An Experimental Verification for the Existence of Dark Matter and its Fluid Nature

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ABSTRACT

The existence of dark matter and its fluid nature, has been investigated by using the most general equation of Sagnac interferometer. The paper proves, first, the existence of the dark matter, second, its fluid nature, and third, its vertical flow. The comparison between the interference patterns of both Sagnac and Michelson-Morley interferometers has been investigated to confirm the experimental results. The experimental verification has been given using the experimental data of Doug Marett. The compatibility between the profiles of Doug Marett and the results of the theory presented in this paper is consistent with each other. The paper predicts that there are changes in the interference patterns of both Sagnac and Michelson-Morley interferometers at the locations of Perihelion and Aphelion, and at any Lunar Space Station at Apogee and Perigee, as well as on any space station (or satellite) travelling through the solar system. The experimental verification is achieved by tilting the plane of the interferometer which produces different interference patterns. The paper shows that the measurements of small scale Sagnac and Michelson-Morley interferometers, is much better than those of large scale interferometers, where the compromise with revolution per minute should be taken into account. Also, the sensitivities increase with the very minor difference in the arm lengths.

o Introduction

Historically; Einstein initially stated that light did not need a medium for transportation, and thus the conclusion was made that the ether does not exist, thus Einstein neglected hundreds of light experiments that require the presence of a medium that carries the transverse waves of light. Einstein half-heartedly tried to retract this conception 15 years later in a very little known lecture in 1920 at the University of Leiden [1], whereby he stated [2];

"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; for in such space there not only would be no propagation of light, but also no possibility of existence for standards of space and time (measuring-rods and clocks), nor therefore any space-time intervals in the physical sense."

By then, however, the damage was already done- and the world of physics by and large is still carrying forward with the contention that there no ether based on Einstein's original theories.

Also, Michelson-Morley (M-M) experiment failed to detect the 30-kilometer motion of the Earth through the ether around the sun, to overcome this problem, Einstein simply abolish the ether in his

relativity theory. On the other hand, Sagnac experiment had proved that ether exists [3, 4], which pervades all the universe, and this existence is known as "Sagnac Effect", which is widely used by airlines as a fiber optic gyroscope to detect the changes in the direction of the plane. However, Sagnac experiment is rarely mentioned, and almost no physicists never mentioned this important experiment.

Thus, if we prove that ether is existing, which is the medium carrying light waves, this will simply means that ether has the same sense as what we call "dark Matter" (DM), otherwise we will have two media permeate the universe and having the same properties. Note that, the medium carrying light waves doesn't mean it interacts with it, which is one of the most important property of DM. Thus, the conclusions of this paper together with those of references [5, 6, 7 and 8] will prove, beyond any doubt, that DM is the ether itself. And we can say that "ether has come back with a new name DM."

Now, NASA, along with many scientists, has gone too far into the deep space of the universe to hunt the existence of DM [9, 10], while we have a near proof, at hand, for the existence of DM and its fluid nature. In fact; this paper is considered part II of reference [5], but in this paper we are dealing with Sagnac Interferometer, and will compare its results with those of reference [5].

In this paper, a new general method for analyzing the vertical rotating Sagnac interferometer has been presented, capable to prove the existence of DM and its fluid nature as well as its vertical flow on any object. The analyses presented include the study of different arm lengths of Sagnac interferometers, as well as the low and high speed rotation and tilting the interferometer. Some of these concepts have been verified using (M-M) interferometer in references [5, 6].

The confirmation of the results, simply means the detection of the change of the shape of the interference patterns, of both Sagnac and (M-M) interferometers, on Earth, or when they are placed in any space station (or any satellite) travelling through the Solar System. The vertical direction in any satellite can be taken approximately as the sum of the vertical DM speeds due to both the sun and the planets. Also, if Sagnac and (M-M) interferometers have enough sensitivities, then they can detect the continuous change in the shape of the interference patterns during the annual journey of the Earth around the Sun. The same can be said for any "lunar space station" (LSS) during its motion around the Moon, and around the Earth as well as around the Sun.

The paper predicts the different interference patterns of both Sagnac and (M-M) interferometers, for the purpose of comparison and verification, at Earth's location at Perihelion and Aphelion, and at any (LSS) at Apogee and Perigee. The paper also predicts the different interference patterns near or at the Terrestrial and Jovian Planets. The paper is considered a reconciliation between references [11] and [12] as well as reference [13].

The paper shows that small scale (short arms) interferometers is better, in measurements, than the large scale (long arms) interferometers, especially when the rotation, of the apparatuses, is taken into account. Thus, the paper recommends the construction of small scale Sagnac and (M-M) interferometers, with enough sensitivity to detect the change in the shapes of the interference patterns at the different locations in the solar system. Finally, the figures presented in this paper have been carefully selected from among hundreds of figures to achieve the purpose of this investigation.

Equations

In the theory presented in this paper, adding or subtracting the vertical component of the speed of the DM, to the speed of light, does not affect or change the results of (M-M) experiment at all. This is due to the simple path of the light beam in (M-M) interferometer. However, the situation is quite different in Sagnac interferometer, as the light beam suffers multiple reflections in these types of interferometers. So, it needs some special treatments and modifications to get the proper equations. In all cases, the equations presented in this paper are written in their most general forms.

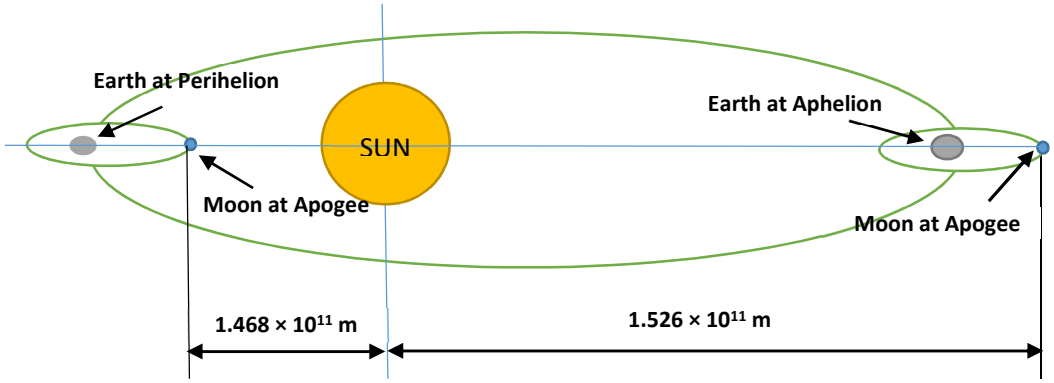


Figure (1) shows the maximum and minimum distances of Earth and Moon from the Sun, where the Earth is at Aphelion and Perihelion, and the Moon is at Apogee. The figure is not to scale.

