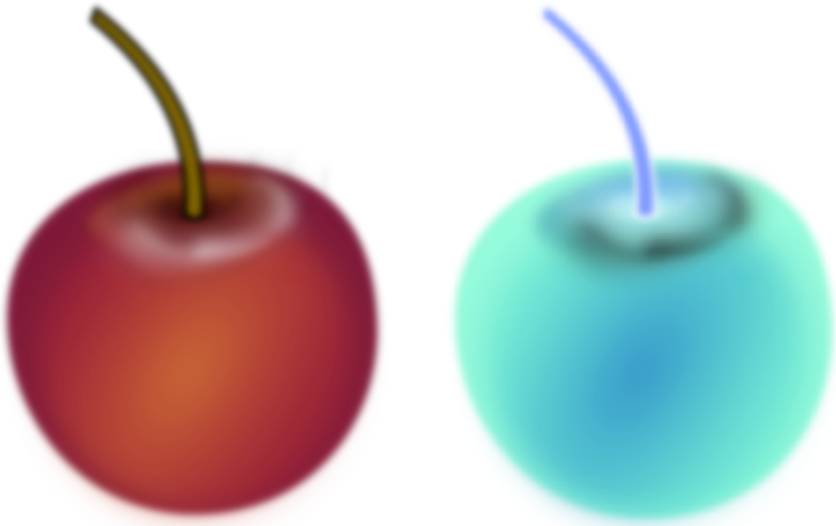
Illusion Of Light

光線的錯覺

Cres Huang



Which is the true color of red apple?

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Abstract

Besides energy, light presents us fastest and most details of the universe. It made us obsessively visual. It controls our understanding as well as misunderstanding of the universe.

We, too, are creatures of motion. Speed is our obsession too. Light and it's speed might seem magical to us. However, what we see is only broadcasting of physical reality in the form of radiations delivered to us in high speed. We only see the visible part of radiations that stands out from the background and perceive it as information. It does not mean background contains less significant information than foreground revealed by light. Additionally, speed of light is no more important than other speed. Say, slow gentle motion can be more beneficial for building structures.

To me, light and it's speed do not have any power to alter the fundamentals of the universe. To the contrary, it is the universe in charge of light and speed. No matter how fast the light, space does not allow it to go to next location instantly. The question is, can we be fooled by information in the form of light delivered at light speed, or by our obsession?

Contents

List of Figures

List of Tables

1 Introduction

Fundamentally, our visual sensor is parallel to passive radar[6]. There is a source of radiations, directly emitted or reflected, and sensor to tune in. In between, is the transportation of radiations. Arrived radiations are collected and decoded into information. Certainly, the wide spectrum of sunlight reveals more details than radar.

Information we collected with our senses can be far from the truth of reality. We can only detect and measure small range of spectrum in measurable unit. Subjective interpretation is an issue that deviates our understanding from truth. We obtain information delivered by many medias. Not only detail but speed, distance, and environment of delivery also come into play. Our visual sense dominates the information collected from the environment. Seeing is believing can be persuaded truth by our conscious and unconscious mind. What we've comprehended is not necessary the whole truth. Consider red light is not absorbed by red apple, we see rejected light. Don't you think the true color of red apple is absorbed light, negative (complement) of red? Is seeing an red apple illusion?

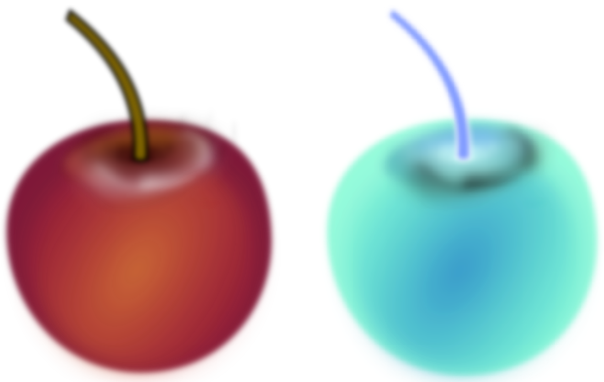

Figure 1: Which is the true color of red apple?

Besides energy, light presents us fastest and most details of the universe. It made us obsessively visual. It controls our understanding as well as misunderstanding of the universe.

We, too, are creatures of motion. Speed is our obsession too. Light and it's speed might seem magical to us. However, what we see is only broadcasting of physical reality in the form of radiations delivered to us in high speed. We only see the visible part of radiations that stands out from the background and perceive it as information. It does not mean background contains less significant information than foreground revealed by light. Additionally, speed of light is no more important than other speed. Say, slow gentle motion can be more beneficial for building structures.

To me, light and it's speed do not have any power to alter the fundamentals of the universe. To the contrary, it is the universe in charge of light and speed. No matter how fast the light, space does not allow it to go to next location instantly. The question is, can we be fooled by information in the form of light delivered at light speed, or by our obsession?

2 Light, Reality, And Information

Light we see is the reaction of our visual sensor to the action of radiation that stands out from the background. It takes duration and amplitude to trigger our sensor to react, amplitude (intensity) to detect shade and frequency to see color. For human eyes to detect radiation as color, the duration and amplitude have to be adequate, and the rate of arrival (frequency or pulsation) has to be within a band in the vicinity of 430 to 770 THz. Otherwise, our visual sensor will not be able to tune in. Generally, red light 400 to 484 THz; Orange 484 to 508 THz; yellow 508 to 526 THz; green 526 to 606 THz; blue 606 to 668 THz; violet 668 to 789 THz; and infinite shades in between[9]. Our visual sensor tune to this range of frequency and decode it into information. Below it, we are able to tune to infrared as heat but unable to map it into image. It is also true for ultraviolet radiation, X-rays and gamma rays. Some birds and insects are able to extract visual information from ultraviolet radiations. It's hard to image what kind of details they see. Nevertheless, our body can detect ultraviolet or higher but unable to decode it into information, only be damaged by it.

THz, terahertz, also means number of 10^{12} pulses (wavelets) detected in one second. The length of light beam per 60 second-ticks of standard clock is one light-second (ls), or about 299,792,458 meters per second. The wave length, distance between crests (or troughs) of 400 THz red light is about $\frac{299,792,458}{400*10^{12}} \approx 750$ nanometers (or diameter of wavelet). A short radiation stream, say $\frac{1}{100}$ of a second of red light at 400 THz, contains $4*10^{12}$ wavelets, or the total length is about 299,792 meters. Despite the light beam is very long, next to 300 km (186.4 miles), it is unlikely be detected by average human eyes. Weak or missing wavelets (pulses) undetected would make it below 400 THz, redshift.

Any object broadcasts it's existence and activity. It can be detected only when we can distinguish it's broadcasting from background. Our eyes see the ground, and our feet confirm it's existence. We see an apple, and our touch, small, and taste confirm it. However, majority of the universe is beyond the reach of our contact senses. We rely on our distance sensing capabilities. Wide spectrum and fast speed of light provides us most significant information. Light reveals location, size, shape, color, as well as identity and action of surroundings.

