Shaking up Newton's Theory
The Anomalous Velocity of Comet Oumuamua

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Abstract

In this article, we focus on a new interpretation of gravity. This view sees gravitational acceleration around a mass as a response to the disruption of spatial symmetry caused by the obstructive effect of the mass on the propagation of radiation. Newton's gravity formula requires some modification, but the key change is that gravity is not directed at the center of gravity of the mass at its actual location, but at the location where the moving mass was located when the radiation making the mass visible passed by. We call this interpretation the obstruction theory. This new theory is successfully applied in this article to calculate the anomalous velocity of the interstellar comet Oumuamua.

Keywords: Oumuamua anomaly; Gravitational Theory; Celestial Mechanics; Obstruction Theory

1 Introduction

Science still struggles with the concept of gravity. The exact property of matter that causes this force remains a mystery. No elementary particle has ever been found that could play a role in transmitting the force. The force does not fit into the Standard Model of forces.
The consequences of the force are obvious. Every object that falls from your hands is an illustration of the force. The motions of the planets in the solar system are also controlled by gravity. Based on these motions, Newton was able to formulate his gravitational formula:

$$\boldsymbol{g} = \frac{\boldsymbol{GM}}{\boldsymbol{r}^2} \text{ m/sec}^2 \qquad (1)$$

Where $\boldsymbol{M}$ is the magnitude of the mass causing the gravity,
$\boldsymbol{G}$ is the gravitational constant $\mathbf{G = 6.67x10^{-11}}$ m³/kg², and
$\boldsymbol{r}$ is the distance from the object to the center of gravity of the mass.

In our research on gravity[1)], we noted that the mathematical concept of curved space hinders deeper cosmological insight. It is comparable to the concept of aether, which was intended to explain the behavior of light but which hindered scientific progress in the 19th century. Einstein's great achievement was to completely dismiss aether. Thus, we must now radically abandon the notion of curved space in order to (once again) explain the behavior of light, namely its bending in a gravitational field. A thorough investigation shows that the bending can be explained simply by classical physics, taking into account the time dilation.
Therefore, in this discussion, we assume that space has no physical properties. All physical processes in space occur between the material and electromagnetic entities present within it. Space is merely the stage for these processes.

2 Gravitational Forces and the Obstruction Theory

Following this idea, we have found that the gravitational time dilation at a certain distance $\boldsymbol{r}$ from a celestial body is equal to the relative magnitude, in the form of the solid angle ω, of the obstruction that that celestial body poses to the radiation reaching the observer from distant space. The total solid angle of the universe $\boldsymbol{\omega_{tot}}$ seen from a point is $\mathbf{4\pi}$ rad, so time dilation is $\boldsymbol{\omega/\omega_{tot}}$.
This isn't about the amount of energy contained in the radiation, but about the irregularity, the asymmetry that occurs in the view of the universe. A black spot forms around a mass, through which radiation originating from deep space cannot pass. The size of the black spot turns out to be equal to the surface area of the Einstein ring, which can be calculated for any mass.

The deviation from a perfectly symmetrical universe by a black spot is the driving force behind the acceleration an object undergoes. We shouldn't imagine this as the universe actively exerting a force on the object. An asymmetrical space creates a time-velocity gradient in space by means of the position-dependent time dilation. A freely moving object will assume a state of motion such that the gradient is cancelled out. Then the time velocity over the object is constant. An observer moving along with the object will observe that the universe is symmetric.
The time velocity across the object is constant, but its magnitude depends on the number of obstacles surrounding it. The more obstacles, the slower the time velocity.

For larger objects, it's not entirely possible to maintain a constant time velocity across the object. The object begins to obstruct itself. This is the basis for tidal forces.

- *We've posited a symmetrical universe here to explain the acceleration of a freely moving object, which achieves a constant time velocity over the object. However, we could also posit the requirement of a constant time velocity over a freely moving object, which achieves a symmetrical universe.*
  The question is: what is cause and what is effect?

Thus, we give new meaning to the concept of gravity. We see that every freely moving object assumes a motion in space such that the time-velocity gradient over the object is minimized. The radiation reaching the object is symmetrically distributed in all directions in space.
From the time velocity variation near a mass that obstructs the radiation, the gravitational acceleration can be calculated by multiplying the derivative of time-velocity with respect to the distance at that location by $\mathbf{c^2}$. This calculation (see literature 1) results in a gravitational formula that differs slightly from Newton's formula, namely

$$\boldsymbol{g} = \gamma_r^2 \frac{\boldsymbol{GM}}{\boldsymbol{r}^2} \quad \text{m/s}^2. \qquad (2)$$

Where $\boldsymbol{\gamma_r}$ is the gravitational Lorentzfactor $\gamma_r = \mathbf{1} + \frac{\boldsymbol{GM}}{\boldsymbol{c}^2}\frac{\mathbf{1}}{\boldsymbol{r}}$ (3)

for the time dilation at distance $\boldsymbol{r}$ in the gravitational field of the mass.

The formulas show that the acceleration due to gravity, according to our theory, which we have called the Obstruction Theory, always has a slightly larger value than according to Newton's theory. In this article, however, we will not use the improved formula offered by the Obstruction Theory, but rather a consequence of the new view of gravity: its orientation toward the location where radiation from the universe is obstructed by the mass. This means that the gravitational acceleration is not directed toward the location where the moving celestial body is actually located, as Newton prescribes, but toward the location where it was at the moment the radiation emanating from that location passed the celestial body. The speed of light plays a significant role in this.

This has major implications for celestial mechanics because it applies to any object traveling at (high) speed. We will use it to explain the dynamical behavior of the interstellar comet Oumuamua.

3 The Interstellar Comet Oumuamua

In 2017, Robert Weryk of the Hallekala Observatory in Hawaii discovered Comet Oumuamua. The name Oumuamua is derived from the local language and means 'Scout'. This emissary from the distant cosmos has surprised and puzzled science. It was surprising because it was the first time it could be definitively established that the object originated outside our solar system. The mysteries, of course, lie in the object's properties, particularly its orbital motion.

The orbit of Oumuamua was traced in data stored at other observatories over a period of 80 days, from early October 2017 to January 2, 2018.
It turned out[2)] to be an elongated object, a few hundred meters long, that tumbled about its center of gravity in about eight hours. It did not rotate around a major axis in the usual way. However, the comet posed the greatest mystery to science by deviating from Newton's and Einstein's formulas for its orbital motion. The orbit is a hyperbola, but the speed at which it travelled differed in detail from theoretical values.

