

Einstein, the War and General Relativity

by Supranta Sarma Boruah - Monday, July 31, 2017

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Einstein's theory of General Relativity is one of the greatest exercise of human thought. For, those of us, who have had the good fortune to study it in detail, we cannot stop wondering in awe at the beauty of the theory. Though, built with techniques of abstract and abstruse mathematics, it serves as the best possible description of the nature of the space and time human beings have yet been able to come up with. Not just the obscure mathematics, but the exotic predictions of the Big Bang, Black Holes and [Gravitational Waves](#) doesn't help the case with non-physicist. It is viewed less as science and more as science fiction. Yet, [Einstein](#) is one of the most celebrated scientist around the world and this theory has invoked a curiosity among people akin to that of religious mysticism.

But the story of the development of General Relativity had another side to it which is closely tied to it. It is that of the impact of the first World War on the development of the theory, and the main characters involved in this story. The theory of general relativity developed as the first world war unleashed destruction across Europe. The both stories thus developing during the same time in the continent of Europe. This is the story of the overlap of the two stories.

After his "miracle year" in 1905, Albert Einstein started his journey as a full academician only in 1907 and he was sort of a wanderer until 1914, when he decided to settle down in Berlin at the invitation of Max Planck. He arrived as the First World War and the jingoistic nationalism that comes free with it was beginning to grip the German population. In September of 1914, a group of German scientists and intellectuals including William Roentgen, Max Planck and Fritz Haber signed a document called the "Appeal to the cultured world", where they claimed that Germany was not responsible for the start of the war. Amazed by the fervent and jingoistic nationalism of his colleagues, Einstein, being the famous pacifist, released a counter document with a handful of his colleagues called "An appeal to the Europeans" lambasting the signatories of the earlier document and reminding them that the duty of the academicians is to uphold the values of unity and peace in the war ravaged Europe. This pacifism in him never died. Even during the Second World War, he was full of pacifistic advice for the Americans and the world. He regretted making the proposal to start the atomic bomb project to President Roosevelt his later life.

Einstein, the first ever rockstar scientist, was propelled to fame after proposing the General theory of relativity in the year, 1915, after 10 years of grappling with it. The theory developed a reputation for being a really difficult theory to comprehend and in the initial days, it was thought to be nothing more than a mathematical curiosity with no connection to the reality. In fact, during a public talk, when the British astronomer, Arthur Eddington was asked if it was true that he was among the three people in the world who really understood the General Theory of Relativity, he famously quipped, "Who's the third?". But in spite of its unintuitive mathematics, like any good scientific theory, it made some testable predictions about the nature of reality which can be tested and possibly falsified with a good enough telescope.

One such prediction was that light, whose trajectory was supposed to be a straight line by [Newton](#) and many scientists who came after him, would bend a little in the presence of a massive object. This fact was known even before the full theory of General Relativity was proposed. So, in 1914, [Erwin Finlay-Freundlich](#), an associate of Einstein, decided to test this prediction during a solar eclipse by observing the stars near the boundary of the sun, which become visible during the eclipse. If the light of the stars were bent by the gravitational pull of the Sun, this could be recorded during the solar eclipse. To achieve this aim, Freundlich set up an observing camp in Crimea. However, as the World War broke, Russian authorities grew suspicious of his instruments and he was therefore detained. The first attempt for experimental verification of the General Theory of Relativity thus ended in a failure due to the war.

Interestingly, after the proposal of the full theory of the General Relativity, Einstein realised that the earlier prediction of the amount of bending of light was off by a factor of 2. Hence, the failure of the first expedition was perhaps not that bad a news after all. The discrepancy of that factor had the potential to put Einstein's inchoate theory in a jeopardy.

Finally, the experimental verification of the theory came at the hands of the English astronomer, Arthur Eddington in 1919. By that time, the First World War was over and the confirmation of a scientific theory proposed by a German scientist at the hands of an English scientist was viewed as signs of reconciliation between the two countries by some quarters. However, this was not the case when the experiment was conceived and the expedition was finalised in the offices of Cambridge.

