Anatomy of Radiation And Propagation
解析輻射與擴散

Cres Huang

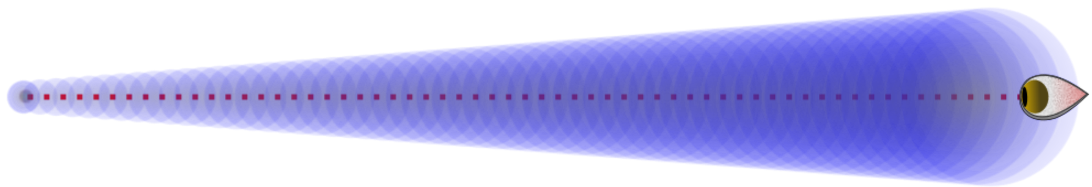

Figure 1: Particle/Wave Stream of Radiation

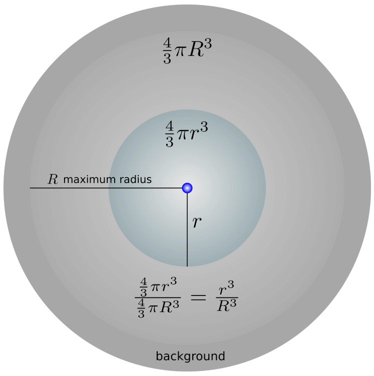

Figure 2: Propagation of Radiation

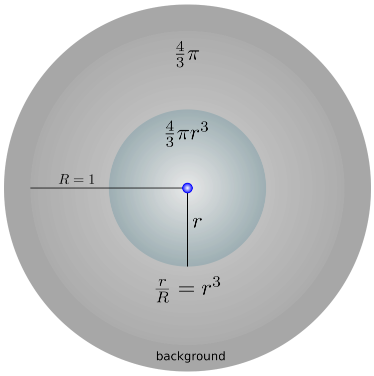

Figure 3: Standardized Propagation

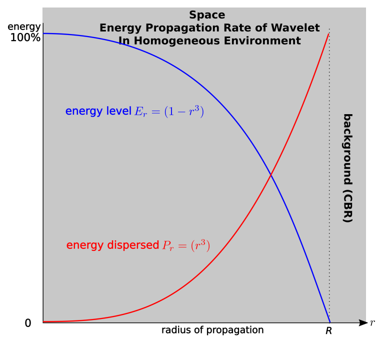

Figure 4: Standard Function of Propagation

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Anatomy of Radiation And Propagation

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Advice and correction are appreciated.
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Abstract

We hear the word radiation often. We see waves revealed by water, and air wave above hot surface. We feel the air (wind) and hear it's motion (sound), even see the supersonic shack wave of air. Say, the Sun is radiation transmitter and our eyes are receiver. Do you think it is fundamentally different from detection and ranging of radar? How particle, wave, radiant energy, or EMR is different from perceivable world in our day to day life? For example, is explosion, candle flame, or shots from shotgun, radiant energy? Or, water droplets coming from a spray bottle and rainbow?

Normally, a meteoroid is not self illuminating. We would not see it unless light is reflected from it. It is silent until it enters the Earth's atmosphere and becomes meteor. There would be heat, sight, and sound from it's interaction with air. Then, ground shake when it impacts with the Earth and becomes meteorite, or remain of meteoroid forged by atmosphere and gravity. So far, we only see it's interaction with the environment displayed by waves. Then, it can be felt if discovered by meteorite hunter. It can be cut open and see what is inside. It is a structure of particles that we can directly observe. However, particle of radiation is invisible and light-speed being. It is very difficult, if possible, for us to hold it still and feel it, let along dissect it. Is the phenomena of meteorite far fetched from radiation? Nonetheless, shouldn't there be fundamental principles that governing the action of matter and it's interaction with it's environment?

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1 Introduction

Here is some definitions of radiation:

- The process in which energy is emitted as particles or waves, dictionary.com.
- The process of emitting radiant energy in the form of waves or particles, merriam-webster.com.
- The emission of energy as electromagnetic waves or as moving subatomic particles, especially high-energy particles which cause ionization, oxforddictionaries.com.
- By thefreedictionary.com:
  1. Emission or propagation of energy in the form of waves or particles.
  2. Energy radiated or transmitted in the form of waves or particles.
  3. A stream of particles or electromagnetic waves emitted by the atoms and molecules of a radioactive substance as a result of nuclear decay.
- Radiation is a process in which electromagnetic waves (EMR) travel through a vacuum or through matter-containing media; the existence of a medium to propagate the waves is not required, wikipedia.org

If radiation can be particle or wave, shouldn't they be different beings? There are many types of energy transmitted in the form of waves or particle. We see wave revealed by water and air wave above hot surface. We feel the air (wind), hear it's motion (sound), and see the supersonic shack wave of air. We even smell the particles. How particle, wave, radiant energy, or EMR is different from clearly perceivable world in our day to day life? Isn't AM/FM radio, sonar, bio-sonar, sound, explosion, candle flame, or shots from shotgun, or water droplets coming from a spray bottle radiant energy?

Normally, a meteoroid is not self illuminating. We would not see it unless light is reflected from it. It is silent until it enters the Earth's atmosphere and becomes meteor. There would be heat, sight, and sound from it's interaction with air. Then, ground shake when it impacts with the Earth and becomes meteorite, or remain of meteoroid forged by atmosphere and gravity. So far, we only see it's interaction with the environment displayed by waves. Then, it can be felt if discovered by meteorite hunter. It can be cut open and see what is inside. It is a structure of particles that we can directly observe. However, radiation particle is invisible and light-speed being. It is very difficult, if possible, for us to hold it still and feel it, let along dissect it. Is phenomena of meteorite far fetched from radiation? Nonetheless, shouldn't there be fundamental principles that governing the action of matter and it's interaction with it's environment?

2 Anatomy of Radiation

Rotation (spin) and translation are fundamental motions of physical object, Figure 5.