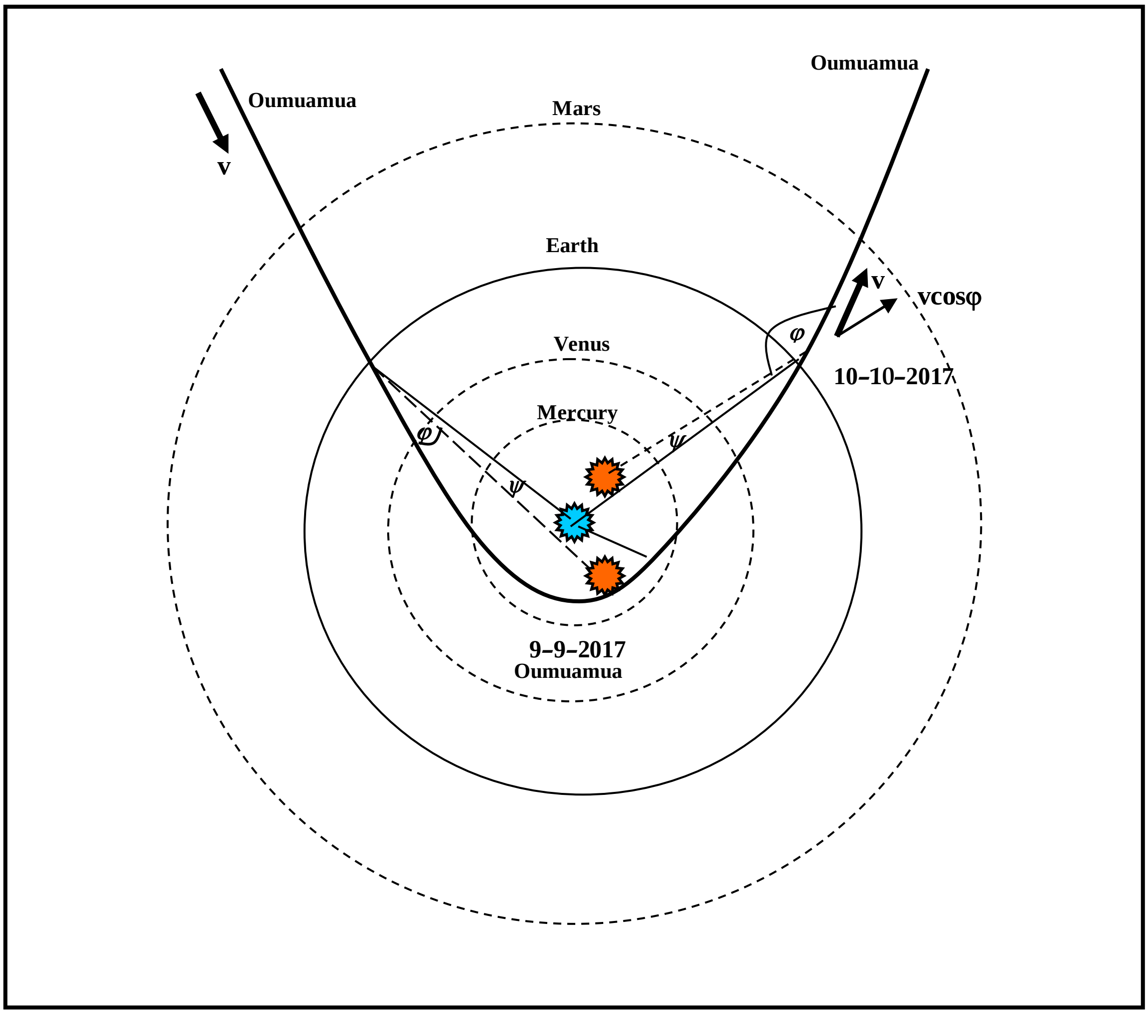

Figure 1 Impression of Oumuamua's orbit through the Solar System with the Sun (collared blue) where it actually is and the displaced, observed Sun (collared red).

When the comet was first observed on October 19, 2017, it was already on its way back out of the solar system. It was then **33** million km from Earth. For comparison: Earth is **150** million km from the Sun.

The comet was not moving in the ecliptic plane, but in a plane that is at a significant angle to it. This is irrelevant for our analysis, as we only need to focus on the difference in velocity between the measured values and the values assumed by current theory, where we can treat both the masses of the Sun and the comet as point masses and neglect the influence of other planets.

Oumuamua's closest point to the Sun, its perihelion, was at **0.256** AU, which is equivalent to a distance $\boldsymbol{r_p = 38.3x10^9}$ meters. This point had already been passed on **September 9, 2017**, more than a month before its discovery. It passed the Earth's orbit on **October 10**.

Despite its close approach to the Sun, the comet did not exhibit the usual cometary characteristics, namely the coma, the hazy cloud of dust surrounding the nucleus, and the tail.
At perihelion, Oumuamua was traveling at a velocity of **87.71** km/s. By the time it crossed Earth's orbit, its velocity had decreased to **49.7** km/s. At a very great distance from the Sun in interstellar space, the comet's velocity is calculated to asymptotically approach approximately **26.33** km/s. This is its base velocity, $\mathbf{v_0}$.
Calculations show that the orbital direction was deflected **66** degrees by the passage near the sun . In the figure 1, the comet on the left is moving toward the sun. Due to the sun's gravitational pull, Oumuamua's speed then increases. As the comet moves away from the sun, its speed decreases. This is self-evident. The question is how much the speed decreases, because according to the literature, its speed – when it moved away from the sun – decreased less than Newton's theory dictates. An unexpectedly higher speed[3)] was measured, given as **17** m/sec, a value that should still be treated with caution.
One thing was clear: an unknown force must be at work, amplifying the sun's gravity. That was the crux of the mystery.

We will show that the outcome can be explained with the Obstruction Theory. According to this theory, the sun's gravity on the comet acts in the direction of a point where the sun was located ***r/c*** sec earlier, as seen from the comet. Here, ***r*** is the distance to the sun and ***c*** is the speed of light. Due to the comet's velocity relative to the sun, the distance has changed noticeably during that time, causing the strength of gravity to have a different value than according to established science. This refers to the difference between the actual distance and the perceived distance. According to the Obstruction Theory, we must use the perceived distance to find the correct velocity and acceleration.

