis is still in pixels so we can still appreciate the size of the fringe in pixels.

We finally interpolate the data points to obtain 360 points (one point per degree of rotation) that we can easily average to obtain a figure like Fig. 5.

This way we are able to estimate the amplitude of the fluctuation upon rotations of the interferometer. This is obviously a very rough estimate as it ignores other seemingly important information like the angular positions of

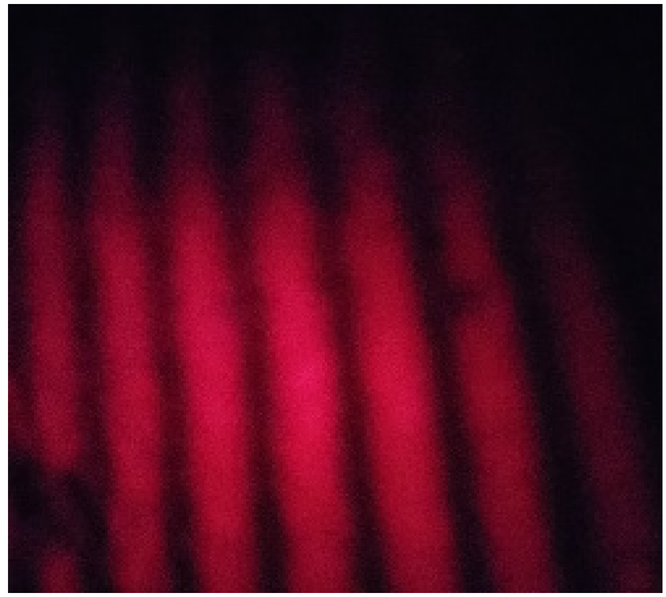

FIG. 2. typical picture of the interference pattern.

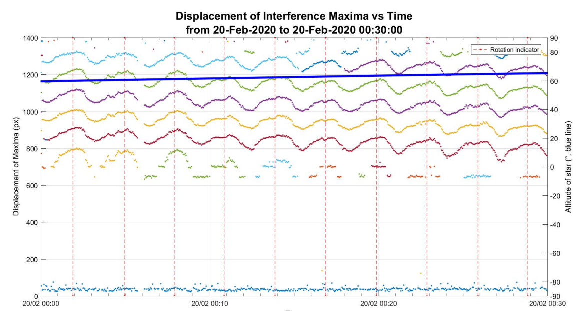

FIG. 3. Easily seen fringe shifts upon rotation. Rotations are indicated with red vertical lines. Blue line shows the altitude (right vertical axis) of HIP54589 as seen in the sky of Caracas, Venezuela at date of measurement.

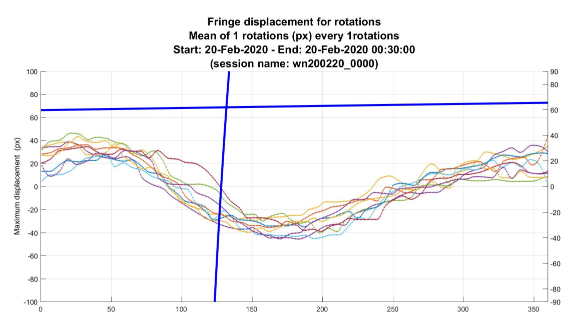

FIG. 4. The plot shows the different rotations of a single fringe during the 30minute window (approximately 10 successive rotations). Notice that the vertical axis is not normalized by the fringe width, so the actual size of the fringe in pixels can be seen. The horizontal blue line shows the altitude (right vertical axis) of the star HIP54589 as seen in the sky of Caracas, Venezuela at date of measurement.

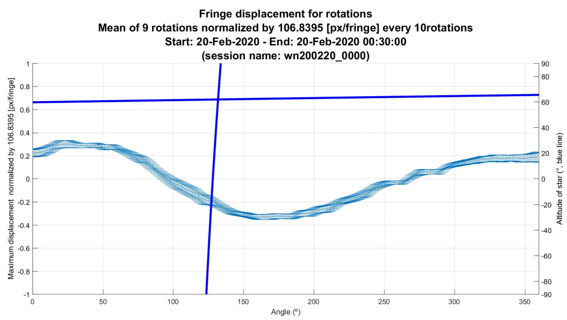

FIG. 5. 30min. average of the shift of a fringe of the interference pattern (≈ 10 rotations, meaning it's an average of ≈ 10 points per angle), shown per angle of rotation. Fringe shift is significantly higher than statistical error bars. Amplitude vs Angle profile is very similar (yet inverted) to the predicted value shown in Fig. The horizontal blue line shows the altitude (right vertical axis) of the star HIP54589 as seen in the sky of Caracas, Venezuela at date of measurement.