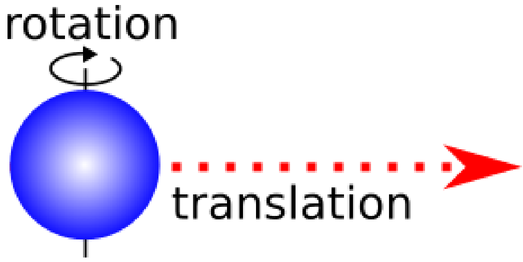

Figure 5: Fundamental Motions

Here, an object can be a simple particle to large structure. Motion of object will disturb the environment; And disturbed environment will disturb objects in it' reach. It displays different drama from fundamental particle to complex structure of galaxy. However, I don't see the difference fundamentally. A lone sardine swims it's own way of reacting to it's surroundings. However, it's interaction with it's neighboring sardines in a school creates complex pattern of display. Equally, we don't see water wave where there is only one water molecule moves. We can't hear the sound when there is only one air molecule in action. However, a collected mass of water molecules shows the ripples, and collected oscillations of air molecule is music in our ears.

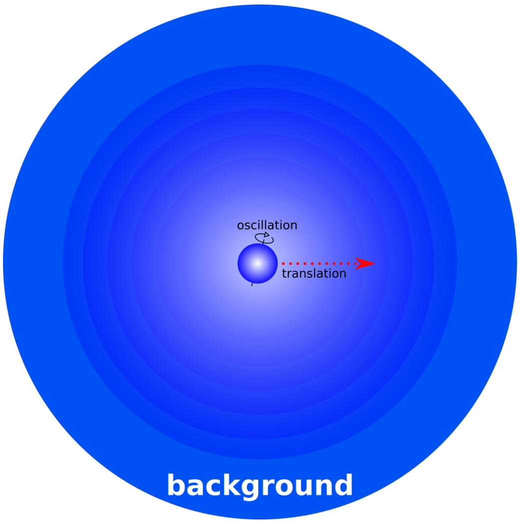

Figure 6: Fundamental Action-reaction-interaction

Air waves and ground shakes when we walk. As of vibration of music instrument causes it's surroundings to react. The energy will be distributed to instrument, musician, and environment, *e.g.* air, floor, ground, audience, and such, until it's energy is fully dispersed. Here, energy is the force created by motion. It can be contact force that requires media to spread, or action-at-a-distance force that does not. Oscillation and translation can force a structure to release it's elements. A star radiates particles and waves from it's nuclear activities. It is the fundamental activity of action-reaction-interaction of an object and it's environment. Here, environment is the absolute complement of the object, or the rest of the universe.

Wavelet is used to describe an unit of a complete wave period. It's energy propagates spherically. Frequency is it's rate of wavelets generated. I believe it will better present the nature of radiation, besides, it has discrete particle involved. A simplest form of radiation may looked like this:

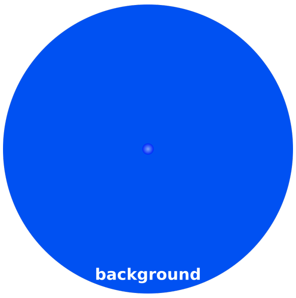

Figure 7: A Still Source

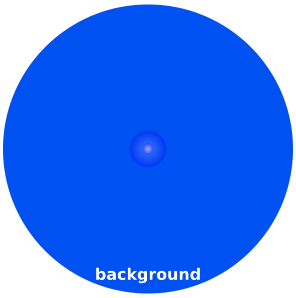

Figure 8: Single Wavelet

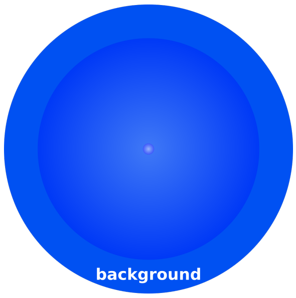

Figure 9: Wave Propagation

Figure 8 shows a single wavelet of radiation is created. Consider it is a packet of energy sharing with it's surroundings created by single oscillation of a still particle. Eventually, it will become indistinguishable from background, or propagated into the environment, Figure 9. Short and unrepeated radiation in speed of light such as this is next to impossible to be perceived by observer, isn't it?

Occasionally, short event such as super nova can be detected. However, in most cases, source would radiate for very long time and we see star filled sky. Here, it is assumed the distance of observation is unchanged. Or, distance to travel for all wavelets is fixed. It is a long stream of cumulated energy as shown in Figure 10 through Figure 17.

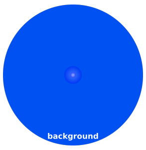

Figure 10: 1

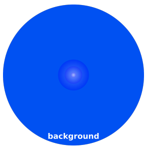

Figure 11: 2

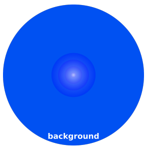

Figure 12: 3

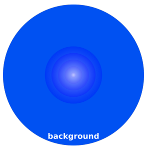

Figure 13: 4

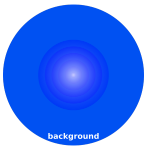

Figure 14: 5

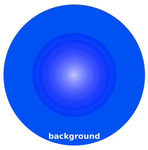

Figure 15: 6

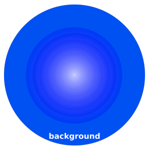

Figure 16: 7

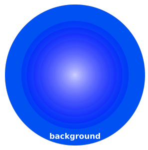

Figure 17: 8

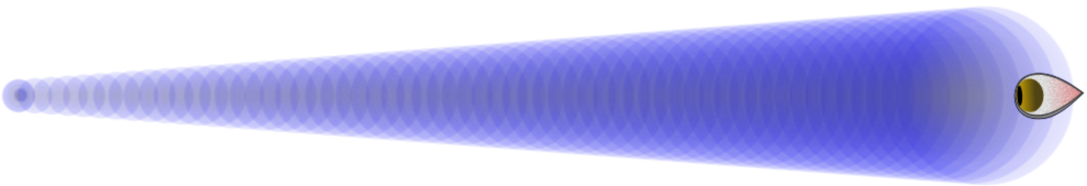

Figure 18: Wave Stream View of An Observer

Certainly, one source can be detected by observers at different locations.

