

"A VOYAGE BEYOND TIME"

Imagine being a young boy in a small town, gazing upon the vastness of the night sky and trying to decipher the secrets unthinkable to many.



That young little boy, Isaac Newton, the giant many stood upon the shoulders of to look ahead in time, was amongst the firsts to have pondered upon the ideas that governed the motion of the bodies in our universe.

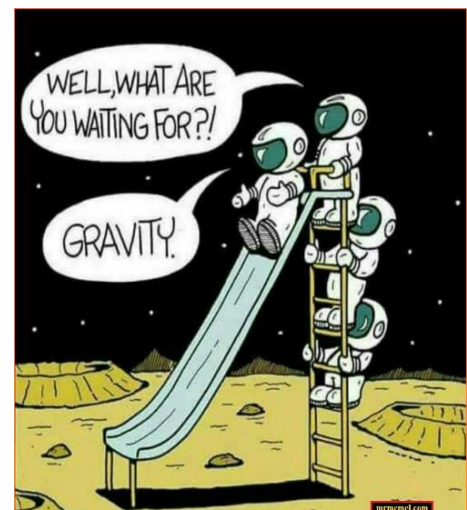
Aren't we all aware of the legend of the apple, that fell upon his head and made him wonder, "why do things fall"?

Disturbed by these profound questions, in the coming years, the 22-year-old boy worked out the laws for better understanding the effects of gravity, along with other findings, and paved a path for many others to venture upon for multitudes of new discoveries.

Ever wondered, what gravity is though? Where does it come from? Why does it even exist?

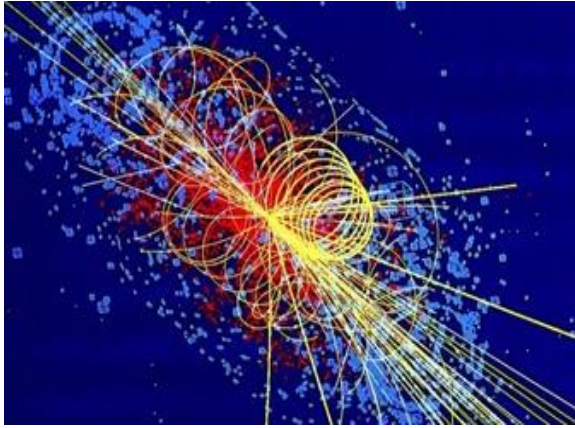
Well answer these, and maybe the next noble prize is yours.

The very thought of everything being attracted to one another by some invisible force, that has kept us bound together, preventing us little earthlings from floating away in the voids of space, is indeed captivating.



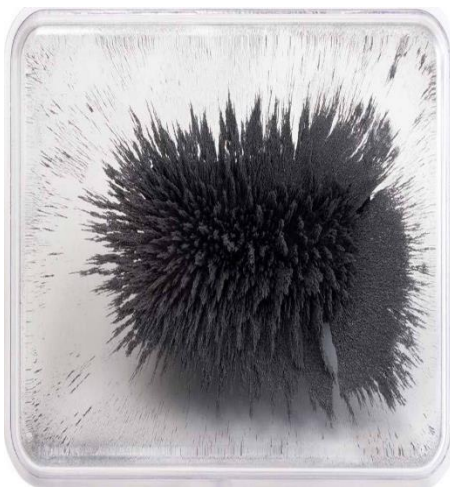
HIGGS BOSON

A remarkable discovery in 2012, that made Stephen Hawking lose a bet of worth \$100, heralded the existence of mass, getting us closest we've ever come to understanding its origin.



Higgs Boson, an elementary particle, generated by the collision of particles at the LHC (Large Hadron Collider), is an excitation of what we know as the **Higgs field**.

This field, imperceptible, omnipresent, and as mysterious as the nature of God itself, interacts with the elementary particles, causing mass.



