Gravitational waves and Earthquake

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ABSTRACT: Newton's law of gravity is independent of time but Einstein suggested there must be a wave which will communicate the gravity and its velocity cannot be more than light. In this paper law of gravity is shown that it is independent of time and it is instantaneous. In this paper the origin of these waves also discussed. Like cosmic microwave background these waves are also filled the entire space[17]. The wavelengths of these waves are very long hence they cannot be detected so easily. Due to superposition of waves they are now in steady state. Creation of a big void in space creates disturbance and only then they can be traced.

Key Words: Gravitational waves, LIGO, binary system, Black hole.

Introduction and Overview[18]:

Three gentlemen Rainer Weiss, Kip Thorne and Barry Barish were awarded 2017 Nobel Prize[13,20] in Physics for their role in the discovery of gravitational waves. Einstein[1] told us gravity is actually a warping of space. The reason why, for example, Earth goes around the sun all the time is not because the sun is pulling the Earth, as Newton thought. Earth, wants to go straight because the space itself is curved it actually ends up going around the Sun. Einstein[2] told us in history of general relativity about the nature of gravity. When the mass of the object is very big, like a black hole, then even the light cannot escape from the black hole. So the space warps so much near the edge of the black hole even the light cannot go out of it. We learned from Einstein, and because the gravity is actually the warping of space.

When two black holes that are circling around each other, they wobble the space so much that they actually propagate out as a wave. As they circle around each other because the wave comes out of it they start to lose energy. They start to circle faster and faster around each other by reducing their orbit size. At the end of the day they merge, they become a one black hole. Merger of black holes happens because the space wobbles so much then this wobbling, the wave of gravity, goes out to a very, very far away universe. So wave of gravity is the bending of space. So when the space goes up and down then space stretches and shrinks a little bit and when that reaches a planet like solid Earth it stretches and shrinks. As the black holes circle around each other gets faster and faster than the wobbling, and also stretching, and the shrinking also happens faster and faster. As they merge into a single black hole then nothing will come out of it anymore and then there will be a dead silence.

Experimental Evidence:

For this purpose a humongous detectors are required. In the United States there is a project called LIGO[4] that stands for *Laser Interferometer Gravitational-Wave Observatory*. Two of these are established at two positions, one in Livingston, Louisiana in the midst of forest area and another one in Hanford in Washington in this big cold desert. Each of these arms is four kilometer long and they are of L shaped. They are perpendicular to each other and the idea is that when one arm stretches the other arm shrinks. Using Laser one can find the amount by which arms stretched or shrunk. This device is very sensitive to even the tiny bit of stretching and shrinking of these arms. This LIGO[9,10] has discovered this amazing detection of gravitational wave for the first time in history. The frequency of this wave is in the range of 100 hertz, and that's the range of the sound we can listen to them if our ears incredibly sensitive so we can detect the motion of ear drum by 10 to minus 16 centimeters[7,8]. So we must have been able to actually hear this as a sound of space stretching and shrinking[16].

Radiation of Gravitational Waves: Black holes start radiating gravitational wave when they start losing energy, and hence they start decreasing orbit, and go faster and faster. Ultimately they become a single black hole. It is called a ring down and then dead silence. These black holes are moving pretty fast nearly 0.3c. Black holes are going actually very fast. They get even faster and faster and when they merge and they get nearly half of the speed of light. Black holes merging are very heavy, one is 29 times the mass of the sun and the second one is 36 times as massive as our sun. So, they are very heavy black holes and when they merged, that produce the end result is 62 times the mass of the sun. The missing mass appears turned into energy just like what happens with the sun. In case of the sun it’s mass to produce so much light and heat as the amount of the mass it sheds. It is a tiny amount. In case of black hole, they radiate large amount of energy in the form of a gravitational wave, this very high energy wobble the space and they lost as much as three solar masses to create this much gravitational wave. This occurred nearly 130 million light years away, we can still feel at our planet stretching and shrinking and that was detected by LIGO. In 2017, a new experiment started in Italy named Virgo[12]. We have these new two experiments, one in the United States and another one in Europe now. So we can use triangulation to locate where the gravitational wave was admitted, much better compared to what it used to be. Introduction of Virgo detector actually came into operation which could locate the source of gravitational wave much better, and therefore because of this triangulation we have two in the United States, one in Europe. By looking at the timing when they detected the gravitational wave, we can tell where it came from much, much better.