Real event and how fast it unfolds is deeply bedded in atomic level. Even best instrument can only open a small widow. Atomic action is too vast, too fast, too small, and never stop. It does not wait for our detector, and it does not replay. We have to objectively quantify the measurement (quanta) to get useful information. Even we can duplicate similar events, however, we can never see the same rainbow again. As simple as an apple contains information that can only be considered infinite. And, it's look, smell, and compositions are changing constantly. It's image is only the rejected light. No matter how fast light can deliver information, an event is history as soon as it unfolds. What we perceive is not the reality but historical information. Light emitted or reflected is separate entity from source object. Equally, we can identify musical instrument from it's melody, but sound and instrument are not the same entity. In fact, it is this separation of reality and information enables us to record events for replay or replicating physically. It does not require original reality.

3 Transportation Of Information

Suppose a riding biker continues to pitch whistle balls forward, backward, and sideways. In the mean time, playing loud music, and flashing his head light. He sets the ball speed by passing his momentum onto it. In other words, the speed of the ball is set by the speed of bike and his arm swing. However, he can not pass his momentum onto sound or light. And, neither the speed of the ball can alter the speed of whistle sound or reflected light.

On the other hand, he can set where to release the ball, sound, and light. It sets the distance to travel for ball, sound, and light. The result is changing arrival rate of ball, sound, and light to receiver, Doppler effect [2]. It will be stretching rate of arrival (redshift) if the distance to a receiver is increasing. Shortening rate of arrival (blueshift) if the distance is decreasing.

Hard copy of information on paper, disc, memory chip, and such are physical goods. It is subject to the laws of physical transportation. Information in the form of force, sound, or light is not exceptions. They have to be delivered. We should not be confused by information in the form of light and it's speed. No matter how fast the speed, the delivery of information can not be instant. Matter and force can not translate to next position instantly regardless of it's speed.

3.1 Catcher And Ball Pitcher

The analogy of delivery of information can be illustrated with a catcher and an automatic ball pitcher, as depicted in Figure 2. Say, the ball pitcher is located at 20 meter away. One ball is pitched per every seconds. It is moving away from the catcher at the average speed of one meter per second, and it will stop moving when last ball is pitched. It is also assume the average ground speed of the ball remains 20 meters per second.

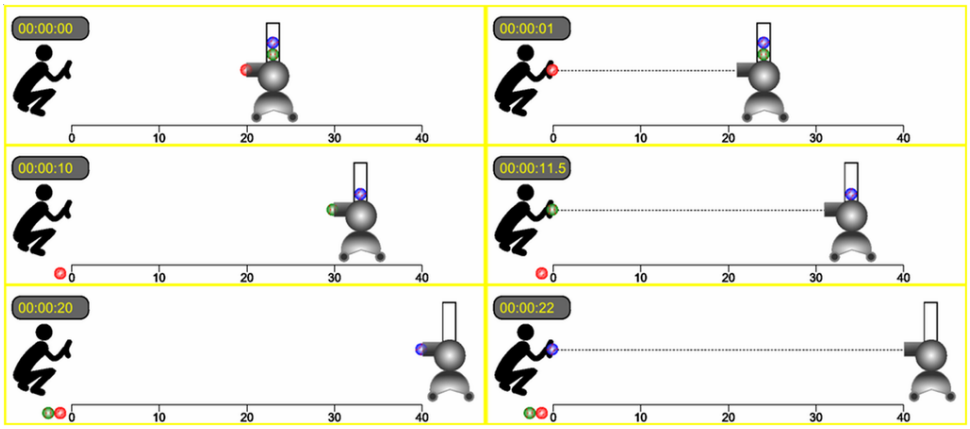

Figure 2: Catcher and his departing ball pitcher

It takes pitcher 20 seconds to finish three ball.

1. Red ball is pitched at 00:00:00 from 20 meters away.
2. Green ball at 00:00:10 from 30 meters away.
3. Blue ball at 00:00:20 from 40 meter away.

However, it takes catcher 21 seconds to receive all three balls.

1. Red ball is received at 00:00:01 from 20 meters away.
2. Green ball at 00:00:11.5 from 30 meters away.
3. Blue ball at 00:00:22 from 40 meter away.

And the arrival rates are:

1. Green ball arrive 10.5 seconds later from red ball.
2. Blue ball also arrive 10.5 seconds later from green ball.

Here, the rate of arrival is one ball per 10.5 seconds, slower than the pitched rate of 10 seconds. It is analogy of Doppler redshift in sound and radiation transportation, stretched arrival of wavelets (balls).

Next, pitcher is moving toward catcher one meter per second on average, depicted in Figure 3. The average ground speed of the ball remains 20 meters per second.

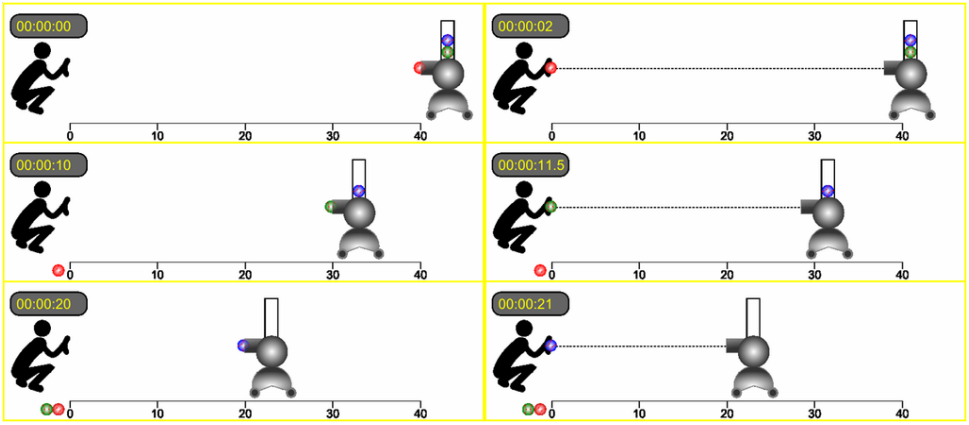

Figure 3: Catcher and his approaching ball pitcher

Again, it takes pitcher 20 seconds to finish all three balls.

1. Red ball is pitched at 00:00:00 from 40 meters away.
2. Green ball at 00:00:10 from 30 meters away.
3. Blue ball at 00:00:20 from 20 meter away.

However, it only takes catcher 19 seconds to receive all three balls.

1. Red ball is received at 00:00:02 from 40 meters away.
2. Green ball at 00:00:11.5 from 30 meters away.
3. Blue ball at 00:00:21 from 20 meter away.

And the arrival rates are:

1. Green ball 9.5 seconds later after red ball.
2. Blue ball arrives 9.5 seconds later after green ball.

This time, the rate of arrival is one ball per 9.5 seconds, faster than the pitched rate of 10 seconds. Again, it is analogy of Doppler blueshift in sound and radiation transportation, compressed arrival of wavelets (balls).

3.2 Dynamic of Moving Pitcher

As depicted in Figure 4, let's say the ball pitcher is moving toward the catcher in identical ground speed with the ball.