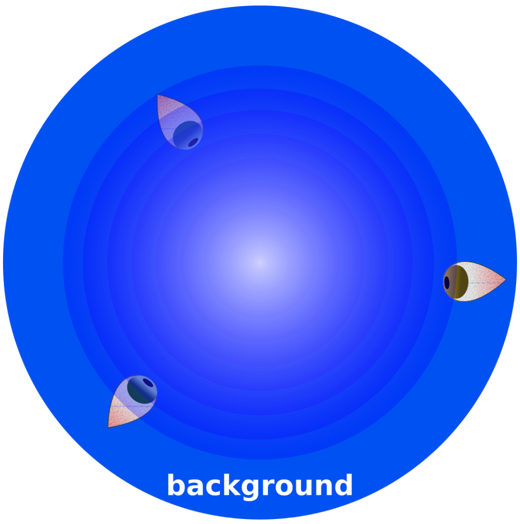

Figure 19: Broadcast View

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

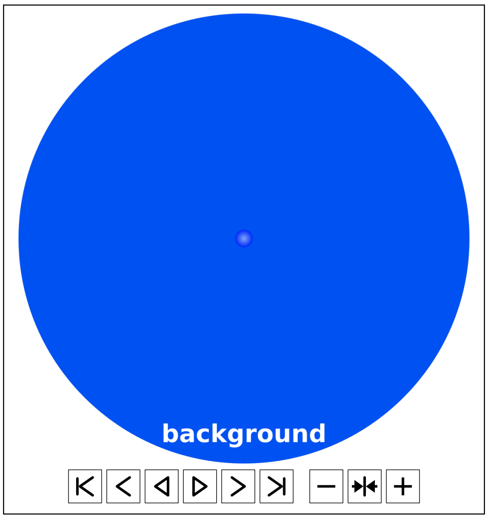

Figure 20: Radiation Stream Animation

The propagation will eventually merge into the background, when it's energy equalized with the environment. It is the principle of reaching equilibrium (sharing) in thermodynamic, force, pressure, and all unequal mass and energy.

Consider this depiction of wave propagation by a singular action of a swallow drinking in flight is shown in Figure 21.

Figure 21: Swallow flying drinking 2
Image credit Nicolas Sanchez, Wikimedia Commons.

Here we see an action, a force is passed onto water. The disturbed water molecules react. Then, the force spreads out into neighborhood. Like a single drum beat, touch and go action of swallow closely displays a singular action. We may miss seeing the action of the bird, but ripples will remain for a while until fully propagated. We don't detect the ripples directly. Instead, it's the reflected light of water. However, water ripple is slow motion of wave. It shows a general idea of how light-speed radiation travels thought space. Intuitively, air also waves in this event, however, it is not directly visible in the photo. But the ripples of water surface reveal the curve of air waves. The question is, wouldn't magnetic and gravity field also wave in this event? Furthermore, do you believe the space can, likewise, wave?

For human eyes to see radiation as visible light, the duration has 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. Color is also determined by the rate of arrival. 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 shades in between[7].

THz, terahertz, also means number of 10^{12} wavelets arrived 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 diameter of a 400 THz red light wavelet is about $\frac{299,792,458}{400*10^{12}} \approx 750$ nanometers (wave length). A short radiation, say about $\frac{1}{100}$ of a second of red light at 400 THz. The stream contains $4*10^{12}$ wavelets in 0.01 of a second, 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. Certainly, it can be detected by camera. However, not all wavelets are equally healthy and emitted at exactly identical rate. Weak wavelets undetected would make it below 400 THz. The result is redshift caused by missing wavelets. I believe it is also the phenomenon we have observed that low frequency sound can transmit further.

This principle is identical in cosmic rays, sight, sound, radio, drum beat, pulsation, and alike. The energy density of light wavelet is brightness, the rate of arrival (frequency, pulsation) is color. The energy density of sound wavelet is loudness, the rate of arrival is pitch. In music, you hear middle C if your ears detected 261.63 sound wavelets (oscillation of your eardrum by air molecules) within one second, or 130.815 sound wavelets in one half of a second. The question is, what particle and wave of radiation have in common with music we hear?

In auditorium, band does not throw musical particles to you (not saying you wouldn't throw eggs to them). Their voice and musical instruments oscillate the environment, air, wall, floor, and ceiling. The energy of oscillation (waves) passed on to yous body. You feel and hear it. What you have received is the reacting wave energy of the environment, irrelevant to source. They travel at their own speed. Even you might not perceive it, you should feel the music before you hear it. It is because wave energy transmitting trough the floor faster than the air. Similarly, mid-ocean volcano eruption would not throw rocks or water at you. You may see the eruption or hear the rumble. But your village could be under tsunami assault by local water. Nonetheless, sight, sound, and water waves travel at their own speed.

In other case, you could hear the bullet whistling by your ear then gun shot. But, you would feel it first if you're on it's flight path. On the other hand, you could first see it coming if you're staring down the barrel (relax, behind bullet proof glass). In this case, the source had send particle and waves to you. The point is the whistling sound and sight of the bullet could continue to travel even the bullet had already dropped out of the race. Unless you are struck by the bullet, what you've perceived is only the image (light wave) of the bullet. Here, the bullet does not propagate. It can only make a point strike. On the other hand, it's sight and sound can be perceived by many observers. Here, sight is the reflection of light from the surrounding source of light, and sound is the reaction of air in vicinity. Bullet is particle traveling in supersonic speed. It's top speed is set by muzzle velocity. It can not accelerate afterward. Gun shot and bullet whistle are waves travel in speed of sound set by the environment. And, the sight of the bullet is reflected light waves set by the speed of light.

You might have seen similar demonstration before. Suppose a riding biker continue to pitch tennis balls forward, backward or sideway. In the mean time, playing loud music, and flashing his head light. He sets where to release the ball, sound, and light. However, he can only set the speed of tennis ball by passing his momentum onto it. In other words, the speed of the tennis ball is set by the speed of bike and his arm swing. Nevertheless, his momentum can not change the speed of sound or light. And, neither the speed of the ball can alter the speed of reflected light from it. Additionally, his displacement sets the distance of his cell-phone to tower, never the speed of it's radio signals.