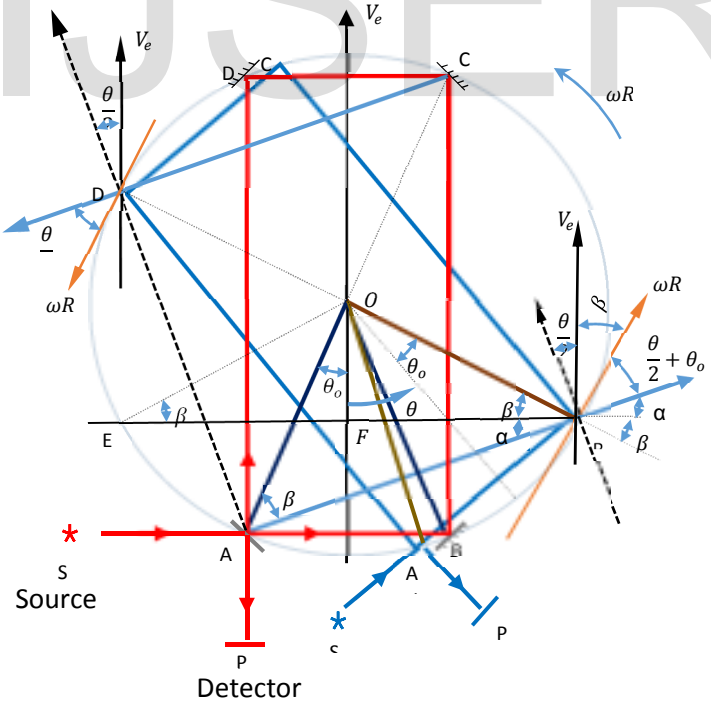


Figure 2: shows a typical rectangular Sagnac Interferometer with different side lengths L_1 and L_2 , when rotated through an arbitrary angle θ. For simplicity the DM flow, V_e , is reversed, as it should directed to the center of the planet.

Figure (2) shows a typical rectangular Sagnac interferometer with different side lengths $\boldsymbol{L_1}$ and $\boldsymbol{L_2}$ at an initial position $\boldsymbol{\theta_0}$, and is rotated through an arbitrary angle $\boldsymbol{\theta}$, with the direction of the vertical flow of DM.

In fact, the derivation of the equations of Sagnac interferometer is much complicated than that of (M-M) interferometer [5], as the internal journey of laser beam inside Sagnac interferometer may suffer multiple reflections before exiting to the detector, which needs some slight modifications to get the right equations which describe this type of phenomenon.

Referring to figure (2), the time taken by the laser beam to cut the forward journey inside the interferometer will be given by;

$$\delta T_{1i} = \sum_{i=1}^{i=4} \frac{L_i}{\sqrt{[c + V_e \cos\varphi_{i,\theta} + \omega R \sin(\varphi_{i,\theta} - \theta_0)]^2 - [V_e \sin\varphi_{i,\theta} + \omega R \cos(\varphi_{i,\theta} - \theta_0)]^2}} \quad (1)$$

Where V_e is the speed of the vertical DM, R half the diagonal of sagnac interferometer and ω is the angular rotation of the interferometer. The corresponding time taken by the laser beam to cut the backward journey inside the interferometer, with slight modification due to multiple reflections, will be given by;

$$\delta T_{2i} = \sum_{i=1}^{i=4} \frac{L_i}{\sqrt{[c + V_e \cos(\frac{\pi}{2} - \psi_{i,\theta}) + \omega R \cos(\psi_{i,\theta} - \theta_0)]^2 - [(-V_e) \sin(\frac{\pi}{2} - \psi_{i,\theta}) + \omega R \sin(\psi_{i,\theta_0})]^2}} \quad (2)$$

Where;

$$\varphi_{i,\theta} = \left(\frac{\pi}{2} - \theta\right) + (i-1)\frac{\pi}{2}; \quad \text{And} \quad \psi_{i,\theta} = \frac{\theta}{2} - (i-1)\frac{\pi}{2} \quad (3)$$

The path difference Δ, is given by;

$$\Delta = c\,\delta T_{1i} - c\,\delta T_{2i} \quad (4)$$

And the number of fringe lines, N, will be given by;

$$N = \frac{\Delta}{\lambda} = \Delta \times \nu \quad (5)$$

Both λ and ν are the wave length and frequency of the laser beam of the interferometer respectively, and c is the speed of light. Equations (1 – 5) are the basic equations of the vertical rotating Sagnac interferometer, as well as tilting and flipping the interferometer, used in the following investigation to prove the existence of the DM and its fluid nature.

Results

To facilitate tracking the figures of this paper, it is necessary to explain the Mathcad legend adjacent to the left of each figure. We shall limit all the figures to describe the number of lines of the fringe pattern, and we shall use two symbols *NS* for Sagnac interferometer and *NM* for (M-M) interferometer. The symbols of the legend *NS* (rpm, θ, $L1$, L_2 , V_e , ν) will denote the following

meanings; NS is the number of fringe lines for sagnac interferometer pattern, *rpm* stands for the revolution per minute of the interferometer, θ is the angular position of the interferometer with respect to the vertical flow of the DM, as shown in Fig. 2. L_1 , L_2 , *are* the lengths of the two opposite arms of the sagnac interferometer and V_e The vertical speed of DM, due to both the planet and the Sun, and finally v the frequency of laser beam.

All these parameters are drawn against the angular position $\boldsymbol{\theta}$ of the interferometer with the vertical direction of the dark matter flow, as shown in Figures 2.

Referring to table I and using equations (1-5), we can construct figures 3 (a, b, c and d), to show the number of the fringe lines at Perihelion, Aphelion, Perigee and Apogee as detected by the Sagnac interferometer. The four arms of Sagnac interferometer are equal and each equals 250 meter, to compare with reference [5]. The Sagnac interferometer has a vertical position and is rotating with very slow speed (0.07 rpm, i.e. 4.2 revolution per hour). The frequency of the laser beam, $\boldsymbol{v}$ = 570 THz, (i.e. 5.7×10^{14} Hz) corresponding to a green light source. The figures are drawn when the Earth and the (LSS) at minimum and maximum locations from the Sun, as shown in figure 1, i.e. at Perihelion and Aphelion for Earth, and at Perigee and Apogee for the (LSS). Note that, the DM speed is inversely proportional to the distance from the center of the planet or the star.