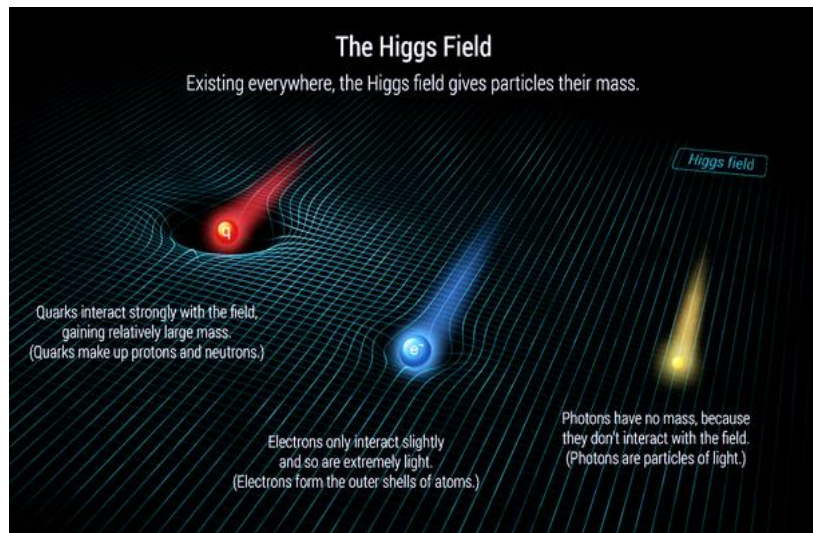
To understand this better, consider some iron fillings housed in a slender transparent plastic container and slide a tiny spherical magnet across one of its sides. Now do the same, but with a small glass ball.

What do you observe? In the first case, the fillings keep clumping together around the magnet as it slides from one side to the other but remain indifferent to the glass in the second.

Deriving the analogy from this example, the fillings correspond to the Higgs boson, the clump to mass, the glass ball to Photons/gluons and the magnet to Quarks. We now know that different particles interact differently with the Higgs field leading to a difference in their masses.

Well, if you're wondering... indeed, this is exactly the celebrity "god particle" that got famous, when Peter Higgs called it the "goddamn particle", acknowledging its difficulty of detection, but the "damn" in the statement got damned away maybe. (dad jokes).

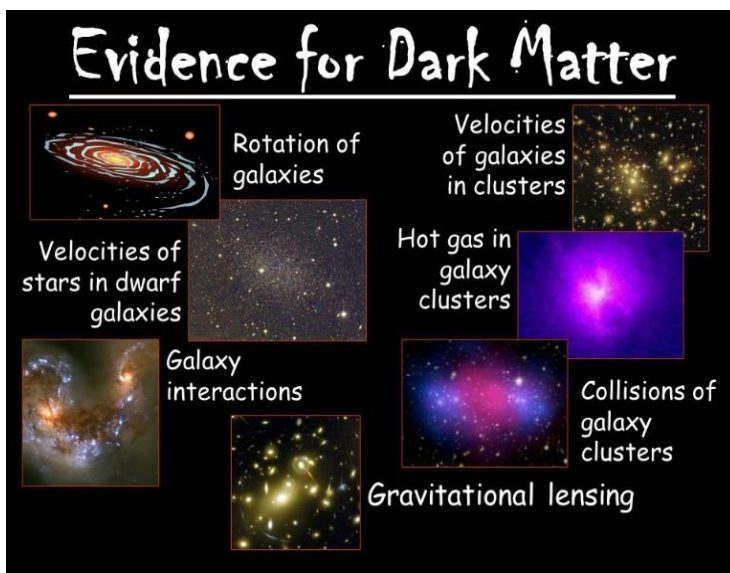
This further grants mass to the atoms and molecules making up the conspicuous matter that goes on to eventually form giant galaxies and stars of unimaginable sizes and *mind-bending masses* (pun intended), distorting the very space time continuum.



Talking of space time, have you ever wondered what does it look like? We haven't really seen it yet, nor have been able to sketch down its exact looks, but observations do clearly allude to its certified presence.

So, when they say, seeing is believing, would you concur to the statement?

What if everything that exists is not everything that's visible?



It's rare for someone in today's world to not have heard of the terms dark matter and dark energy. Fuels of imagination, aren't they?