In order for observer to detect the radiation, it's energy has to be delivered by particle, wave, or both at significant level. Direct radiation observation is detecting particle stream accompanied by waves. Similarly, you would not see the light from light-house in crystal clear night, unless the light beam is directly pointing at you. The difference is light-house light-beam is directional. Radiation is omnidirectional, it radiates to all directions from source. However, one observer is looking at his personal beam. Figure 22 shows all particles and waves arrived and all waves are detected by an observer staring down the barrel.

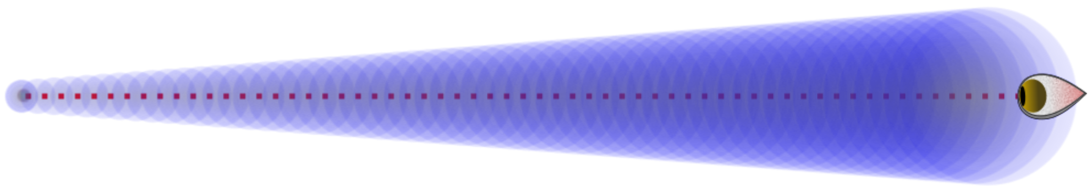

Figure 22: Healthy Particle/Wave Stream

Particle and it's activity stand out from it's background. The force is propagated into it's surrounding and eventually becomes indistinguishable from background. Note, it is only sharing energy, or force of it's action. Particle itself has different fate. With higher density of mass and energy, particle strike can inflict worse damage to a structure. However, it's point size makes it easier to miss. On the other hand, it is harder to escape from wave and makes it easier to detect.

It is not necessary all arrived particles and waves are detected. It is rather difficult to catch a particle due to it's point size and restlessness. I suspect we have devices capable of keeping a particle still on tabletop and perform autopsy. It is not questioning the existence of neutrino, the difficulty of detecting it is due to it's speed, size, and very difficult to detect it's trace (wave, or reaction of it's surroundings). If something is detected, is it neutrino or something else? Can we be sure if the identity of particle is not recognized even some trace had detected?

Nevertheless, particle and wave are different beings to me. Particle is considered point like, and it's trajectory line like. It can only make a point strike. Wave, on the other hand, is a sweep. It propagates to fill the space, and delivery impacts to detectors at many locations. It enables waves to exist at many places at the same time. Yet, particles can park but never vanish, but wave has to continue to propagate and die out eventually.

3 Propagation Function

Action of an object will trigger vast reactions of it's environment. The effect will spread out in chain reactions or propagate into the environment. The propagation of it's environment may be observable by us in the formation of waves perceived in the form of sight, sound, smell, temperature, feel, and so forth. For example, a finger-tap on the surface of calm lake would cause the reactions of water, air, ground, fish, and on. Certainly, the effect can only spread out until it is no longer causing significant reaction of the environment. In other words, the energy has passed onto furthest distance it can reach. Basically, it is spherical range in free space.

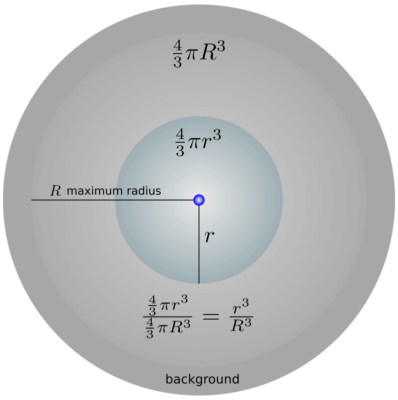

Figure 23: Propagation of Radiation

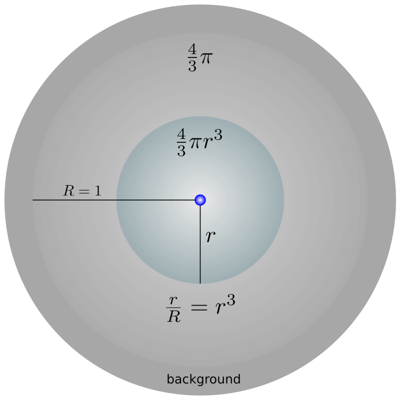

Figure 24: Standardized Propagation

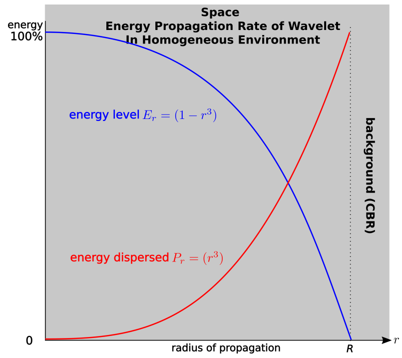

Figure 25: Standard Function of Propagation

In homogeneous environment, the propagation of energy is depicted as a sphere. It's volume increases and it's energy density decreases proportionally, Figure 23. Figure 24 is standardized propagation, and Figure 25 is standard function of propagation, where

R = maximum radius of propagation before merged into the background.

r = radius of propagation, where $0 \le r \le R$.

$E_0 = 100\%$ *at* $r = 0$, initial energy level at origin.

$E_R = 0\%$ *at* $r = R$, energy fully dispersed into the background.

$P_0 = \frac{4}{3}\pi 0^3 = 0$, no energy has dispersed at origin, 0.

$P_R = \frac{4}{3}\pi R^3$, volume of maximum propagation, where all energy has dispersed into the background.

$P_r = \frac{4}{3}\pi r^3$ where $0 \le r \le R$, energy dispersed at radius r.

$\frac{\frac{4}{3}\pi r^3}{\frac{4}{3}\pi R^3} = \frac{r^3}{R^3}$, portion of dispersed energy at radius r per total energy.

Set $R = 1$, $\frac{r^3}{R^3} = r^3$, standard portion of dispersed energy at radius r relative to maximum radius of 1.

Here, the rate of energy dispersion is directly proportional to the cube of the radius.

For example, at half the radius, $r = 0.5$, the portion of dispersed energy $P_r = 0.5^3 = 12.5\%$ of total energy.

Reversely, to lose half of it's energy, the propagation has to reach $r = 0.5^{1/3} = 79.3700526\%$ of it's maximum radius.