- The ball pitcher is located at 1,000 meters away.
- There are 3 balls to be pitched.
- It will loft one ball per 10 seconds to catcher.
- The average ground speed of the ball is 25 meters per second.
- The average ground speed of the ball pitcher is also 25 meters per second.
- Ball pitcher will stop moving when last ball is pitched.

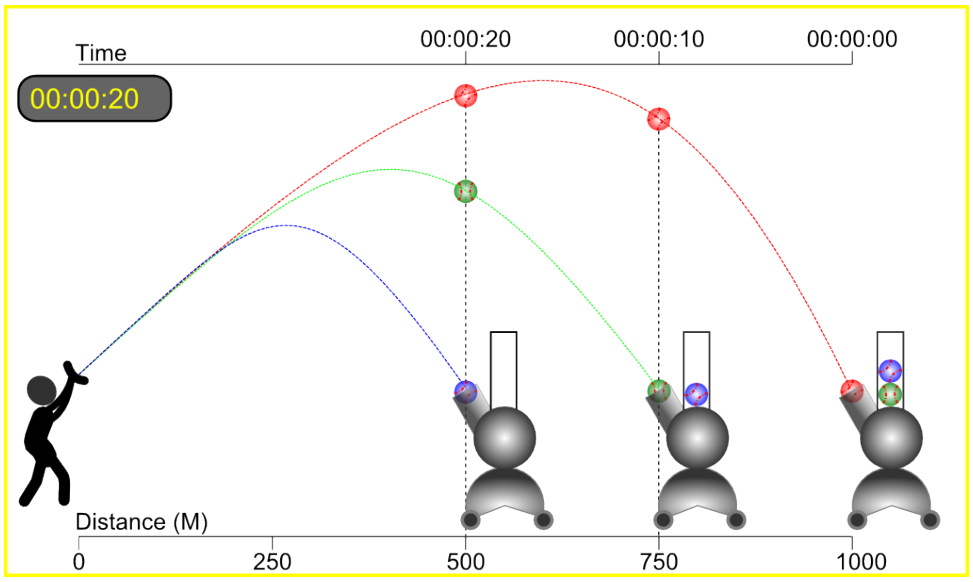

Figure 4: Ball pitcher and ball travel at same ground speed

1. Red ball is pitched at 00:00:00 from 1,000 meters away.
2. Green ball at 00:00:10 from 750 meters away.
3. Blue ball at 00:00:20 from 500 meter away.

At 00:00:20, all three ball are aligned at 500 meter mark at the time the blue ball is launched. Assume all balls are off alignment from the side and no midair collision. They will arrive about the same time by 00:00:40, Figure 5.

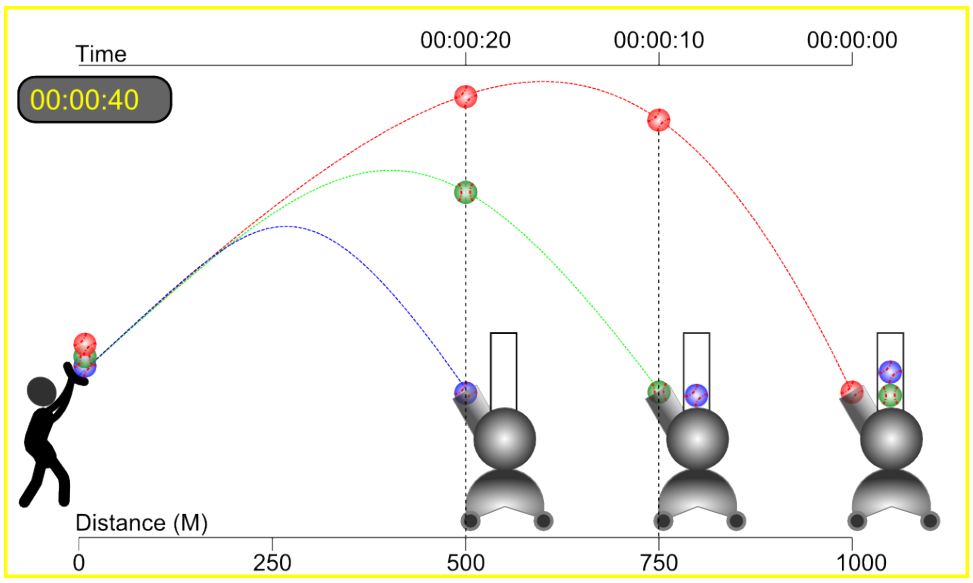

Figure 5: All arrival at the same time

Next, suppose the average ground speed of the ball is only 20 meters per second, and ball pitcher remains 25 meters per second on average:

1. Red ball is pitched at 00:00:00 from 1,000 meters away.
2. Green ball at 00:00:10 from 750 meters away.
3. Blue ball at 00:00:20 from 500 meter away.

At 00:00:20, when the blue ball is launched at 500 meters away, green ball is 550 meters ground distance away, and red ball is 600 meters ground distance away, as depicted in Figure 6.

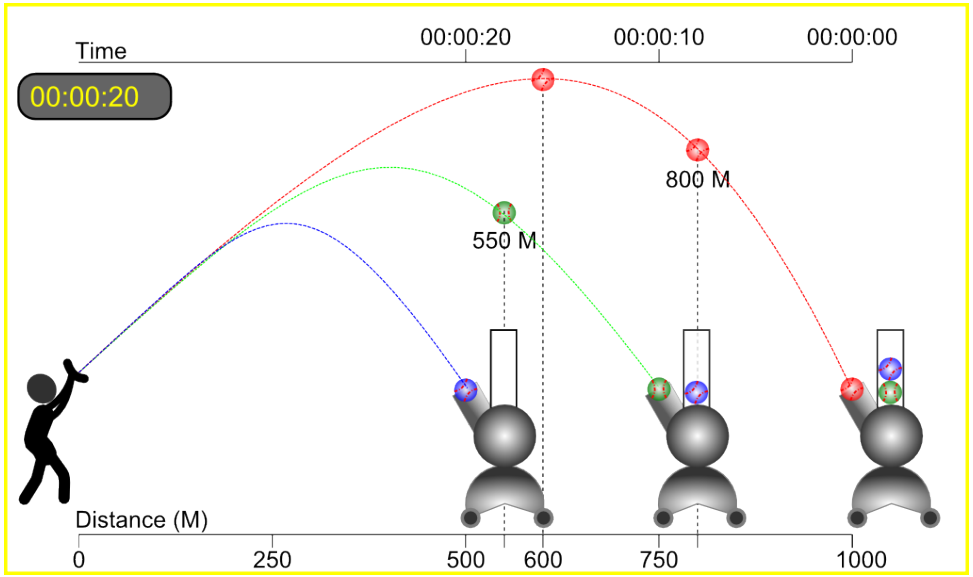

Figure 6: Ball pitcher travels at higher ground speed

However the receiving is not the same order of delivery, as depicted in Figure 7.