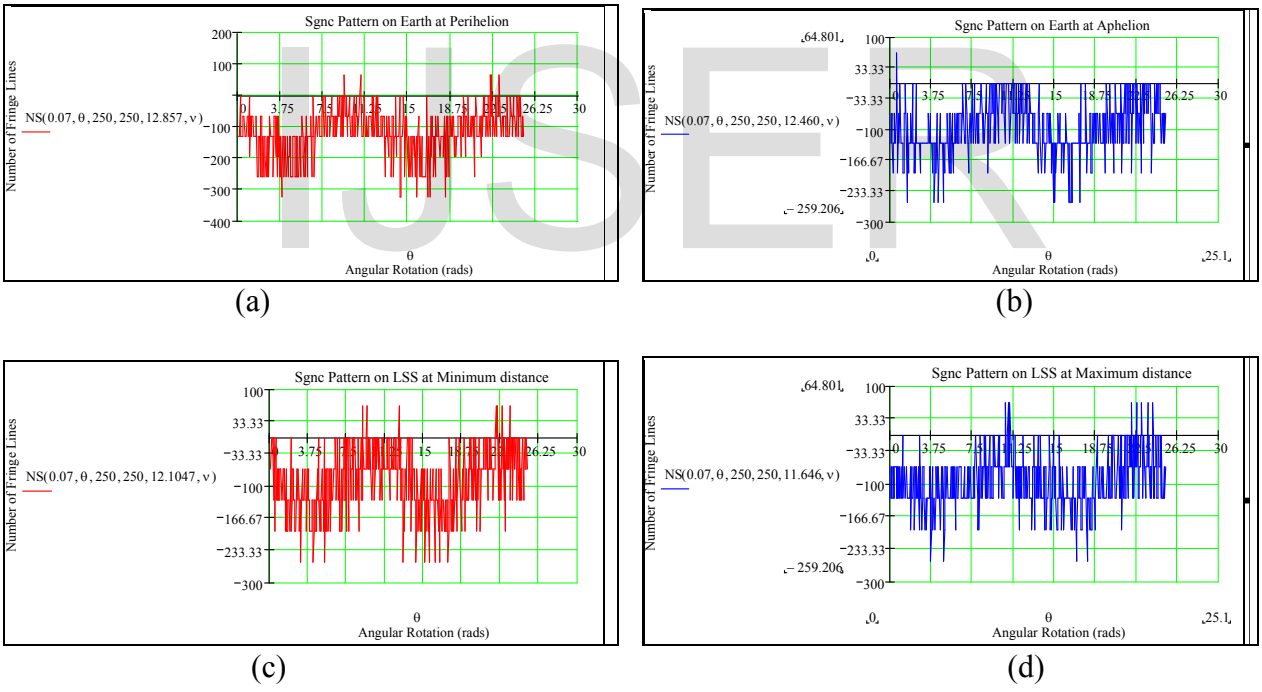
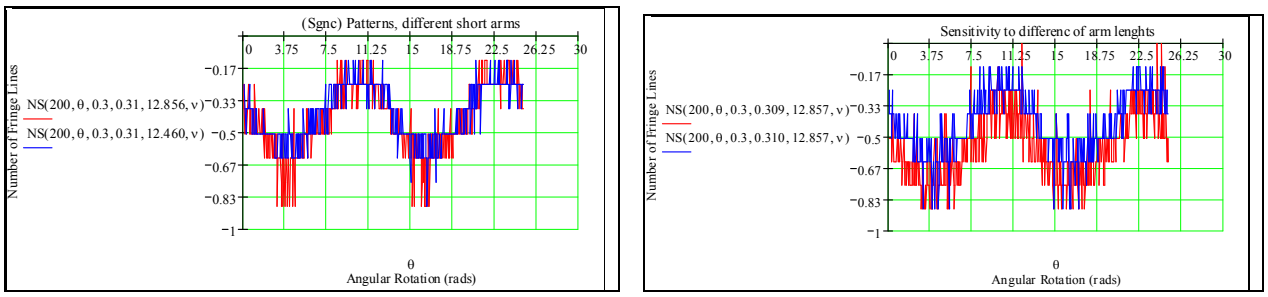


Figure 3: (a), (b), (c) and (d) show the number of lines of the fringe patterns as detected by Sagnac interferometer on Earth at Perihelion (Red), (a, b), and Aphelion (Blue) and on (LSS), (c, d), at minimum distance (Red) and maximum distance (Blue) from the Sun.

It is preferred to put the figures side by side, in figure 3, to show clearly the difference between the shapes of the patterns, as well as the difference between the numbers of the fringe lines of the patterns. The differences between the patterns of the figures are quite clearly, however, it needs a very sensitive interferometer to detect these differences.

The increase of the sensitivity of the interferometer can be made by using shorter arm lengths (30 cm), while making a slight difference between the two arm lengths (of order or less than 0.3 %, in our case 1 mm) as shown in figure (4-a). As shown in figure 4, the speed (200 rpm) is a crucial factor for increasing the sensitivity.



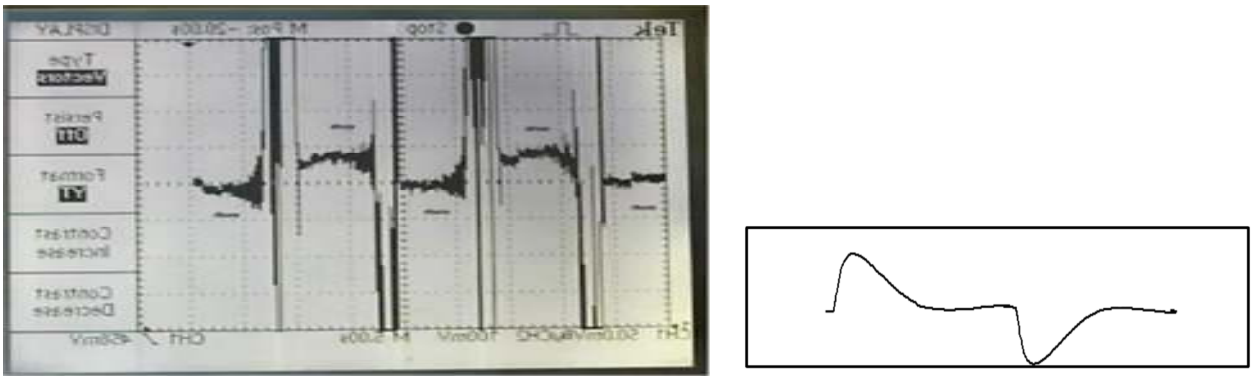
(a) (b)

Figure 4: (a) show the interference patterns of Earth at Aphelion (Red) and Perihelion (blue), at 200 rpm, while (b) shows the change in patterns due to the change in arm lengths by 1 mm, at the same location.

