Albert Einstein and his marvelous theory of Gravity and why it is important.

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Albert Einstein was a theoretical physicist of the 20th century who developed some of the most influential physics in history. His work is now considered to be one of the two pillars of modern physics as we know it, the other being Quantum Mechanics.

Einstein's name has now become synonymous with the word genius, but who among us truly has a clear idea of what great work he did and why it was so revolutionary?

Today we will be looking at what many consider to be Einstein's greatest piece of work. Physicists call it General Relativity, or GR for short. GR is a theory about gravity. If you have ever heard of Einstein it is likely that you have heard of Special Relativity, a piece of his work which is credited with resolving the conflicts between classical mechanics and Maxwell's electromagnetic theory. We can look at Special Relativity as also being the bedrock upon which General Relativity was built on.

Gravity is a force which tries to pull objects to one another with bigger objects having a larger gravitational pull, like the Earth, and smaller objects having a smaller gravitational pull, like humans. The closer you are to an object the stronger you feel the gravitational pull of that object. It is also one of the most important forces of nature that we as humans experience everyday, through Earth's gravity.

Before GR was discovered the scientific community agreed that Newton's Law of Universal Gravitation was the gold standard. What's so special about GR is that instead of being a theory which simply described a pattern in the interactions of masses, like Newton's, it used the geometry of our universe to explain this.

This work was groundbreaking for 3 reasons…

One, it gave clarity to what the universe was and, in many ways, how it worked. Special Relativity, an earlier study of Einstein, had shown us that space and time are fundamentally linked in what Physicists now call spacetime. Spacetime can be thought of as the surface of a trampoline which is the fabric that makes up our universe and that we as matter simply inhabit this structure. The same way we bend the surface of a trampoline when we step on it, we as bodies of mass bend spacetime by simply inhabiting it! One of the byproducts of bending spacetime being gravity. This was an insight that no one had ever previously conceived and gave clarity to gravity's mysterious inner workings. It also gave me meaning to the medium of space, something which had never previously had any physical significance as, it was such an abstract concept.

Two, the theory of General Relativity was incredibly accurate at predicting the movement of planets and accounted for such accuracy which simply was not present in Newton's Law of Universal Gravitation. An example of this was the fact it predicted and explained the slight elliptical orbits of certain planets like Mars, as opposed to the regular circular orbits. Even more astonishing though was the fact that it was able to describe how elliptically shaped orbits undergo a shift after each complete revolution, for planets such as Mercury.

Three, during the 1900's the progression of Physics had sadly stagnated. Physical theory, known as classical physics, had been developed to a very advanced state and had the ability to answer and describe incredibly complex problems and systems. At this point it was assumed by many people that Physics was in a sense finished, with all the most important theory discovered, and that the work of further researchers would only be to fill in the small gaps left. Today we know that this was not the case.

In 1905, what many consider to be his marvelous year, a 26 year old Albert Einstein stepped onto the field of physics and published 4 game changing studies. These papers have been credited as being some of the reasons behind Physics's reinvigoration of the 1900's. One of these papers was "On the Electrodynamics of Moving Bodies" or Special Relativity. Through "On the Electrodynamics of Moving Bodies" we had finally resolved what at the time had been one of the long lasting problems in physics (This was that under Maxwell's equations the speed of light was constant for two observers even when one was moving relative to the other. Which is not true in Classical Mechanics.). We had also opened up the world to a new area of physics involving our new found laws of the universe.

Special Relativity's development also lead to the development General Relativity which opens up many questions. Such as, why are space and time forever joined together in this structure called space time? Why does the speed of light have to remain conserved for all bodies in the universe? Is it possible to travel through time the same way we can travel through space?

Einstein's work on General Relativity has now been supported by evidence too. In his theory Einstein predicted that if two bodies of incredibly high mass ever came together, like two galaxies or black holes, the fabric of spacetime would experience what we may think of as a ripple. These ripples are called gravitational waves and were firs ever detected in February 2016 by the advanced LIGO (Laser Interferometer Gravitational-Wave Observatory) team.

Einstein's theory still to this day, a 100 years later, is considered the gold standard and one of his most elegant pieces of work. The next step now must be to resolve the issues that we have when trying to combine General Relativity and Quantum Mechanics. Many Physicists believe that once we have been able to do this we will finally have A Grand Unified Theory of The Universe, something which Einstein furiously dedicated his whole life in search of.