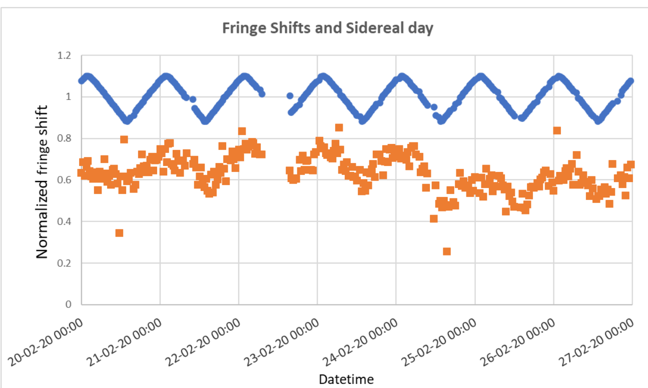

FIG. 6. daily-variation-2020-02-20. The blue line is a visual indicator of the sidereal day frequency, by plotting the altitude of the star HIP54589 as seen in the sky of Caracas, Venezuela at the time of measurement. Orange dots represent the amplitude of the fringe shift, calculated by averaging 10 rotations of the interferometer and then taking the difference maximum-minimum of this average.

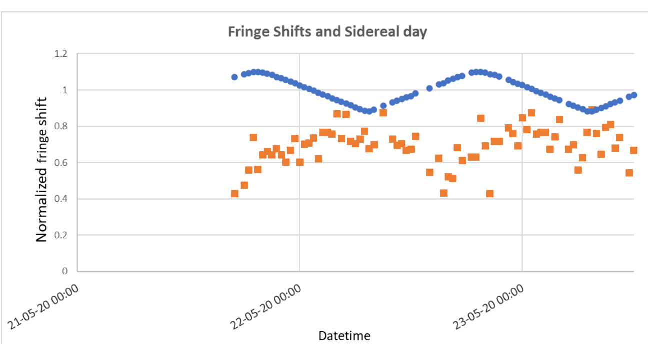

FIG. 7. daily-variation-2020-05-20. The blue line is a visual indicator of the sidereal day frequency, by plotting the altitude of a fixed galactic coordinate. Orange dots represent the amplitude of the fringe shift, calculated by averaging 10 rotations of the interferometer and then taking maximum-minimum.

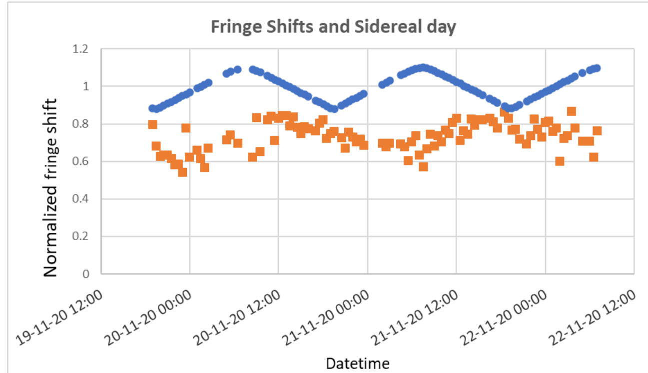

FIG. 8. daily-variation-2020-11-19. The blue line is a visual indicator of the sidereal day frequency, by plotting the altitude of a fixed galactic coordinate. Orange dots represent the amplitude of the fringe shift, calculated by averaging 10 rotations of the interferometer and then taking maximum-minimum.