The point is this: the radiation passing by the sun needs time to reach the comet. The object moving toward the sun will, at a certain point, receive the radiation that was previously emitted when the sun—as seen from the comet—was still farther away. This perceived distance, which is longer than the actual distance, results in the sun's gravitational pull being weaker than according to traditional theory. Consequently, the strength of gravity, according to the Obstruction Theory, is **weaker** in this case than according to Newton.
When a comet moves away from the Sun, the Sun is perceived to be closer than its actual distance at that point. Gravitational force is then **stronger** than according to conventional theory.
The acceleration the comet experiences from the Sun is therefore smaller during the approach, causing the comet to slow down, and stronger during the retreat, causing the comet to lose even more speed. All in all, the comet loses speed due to the passage. Symmetry dictates that the reduction in speed during the approach is equal to the reduction in speed during the retreat.

- The difference in distance between the actual distance and the perceived distance during the movement of the object I call the **Optical Distance Difference**.

We calculate the difference in acceleration by the optical distance difference at a certain distance ***r*** from the sun for the comet. The time it takes light to travel this distance is $t = r/c$ sec. In that time, the comet has travelled a distance $\Delta r = (r/c)v$ meters. If the comet is hurtling directly toward the sun, this is precisely the optical distance difference, resulting in a gravitational difference, which causes the comet to slow down as it approaches the Sun. However, the comet isn't speeding directly toward the Sun. It approaches the Sun in an orbit that exhibits an angle φ between its direction of motion and the direction in which the Sun is observed. The unexpected reduction in orbital velocity experienced by the comet as a result is calculated using the component of the gravitational difference along the comet's orbit. This component is found by multiplying the gravitational difference by **cos φ** (see Fig. **1**).
When the comet passes perihelion, the optical distance difference at a certain point is zero, and the gravitational difference component is also zero.

After passing perihelion **P**, the difference component along the comet's orbit strengthens the Sun's gravity, further decreasing the comet's velocity compared to conventional theory.

The observant reader will conclude that:

- This calculates that the speed should decrease, while the measurements actually showed it increasing. Well spotted. So we're not done yet!

Fortunately, besides the optical distance difference, there's a second aspect to the difference between the observed and actual positions, which actually increases the comet's speed. We can find this effect by considering that when the sun is observed from the comet, it always appears slightly closer to the comet's orbit than it actually is (see Figure **2**). The angle φ is smaller, so **cosφ** is larger. We call the difference between the two angles ψ.

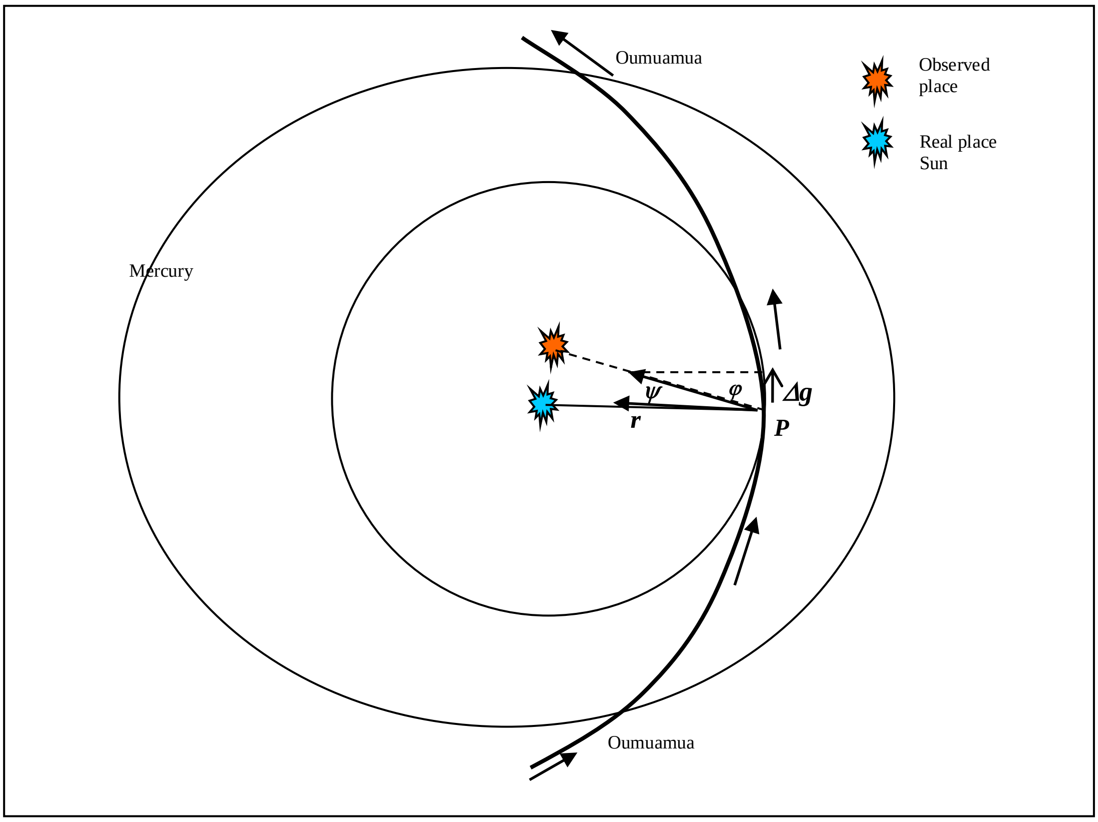

Fig 2 The comet passes its perihelion P when the angular effect is maximum.

We can best imagine this as the comet passes its perihelion **P** . We see that the red sun in the drawing is then slightly ahead in the direction of the velocity. This means that the gravitational force of the sun has a slightly larger component Δg in the direction of the velocity than if the force were directed towards the actual position of the sun. This gives the comet an acceleration in its direction of motion and thus a greater velocity than Newton's.

We called this the **Optical Angle Effect**. Near perihelion, this effect appears to be greater than the distance effect.