Figure (4-a) shows that, the sensitivity of the interferometer due to the difference of the arm lengths is very high. A difference of 1 mm radically changes the shape of the interference patterns, at the same location.

o Experimental Verifications by flipping the interferometers

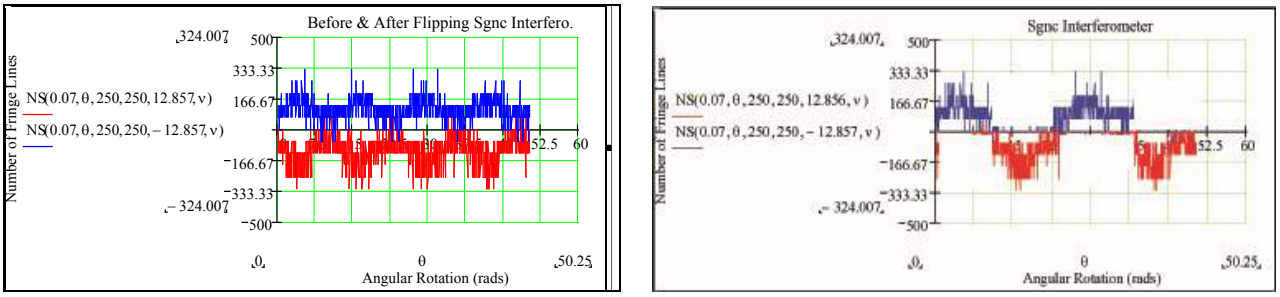
The experimental verifications of the theory presented in this paper as well as those presented in our previous paper [5], depends on the experimental research work performed by **the scientist Doug Marett**, in his site, **the conspiracy of light** [3,4]. Doug Marett made two important experiments concerning Sagnac and (M-M) interferometers. He used 1000 meter Sagnac circular loop to get the oscilloscope results. In our calculations the 1000 meter loop is transformed into 4 equal arms each arm of length 250 meters. The obtained profiles of the interference patterns, as appeared on the Oscilloscope Screen of Sagnac interferometer before and after flipping the interferometer, is shown in Fig. (4), this profile is well agreed with the theory presented in this paper, as shown in figure (5).



(a) (b)

Figure (5): (a) Sagnac pattern as appeared on the oscilloscope screen before and after Flipping the interferometer. (b) Schematic diagram shows clearly the flipping the pattern

Fig. (5- a, b) shows the oscilloscope screens of Sagnac interferometer before and after flipping the interferometer. Flipping the interferometer simply means the reversal of the DM flow with respect to the interferometer, which will flip the interference pattern as shown in figures (5).



(a) (b)

Figure (6): the right figure (a) shows theoretical curves of Sagnac interference patterns before (Red) and after (Blue) flipping the interferometer. The left figure (b), shows the two curves put side by side to match with the experimental figure (5). The difference between figures 4 and 5, is due to shapes of Sagnac interferometers. The theory presented for rectangular interferometer, while the experiment is for circular loop interferometer.

Figures (5) show the theoretical curve of Sagnac interferometer before (Red) and after (Blue) flipping the interferometer. Figure (a) shows, the red curve is the interference patterns at Aphelion (of course, or at any location) and the blue curve is the interference pattern at the same location, when the interferometer is flipped upside down. Figure (b) shows the un-flipped and the flipped curves placed side by side along (16π) period. Both figures are drawn at very low rpm (0.07 rpm). Clearly, the profile of the theoretical figures is full matched with the experimental result, which is considered a solid proof for the existence of DM and its fluid nature. Noting that the difference in shapes between the profiles are due to, the experimental curve is due to a circular loop with total length 1000 m, while the theoretical curve is due to square interferometer each arm length is 250 m.

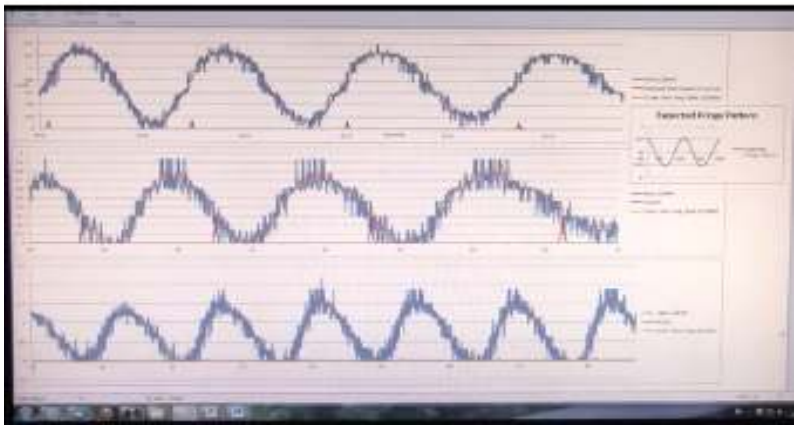
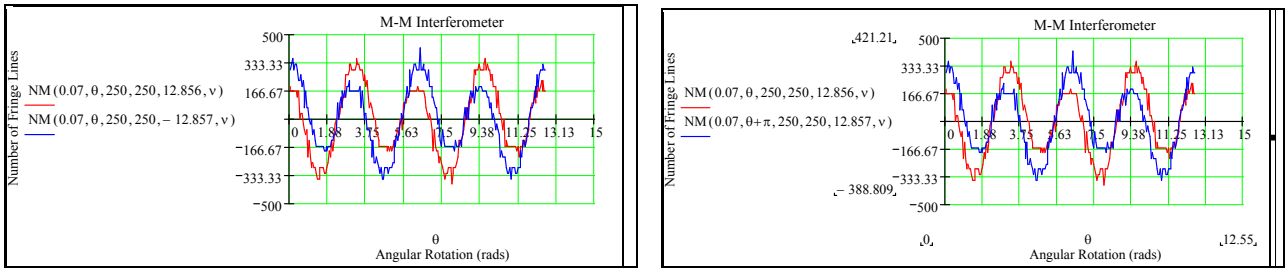


Figure (7) Oscilloscope screen of Michelson-Morley experiment

On the other hand, there is no meaning to flip (M-M) interferometer, as the rotation means periodical flipping the interferometer with the rotation. Figure (8) shows two identical interference patterns, the left figure is drawn with reversing the velocity of the DM flow. This is done by

introducing a negative sign before the speed of DM, as shown in the legend of figure (5-a). While figure (5-b) is drawn by adding a phase difference equals π to the angle of rotation $\boldsymbol{\theta}$, as shown in the legend of the figure, which yield identical curves. Of course, this confirms the validity of the given theories.



(a) (b)

Figure (8): Theoretical curves of (M-M) Interference patterns before and after flipping the

It should be noticed that, the ripples of the laboratory curves are not noises due to the oscilloscope circuit parameters, as Doug Marett recorded, but it is part of the phenomenon, as the theory proves that. A full investigation of this case was introduced in our previous paper [5].

○ Infinite Experimental Verifications

In fact, we can claim that we have infinite experimental verifications for the existence of DM and its fluid nature. This simply means, we can record a continuous change in the shape of the interference patterns, of both (M-M) and Sagnac interferometers on Earth, on any space station or on any satellite, travelling through the Solar System. Also, if (M-M) and Sagnac interferometers have enough sensitivity, then we can detect the continuous change in the shape of the interference patterns during the annual journey of the Earth around the Sun. The same can be said for any lunar space station during its motion around the Moon, around the Earth as well as around the Sun.