This network of Gravitational wave observatory is expanding. The LIGO team signed an agreement with the Indian government that they are going to build a copy in India. Also in Japan, where they are already building a gravitational wave detector named CAGRA.

Seeing with Gravity: Gravitational waves predicted by Einstein have recently become the hot new tool to generate scientific data on the behaviors of black holes and compact objects in extreme orbits. In order to see a gravitational wave[5], there are a couple options. We can measure the influence of a passing wave on laser beams, or we could precisely time how the pulses of fast rotating pulsars change when a gravitational wave passes by. Since gravity causes light to travel in curved spacetime, any object with a gravitational field appears to bend light as a gravitational lens. Nasa's NICER x-ray telescope is measuring the gravitationally lensed and Doppler boosted light from hotspots on neutron stars. NICER is attached to the International Space Station and observes X-rays emitted by neutron stars with spots as well as black holes. Black holes do not have a surface so, we can't observe hot spots on rotating black holes in the same way that we observe them on neutron stars, but we do know that there are light emitting structures like accretion disks that orbit black holes. A black hole with an event horizon with the same size as this hole has a Schwarzschild radius of 3.6 millimeters. This corresponds to a mass that is about half of the planet Venus squished into this hole. The strong gravity of the black hole will distort our image of the back of the disk; we will still see the front of the disk since the light rays don't have to pass by the black hole in order to get to the camera. The researchers are simulating realistic patterns in the disk which makes it easier to see the motion of the gas. The warping effect of gravitational lensing becomes more apparent as we look into the equatorial plane. When we are viewing the disk from the side, we can see that the side that is spinning towards us is brighter than the side spinning away from us[11].

Velocity of Gravitational Radiation: Newton's equations had no time dependents. If the sun's mass suddenly changes the earth would feel a different force due to gravity instantaneously, with no delay as Newton predicted. Whereas light takes 8.3 minutes to reach the Earth from Sun, revealing the alien's actions as the Sun becomes dimmer. This means that we could receive information about changes to the Sun at a speed faster than light by using gravity. This instantaneous transmission of information is sometimes called action at a distance. Einstein realized that Newton's theory of gravity was wrong because it implies that action at a distance takes place and that gravity could transmit information faster than the speed of light. Although there were no experiments Einstein could conduct that show that action at a distance is incorrect, Einstein[3] knew that it would imply that there could be ways to transmit information at speeds faster than light which would contradict the principles of special relativity. Einstein theorized that gravity could be made compatible with special relativity if changes in gravitational fields are transmitted by gravitational waves that obey the speed of light limit in the universe. Gravitational waves, also called gravitational radiation, are an important part of Einstein's general theory of relativity. The important thing to know is that light is only emitted when there are time-changing electric charges or magnets. A star or planet has a gravitational field that doesn't change with time, and unlike electrostatic forces, gravity is only attractive. A small mass place near a heavy planet will feel an attractive gravitational force that will pull it towards the surface. If there is no motion of the masses, there will be no gravitational radiation emitted.

When gravitational waves are created, they move away from their source at the speed of light and, as the wave moves. It distorts space time by stretching and compressing special dimensions periodically in the two directions perpendicular to the direction that the wave travels. These waves are called transverse waves. A gravitational wave is a wave in space-time, which means that instead of moving objects a gravity wave compresses and decompresses space-time. For this reason, scientists often convert gravitational waves into equivalent sound waves, which is how we got the chirp sound of two merging black holes. .