Our explanation of Oumuamua's anomalous velocity is therefore based on the Sun's altered geometric position – both in distance and direction – due to the comet's velocity. We will discuss the effect of the distance difference and the effect of the angular change separately. As long as these effects are very small compared to Newtonian acceleration, we can simply take the sum or difference of the results.

Finally, we will investigate whether the velocity change due to these two effects can explain the aforementioned **17** m/s.

4 Calculation with the Optical Distance Effect

The velocity at which Oumuamua moved toward the solar system is practically equal to the velocity at which the comet ultimately moves away from the solar system. According to astronomers' calculations, this base velocity was $\mathbf{v_0 = 26.33 \times 10^3}$ m/s. This allows the velocity to be calculated with sufficient accuracy at the distance r from the Sun using a calculation based on energy conservation with the formula $v = v_0\sqrt{1+2\frac{GM}{r}\frac{1}{v_0^2}}$ m/s. (4)

If the comet's orbital velocity is v m/s and the angle of its motion with the radial distance r to the Sun is φ, then the radial velocity is $\mathbf{v_{rad} = v\cos\varphi}$ m/s.
Then the distance to the Sun, seen from the comet during its approach, is greater than Newton's, because he observes the Sun at a location where it had previously been.

The difference in distance is $\Delta r = v\frac{r}{c}\cos\varphi$ meters. (5)

The difference in acceleration towards the sun at a distance of Δr meters from the Sun is found as

$$\Delta g = \left(\frac{GM}{r^2} - \frac{GM}{(r+\Delta r)^2}\right) \approx \frac{GM}{r^2}2\frac{\Delta r}{r} = 2\Delta r\frac{GM}{r^3} \text{ m/s}^2. \quad (6)$$

With the optical distance difference (5), the difference in acceleration towards the Sun becomes

$$\Delta g = 2\Delta r\frac{GM}{r^3} = 2\frac{GM}{r^3}\frac{r}{c}v\cos\varphi = 2\frac{v}{c}\frac{GM}{r^2}\cos\varphi \text{ m/s}^2. \quad (7)$$

Slightly smaller than according to Newton's theory. The acceleration in the direction of motion then becomes $\Delta g\cos\varphi$ m/s^2 smaller as it approaches, so the comet is accelerated less by

$$\Delta g\cos\varphi = 2\frac{v}{c}\frac{GM}{r^2}\cos^2\varphi \text{ m/s}^2 \quad (8)$$

in its direction of motion than according to the traditional theory.

We have compiled all the basic data for the comet's orbit in Table 1.

To obtain an approximate increase in velocity, we simply need to multiply this acceleration by the time the acceleration is active. We can therefore calculate the increase in velocity over a long distance numerically (Table **2**) by adding the values between successive points where the distance to the Sun and the comet's velocity are known.
We use an estimated average value for $\cos\varphi$ between these points and calculate the time it takes the comet to travel the distance between them.

Basic Velocity	v_0	=	**26,33x10^3**	**m/sec**
Perihelion	**r(0)**	=	**38,3x10^9**	**meter**
Speed in Perihelion	v_{ph}	=	**87,71x10^3**	**m/sec**
Gravity Constant	**G**	=	**6,67x10^{-11}**	**m^3/kg.s^2**
Solar Mass	M_{sun}	=	**1,99x10^{30}**	**kg**
Speed of Light	**c**	=	**3,00x10^8**	**m/sec**
Astronomical unit	**1 AU**	=	**150x10^9**	**meter**

Table 1 The data for comet Oumuamua used for the calculations.

In Table **2**, we have listed the various distances (column ***C***) of the planetary orbits from the Sun. We have estimated the angle φ in column ***D*** based on Figure 1. We calculated the velocity at the various distances using formula (4), and from those velocities we could calculate the time it took for

Oumuamua to cover those distances. The average deceleration experienced by the comet over those distances – calculated with formula (**8**) – is shown in column ***H***, and from that, the reduction in velocity ***Δv*** after covering that distance could be calculated in column ***I***. In the last column, ***J***, we find the reduction in velocity relative to Newton's velocity since passing perihelion. This ultimately amounts to **9** m/s.
The speed reduction during approach is identical to the reduction during removal, so we do not need to calculate the latter separately.

A	B	C	D	E	F	G	H	I	J
							Optical Distance Effect		
	OUMUAMUA						Deceleration delay	Speed decrease	Sum
	Distance	Distance	Angle	cos φ	Speed	Duration	$\Delta g = 2\frac{v}{c}\frac{GM}{r^2}cos^2\varphi$	Δv	Δv
	AU	meters	De-grees		m/sec	sec	m/sec^2	m/sec	m/sec
Perihelion	0.26	3.83E+10	90	0.00	87319	0.00E+00	0.00E+00	0.00	0.0
Extra point	0.30	4.49E+10	95	0.09	81292	1.79E+06	7.03E-08	0.13	0.1
Extra point	0.34	5.09E+10	105	0.26	76893	4.37E+05	8.10E-07	0.35	0.5
Mercury	0.39	5.79E+10	130	0,64	72655	2.09E+05	4.01E-06	0.84	1.3
Venus	0.72	1.08E+11	150	0.87	56105	1,03E+06	2.77E-06	2,87	4.2
Earth	1.00	1.50E+11	160	0,94	49678	8.68E+05	1.70E-06	1.48	5,7
Mars	1.52	2,27E+11	165	0,97	43138	1.76E+06	7.21E-07	1,27	6.9
Asteroids	2.77	4,14E+11	168	0.98	36525	4.83E+06	1.94E-07	0.94	7,9
Jupiter	5.20	7.78E+11	170	0,98	32166	1.08E+07	4,84E-08	0.52	8.4
Satern	9.55	1,43E+12	172	0.99	29652	2,13E+07	1.31E-08	0,28	8,7
Uranus	19.20	2.87E+12	174	0,99	28033	5.04E+07	3.05E-09	0.15	8.8
Neptune	30.10	4.50E+12	176	1,00	27430	5.90E+07	1.20E-09	0.07	8.9
Far away	50.00	7,48E+12	178	1,00	26998	1,10E+08	4.29E-10	0.05	8.9
space	100.00	1,50E+13	179	1.00	26668	2.79E+08	1.06E-10	0.03	9.0

Table 2: The difference in speed between the Obstruction Theory and Newton's theory due to the optical distance difference. The comet loses speed.