Referring to reference [7], we can construct table I, II and III, which shows the speed of DM that falls vertically on the corresponding planets. The calculation is approximately made, by simply adding the speeds of the falling DM due the planet itself and that due to the Sun at the planet location. The DM speed due to the Black Hole at the center of our Milky Way galaxy is not taken into consideration. Or more specifically, it is left deliberately to compensate any inaccuracy needed, when the interferometers are put into action.

○ Effect of increasing the rpm on the spectrum of the Terrestrial Planets

In the following we shall investigate the number of lines of fringe patterns as detected by both Sagnac and (M-M) interferometers, for different rpms and different arm lengths, for both Terrestrial and Jovian Planets.

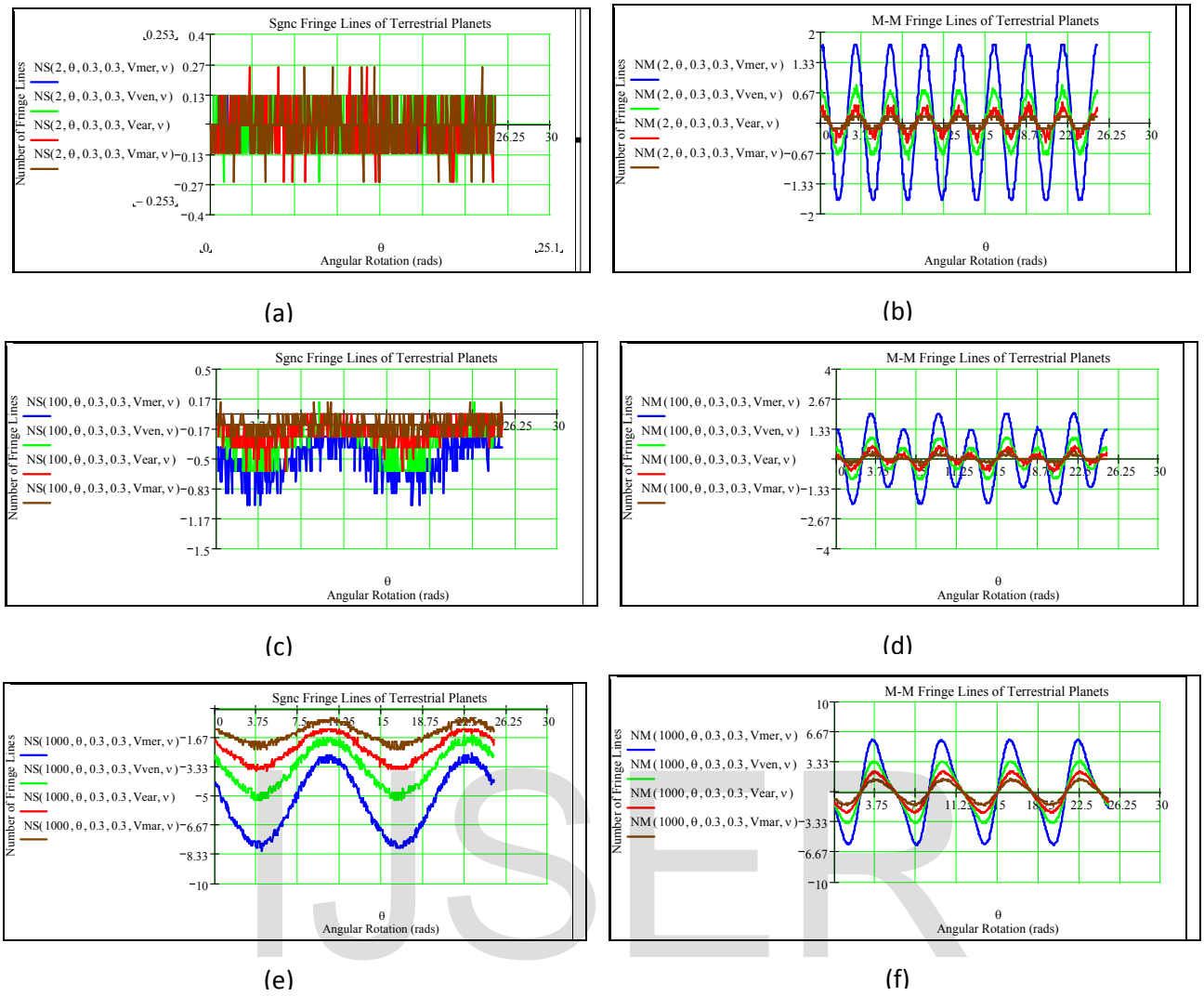
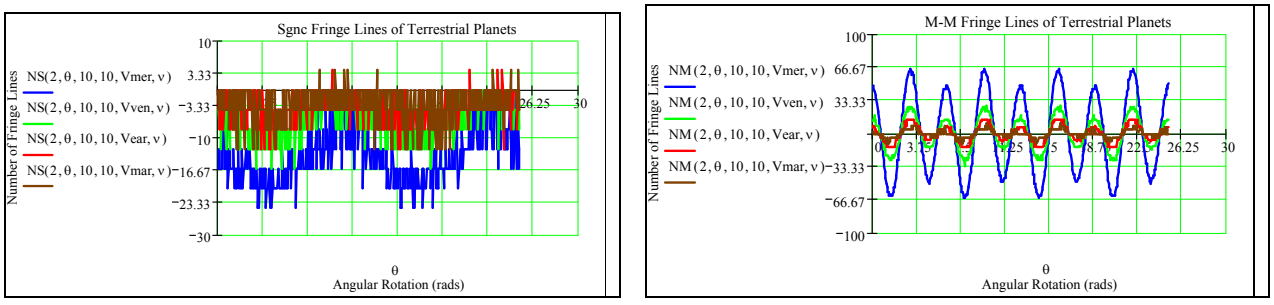
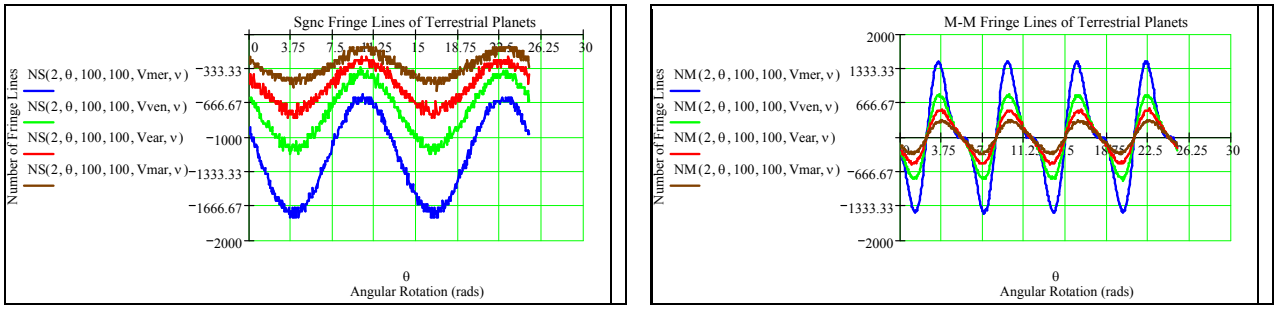


Figure (9): Sgnc and (M-M) interference patterns of the Terrestrial Planets. Effect of increasing the rpm. From upper; Mercury (Blue), Venus (Green), Earth (Red) and Mars (Brown)

Figure (9) shows the effect of increasing the rpm (2, 100 and 1000) on the interference patterns of Terrestrial planets of the Solar system as detected by both Sgnc (a, c and e) and (M-M) (b, d and f) interferometers. The figure shows the high rpm of the interferometer improve the sensitivity of the interferometer, especially for Sgnc interferometer.