1. Blue ball is received at 00:00:45 from 500 meters away.
2. Gree ball at 00:00:47.5 from 750 meters away.

3. Red ball at 00:00:50 from 1,000 meter away.

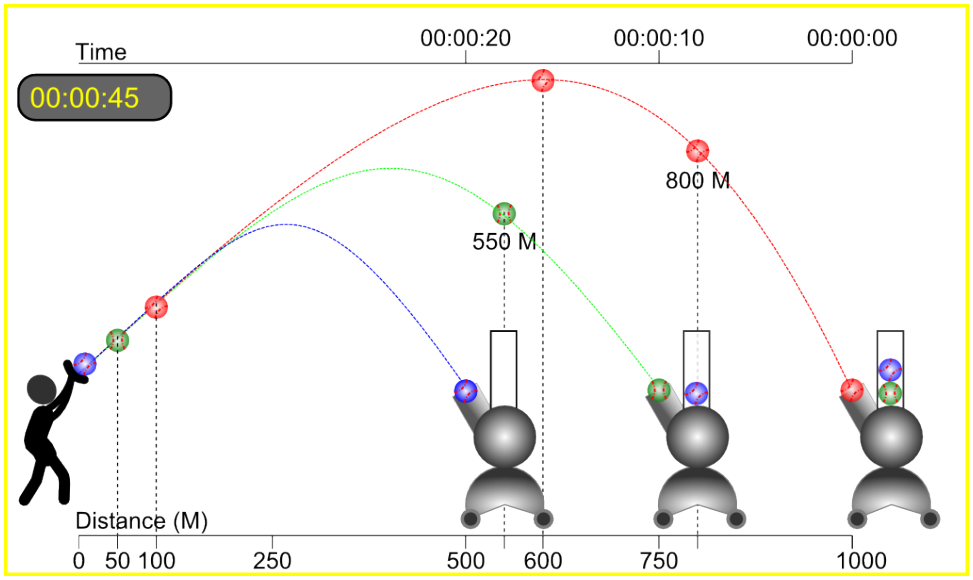

Figure 7: Reverse arrival of balls

Again it took 20 seconds to finish pitching all three balls, however it only took 15 seconds to finish receiving, and the arrival is reversed. The arrival rates are:

1. Third ball, blue, arrives 2.75 seconds earlier than second ball, green.

2. Second ball also arrives 2.75 seconds earlier from first ball, red.

Don't you believe it also depicts the transportation of scent, sound, or radiation? Can you say the reverse order of receiving balls meant time reversed? Nevertheless, the information has been altered, but not the reality. All methods of artificial data processing in computer and network. From drum beat, smoke ring, Morse code, radio, electromagnetic, laser and particle beams just to name a few.

3.3 Dynamic Observation Simulation

Suppose there are six observers detecting signals from a source broadcasting sequential numbers in fixed time interval, Figure 8.

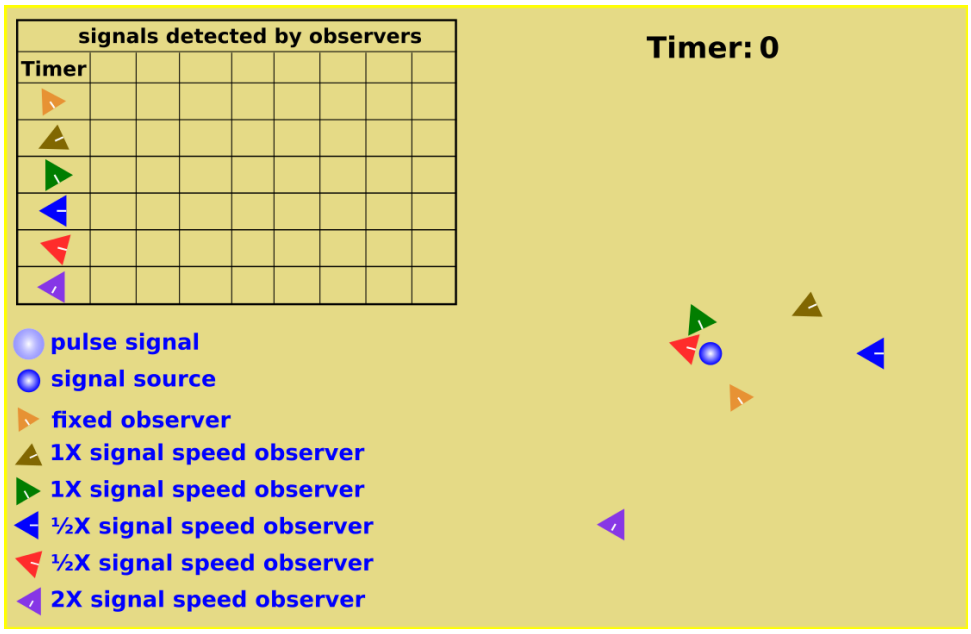

Figure 8: Signals and detectors

Observers are shown in color triangles:

1. Orange is anchored at a fixed distance from source.
2. Brown is coming from northeast toward the source at the same speed of the signal.
3. Green is moving away at the same speed of the signal.
4. Blue is coming from east toward the source at one half speed of the signal.
5. Red is moving away at one half speed of the signal.
6. Purple is coming from southwest toward the source at twice speed of the signal.

Here, table at the top left corner shows the numbered signals detected by each observer at each reference frame of time interval.

Say, source starts to broadcast sequential numbers from 1 to 8 at time 0

At time 0, Figure 9.

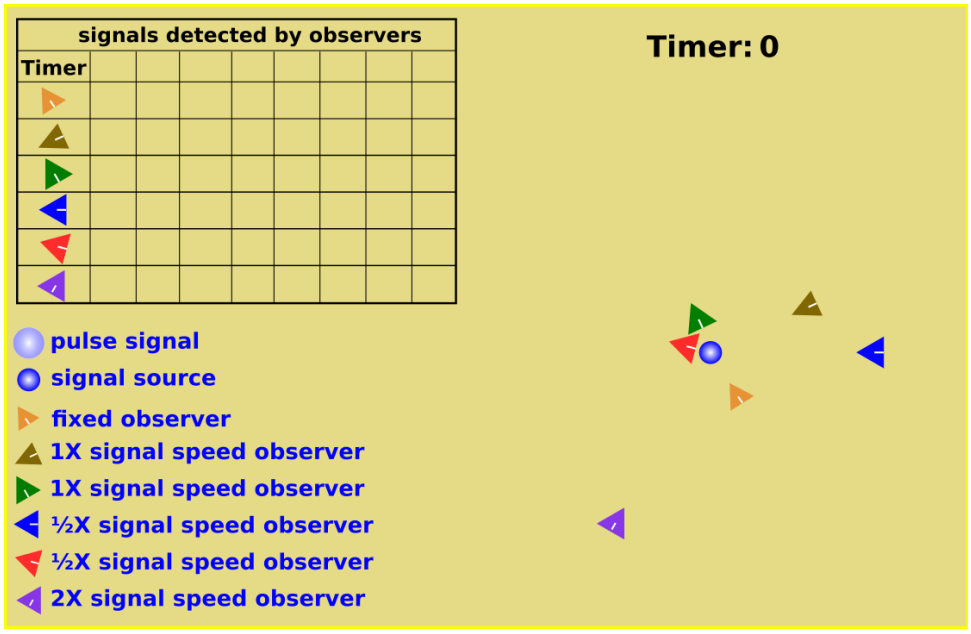

Figure 9: Signal and detection at time 0

1. Orange has no detection.
2. Brown has no detection.
3. Green has no detection.
4. Blue has no detection.
5. Red has no detection.
6. Purple also has no detection.