5 Calculation with the Optical Angle Effect

Due to the distance effect, the comet loses velocity during the perihelion passage, while a gain in velocity was expected. However, on page **6**, we already mentioned the optical angle effect, which could have achieved a gain in velocity. This effect is maximal during the perihelion passage.

See Figure **3**. According to Newton, the gravitational acceleration is directed toward the (blue) sun, where it is actually located at that moment. The ***g.cosφ*** component of the gravitational acceleration at point B* is negatively directed and slows the velocity of the receding comet. Its magnitude can be calculated with Newton's formula (**1**): $\Delta g = \frac{GM}{r^2}cos\varphi$ m/s^2.

However, according to the Obstruction Theory, the gravitational acceleration is equal to the value found in the figure from **B*** along the connecting line to the observed (red) apparent Sun. The angle at which the Sun is observed therefore differs by ψ rad from the value prescribed by Newton. Assuming that the difference in distance is negligible—which is true if the probe is still close to its peripoint—the acceleration component in the direction of motion is $\frac{GM}{r^2}cos(\varphi - \psi)$ m/s^2.

This last value is smaller (note: $\varphi > 90°$ in **B***) than the value used with Newton, meaning the comet is slowed down less than according to current theory. It therefore retains more speed as it moves away from the Sun than according to established science. We'll calculate this.

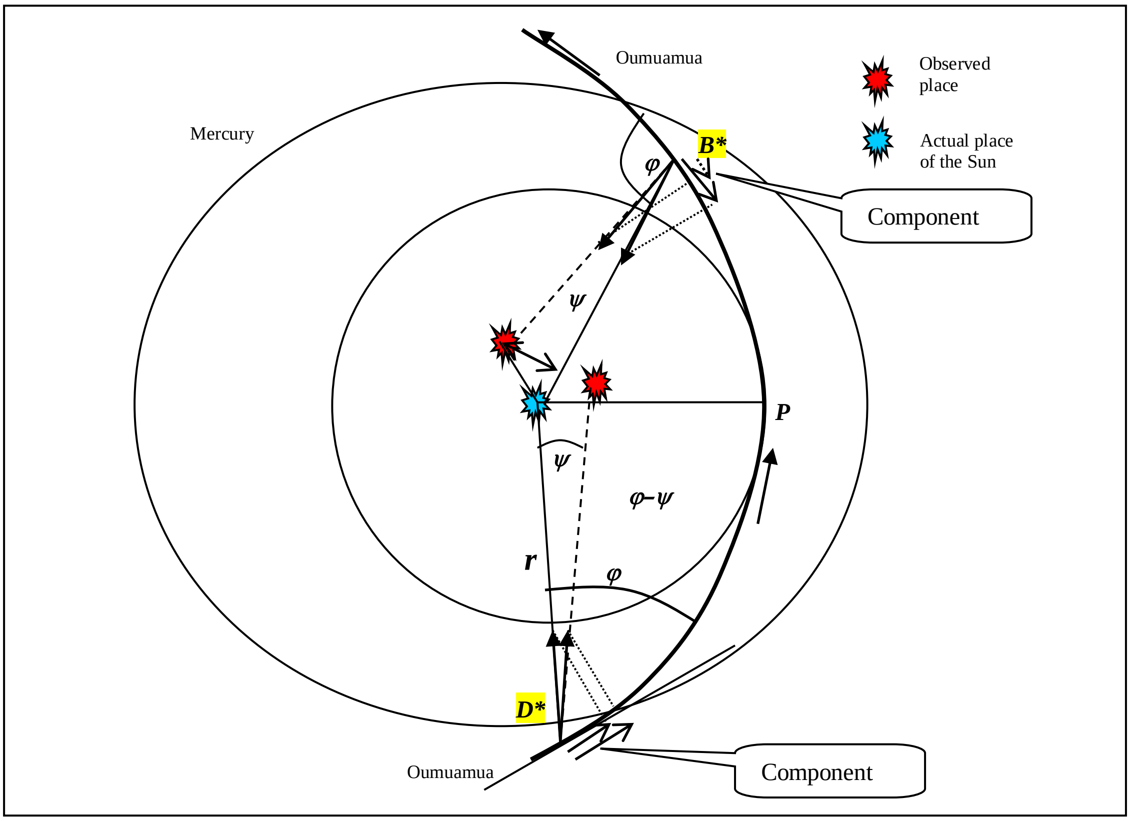

Fig. 3 Acceleration component due to the angular difference between the actual position of the Sun and the position where it is observed.

The acceleration component according to the Obstruction Theory along the orbital direction is therefore less than according to Newton during removal with:

$$\Delta g_{\varphi} = \frac{GM}{r^2}\cos\varphi - \frac{GM}{r^2}\cos(\varphi-\psi) \approx \frac{GM}{r^2}\frac{d\cos\varphi}{d\varphi}(-\psi) = \frac{GM}{r^2}(\sin\varphi)(\psi) \quad \text{m/s}^2. \qquad (9)$$

For ψ, we find $\psi = \frac{r}{c}\frac{v\sin\varphi}{r} = \frac{v}{c}\sin\varphi$ radians. (10)

Therefore, we find: $\Delta g_{\varphi} = \frac{GM}{r^2}\sin\varphi\frac{v\sin\varphi}{c} = \frac{GM}{r^2}\frac{v}{c}\sin^2\varphi$ m/s^2. (11)

As the comet approaches the Sun, the angular effect has the opposite effect. The comet is accelerated more than Newton's. In that case, the component toward the observed Sun is actually larger than the component toward the Sun's actual position. This is illustrated in Figure **3** at point **D*.** As it approaches the Sun, the comet's acceleration is increased relative to Newton's. It gains more speed than Newton's.

Both when approaching and receding from the Sun, the comet's velocity increases relative to Newton's due to the angle effect. This increase is most pronounced when the comet passes through its perihelion. At that point, the deceleration effect due to the distance effect is minimal. However, this would mean that a regular planet in a circular orbit, where it is, so to speak, "permanently at perihelion," would also constantly accelerate. This contradicts experience. We have apparently overlooked something: it turns out that the angle ψ can be determined more precisely.