[Sir Arthur Eddington](#), was born into a Quaker Christian family in Britain. The Quaker teachings preach against any form of violence or war. Thus, while Einstein was fighting the jingoism on the German side, Eddington was doing the same on the English side. During the war, the English scientists froze their relationships with the German scientists. One of the consequences of the freeze-out of the relationships was that the scientific developments on each side were finding it difficult to trickle down to the other side of the divide. In fact, Eddington could keep abreast of the developments about relativity only through the Dutch scientist Willem de-Sitter. Netherlands, being neutral, during the World War I, was in touch with both England and Germany. Eddington figured that a solar eclipse was predicted for May 1919 and therefore he had to convince his bosses in the English scientific establishment to fund the expedition to observe the solar eclipse. Since, these expeditions have to be planned much in advance, the planning for the expedition started in 1918. At that time, the world war was still on and the news about Einstein's passionate opposition of the war had not yet reached England. For the English, Einstein was one among the enemy. Around this time, the war intensified and Eddington was called in for forced conscription into the army. The chances appeared bleak that his appeal for an exemption would be approved by the tribunal. Just then, his boss, Astronomer Royal of England, Frank Dyson intervened and saying that Eddington had the "peculiar skills" to observe the solar eclipse of 1919 and therefore he should be exempt. It is rumoured that Dyson convinced the authorities by using a particularly clever trick with the authorities by stating that this was an opportunity to falsify the German science of relativity. Finally as Eddington observed the solar eclipse of 1919 from the Portuguese colony of Principe, he confirmed the most important predictions of the General Theory of Relativity. This set Einstein's theory of general relativity on solid scientific ground.

It is true that Einstein's theory of general relativity involves some counter intuitive mathematics of differential geometry which sometimes make disentangling the physics from it a bit difficult. The first true solution to what is known as the Einstein's Equation, the equations governing the theory of general

relativity was found in a German war trench. Karl Schwarzschild, was the director of the Potsdam Observatory. His perks of being in the academic circle at that time included not being compulsory for him to participate in the war. However, with the surge of nationalism gripping Germany, Schwarzschild volunteered to fight in the ongoing war. There, he used his skills as a physicist for predicting with greater accuracy, how to fire cannons. In the trenches, however, he used his free time to study general relativity and find a solution to the difficult equations. Barely a month after Einstein proposed his theory, Schwarzschild wrote a letter to Einstein from the German trenches on the Russian front describing his solution. This solution, was mathematically simple and was therefore easily derived. However, the physical predictions it made were bizarre to say the least. For this mathematical solution, it predicted that no matter how fast an object moves, it will not be able to escape the gravitational pull of the massive object, if it is near enough to it. This was the origin of one of the most counter intuitive predictions of General Relativity- *The Black Hole*. One has to appreciate the irony that the concept of a Black hole actually came from a dark holes (trenches) of war.

After the war ended, the 1920s saw the development of some fantastic ideas to describe the behaviour of the universe- a field that is known as cosmology. This too gave rise to some ideas like Big Bang which were bizarre enough with theological connotations to raise the curiosity of the general population to unprecedented levels. Two scientists; who played crucial role in the development of this idea were [Georges Lemaître](#) and [Alexander Friedmann](#). Both these men were heavily involved for their countries during the war. Alexander Friedmann was a pilot in the Russian Air force during the war. He used his training as a physicist to calculate the trajectory of his bombs to inflict maximum damage on his enemies; resulting in him winning the Cross of St. George. On the other hand, Georges Lemaître, served as an artillery officer for the Belgian army. He too was awarded with Belgian bravery award after the end of the war.

After this golden period during the first decade, the theory of general relativity was pushed into the corners of Physics research for a long time. There was a brief revival under American scientist, Oppenheimer. He published a breakthrough paper on how black holes can be formed from the collapse of a star. But, it was published in the same week as the start of the Second World War and in the same journal, another paper was published which probably changed the world in a much more drastic way. It was one of the first paper which would later be used to speculate about the possibility of the use of Uranium-235 isotope for the development of the atomic bomb. Soon after Oppenheimer would himself be roped in to lead the American project of development of the nuclear bomb; consequently, general relativity remained in the gutter till American scientists like Wheeler and his company revived it and started the second golden period of General Relativity.

The development of the theory of general relativity happened against the backdrop of World War I. Almost all the main protagonists in the story of the development of general relativity were engulfed and affected by the war in some form or the other. A study of this history, gives a glimpse into the scientific world of the time and the difficulty war poses to the development of science. There are some lessons to learn from this period of scientific development.

Further Reading

[1] *The Perfect Theory*, Pedro Ferreira

[2] [Manifesto of the Ninety Three](#)

[3] The [link of the Physics Review](#) issue which carried both the papers of Tolman-Volkoff-Oppenheimer solution (Page 364& Page 374) and Neils Bohr's paper on the fission of Uranium-235 (Page 418).

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