At time 1, Figure 10.

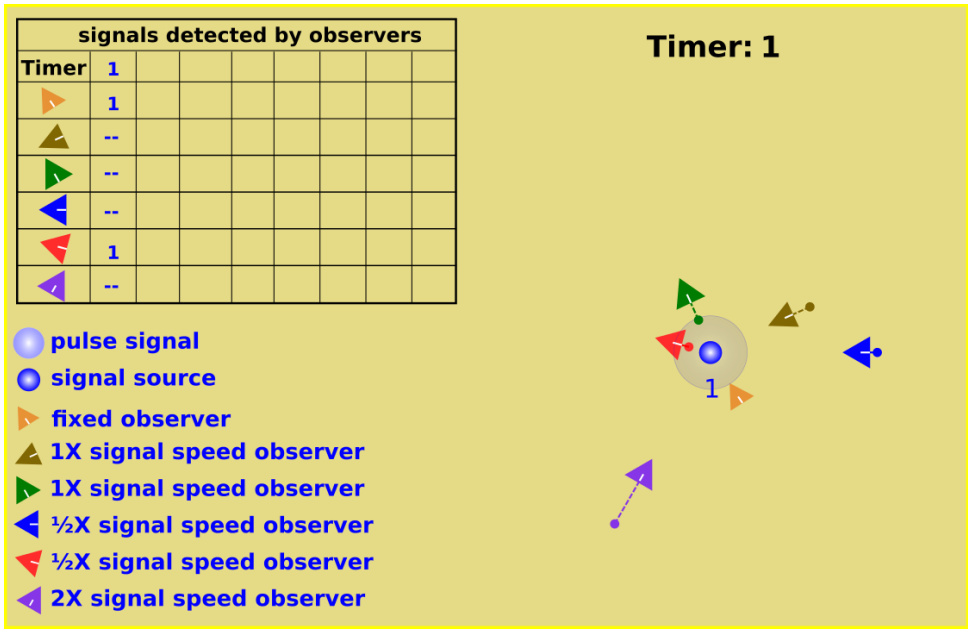

Figure 10: Signal and detection at time 1

1. Orange detects 1 from the source at time 1.
2. Brown has no detection.
3. Green has no detection.
4. Blue has no detection.
5. Red also detects 1.
6. Purple also has no detection.

At time 2, Figure 11.

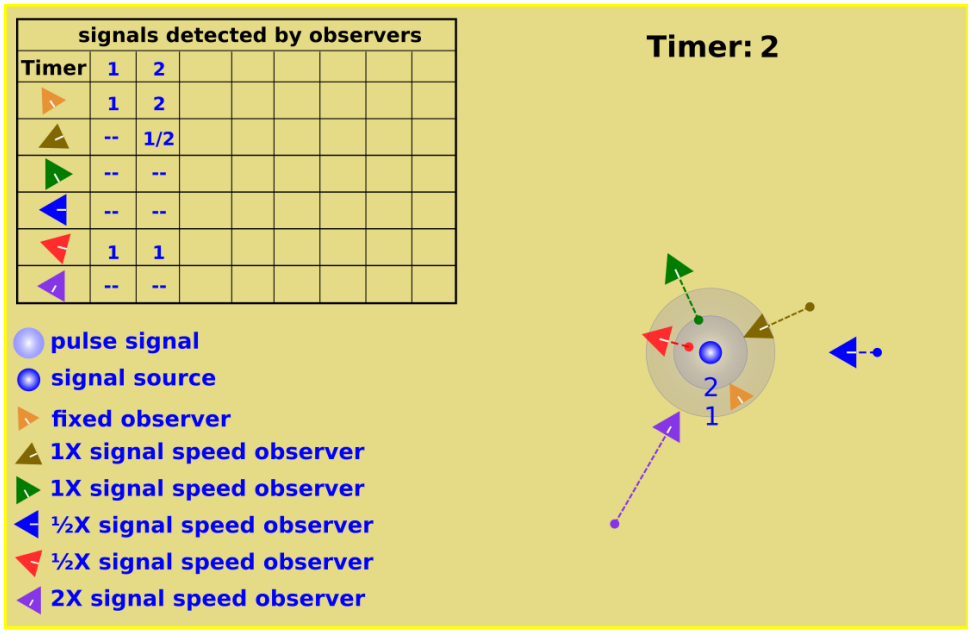

Figure 11: Signal and detection at time 2

1. Orange detects 2 from the source.
2. Brown would detect 1 and 2 within the interval.
3. Green remains no detection.
4. Blue has no detection.
5. Red still detects 1.
6. Purple also remains no detection.

At time 3, Figure 12.

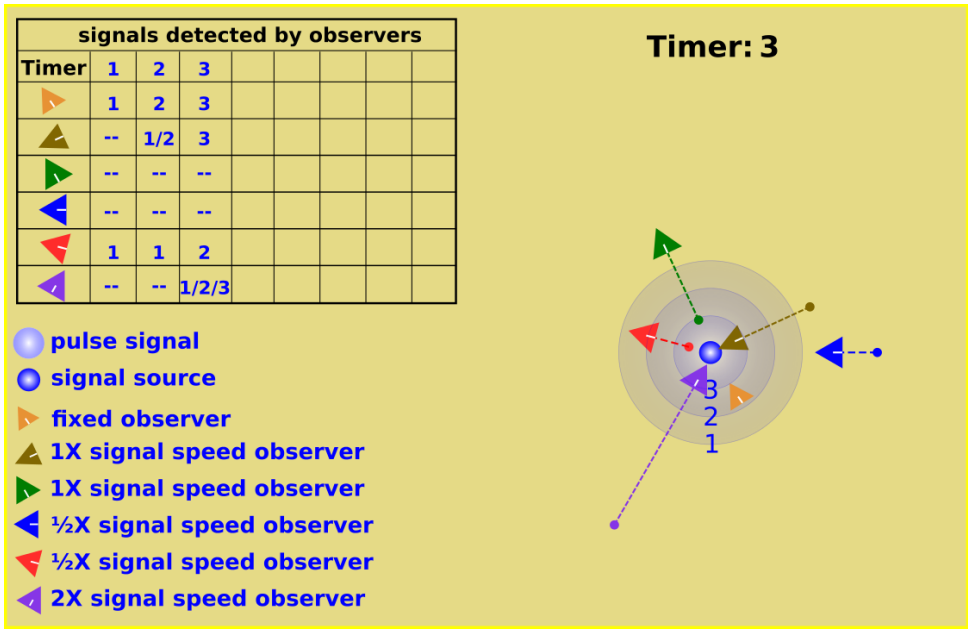

Figure 12: Signal and detection at time 3

1. Orange detects 3.
2. Brown also detects 3.
3. Green remains no detection.
4. Blue detects 1 and 2 within the interval.
5. Red also detects 2.
6. Purple would detect 1, 2, and 3 within the interval.