We are investigating this. Fig. **4** illustrates the angle at which the Sun is seen from the comet. When the comet approaches the Sun and reaches point **D***, it has travelled a certain distance since its light was emitted by the Sun. At the moment the light left the Sun, the comet was at point **D****. At that point, the Sun was observed from the comet at an angle ψ rad smaller than Newton's value φ at position **D***.
During the time the comet moved from **D**** to **D***, the comet's direction also changed slightly by an angle $\Delta\varphi$ due to the Sun's gravitational pull. Therefore, the angle at which the Sun is observed relative to the direction of motion must be corrected.

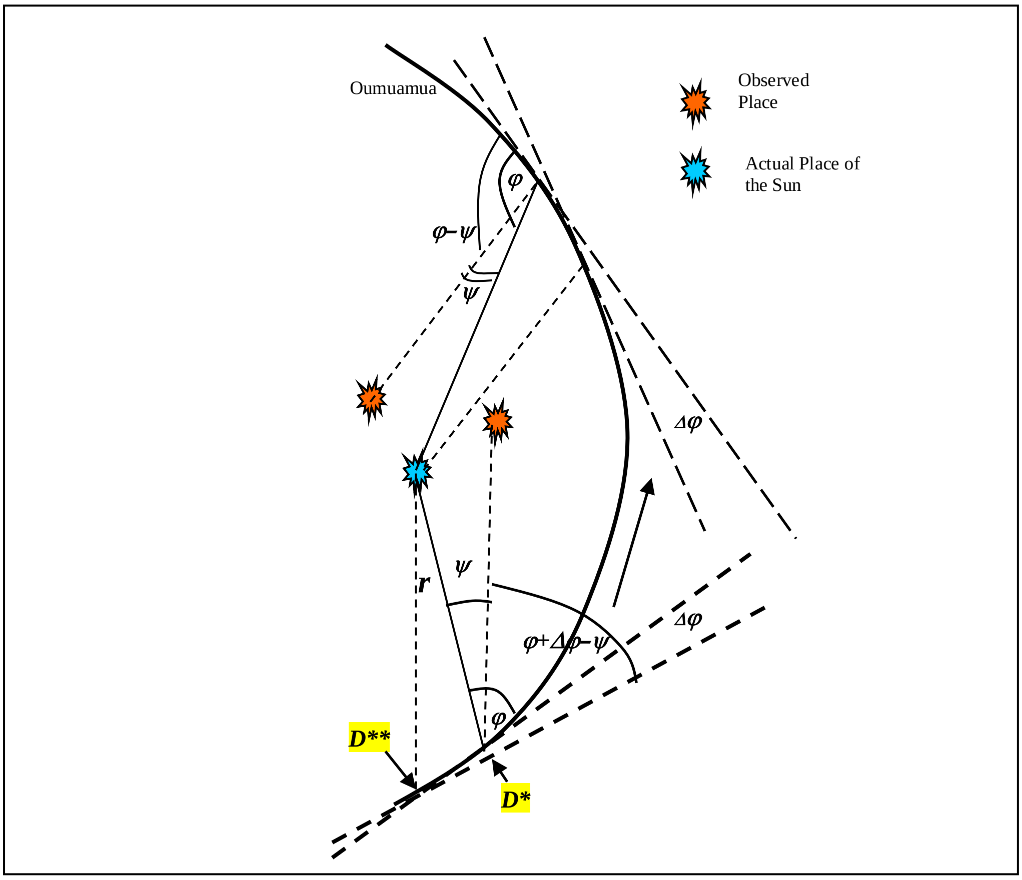

Fig 4 Calculation of the correction on angle ψ.

The question is how much the comet changed direction. In **D****, its direction was still $\Delta\varphi$ greater due to the deflection in its orbit, so the angle there was ($\varphi + \Delta\varphi$) rad. The angle between the two directions is indicated in **D**** by two bold dashed lines.
The figure shows that the angle at which the comet observes the Sun at point **D*** relative to its direction of motion is equal to: ($\varphi - \psi + \Delta\varphi$) radians.
We calculate the magnitude of $\Delta\varphi$.

The time it takes for light to travel from the Sun to the comet is r/c sec. The distance travelled by the comet in that time is: $(r/c)\, v$ meters. Due to the Sun's gravity, the speed in the direction of the Sun has increased in that time by $g_{sun}\,(r/c)$ m/sec. Then a speed perpendicular to the orbital motion has arisen in r/c sec of $v_\perp = g_{sun}\,(r/c)\sin\varphi$ m/sec. Then we get an increase in the angle φ with the correction $\Delta\varphi = v_\perp/v$ rad in that time period.

The value of ψ then becomes : $\psi = \frac{v}{c}\sin\varphi - \frac{v_\perp}{v} = \frac{v}{c}\sin\varphi - \frac{GM}{r^2}\frac{r}{c}\frac{\sin\varphi}{v} = \frac{v}{c}\sin\varphi\left(1 - \frac{GM}{r}\frac{1}{v^2}\right)$ rad.

With (**9**), we find the corrected angle effect:

$$\Delta g_\varphi = \frac{GM}{r^2}(\sin\varphi)(\psi) = \frac{GM}{r^2}\frac{v}{c}\left(1 - \frac{GM}{r}\frac{1}{v^2}\right)\sin^2 \quad \text{m/s}^2\,. \qquad (12)$$

This allows us to demonstrate that a planet in a circular orbit maintains a constant speed, because for circular motion it holds $\frac{v^2}{r} = \frac{GM}{r^2}$ so it follows that $v^2 = \frac{GM}{r}$, with the result:

$$\frac{GM}{r^2}\frac{v}{c}\left(1 - \frac{GM}{r}\frac{1}{v^2}\right)\sin^2\varphi = \frac{GM}{r^2}\frac{v}{c}(1-1)\sin^2\varphi = 0\,.$$

That's the outcome we were looking for. We found that the velocity of a planet in a circular orbit at perihelion cannot change due to the angle effect. This was also true for the optical distance effect, because the distance to the Sun remains constant in a circular motion. They are constantly at perihelion. Therefore, neither effect affects the circular orbits of the planets.

The effects certainly do affect Oumuamua. We again tackled the problem numerically to calculate the extra velocity the comet gains due to the optical angular effect using the formula we found.

