Albert Einstein changes the world - How Achilles could become an immortal hero

Every mother wants their beloved child to stay out of trouble and live a successful life. She cares about her child so much that when something horrible happens to her child, a mother will feel deep sorrow. The same was the case with Thetis, a sea goddess. According to *Iliad*, her son Achilleus was a great hero with dauntless spirit and high intelligence [1]. Thetis must have been proud of her son's outstanding talent and amazing skills. However, Achilleus was a mortal, because his father, Peleus, was a human being. Born brave and bold, Achilleus chose to live as a warrior rather than to live long without fame, despite a seer's prediction that he would die young in the battle against the Trojans. It is unpredictable how deep the goddess' grief was when he actually died in the Trojan war. In this essay, I would like to show how Einstein's theory of relativity could be used to make Achilleus immortal.

The theory of relativity is a scientific explanation about how space relates to time, which was proposed by physicist, Albert Einstein, in the early 1900s. It revolutionized the concepts of space, time, mass, energy and gravity, giving great impact to the scientific world. In spite of numerous scientific breakthroughs achieved after that, the theory still remains as one of the most significant scientific discovery in human history. The theory of relativity consists of two interrelated theories: special relativity and general relativity. Special relativity is based on two key concepts. The first concept is that the laws of physics are the same for all observers, and the second is that the speed of light is the same for all observers no matter how fast they are moving. General relativity is a theory of gravity. The basic idea of this theory is that gravity is a curving or warping of space. Massive objects cause a distortion in spacetime, which is felt as gravity and the more massive an object, the more it warps the space around it [2,3].

From these two relativity theories, Einstein postulated the theory of time dilation, which was later proven by numerous experiments. According to special relativity, time dilation, or the difference of elapsed time between two events, occurs when objects start to approach the light speed. When an object travels at a very high speed, the time runs slower compared to the stationary object. On the other hand, according to general relativity, time passes differently when it is close to a large mass object, because space-time is curved around it. This means that if the object travels at very high speed, or if it gets a large amount of gravitational force, its time runs slower compared to our time [2,3].

As I stated at the beginning of this passage, my goal is to save Achilleus and Thetis

by using the theory of relativity. Let's take a larger view and look at massive objects in the outer space. Neutron stars are thought to be the densest object in the universe. After the star's life ends and it explodes in Type II supernova, the remaining core turns into a neutron star. The gravitational force in neutron stars are so strong that the protons and electrons in an atom collide and make neutrons. Neutron star is a ball of neutrons, and its density is approximately 1 billion tons/1 teaspoon, which is an extremely large number. Even though the density of a neutron star is so large, its gravitational time dilation is approximately 30%, which only makes Achilleus' lifespan to be 1.4 times longer [3]. This is far from making Achilleus as an immortal person.

If this is not enough, it might be a good idea for him to live at a place that is very close to the black hole. It is formed when stars more than 5 times heavier than the Sun explodes. The gravitational force of black holes is beyond our imagination; in fact, its gravity is one of the most powerful forces in the universe, and even light cannot escape from it. Since the mass of black hole is so large, the time of the object completely stops at the event horizon [3]. However, as long as Achilleus does not get inside the black hole, he can gain eternal life when observed from his mother living on Earth. Usually, the object will break when it approaches so close to the black hole, but given birth as half-god, chances are that Achilleus' body can stand the literally, astronomically large force of gravity.

The closest black hole from the Earth that has been discovered is V616 Monocerotis, and it has about 10 times the mass of sun [4]. Here, we assume that Achilleus rotated around V616 Monocerotis, and eternal life means living 40 years in 100,000 years of Earth's time, since Homo Sapiens started to move out of Africa 100,000 years ago and Achilleus presumably died at 40 years old [5]. By using the time dilation formula in Einstein's theory of special relativity and general relativity, I was able to prove that if Achilleus lived at 14.76km from the center of the black hole, he could become immortal (Calculation in appendix). Since this is larger than the Schwarzschild radius, he could still move out of the orbit, while enjoying immortality from our perspective.