- Effect of increasing the arm lengths on the spectrum of the Terrestrial Planets



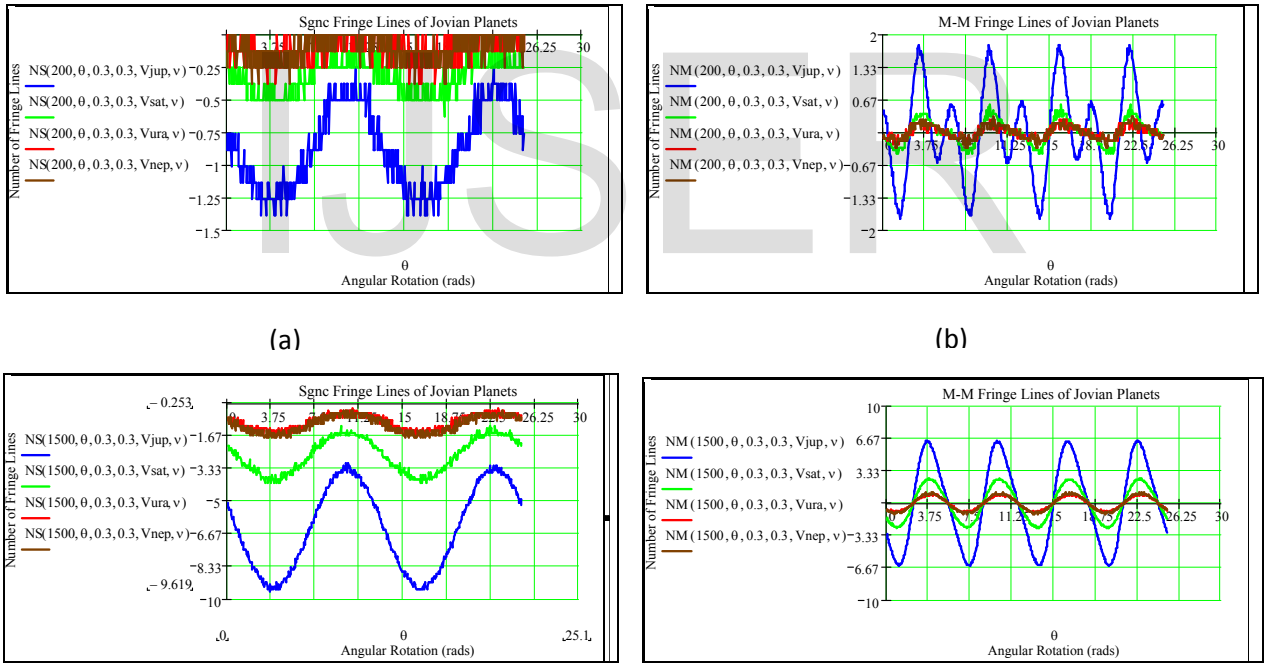


(c) (d)

Figure (10): (M-M) and Sgnc interference patterns of the Terrestrial Planets. Effect of increasing the arm length. From upper; Mercury (Blue), Venus (Green), Earth (Red) and Mars (Brown)

Figure (10) shows the effect of increasing the arm lengths, (2, 100), of the interference patterns of Terrestrial planets of the Solar system as detected by both Sagnac (a, c) and (M-M) (b, d) interferometers. The figure shows the increase in the arm length of the interferometer, for the same rpm, improve the sensitivity of the interferometer, especially for Sgnc interferometer.

- Effect of increasing the rpm on the spectrum of the Jovian Planets



(a) (b)

(c) (d)

Figure (11): Effect of increasing the rpm on number of fringe lines of the interference patterns of Sagnac interferometer (a, c), and (M-M) interferometer (b, d), at or near the locations of Jovian Planets, from upper; Jupiter (Blue), Saturn (Green), Uranus (Red) and Neptune (Brown) .

Figure (11) shows the effect of increasing the rpm on the interference patterns of Jovian planets of the Solar system as detected by both Sagnac (a, c) and (M-M) (b, d) interferometers. The figure shows the increase in the rpm of the interferometer improve the sensitivity of the interferometer, especially for Sgnc interferometer.