In the calculations for Table **3**, we used the same data from Table **1** as for Table **2**. We also used the same estimates for the angle φ.
Column ***I*** of the table shows the acceleration the comet experiences at the indicated distance as a result of the angular effect, including the correction. Column ***J*** shows the additional velocity the comet gains between two consecutive points on its path through the solar system. Column ***K*** shows the sum of the velocity increases between the consecutive distance points from column ***A***.
This shows us how much faster Comet Oumuamua travels at various distances, given the estimated angle φ, after passing perihelion and receding from the Sun. For example, at Venus's orbit, this effect increases the speed by **20.9** m/s.
We saw earlier (Table **2**) that the optical distance difference at Venus's orbit slowed the speed by **4.2** m/s. According to these calculations, the speed at Venus's orbit increased by **20.9 - 4.2 = 16.7** m/s.

A	B	C	D	E	F	G	H	I	J	K
								Angular Effect		
	OUMUAMUA						Angular effect	Corrected	Accele-ration	Sum
	Distance	Distance	Angle	cos φ	Speed	Duration	$\Delta g_\varphi = \frac{GM}{r^2}\frac{v}{c}\sin^2\varphi$	$\frac{GM}{r^2}\frac{v}{c}\sin^2\varphi\left(1-\frac{GM}{r^2}\frac{r}{v^2}\right)$	Δv	Δv
	AU	meters	De-grees		m/sec	sec	m/s^2		m/sec	m/sec
Perihelion	0.26	3.83E+10	90	0.00	87319	0.00E+00	2,54E-05	1.39E-05	0.00	0.00
Extra point	0.30	4.49E+10	95	0.09	81292	1,79E+06	1,72E-05	9,53E-06	17.06	17.1
Extra point	0.34	5,09E+10	105	0.26	76893	4.37E+05	1.19E-05	6,67E-06	2.92	20.0
Mercury	0.39	5,79E+10	130	0.64	72655	2,09E+05	4,99E-06	2,82E-06	0,59	20.6
Venus	0,72	1.08E+11	150	0.87	56105	1.03E+06	5.00E-07	3.05E-07	0.32	20.9
Earth	1,00	1,50E+11	160	0.94	49678	8.68E+05	1,07E-07	6.87E-08	0.06	20.9
Mars	1.52	2.27E+11	165	0.97	43138	1,76E+06	2,28E-08	1,57E-08	0,03	21,0
Asteroids	2.77	4.14E+11	168	0.98	36525	4.83E+06	3,83E-09	2,91E-09	0.01	21,0
Jupiter	5.20	7.78E+11	170	0.98	32166	1.08E+07	6.81E-10	5.69E-10	0.01	21.0
Satern	9.55	1.43E+12	172	0.99	29652	2.13E+07	1.21E-10	1,08E-10	0.00	21.0
Uranus	19.20	2.87E+12	174	0.99	28033	5.04E+07	1.62E-11	1.53E-11	0.00	21.0
Neptune	30,10	4.50E+12	176	1.00	27430	5.90E+07	2.89E-12	2.78E-12	0.00	21,0
Far away	50.00	7.48E+12	178	1.00	26998	1,10E+08	2.58E-13	2,52E-13	0.00	21.0
space	100.00	1.50E+13	179	1.00	26668	2,79E+08	8.03E-15	7.93E-15	0,00	21,0

Table 3 The velocity difference of the comet between the Obstruction Theory and Newton's theory due to the angular effect.

Figure **5** graphs the changes in velocity caused by the optical distance effect and the optical angular effect. We see that the velocity increases sharply past the perihelion at **0.26** AU due to the angular effect. The distance effect is minimized there. At greater distances, the distance effect increases again, but not enough to cancel out the angular effect.

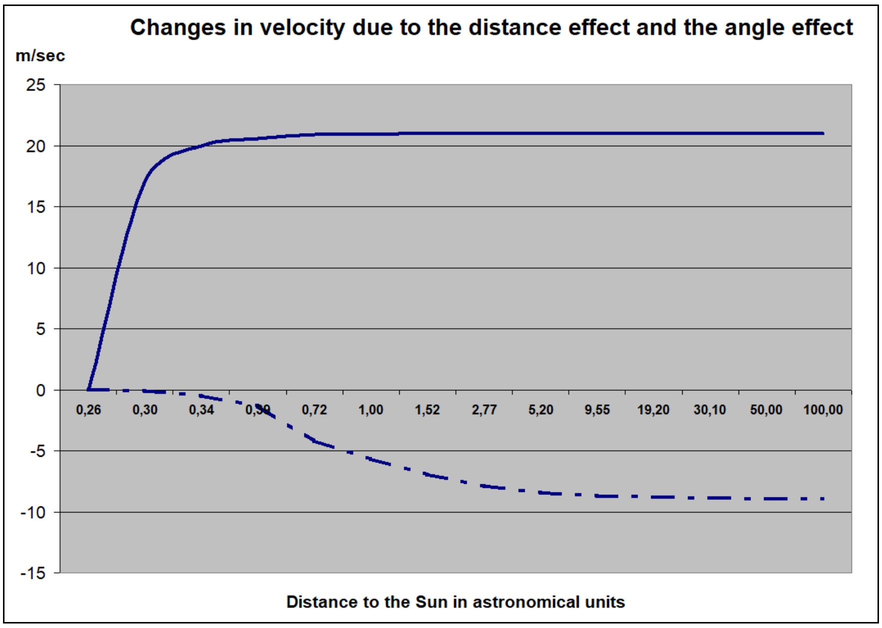

Figure 5 The top line represents the increase in velocity of Comet Oumuamua due to the angular effect, and the bottom dashed line shows the decrease in velocity due to the distance effect after passing perihelion.

By subtracting the results of the distance effect from the results due to the angular effect, we find the increased speed of the comet at different distances from the Sun in Table **4**, column ***F***.
From this, we see that the speed near Venus increases to **16,7** m/sec. At a great distance beyond the Earth's orbit, the increase in speed decreases to approximately **12** m/sec.