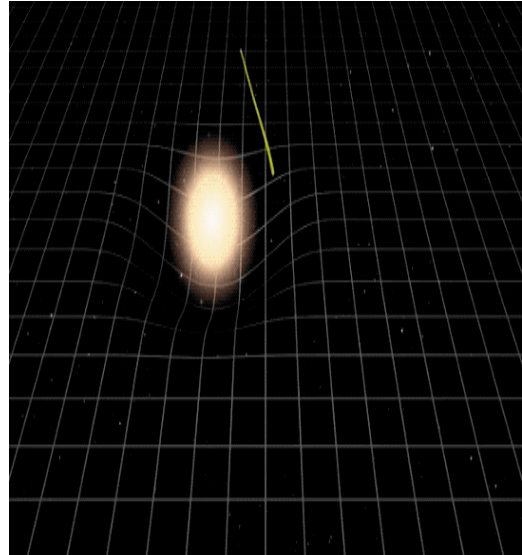
Dark, that is unseen to the naked eye, even that of the many powerful telescopes, yet existing and significant enough to be held responsible for accelerating the expansion of the universe.

GRAVITATIONAL LENSING

Upon rereading the pages penned long ago by Einstein himself, do we come across this ingenious method to detect and confirm the existence of the “dark duet”, built upon his ideas as the foundation.

In the year 1912, he figured that if gravity bends space-time, then the light coming from a source would bend too, due to the massive star or the Galaxy system that is in between the light source and the observer.

This, therefore, would serve as an instrument, universe’s magnifying glass, for a method of discovering the cosmic constituents of the skies of far-gone times, in worlds too distant to ever reach.



DOUBLE QUASAR

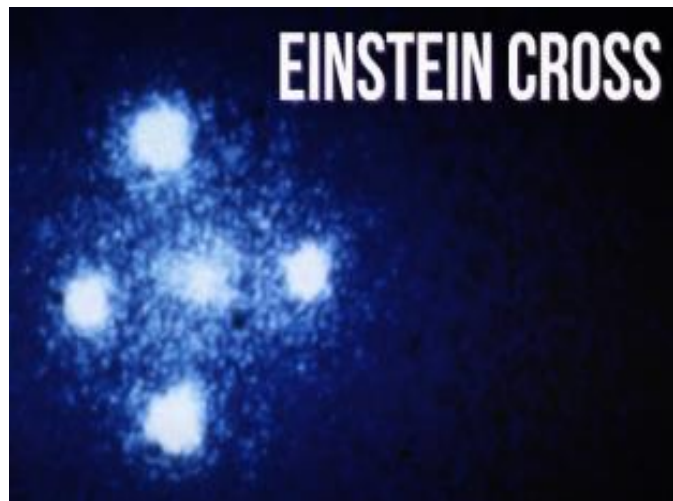


1979, about half a century later, we witnessed the event for the very first time through our telescopes, wherein the light from a single quasar, Q0957-561, bent around an elliptical Galaxy behaving as a lens, just enough to create a double visual image effect.

EINSTEIN CROSS

Einstein Cross was another effect seen for the first time in 1985. It shows four images of the same object arranged perpendicular to each other around the lens. The *lens* in this case was a Galaxy that was distorting the light around it.

This galaxy was named as HUCHRA'S LENS.



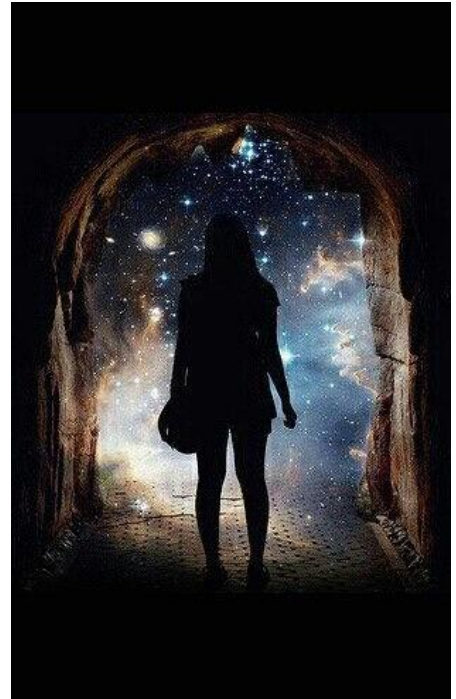
EINSTEIN'S RING



Later, in 1988, a stunning phenomenon was observed by astronomers where circular distortion of light happens around a massive cosmic entity acting as the lens, forming a halo, more pronounced in a black hole. This phenomenon was named as the Einstein Ring.