The first detected binary[19] star system demonstrating the emission of gravitational waves was a binary composed of two in spiraling neutron stars. The system was first observed by Russell Hulse and Joseph Taylor, using the Arecibo Radio Telescope in 1974. It contains a pulsar and a neutron star that orbit one another once every eight hours. Therefore, they are separated by a mere three light seconds, which is similar to the diameter of the sun. Together, the two neutron stars slowly spiral in towards each other, allowing Hulse and Taylor to detect the change by measuring the orbital period of the pair over time. They found that the orbit of the two starts slow by approximately one-tenth of a millisecond every year. This tiny change in orbital period agrees with the predictions of gravitational radiation coming from Einstein's theory of general relativity. Although indirect, this was the first evidence of gravitational radiation demonstrating that gravitational waves do carry energy away from binary systems. This led Hulse and Taylor to be awarded the Nobel Prize[6] in Physics in 1993. The two neutron stars in the Hulse-Taylor Binary System are radiating gravitational waves so slowly that the stars won't collide for another several billion years.

Gravitational Telescopes: Gravitational waves are extremely weak. These waves wouldn't be felt by a human, for example, or any other living creature for that matter. So in order to detect gravitational waves, scientists must use the most sensitive instruments ever invented. In order to leverage the sensitivity of interferometers, astronomers built the Laser Interferometer Gravitational-wave Observatory; whose acronym is LIGO. The Laser Interferometer Space Observatory; LISA consists of three spacecraft which will trail behind earth in its orbit around the Sun, flying in a triangular formation. Each of LISA's arms extended between the three spacecrafts 2.5 million kilometer long arms. As a result, LISA will be able to detect much smaller and quieter collisions than LIGO but also begin probing into the processes by which compact objects are captured by but not collided with black holes.

Quantum Gravity: Gravitational waves are generated by heavy objects. This paper proposes that these waves are basically material waves. Heavy bodies having atmosphere, which has small molecules or atoms, they are moving with very high speed. These atoms are generating matter waves. Black holes are having speed nearly 0.3c and our Earth has velocity 3×10^{4}m/s. Atoms moving at such a high speed will generate waves of wavelength of the order of 10^{15}m to 10^{7}m as predicted by de-Broglie’s formula. This high wavelength can travel very long distance because their diffraction will be very small.
During the creation of universe small particles and dust[21] have generated these waves and they have filled entire space like CMB[14,15]. These waves are still created by heavy bodies carrying atmospheric atoms and molecules and particles. In case of Black hole it contains elementary particles at speed 0.3c.
Contrary to Einstein hypothesis that he imposed on gravitational wave that the changes in gravity cannot be transmitted instantly, this paper supports the Newton’s law of gravity which is independent of time.

If Sun is shining in the sky then we see it instantaneously it does not take 8 minutes because light is filled everywhere[17].

Similarly since these waves are already filled in entire space therefore as a Black hole swallow the other Black hole the empty region created has to be filled by gravitational waves[22]. As these waves rearrange themselves to fill the big empty space, produced due to disappearing of the Black hole, they generate perturbation in space. This changes the path difference between gravitational waves coming from different stellar bodies. The change in path difference may cause maximum at some places and minimum some other places. Maximum or minimum both will create disturbances like tide in sea[23]. At some places this tide or gravitational wave pressure may cause permanent change in position of an object. After the evolution of universe the positions of planets changed rapidly. Jupiter migrated inward, while Saturn, Uranus and Neptune migrated outward. After just a few million years, a brief period in astronomical terms, the planets had settled into stable positions very close to those we see today. The stability may be disturbed any time when a big Black hole swallows a Black hole. The gravitational tide may vibrate any stellar body which we may feel like earthquake. The effect of this earthquake will be observed nearly all part of earth if it appears here.

Discussion: Here in this paper gravitational waves are proposed as material waves which have filled entire space. The disturbances in these waves occur only when a big void is created due to disappearance of Black hole. Newtonian gravitational formula is independent of time hence any change in space will affect the body immediately.

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