At time 4, Figure 13.

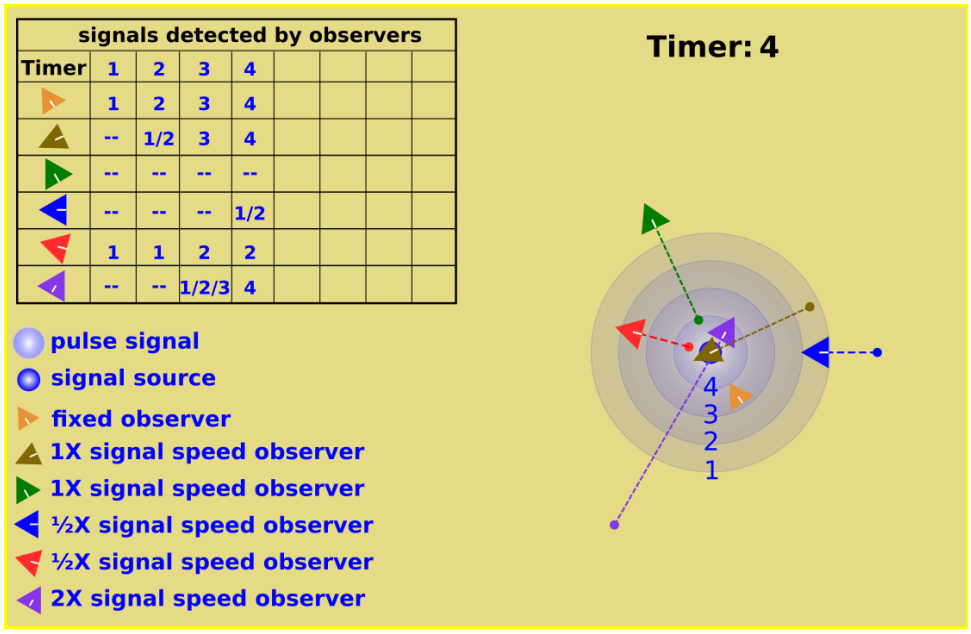

Figure 13: Signal and detection at time 4

1. Orange detects 4.
2. Brown also detects 4.
3. Green remains no detection.
4. Blue detects 2 and 3.
5. Red detects 2.
6. Purple detects 4.

At time 5, Figure 14.

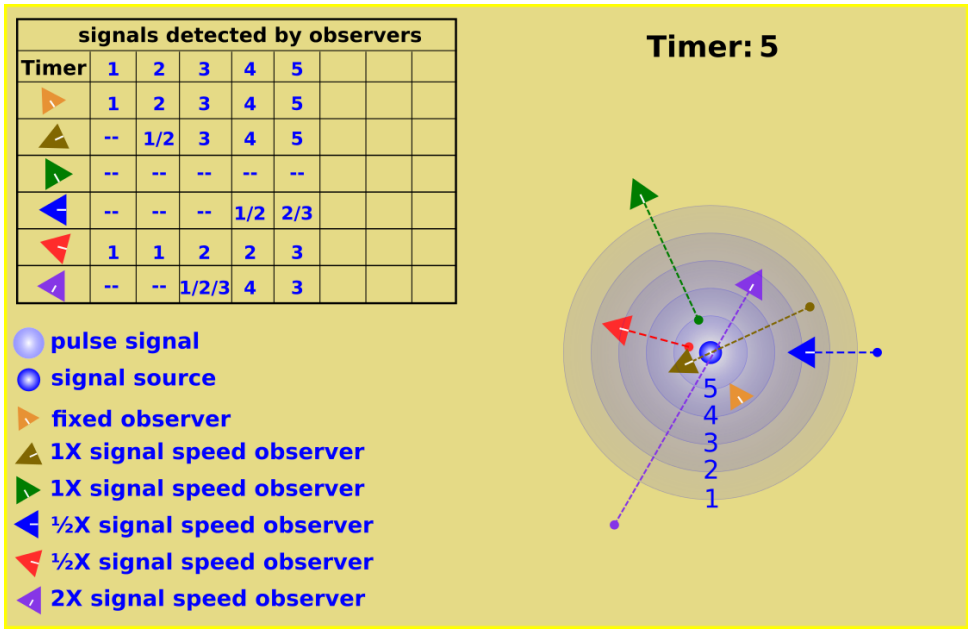

Figure 14: Signal and detection at time 5

1. Orange detects 5.
2. Brown also detects 5.
3. Green remains no detection.
4. Blue detects 4 and 5.
5. Red detects 3.
6. Purple detects 3.

At time 6, Figure 15.

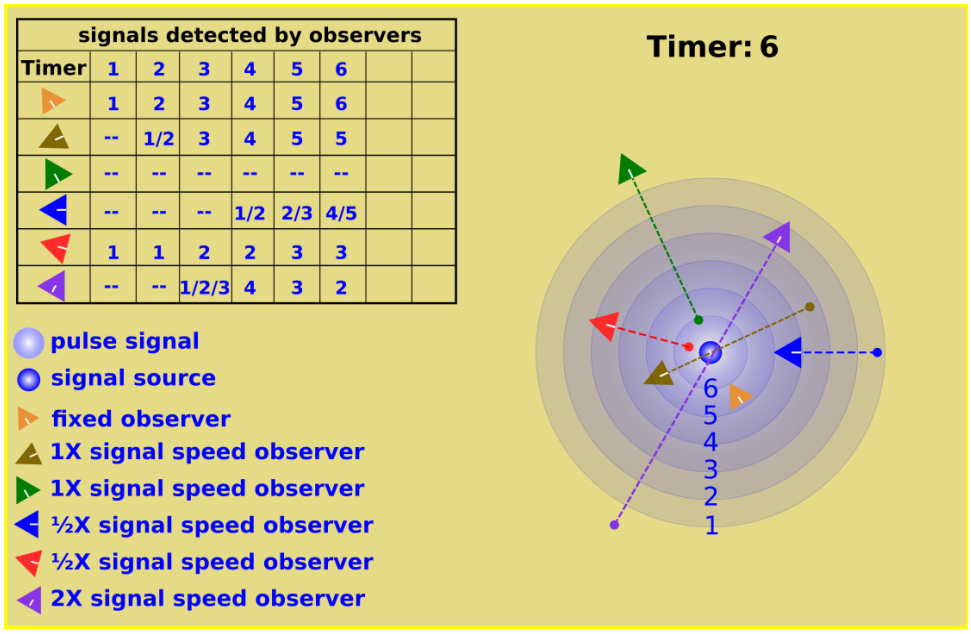

Figure 15: Signal and detection at time 6

1. Orange detects 6.
2. Brown also detects 5.
3. Green remains no detection.
4. Blue detects 5 and 6.
5. Red detects 3.
6. Purple detects 2.

At time 7, Figure 16.