○ Effect of increasing the arm lengths on the spectrum of the Jovian Planets

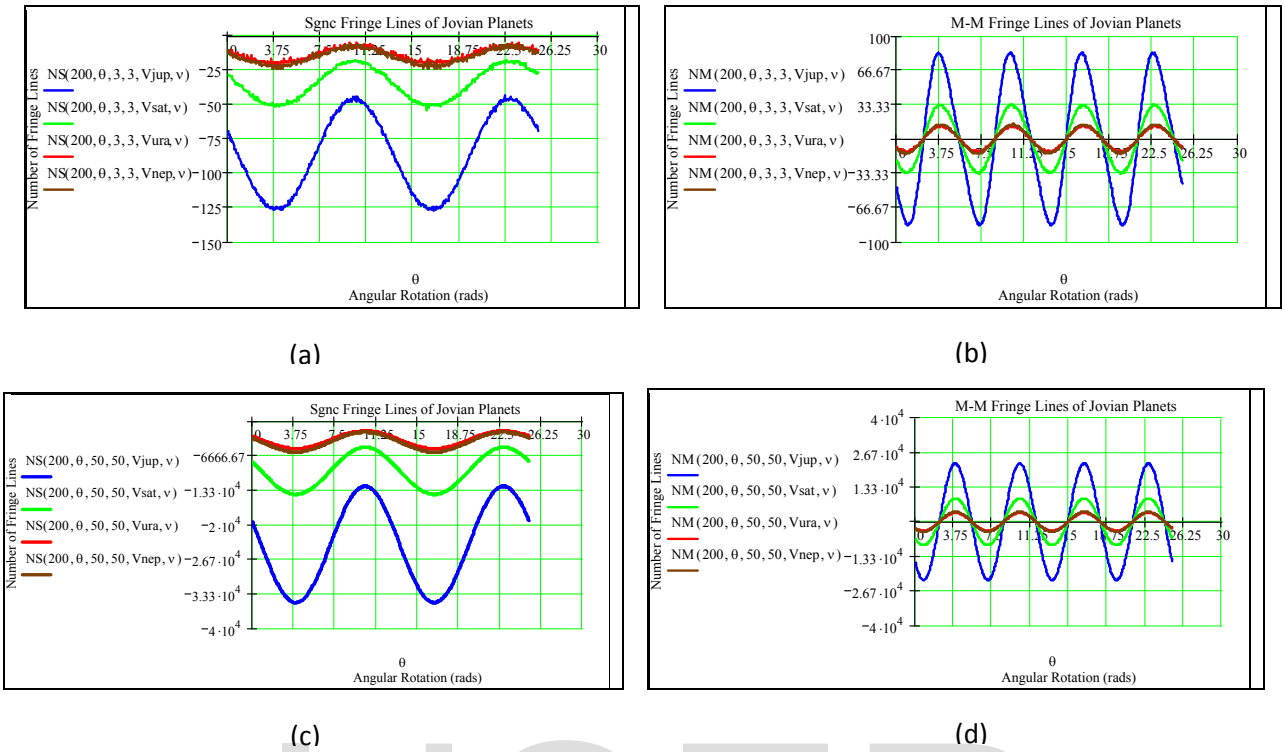
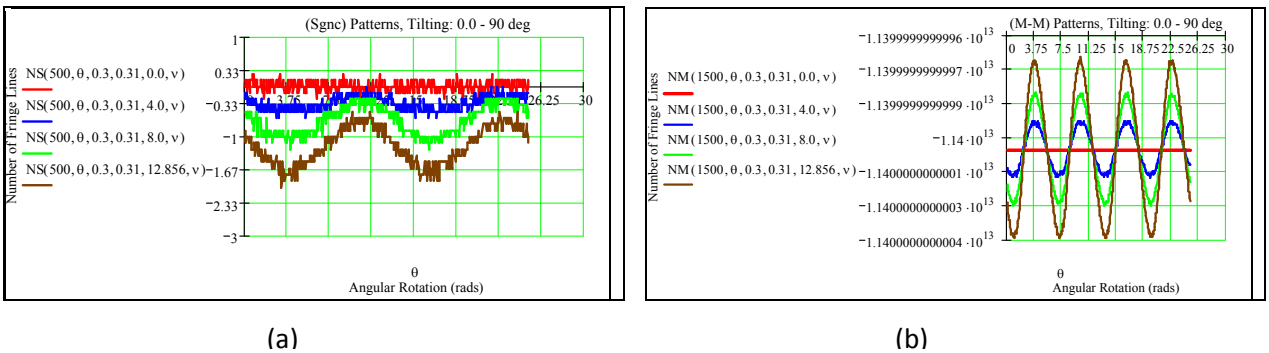


Figure (12): Effect of increasing the arm length on number of fringe lines of the interference patterns of Sagnac interferometer (a, c), and (M-M) interferometer (b, d), at the locations of Jovian Planets.

Figure (12) shows the effect of increasing the arm lengths (3 and 50 meters) on the interference patterns of Jovian planets of the Solar system as detected by both Sagnac (a, c) and (M-M) (b, d) interferometers. The figures show short arm lengths of the interferometer give better results than long arm lengths.

○ Effect of Gradual Tilting the Plane of the Interferometers

In the previous analyses we consider only the vertical rotating of both Sagnac and (M-M) interferometers, in this section we shall consider the case of tilting the rotating interferometers.



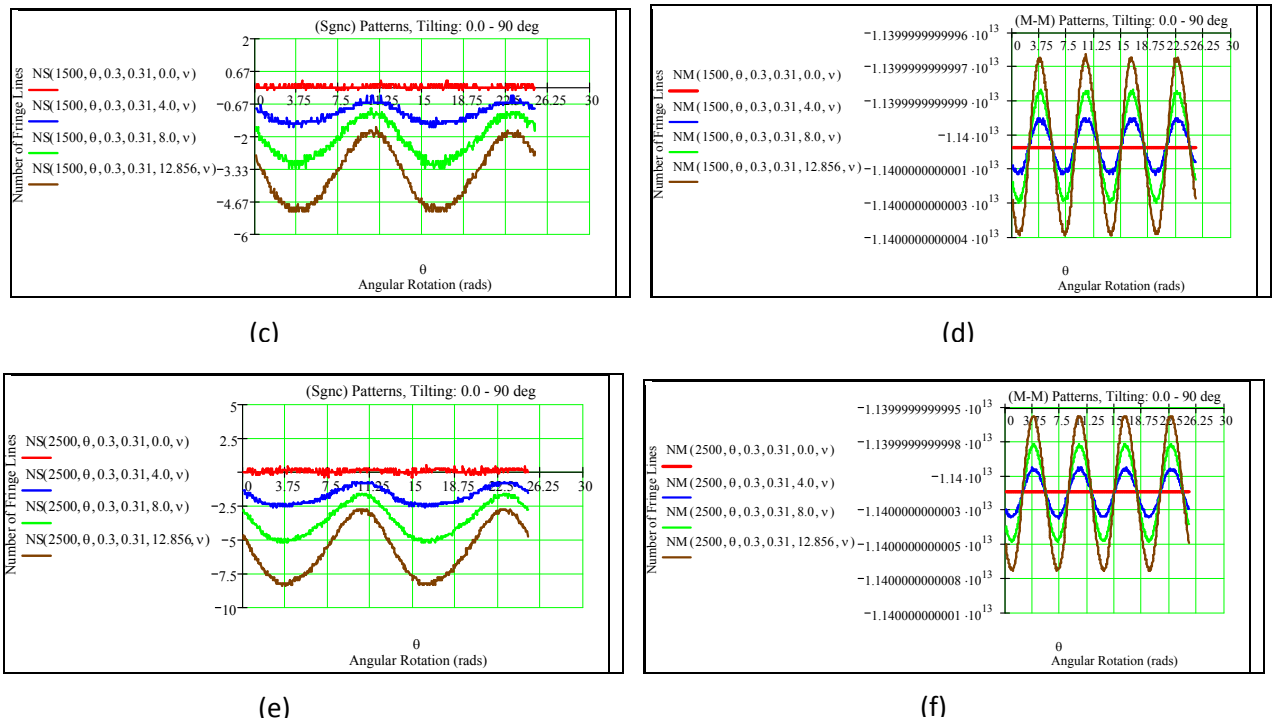


Figure (13): Sagnac and (M-M) number of fringe lines of the interference patterns, when the planes of the interferometers are tilting by different angles to the horizontal plane (gradual flipping).