Now imagine the wonder of the astronomers of the time, beholding a spectacle so basic here on earth, yet at such a grand scale, out there in the cosmic background.

This method of exploring the universe unlocked many new doors that were previously believed to not even exist. Detection and confirmation of dark energy and dark matter became much easier, whereas the thirst of knowledge throttled us ahead in time.

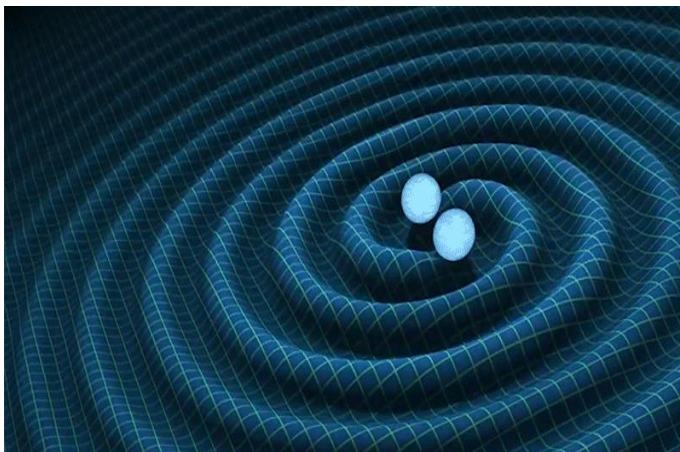


Talking about the grandeur of this multi-world arena, we are privileged to live in the times when we can conceive of notions never thought of before, and thus perceive the universe on a scale that would have been unthinkable by many wise men of the past.

GRAVITATIONAL WAVES



A long time ago, in a pocket of space, some 1.3 billion light years away, two massive black holes of behemoth sizes, 29 and 31 solar masses, collided with one another and rumbled the entire universe.

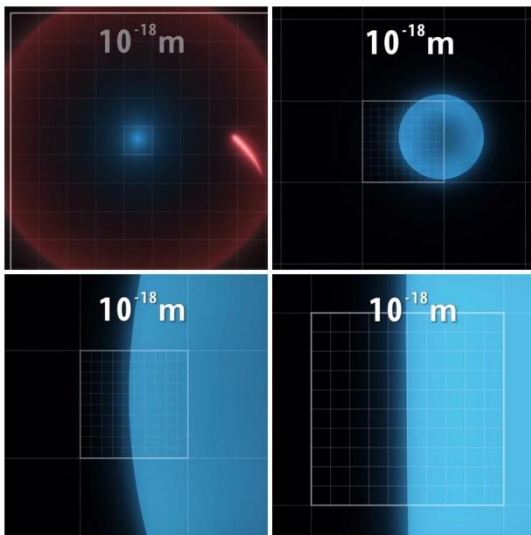
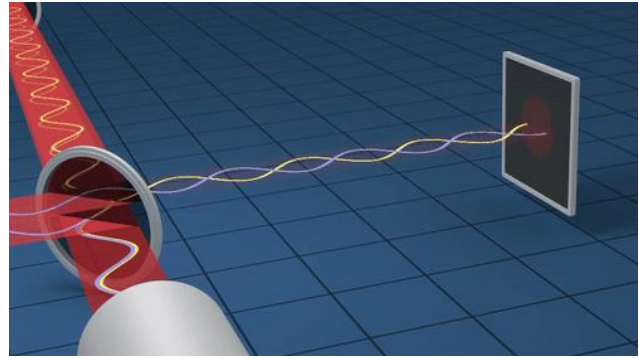


The monstrosity of the event can be guessed upon realizing that it released an energy of magnitude more than the combined power of all the light radiated, by all the stars in the entire observable universe, put together at a time. Now try to wrap your head around that!!