On the other hand, at radius r, the remainder energy E_r is $(1 - r^3)$. For example, at half the radius, $r = 0.5$, the remainder energy is $(1 - r^3) = 1 - 12.5\% = 87.5\%$. The propagation will continue as long as it's energy density is higher than the environment. It will eventually reach equilibrium with the environment (background). It is path attenuation (or path loss) in telecommunication. This is the same principle of interaction to reach equilibrium all around us, *e.g.* temperature, pressure, density, etc.

3.1 Surface Propagation

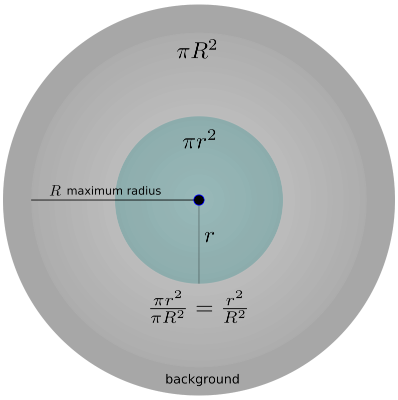

Figure 26: Surface Propagation

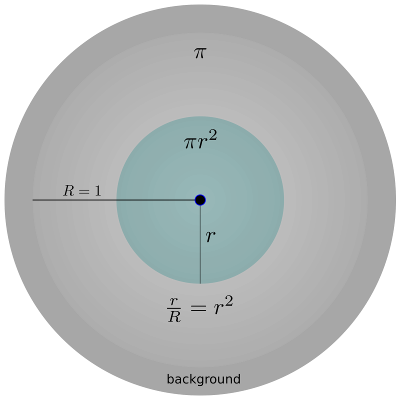

Figure 27: Standardized Surface Propagation

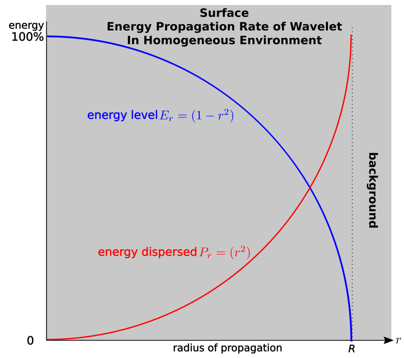

Figure 28: Standard Function of Surface Propagation

As depicted in Figure 26, 27, and 28:

R = maximum radius of propagation before merged into the background.

r = radius of propagation, where $0 \leq r \leq R$.

$E_0 = 100\%$ *at* $r = 0$, initial energy level at origin..

$E_R = 0\%$ *at* $r = R$, energy fully dispersed into the background.

$P_0 = \pi 0^2 = 0$, no energy has dispersed at origin, 0.

$P_R = \pi R^2$, volume of maximum propagation, where all energy has dispersed into the background.

$P_r = \pi r^2$ where $0 \leq r \leq R$, energy dispersed at radius r.

$\frac{\pi r^2}{\pi R^2} = \frac{r^2}{R^2}$, portion of dispersed energy at radius r per total energy.

Set $R = 1$, $\frac{r^2}{R^2} = r^2$, standard portion of dispersed energy at radius r relative to maximum radius of 1.

The rate of energy dispersion is directly proportional to the square of the radius.

For example, at half the radius, $r = 0.5$, the portion of dispersed energy $P_r = 0.5^2 = 25\%$ of total energy.

Reversely, to lose half of it's energy, the propagation has to reach $r = \sqrt{.5} = 0.707106781$ of it's maximum radius.

On the other hand, at radius r, the remainder energy E_r is $(1 - r^2)$. For example, at half the radius, $r = 0.5$, the remainder energy is $(1 - r^2) = 1 - 25\% = 75\%$. The propagation will continue as long as it's energy density is higher than the environment. It will eventually reach equilibrium with the environment.

4 Heterogeneity

Universe is not homogeneous. It can not be absolute zero. It means there are activities in all regions of the universe. It also means that there is no vacuum can exist in the universe. Logically, we can not detect vacuum. We can only detect the absent of detestable. To be complete vacuum, it has to be absolute zero.

The dynamic of source and the environment will not be constant. Same music played is different from instrument to instrument, musician to musician, place to place, and time to time. The condition of musician, instrument, air current, pressure, temperature, and other variables in the environment can not remain constant, even it is not truthfully perceived by audience.

Detectable or not, action of particle itself is heterogeneous. Intuitively, there are infinite vacillations of rotation and translation of particle.

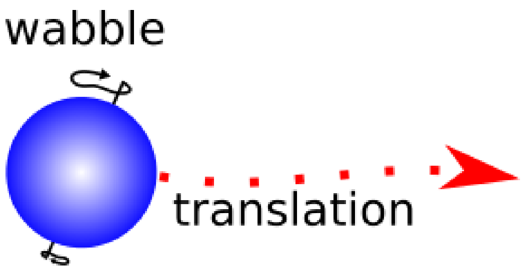

Figure 29: Vacillations Of Rotation And Translation

The result is compound heterogeneity of frequencies. In music, it creates the special characteristics of instruments. Two pianos will not sound the same in experts' ears.

Quality of radiation can also be altered by interacting with heterogeneous environment.