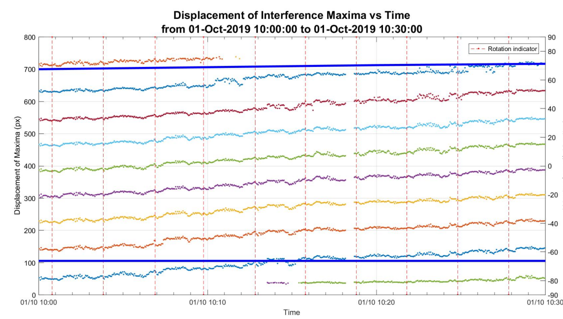

FIG. 9. In this configuration of the interferometers there are no ovious visible oscillations correlated to rotation like in previous figures. Bottom blue line seems to be an error of the plot, please disregard.

the maxima and the shape of the fringe shift profile.

We work with a stream of pictures of 30min in length (around 600 pictures) to take the average. That is why in figures such as Fig. 6 there is a point every 30 minutes.

III. RESULTS

A. Amplitude of fringe shifts and their daily variation

Figures like Fig. 4 show the correlation between the amplitude of the fringe shifts and the angle of rotation. Figures like 6, 7 and 8 show how this amplitude varies over time.

Furthermore, it can be seen that in the three figures 6, 7 and 8, there is a strong correlation between the blue line (visual indicator of the sidereal day frequency) and the measurements, indicating a strong correlation with the sidereal day.

Figures 6, 7, and 8 are some examples of daily varia-

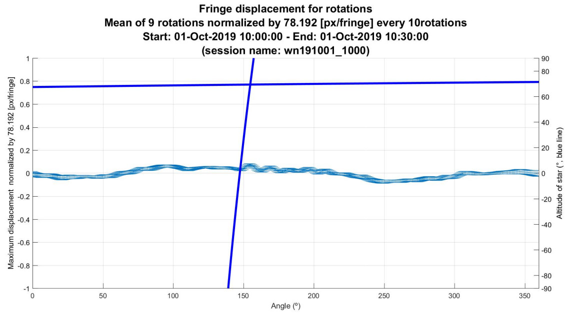

FIG. 10. In this configuration of the interferometer the average of rotations is almost under the error bars.

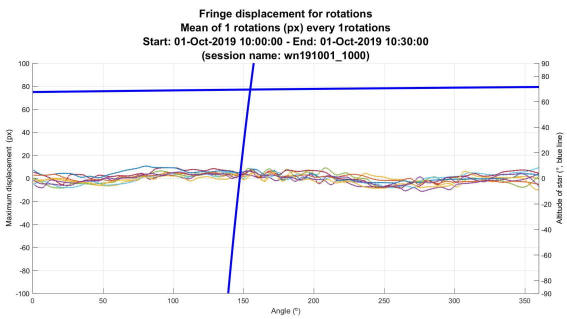

FIG. 11. In this configuration of the interferometer we can see that in the individual rotations of a single fringe there are no visible oscillations correlated to rotation - at least without further, deeper analysis.

tions of data taken during 2020. The orange dots represent the amplitude of the fringe movement, while the blue dots are a visual indicator of the sidereal day - more precisely, the altitude of the known star HIP54589. [3]

The daily variations, on the other hand, were harder to find since we didn't expect them to be so small sometimes (for example, 0.1 fringes, February 2020), and because of natural, expected noise in the data.

These results are in stark contrast with measurements in other configurations of the interferometer. See for instance Fig. 9.

In the figure showing the average of rotations, Fig. 10, and the independent rotations of the fringe as seen in Fig. 11 movement along each independent rotation shown in Fig. 11 in this same configuration as in Fig. 9.

These alternate configuration will be reported more in depth in future, more comprehensive, reports.

Our results show not only rotational effects (fringe shifts) correlated to the angle of rotation of the interferometer - which is interesting enough. We further show that the amplitude of these fringe shifts varies with a period strongly correlated with the Sidereal Day.

Our measurements can be interpreted as confirming our motion relative to the medium that propagates light.

Since both Special Relativity and classical Lorentz theory are compatible with the idea of an ether [4], our experiment does not support or contradict any of the two theories (see for instance 34 in [4]).

Rather, our results strongly support the existence of an ether and of our motion relative to it.

IV. DISCUSSION

A. Meaning of the results

We interpret our results as the detection of motion through the medium that propagates light (aka, the ether).