A	B	C	D	E	F	G
OUMUAMUA				Distance Effect	Angle Effect	
	Distance	Distance	Angle	Sum	Sum	Difference
	AU	meters	in de-grees	m/sec	m/sec	m/sec
Perihelion	0,26	3,83E+10	90	0,0	0,0	0,0
Extra point	0,30	4,49E+10	95	0,1	17,1	16,9
Extra point	0,34	5,09E+10	105	0,5	20,0	19,5
Mercury	0,39	5,79E+10	130	1,3	20,6	19,2
Venus	0,72	1,08E+11	150	4,2	20,9	16,7
Earth	1,00	1,50E+11	160	5,7	20,9	15,3
Mars	1,52	2,27E+11	165	6,9	21,0	14,0
Asteroids	2,77	4,14E+11	168	7,9	21,0	13,1
Jupiter	5,20	7,78E+11	170	8,4	21,0	12,6
Satern	9,55	1,43E+12	172	8,7	21,0	12,3
Uranus	19,20	2,87E+12	174	8,8	21,0	12,2
Neptune	30,10	4,50E+12	176	8,9	21,0	12,1
Far away	50,00	7,48E+12	178	8,9	21,0	12,0
Deep space	100,00	1,50E+13	179	9,0	21,0	12,0

Table 4 The speed gain of Oumuamua with a favourable estimate for the angle φ

This has been plotted (Fig. **6**). The velocity increase of **17** m/sec, mentioned in the literature, is found between Mercury and Venus. This value provides confidence that the comet's anomalous velocity behavior is explained by the Obstruction Theory. However, we will have to leave it to astronomers studying the orbital motion of Oumuamua to determine the exact results.

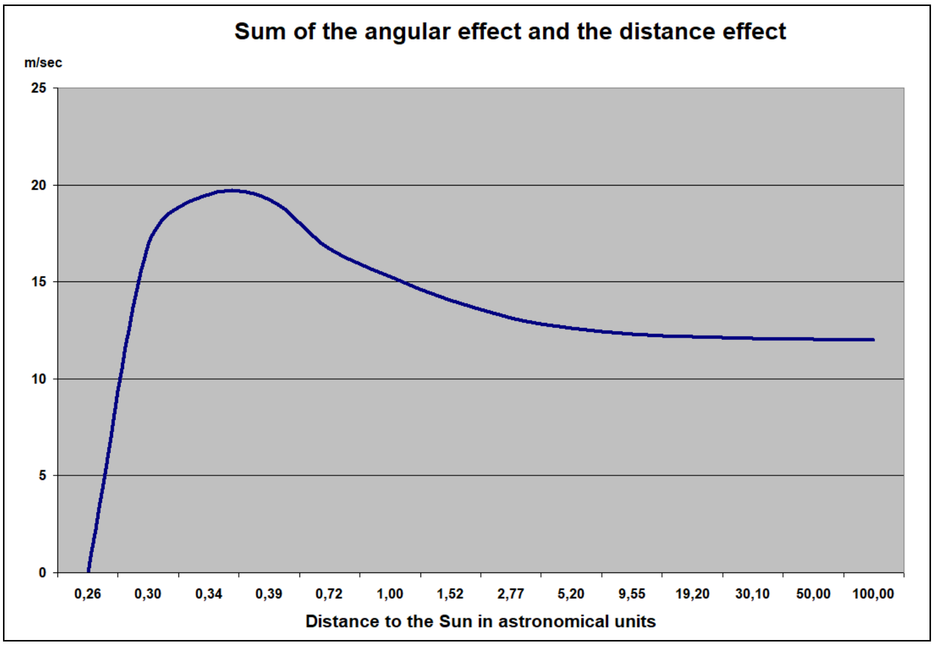

Figure 6 The velocity gain experienced by Comet Oumuamua after its passage past the Sun due to the distance effect and the angular effect together

We also investigated the progress by visualizing both the approach and departure relative to perihelion. From this, we conclude (see Figure **7**) that Oumuamua reached a final velocity increase of approximately **24** m/sec during its passage past the Sun.

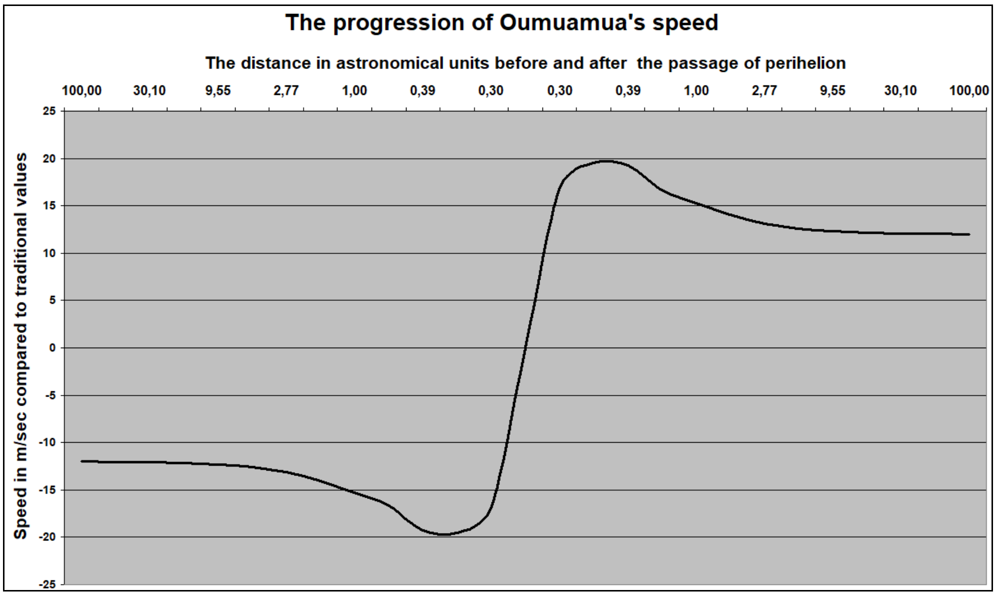

Figure 7 Change in velocity of Oumuamua upon approach and departure from the Sun.

6 Conclusion

From the foregoing, it appears that the unexpected orbital motion of Comet Oumuamua can be understood by interpreting gravity according to Obstruction Theory. This takes into account the time difference between the attracting mass and the point where the object is located within the gravitational field of that mass.

This result raises the question of whether a comet moving in an elliptical orbit around the Sun also moves away from the Sun at a greater speed than the speed at which it approaches the Sun, and whether this speed gain persists after one orbit.
This should then also apply to Mercury.

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[1] Henk Dorrestijn; Time and Cosmos, A new cosmological Worldview; 2024 Den Haag.
[2] Wikipedia.org/Oumuamua
[3] Wikipedia 1I/'Oumuamua *Non–gravitational acceleration*