So powerful was the collision, that it generated ripples, what we call the gravitational waves, through the very fabric of space time itself, stretching and squeezing anything and everything that it encountered in its way.

YES, YOU AND I WERE TALLER FOR A MOMENT IN TIME TOO!

On 14th of September 2015, these ripples from far off worlds washed our earthly shores, and were detected by LIGO, Laser Interferometer Gravitational Observatory, proving Einstein's prediction of their existence from over 100 years ago.

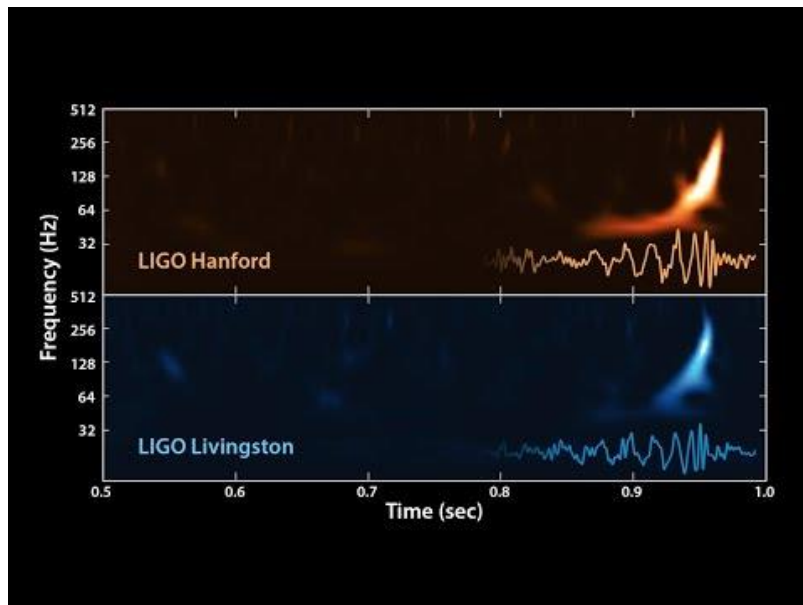


Yet their amplitude was so miniscule, about 1/100,000 of a nanometre (the width of an atomic nucleus), that it makes the discovery even more of a mindboggling scientific feat.

What a fortunate time to exist, with capabilities of modern cutting-edge technology to make recording of this heavenly event even a possibility.

These cosmic waves, travelling at the speed of light, not only carried with them the information about their origins, but also some clues to the nature of gravity itself.

The most beautiful aspect of their detection was our ability to be able to hear them. Yes, you read that right, a cosmic event we could really listen to. The waves encoded within themselves the vibrations, frequency of which the two massive black holes spiralled around and collided at. This, when digitally produced, generated a sound that scientists now call a “chirp”.



Link: <https://www.youtube.com/watch?v=QyDcTbR-kEA>

It's overwhelming, being able to hear 1.3 billion years into the past, a message from the cosmos, far and beyond.

It's impossible to not fall into a reverie of the myriads of wonders this universe preserves. Gravitational lensing, gravitational waves and the Higgs boson are merely a fraction of what more gravitational astrophysics consists of.



Looking back, it's hard to not marvel upon how far we've come, and how much further we still need to go. The mysteries of the past have become the norms of today. So, will it be right to assume that the lingering doubts of the present may someday soon unravel their secrets too?

Everything is uncertain, true, but one thing that we're absolutely sure of, is our hunger for knowledge will never quench.

Somewhere, in some space and time, there exists the same young little boy, sitting under the same old tree, looking up into the night sky, with a wondering curiosity for the unbound cosmos...oblivious to the greatest foundation he's going to lay soon, in the field we today admire as astrophysics.

That genius left us with the tools to mend our doubts that prevailed since eons. Now it's time we use them well and chisel out the science of today as we know it.

Let's carry on his legacy and keep looking up, because one never knows what more of a treasure still awaits to be discovered next, hidden beyond the unfathomable depths of this infinite unpredictable cosmic ocean...



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