Our results are compatible with both the Lorentz theory and Special Relativity [4] but are decisive in the existence of the ether.

It has also been shown recently that "Einstein equations [can be derived] using aether theory" [5].

We expected to measure daily variations in the amplitude of the fringe shifts observed upon rotation (because of Earth's rotation and hence our perspective of the sky), but we expected a greater amplitude in the intraday variation of the amplitude of these fringe shifts.

B. Rotational effects

As evidenced by the figures in the Results section, there is a correlation between the amplitude of the fringe shifts and the angle of rotation.

C. Small daily variations

Initially, our hypothesis was that any detected movement would likely be aligned with the CMBR dipole. However, given the observed daily variations of 0.1-0.3 fringes, it is unlikely that our motion is directed towards the CMBR (or perhaps some geometric effect of Earth's axis orientation).

If our velocity were directed towards the CMBR dipole, we would expect a greater decrease in amplitude in accordance with the trajectory of the galactic coordinates of HIP54589 as seen in the sky ([6]).

While we cannot rule out this possibility, it seems unlikely. The detection of daily variations as small as 0.1 fringes (on fringe shifts of 0.6 fringes per rotation) suggests a relatively small solid ring (or annular solid angle) in the sky where our velocity could be pointing to ([7]).

D. Sidereal day frequency

The period of the daily variations is seemingly correlated with the sidereal day. This has to be studied in much more detail. More data and other analysis are yet to be done by the authors.

There are some yet unexplained phase differences, but it can be argued that the correlation holds.

V. CONCLUSIONS

In our investigation, we measured the amplitude of the fringe shifts observed upon rotation of the interferometer.

We interpret these as evidente of our movement though the medium that propagates light (aka, the ether).

Once we detected the fringe shifts on rotation, we naturally expected to measure daily variations in the amplitude of these fringe shifts, because of Earth's rotation.

Given the trayectory of HIP54589 as seen in the sky of Caracas (which crosses the horizon and mostly passes through the cenit/nadir), we expected to measure a greater amplitude of the daily variation than what we ended up measuring.

We initially hypothesized that any detected movement would likely be towards the CMBR dipole, but the observed daily variations of 0.1-0.3 fringes seem to suggest otherwise. We also observed unexplained phase changes between the period of the daily variations and the sidereal day.

We have discussed potential causes for these daily variations. However, further research is necessary to confirm these findings and investigate their broader implications in physics.

These results are sure to provide new insights into our understanding of the universe.

ACKNOWLEDGMENTS

This draft manuscript and research wouldn't have been possible without the hard-work and collaboration of a person that prefers to remain anonymous. ....

[1] R. Te Winkel and a. M. Rodríguez, On the Detection of Absolute Motion Relative to a Preferred Frame (2011), https://hal.science/hal-00588494.

[2] Authors, The light beam traverses twice the optical path in glass hence giving double the effect, as expected. Usually this an optical path of almost 2m. vs 60cm. through air (glass slab is 60cm).

[3] This star was chosen as a reference to find the approximate location of the CMBR dipole in software such as Stellarium [8] [9].

[4] L. E. Szabó, Lorentzian theories vs. einsteinian special relativity — a logico-empiricist reconstruction, in *Der Wiener Kreis in Ungarn / The Vienna Circle in Hungary*, edited by A. Máté, M. Rédei, and F. Stadler (Springer Vienna, Vienna, 2011) pp. 191–227.

[5] F. J. T. Maurice J. Dupre, General relativity as an aether theory, arXiv:1007.4572 (2010), 'Most early twentieth century relativists — Lorentz, Einstein, Eddington, for examples — claimed that general relativity was merely a theory of the aether.'.

[6] HIP54589 is seen traversing the horizon and cenit/nadir in Caracas'sky.

[7] For example, if our movement were towards the Polar star, we would not expect almost any daily variation in the amplitude of the fringe shifts since the altitude of the polar star stays fairly constant.

[8] Y. M. Zalkins, arXiv:1303.5087 [astro-ph.CO] (2015).

[9] P. Z. et al. (Particle Data Group), Cosmic microwave background review by scott and smoot, doi:10.1093/ptep/ptaa104 (2015).