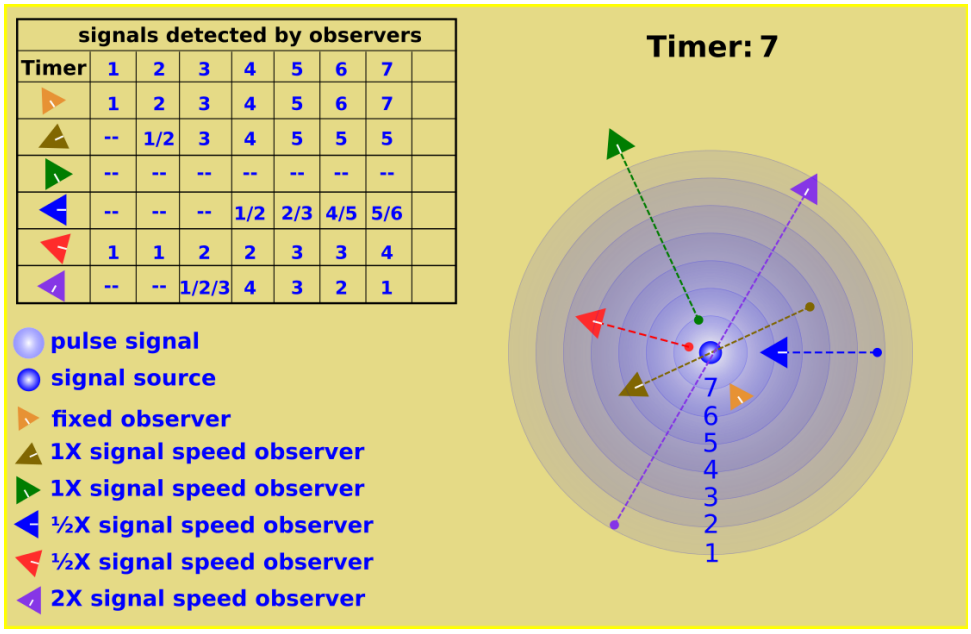

Figure 16: Signal and detection at time 7

1. Orange detects 7.
2. Brown also detects 5.
3. Green remains no detection.
4. Blue detects 7.
5. Red detects 4.
6. Purple detects 1.

At time 8, Figure 17.

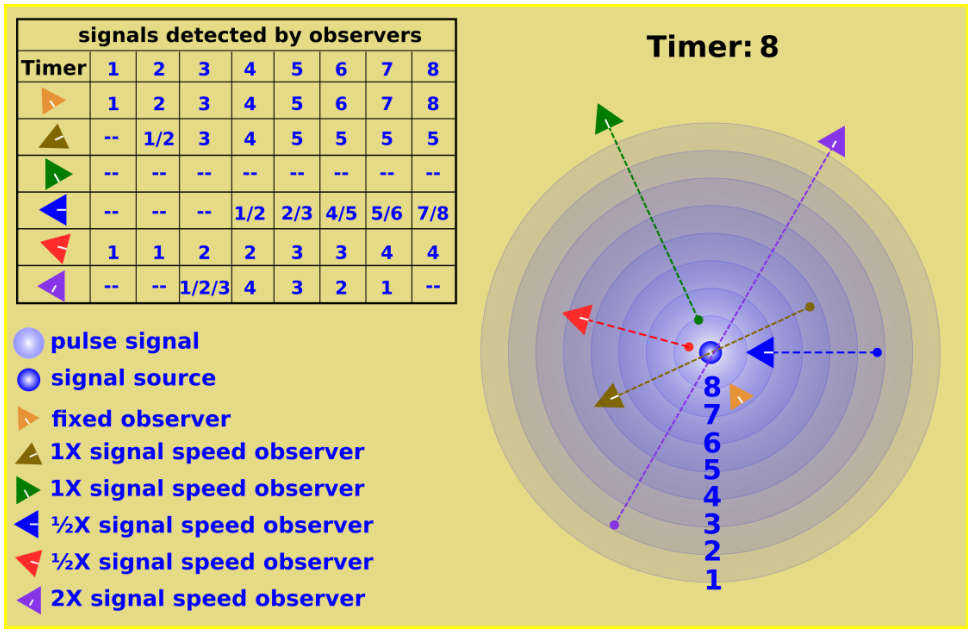

Figure 17: Signal and detection at time 8

1. Orange detects 8.
2. Brown also detects 5.
3. Green remains no detection.
4. Blue detects 8.
5. Red detects 4.
6. Purple has no detection.

Here is an animated illustration. Please note that not all PDF viewer will display it properly.

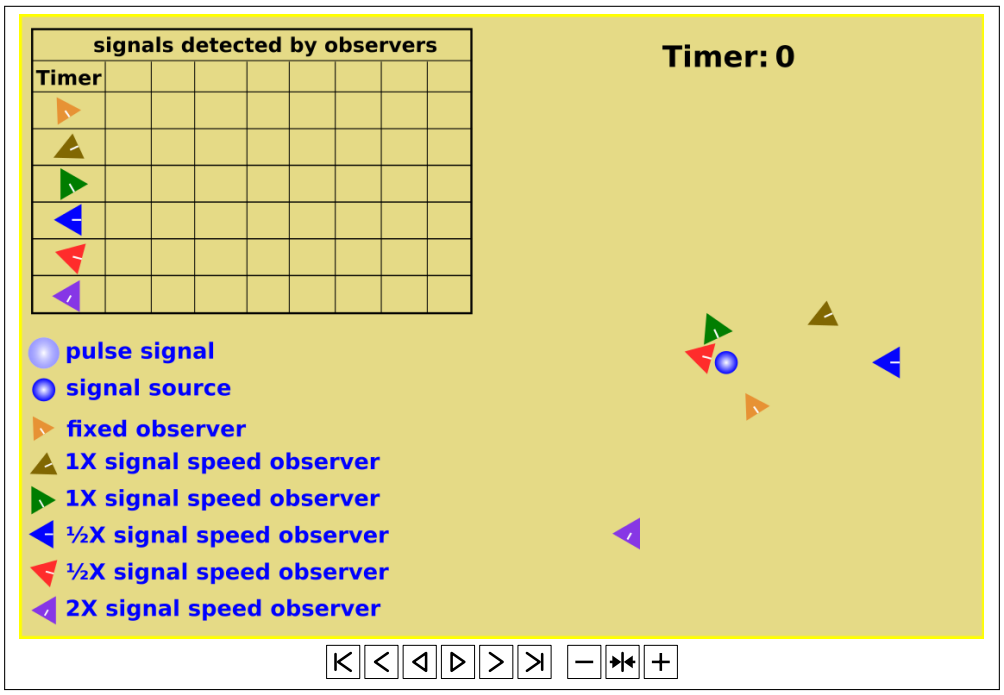

Figure 18: Signal and detection animation

Signal detection is further listed in Table 1:

Timer	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
Orange	1	2	3	4	5	6	7	8	–	–	–	–	–	–	–	–	–
Brown	–	1/2	3	4	5	5	5	5	5	5	5	5	5	5	5	5	5
Green	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Blue	–	–	1/2	2/3	4/5	5/6	7	8	–	–	–	–	–	–	–	–	–
Red	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	–
Purple	–	–	1/2/3	4	3	2	1	–	–	–	–	–	–	–	–	–	–