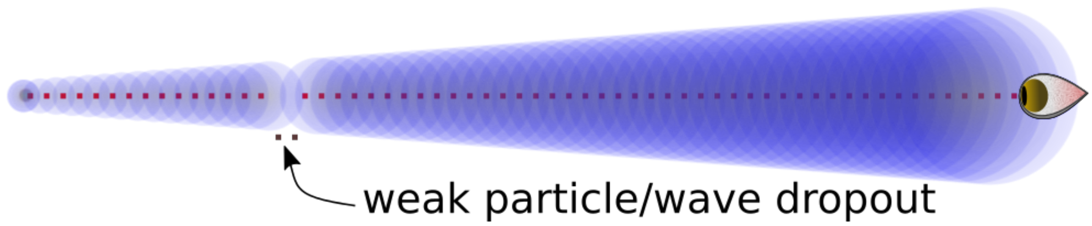

Figure 30: Weak Particle/Wave Dropout

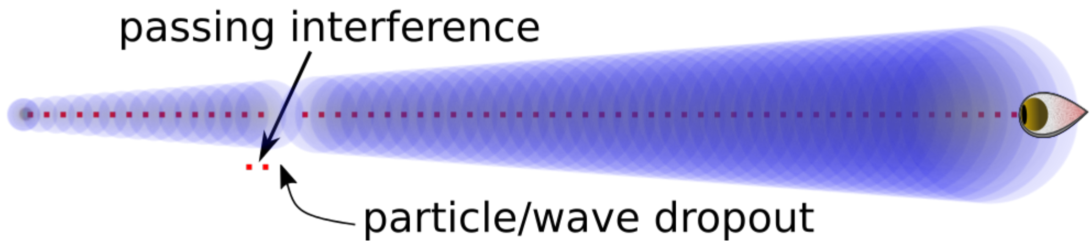

Figure 31: Particle/Wave Dropout by Interference

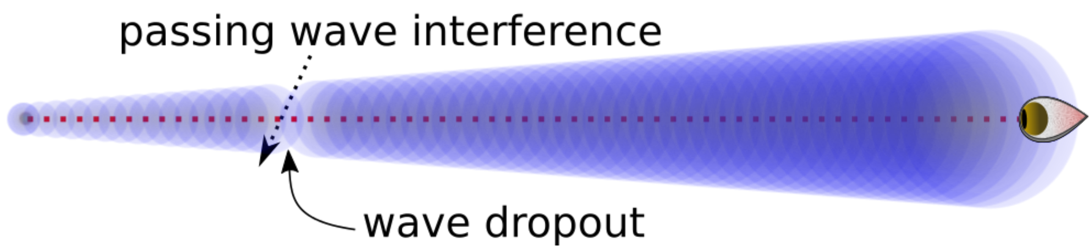

Figure 32: Wavelet Dropout by Interference

Radiations will not move in complete freedom without interactions, *e.g.* crossing magnetic field, particle cloud, or radiations. Wavelets can be weaken and drop out by interference. Wavelet dropout is frequency loss. It causes redshift, or stretched wave period. Attenuation of radiation can not be avoided. The accumulated effect can only be positively and exponentially proportional to the distance (other than changing in distance). It is the same principle of our daily delivery of perishable goods, the quality and arrival time of packages is heterogeneous, despite the distance from warehouse to destination is fixed. The received quality and arrival time of packages depend on distance, delivery speed, en route heterogeneous conditions, *e.g.* weather, road, vehicle, driver, and etc. Additionally, the condition of observer, such as response time and sensitivity, also limit the quality of observation.

5 Heterogeneity Redshift Calculation

A simplified depiction is used here to show the calculation of redshift caused by internal and external heterogeneities. Suppose strong, weak, and average wavelets were emitted, represented by the size of ball. And, assume there were three observers, Brown Eye, Green Eye, and Red Eye of equal capability are watching, Figure 33 and Figure 34. Suppose emitted frequency is 3 Hz, or three pulsations per second.

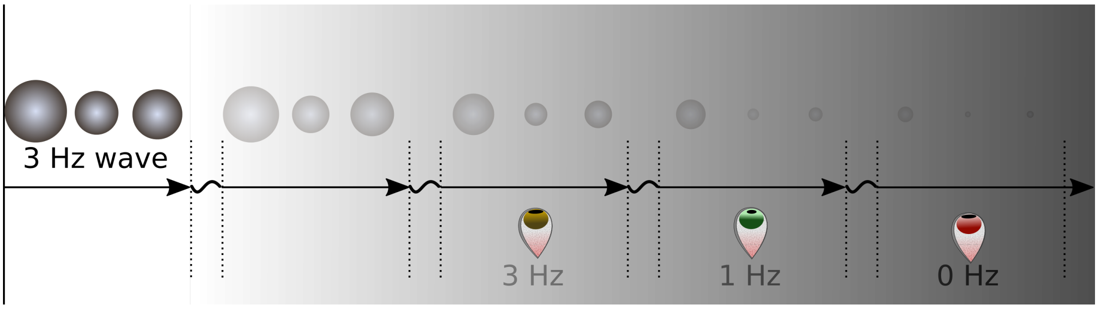

Figure 33: Weak Wavelet Radiation

Here, redshift is symbolized by z. The definition is

$z = \frac{emitted\ frequency - observed\ frequency}{observed\ frequency}$

Brown Eye detected 3 Hz signal: $z = \frac{3-3}{3} = 0$, all wavelets are detected, no redshift.

Green Eye detected 1 Hz signal: $z = \frac{3-1}{1} = 2$, weak wavelet fell below the capability, redshift.

Red Eye detected 0 Hz signal: $z = \frac{3-0}{0} = \infty$, beyond detection. After long propagation, the energy of all wavelets is indistinguishable from background.

External heterogeneity of environment also affect the delivery of wavelets. The radiation encountered interference may not remain intact. The risk is also positively proportional to the distance of travel.

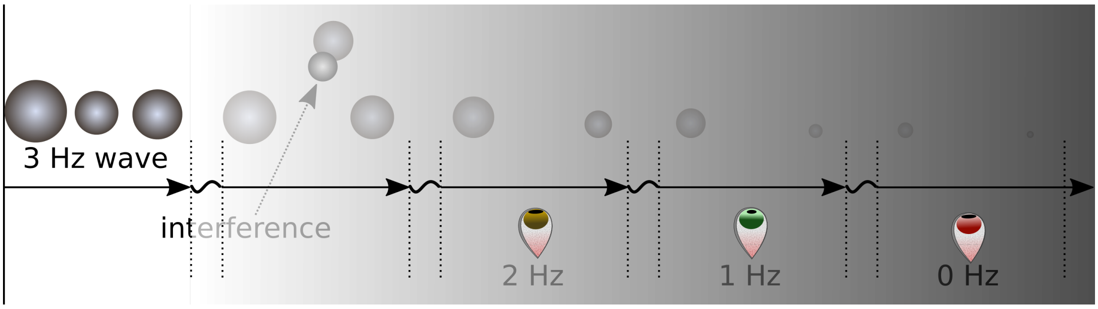

Figure 34: Lost Wavelet Radiation

Brown Eye detected 2 Hz signal: $z = \frac{3-2}{3} = 0.5$, not all wavelets had arrived, redshift.