However, is this what Achilleus really wants? Achilleus was a valiant hero who never feared of death. Spending a monotonous life and gradually being forgotten by people, as if he hadn't existed, will be the last thing the brave man wants to do. Even Thetis wouldn't hope his son to spend a miserable life like this. Then, how could Achilleus be a hero and at the same time gain eternal life? The universe is still filled with many mysteries and dangers. There may be unknown, harmful substances elsewhere outer space. Therefore,

I think that Achilleus' courage, intelligence and tough body are the elements that are required for further space exploration. His half-god, tough body allows him to explore regions that are impossible for normal humans to even approach, and his strong heart will never be beaten by the solitude of traveling alone. He can provide scientists with many valuable information that can lead to the findings about the origin and functions of the universe, or even discover habitable planets. Space exploration enables him to become the next-generation Columbus. He would definitely become a hero, and at the same time, become immortal as long as he stays in space.

In conclusion, I have succeeded to prove that there is at least one possible way that the theory of relativity can save Achilleus' sad fate. I believe that becoming a space explorer and living longer is certainly better than to die young in the Trojan battle field. Also, apart from having eternal life and relieving Thetis, there is another benefit of being a space explorer rather than a warrior: he does not have to kill any people. His achievements will be judged by not the number of soldiers he defeated, but how much benefits he brought to humans. His accomplishments will make no one sad and can bring bright futures for all human beings. I am convinced that by using the theory of relativity, space exploration will be the key for Achilleus to become a hero of the new era and at the same time save her mother from great grief.

Appendix: Calculating Achilleus' immortality

Constants: [6]

G: gravitational constant = 6.7 × $10^{-11} m^3 kg^{-1} s^{-2}$

c: speed of light = $3.0 * 10^8 \text{ms}^{-1}$

Time dilation in special relativity: [6]

Lorentz factor = $\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$

Time dilation in general relativity: [6]

$$\sqrt{1 - R_s/R_e} = \sqrt{1 - \frac{2GM}{c^2 R_e}}$$

R_e = Distance from the object

R_s = Schwarzschild radius = $2GM/c^2$

Velocity: [7]

Gravitational Force = $\mathrm{m}\frac{GM}{R_e^2}$

Centripetal Force = $\mathrm{m}\frac{v^2}{R_e}$

m: mass of object

Since gravitational force = centripetal force,

Velocity = $\sqrt{\frac{GM}{R_e}}$

Time dilation by special and general relativity:

Here, we assume that time dilation will be 100,000 years/40 years = 2500

M = mass of black hole = 10 * mass of sun = $1.989 * 10^{31} kg$

Step 1: Multiply time dilation in special and general relativity to find out the overall time dilation

$$\frac{1}{\sqrt{1-\frac{v^2}{c^2}}} * \sqrt{1 - \frac{2GM}{c^2 R_e}} = 2500$$

Step 2: Use $v = \sqrt{\frac{GM}{R_e}}$

$$\frac{1}{\sqrt{1-\frac{GM}{R_e c^2}}} * \sqrt{1-\frac{2GM}{c^2 R_e}} = 2500$$

Step 3: Solve the equation

$$\frac{1-\frac{2GM}{c^2 R_e}}{1-\frac{GM}{c^2 R_e}} = 2500 \ (Square\ both\ sides)$$

$$1-\frac{2GM}{c^2 R_e} = 2500 - 2500\frac{GM}{c^2 R_e} \ (Multiply\ both\ sides\ by\ 1-\frac{GM}{c^2 R_e})$$

$$\frac{2497GM}{c^2 R_e} = 2499 \text{ (Algebra)}$$

$$R_e = \frac{2497}{2499} * \frac{GM}{c^2}$$

R_e =14760 m = **14.76 km** (G,M and c are constants shown above)

This means that Achilleus has to be at most 14.76km from the center of the black hole to be immortal.

Works Cited:

1. Homer, et al. *The Iliad of Homer*. University of Chicago Press, 2011.
2. Helfand, David. “Special Relativity.” Frontiers of Science: Astrophysics. Columbia University, New York. Lecture.
3. Helfand, David. “General Relativity.” Frontiers of Science: Astrophysics. Columbia University, New York. Lecture.
4. Cain, Fraser. “Where Is the Closest Black Hole?” *Phys.org*, Phys.org, 21 Mar. 2016, phys.org/news/2016-03-closest-black-hole.html.
5. Menocal, Peter B. “Climate and Human Evolution.” Frontiers of Science: Earth Science. Columbia University, New York. Lecture.
6. Hughes, Ivana N. “Final First Two Pages.” Frontiers of Science, Columbia University. Course handout.
7. Halliday, David, et al. *Fundamentals of Physics*. Wiley, 2014.