Table 1: Signals detected by observers

3.4 Divergence of Delivery

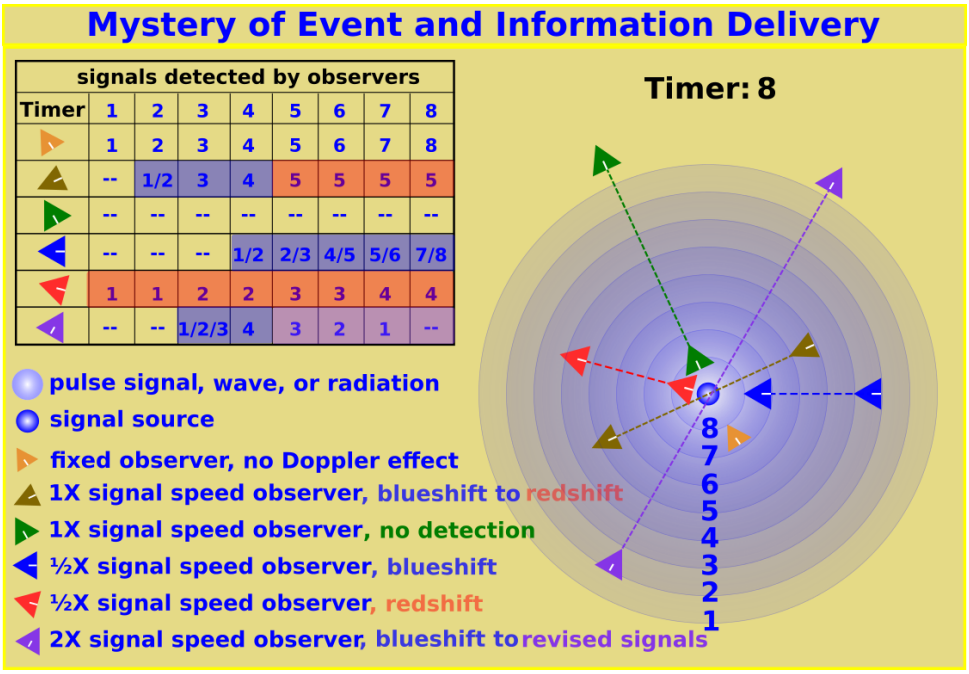

Figure 19: Doppler Effect of Delivery

Information can be augmented by the nature of delivery. Signals can be weaken, interfered, or lost. It also creates Doppler effect of observation summarized here:

1. Orange, , at fixed distance from the source would receive the signals in proper order in identical interval as transmitted. There is no Doppler effect of the signals.

2. Brown 1X signal speed observer, , would receive the signals at twice the speed, blueshift $z = -1$, before passing the source. Then, it is traveling at the same speed of signal 5 after, signals 6, 7 and 8 would never catch up. Signal 5 would remain still, flat line. In other words, it switches to redshift at $z = \infty$, signal 6, 7, and 8 can never catch up. However, Brown will never be aware of redshift unless he knew the transmission of signal 6, 7, and 8.

3. Green 1X signal speed observer, , is moving away from the source at the same speed of the signal from start, it would never detect any signal.

4. Blue 1/2X signal speed observer, , is receiving the signals at 0.5 times the speed of the signal, it would detect compressed signals of Doppler blueshift at $z = -0.5$.

5. Red 1/2X signal speed observer, , is receding at 1/2X speed, signals would be stretched, or Doppler redshift at $z = 0.5$. would experience only redshift through out.

6. Purple 2X signal speed observer, , is coming and leaving at twice the speed of the signal. It would receive blueshifted signal at triple speed before reaching the source. Then no new signals after 4 would be able to catch up. Instead, it would chase down the earlier signals in reverse order and surpass, however no Doppler effect of the signals, $z = 0$.

Suppose source had been sending the message long before time 0, Figure 19. Observer Purple traveling in twice the speed of signals would be able to chase down the signals before time 0 in reverse order. This is also predicted by Lord Rayleigh in his book on sound; that if the source is moving at twice the speed of sound, a musical piece emitted by that source would be heard in correct time and tune, but backwards.[7].

The principles have to be the same regardless of signal type and it's speed. The motion of source alters the location of the origination, and the motion of the observer alters the location of destination. The result is changing distance to travel for signals, hence rate of arrival. As soon as the signal is released. It is on it's own. Neither the motion of source nor observer can alter the quality and speed of signal in flight. It can only be affected by the environment it travels through.

4 Illusion of Information

Suppose all clocks are perfectly synchronized. One clock is traveling from you in high speed. It broadcasts it's readings in light and radio signals. It's reading will appear slower to you since next reading has to travel longer distance to reach you. An observer at the opposite end of flight path will detect a late clock initially and faster clock reading afterward. Then the reading get slower when the traveling clock passed him. Reading Big Ben Clock from orbiting space station, if possible, will always be late. Big Ben will appear running faster on approaching Landon and slower on leaving.

Clock is only good for telling event on time scale to observers in close vicinity. The further away from a clock, the later the reading is. Logically, clock can not display 00:00:00 before midnight exact. Midnight has already passed before the clock is read. Clock display is historical information. The reading has nothing to do with clock or time, but the delivery of information.

Table 1 shows different data is collected among observers. Not only information can deviates from the chronological scale of event, but also alter the order of progression last in, first out. Wouldn't their interpretations differ if none of them had knowledge of the nature of signal transmitted?

A physical object can deliver radiations to infinite angles. Not all angles show identical information. Captured information can be used to recreate the image of the object. For example, hologram[4] is created from information not from reality. So is the image from photo, augmented reality (AR)[1], virtual reality (VR)[8], hypothetical immersive virtual reality[5] or any display. Even our imagination or artificially manipulate mind. Furthermore, misinformation can also be created in our mind without reality.

Some interesting phenomena about detection and ranging of signal to consider.

- How useful the information of echolocation[3] for a bat flying past half the speed of sound? Wouldn't it miss or collide with the target before detection?
- Or, active radar for vessel traveling past half the speed of light?
- Isn't headlights in night driving active detection, and sunlight in daytime passive?
- Given same amplitude, blue ray seems to feel cooler despite it has higher energy density. Is it due to red

band is closer to resonance of our temperature sensor?

5 Summary

Information can be in many forms. Radiation, light, particle, air, sound, radio, or print, just to name a few. In any form, it has to obey the fundamental principles of mass, energy, and motion. At any single frame of moment, there is only one physical location for any object and it's action to unfold. It is the progression of the universe we perceived it as arrow of time. Real event does not replay, however, it's radiations can be delivered as information to observers at countless locations. Information can be preserved in our memory or external medias. This separation of reality and information enable us to replicate history without original real actors.

We live in a totally immersed reality. What we perceive and preserve is the information presented by physical universe. Information can be tampered by environment as well as personal consciousness and sub-consciousness. It can also be manipulated into fictitious fantasies that is impossible in physical universe. It is illusion if we can not distinguish reality and it's information. I believer there is danger of overexploitation and misinterpretation due to our obsession. Speed and light can not alter the fundamentals of the universe. Yet, truth and paradoxes can entangle in specious interpretations from obsession.

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