Green Eye detected 1 Hz signal: $z = \frac{3-1}{1} = 2$, unawares of lost and weak wavelets, redshift.

Red Eye detected 0 Hz signal: $z = \frac{3-0}{0} = \infty$, beyond detection.

The summary:

- redshift can be caused by weaken or missing wavelets (wave periods),

- it is positively and exponentially proportional to the distance of observation,
- when observed frequency is approaching flat line, $z \to \infty$, and
- it does not cause blueshift. Wavelet can not self-accelerate and the distance of observation is assumed fixed here to isolate redshift from Doppler effect.

6 Anatomy of Redshift

We also hear the word redshift often. Here is example definitions:

- A shift toward longer wavelengths of the spectral lines emitted by a celestial object that is caused by the object moving away from the earth, dictionary.com
- A displacement of the spectrum of a celestial body toward longer wavelengths that is a consequence of the Doppler effect or the gravitational field of the source; also :a measurement of a celestial body's redshift equal to the ratio of the displacement of a spectral line to its known unshifted wavelength and used especially to calculate the body's distance from earth, merriam-webster.com.
- The displacement of spectral lines towards longer wavelengths (the red end of the spectrum) in radiation from distant galaxies and celestial objects. This is interpreted as a Doppler shift that is proportional to the velocity of recession and thus to distance, oxforddictionaries.com
- An increase in the wavelength of radiation emitted by a receding celestial object as a consequence of the Doppler effect, thefreedictionary.com
- In physics, redshift happens when light or other electromagnetic radiation from an object is increased in wavelength, or shifted to the red end of the spectrum, wikipedia.org

Consider these natures of radiation observation:

- Source radiation is compounded of heterogeneous frequencies and amplitudes. Nature does not create perfect wavelets. Rate of emission (frequency) is also heterogeneous from wavelet to wavelet and particle to particle.
- Environment is heterogeneous. There are contaminants en route, *e.g.* passing magnetic field, particle cloud, or crossing radiations.
- Energy is exponentially propagated into environment.
- Observer does not have perfect vision.
- Constant displacement of source and observer.

In summary, redshift is primarily the combined effects of:

1. Distance of observation. Amplitude and frequency loss over distance (other than change in distance). It causes stretching frequency due to weakened or lost wave periods by absorption of the environment. Redshift effect of heterogeneity is limitless. It is flat-line amplitude and frequency to observer, when all energy of the radiation is fully absorbed by background. It means redshift is infinite, $observed\ frequency \to 0,\ then\ z \to \infty$. Additionally, loss of wavelets can not create blueshift effect. I believe it has caused the interpretation of Hubble's Law[3], however, created the illusion of run-away universe.

2. Change of distance of observation. It causes Doppler effect. It is independent of the location of it's source. Faster receding object at any location, near or afar, will have higher Doppler redshift. So is Doppler blueshift. It is the function of changing distance of observation (speed), and limited by the top speed of the source and observer. Doppler blueshift switches into redshift when radiation passed the observer (passed zero meridian). Redshift of Doppler effect also predominates over Doppler blueshift by far.

3. Energy level change of source also can cause frequency and amplitude to change.

6.1 Heterogeneity Redshift

John Tyndall's[6] sky in a box, BBC Two Science Britannica - Clear Blue Skies,hosted by Prof. Brian Cox. clearly demonstrates the frequency loss as well as amplitude loss over distance in the visible region of electromagnetic spectrum. Here is a screen shot of BBC's Science Britannica - Clear Blue Skies hosted by Prof. Brian Cox, Figure 35. We can see the high frequency (blue light) is lost first, and low frequency (orange) passes through. It will be color red at the end if the glass box is longer, as Prof. Brian Cox explained in the video.

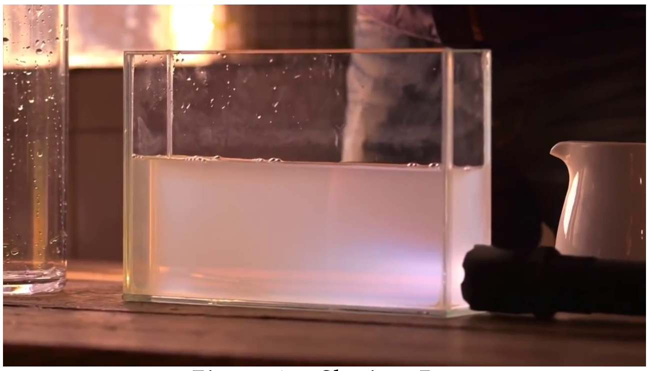

Figure 35: Sky in a Box
BBC Science Britannica- Clear Blue Skies

Tyndall effect is radiation redshift, but not Doppler effect. Stretched wave period caused by missing wavelets. In other words, lower frequency caused by slower rate of arrival. It is further validated the loss is exponentially proportional over the distance by John Strutt in Rayleigh scattering[5]. Note that this experiment shows the side observation. It show the progress of frequency loss over distance from sideline. The effect would not revealed if water is not milky enough. It is the same principle that there always be rainbow as long as there is water droplets in the air. However, it may not be significant enough for detector to perceive it.

6.2 Doppler Redshift

Changing distance of observation causes blueshift or redshift to observer, Doppler effect[1]. In other words, the distance to travel for subsequent wavelets is changing. The result is arrival rate (frequency) of wavelets is increasing (blueshift) or decreasing (redshift). A summary is listed here. Details of my study of Doppler effect is covered in *Stochastic Functions of Blueshift vs. Redshift* [2]. Here, all wavelets are assumed equally healthy and travel at the same speed, or absent of path loss.