If α is the angle between the two perpendiculars of the horizontal plane and the tilted plane of the interferometer, and with V_e is the speed of the DM normal to the horizontal, then (V_e ***sin α***) will be the component of the DM speed along the plane of the interferometer. Figures (12) show the number of lines of the interference patterns of both Sagnac to the left, and (M-M) to the right, interferometers. The figures are drawn corresponding to DM speed (V_e ***sin α***) equals 2,4,8 and 12.856 meter/sec, which are corresponding to tilting angles equals, 0º, 8.95º , 18.128º , 38.483º , 90º, respectively. To increase the sensitivity of the interferometers, the figures are drawn with unequal arm lengths (30 and 31 cm). The detection of the differences among the interference patterns of the (M-M) interferometer (b, d, e) are extremely hard, compared to those of Sagnac interferometer.

In fact, the experimental verification of figures (13) follows directly from figures (5) and (6), as gradual tilting the interferometers can be considered as "Gradual Flipping' through 90 degrees. As shown from figures (13), it is extremely hard to discriminate between the patterns of the (M-M) interferometer, while it is easy to discriminate between these patterns in case of Sagnac interferometer. In short, the principle of this test is to get different interference patterns for different tilting angle, which an easy test to confirm the existence of DM and its fluid nature.

○ Conclusion

This paper fully investigates almost all aspects of the theory of the vertical rotating Sagnac interferometer. The most general equations of the vertical rotating interferometer, have been derived, to cover all the possible design considerations of these types of experiments. The paper shows that a small scale interferometers with slight difference in arm lengths of order (0.2-0.3%), gives higher sensitivity than the corresponding large scale interferometers, where the compromise between the

(rpm) and arm length should be taken into account. The paper investigates the different cases of the effect of varying; the arm lengths, the angular rotational speed, as well as the different speeds of the vertical flow of dark matter, on the interference pattern of the interferometer, of Terrestrial and Jovian planets.

The paper shows that there is a continuous change of the shape of the interference patterns, of both Sagnac and (M-M) interferometers, whether on Earth, or when they placed in any space station (or any satellite) travelling through the Solar System. Also, if (M-M) and Sagnac interferometers have enough sensitivity, then we can detect the continuous change in the shape of the interference patterns during the annual journey of the Earth around the Sun. The same can be said for any (LSS) during its motion around the Moon, around the Earth as well as around the Sun. Also, the paper shows that tilting the plane of a sensitive interferometer will produce different interference patterns.

Thus, the paper introduces a solid proof and confirms the Existence of DM and its fluid property, **not only** due to the difference in shapes of the interference patterns of Earth at **Perihelion** and at **Aphelion;** or at any Lunar Space station at **Apogee** and at **Perigee**; **but also,** due to the continuous change of the different shapes of the interference patterns recorded by the Sagnac and (M-M) interferometers mounted on any space station travels in the solar space through or near the Terrestrial and Jovian planets. The paper shows the gradual tilting of Sagnac interferometer can detect the change among the interference patterns. Also, the paper shows that, small scale interferometers are better in measurements than large scale interferometers, when the compromise with the revolution per minute (rpm) is taken into account. Also, the sensitivities increase with the very minor difference in the arm lengths. Finally, emphasizing the validity of these experiments means a next generation of Paradigm shift into physical thinking!

Table I: Distances and Speeds of Dark Matter at Earth Locations at Perihelion and Aphelion

Location of Earth	Distance From Sun (meters)	Dark Matter Speed due to Sun at Earth location (m/s)	Dark Matter Speed due to Earth alone (m/s)	Total Dark Matter Speed (m/s)
At Perihelion	1.4717×10^{11}	12.024	0.833	12.857
At Aphelion	1.5219×10^{11}	11.627		12.460

Table II: Distances and Speeds of Dark Matter at Different Locations of Lunar Space Station at Apogee and at Perigee

Location of Moon	Distance From Earth	DM speed due to Earth (m/s)	Distance from Sun* (Max. & min. distances)	DM Speed due to Sun (m/s)	DM speed due to Moon itself (m/s)	Total DM Speed** (m/s)
At Apogee	4.0672×10^{8}	0.013	1.526×10^{11} (Earth at Aphelion)	11.59569	0.0377	11.646
At Perigee	3.5637×10^{8}	0.015	1.468×10^{11} (Earth at Perihelion)	12.054		12.1047 ***

* The calculations are carried out based on the two positions of Perihelion and Aphelion and Apogee are aligned with the Sun in both cases, see Fig. 1.

** The estimated velocity of the dark matter at the solar system due to the central black hole (of mass 4.5 ± 0.4 million times that of the sun), is about 0.029 – 0.033 m/s, which was left deliberately for corrections, as the best guess of the distance of the solar system is about 26,000 to 28,000 light years from the center. Note: if the speed of the DM at the Solar System is correctly estimated, the mass of the Black Hole will be correctly estimated.

*** The three DM speeds are: 0.013 + 12.054 + 0.0377 = 12.1047. We use 0.013 instead of 0.015, as we consider the maximum distance of the Moon from the Sun, see figure 1.

Table III. Dark Matter Speeds at or near the Surface of the Planets of the Solar System*

#	Planet	Mass (Earth-Mass-unit)	Equatorial diameter (Earth-diameter-unit)	DM Speed Due to Planet itself (m/s)	Distance from Sun (AU)	DM speed due to Sun at planet location (m/s)	Total DM speed (m/s)
1	Mercury	0.06	0.382	0.131	0.4	29.571	29.702
2	Venus	0.82	0.949	1.786	0.7	16.897	18.683
3	Earth	1.00	1.00	0.832	1.0	11.828	12.66
4	Mars	0.11	0.532	0.172	1.5	7.885	8.057
5	Asteroid belt	------	------	------	2.3 – 3.3	------	------
6	Ceres (Dwarf Planet)	------	------	------	2.77	------	------
7	Jupiter	317.8	11.209	21.653	5.2	2.275	23.928
8	Saturn	95.2	9.449	8.381	9.5	1.286	9.667
9	Uranus	14.6	4.007	3.031	19.2	0.616	3.647
10	Neptune	17.2	3.883	3.685	30.1	0.393	4.078

* Based on reference 9, and DM speeds, at the planet surfaces, due to the Black Hole of the Center of the Milky-Way galaxy is not taken into consideration.

- Mass of Sun = 1.98855×10^{30} (kg)
- Mass of Earth = 5.97219×10^{24} (Kg)
- Mass of Moon = 7.35×10^{22} (kg)
- Diameter of Earth at Equator = 1.2756×10^{7} (m)
- Diameter of Moon at Equator = 3.4762×10^{6} (m)
- Astronomical Unit (AU) = 1.496×10^{11} (m)
- Radius of Sun = 6.95999250×10^{8} ($\sim 6.96 \times 10^{8}$) (m)

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