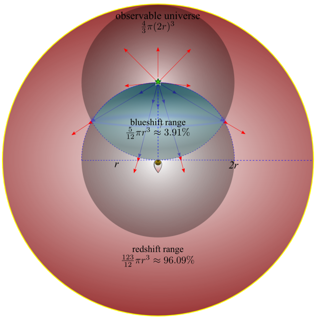

Figure 36: Doppler Blueshift vs. Redshift in Space

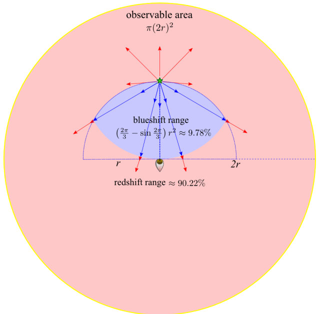

Figure 37: Doppler Blueshift vs. Redshift in Surface Observation

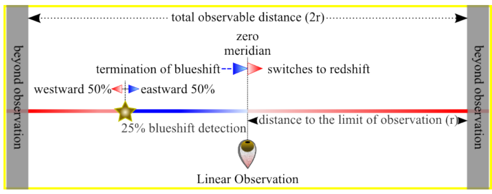

Figure 38: Doppler Blueshift vs. Redshift in Linear Observation

Probability of Doppler Blueshift Detection at Location r, $(0 \le r \le 1)$

Blueshift Detection	Probability Function $p(r)$	Population Mean (%)	Mode (%)	Range (%)
Space	$\frac{5}{16}r^3$	7.81	31.25	0.00 – 31.25
Surface	$\left(\frac{2\pi}{3} - \frac{\sqrt{3}}{2}\right)\frac{r^2}{\pi}$	13.04	39.10	0.00 – 39.10
Linear	$\frac{r}{2}$	25.00	50.00	0.00 – 50.00

Table 1: Blueshift Probability Functions

Probability of Doppler Redshift Detection at location r, $(0 \le r \le 1)$

Redshift Detection	Probability Function $1 - p(r)$	Population Mean (%)	Mode (%)	Range (%)
Space	$1 - \frac{5}{16}r^3$	92.19	100	68.75 – 100
Surface	$1 - \left(\frac{2\pi}{3} - \frac{\sqrt{3}}{2}\right)\frac{r^2}{\pi}$	86.96	100	60.90 – 100
Linear	$1 - \frac{r}{2}$	75.00	100	50.00 – 100

Table 2: Redshift Probability Functions

$$r = \frac{\textit{distance of observation}}{\textit{limit of observation}} = \frac{\textit{distance of object}}{\textit{observable universe}}$$

The function obtained here is the probability of a object coming toward (blueshift) or moving away (redshift) from the observer's prospective, *i.e.* the physical displacement of the object in reference to the observer. The information obtained from the observation is centered at the observer.

Doppler effect is motion dependent. It affects not only wave period of radiation but also rate (period) of pulsation. A quasar for example, it's pulse rate has to be stretched (or compressed) precisely concise with it's wave period. It is the function of changing distance of observation (speed), and limited by the top speed of the source and observer. Any structure has it's top speed limited by the energy it can generate. It is also impossible for a structure to accelerate at speed faster than it can tolerate, self-propelled or free-ride. The inertia of different substructures would tear the structure apart by acceleration. The question is, can top speed and acceleration of receding astronomical body be equal or greater than the speed of light, Doppler redshift $z \geq 1$?

In real life, Doppler effect is analogous to target shooting of a machine gun, while the gun or the target is moving. The arrival rate of bullet changes with the displacement of distance. On the other hand, no such effect when distance to target is unchanged, provided that gun and bullets are consistent through out.

Nevertheless, Doppler effect is irreverent to the location of the source. Faster receding object at any location, near or afar, will have higher Doppler redshift effect. In all, large or small Doppler effect (blueshift or redshift) can be caused by sources at any location, if the distance of observation is changing. Note that, redshift in Hubble's Law[3] is location dependent, which is not Doppler effect. To me, Hubble's Law describes more appropriately the propagation of radiation over distance than receding source.

7 Summary

Even a lone particle stands out from it's background. Any object broadcasts it's existence, from insignificant to strong, simple to complex. It will never stop regardless it is observable to us or not. Action of object casts force (energy) into the environment. It can be contact force that requires media to spread, or action-at-a-distance force that does not. Energy is passed onto next neighbors and spread out. The collected interactions of neighbors will be in the form of waves. It is the fundamental activity of action-reaction-interaction of an object and environment. Here, environment is the absolute complement of the object, or the rest of the universe.

Objects such as radiative material or star can simultaneously broadcast particles to all directions. Each particle ejected will initiate it's interaction with it's surrounding. Particle is considered point like, and it's trajectory line like. It can only at one location and make a point strike at a time. Wave, on the other hand, is a sweep. It propagates to fill the space, and delivery impact to detectors at many locations. It enables waves to exist at many places at the same time. Yet, particle can park and never vanish, but wave has to continue to propagate and die out eventually. Radiation might not be fully observable by us, however, it has to obey the same fundamentals.

Our body reacts to all radiations from insignificant, beneficial, to harmful. But we only obtain information within a small range from temperature to sight. Radiation loses it's amplitude and frequency over distance. It is positively exponentially proportional to the distance. Otherwise, sky will filled with heat, radio, light, particles, and radiation much stronger than what is sent to us by the Sun. Frequency loss is also detected as redshift by observer. Over vast distance, It can easily overwhelm Doppler effect. The quality and how it is delivered to our sensor can affect our perception and judgment.

Combustion of hydrogen creates light, heat, force, and water. The question is where did photon[4] came from? Is it part of the hydrogen or oxygen atom, plain electron oscillating in the visible range, or our obsession with light? Besides, there are many sources of luminescence including bioluminescence. If photon can be detected by eyes, shouldn't it be easily identified in the structure of atom?

Musical instruments can produce same notes regardless the differences of material. Oscillating piano string with hummer, it makes sound and heat. Dust or water droplets on th string will be shook off. Oscillating it with electricity, it produces heat and light. Particles are radiated when oscillated in high energy. Certainly, the structure of the string will not survive long in such intense. Comparing to what the Sun is doing, do you see the similarity? Isn't the Sun is oscillating at the intense of destruction?

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