Particle Physics Changing the Method of Cancer Treatment

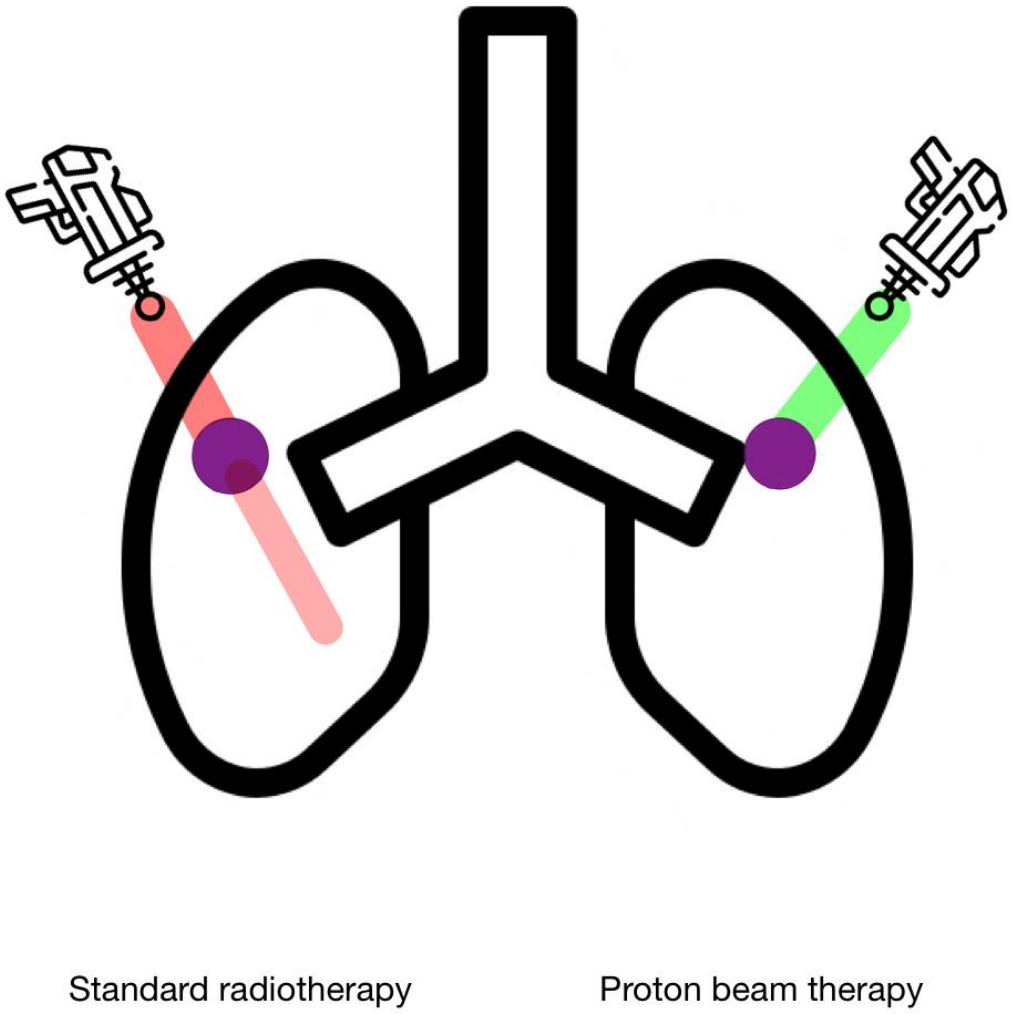

Figure.1 Comparison with standard radiotherapy and proton beam therapy

In Japan, cancer is the most reason that causes people to die. There is one person died of cancer in every four people. There are several treatments for cancer, for example, surgery treatment, drug treatment, and radiation treatment. In this article, I would like to focus on one of the developments of radiation treatment called proton therapy. Proton therapy is believed to be one of the most efficient and safe ways to cure cancer and it's a utilization of the particle accelerator which is designed to explore the basic physics laws originally. You may have many questions like what is a particle accelerator, and how can it cure cancer? Let me first introduce the history and discovery of the particle accelerator and then explain how it can be used as a

treatment for cancer.

Particle accelerators are built for investigating the features of particle physics, but what is particle physics? Particle physics concerns most of the elementary particles and their interactions. The elementary particle is defined to be the most basic part of anything in our universe, which means it can't be divided anymore. For example, electrons, photons, and quarks are elementary particles. The elementary particles are interacting with each other through four types of basic force called the strong force, the weak force, the electromagnetic force, and gravity. In the early 20th century, we know these four interactions exist, but we didn't have the correct theory to describe them. Many physicists wrote down many theories which were waiting for tests. The key to testing them is that theories of elementary particles always introduce new particles. These new particles can be produced during a high-energy collision of other particles. Thus, we need some experimental tools to give energy to particles and made those high-energy particles to collision. This is exactly what the particle accelerator does. The accelerator uses electric fields to accelerate charged particles like electrons and protons. During an experiment, two groups of particles (called beams) are accelerated. After that, we use the magnetic fields to control the trajectory of these two beams and make them collide with each other. It is then a possibility for new particles to show during the collision. The first particle accelerator was built in 1928 by Rolf Widerøe. Now the biggest accelerator is the Large Hadron Collider (LHC) at CERN. The size of LHC is like the Yamanote line in Tokyo. Now let me introduce one of the most important discoveries of the LHC. In 2012, the LHC discovered an elementary particle called the Higgs boson [1]. The Higgs boson was the last piece of the particle standard model. The existence of the Higgs boson proves the Higgs mechanism, which describes the origin of masses of elementary particles and our universe. In the future, the LHC will also help us to unravel more and more mysteries of particle physics. Topics like the extra dimension, supersymmetry, the grand unification theory, etc.

Away from particle physics, the particle accelerator has the potential to be a great cancer treatment. In this paragraph, I will introduce how to use particle accelerators

for cancer treatment. Traditionally, doctors are using the energy carried by X-rays (radiation) to kill the tumor cells. However, the lights used to cure cancer also damage other parts of the patient's body, you can see this from the image of "Standard radiotherapy" in the upper figure. Instead of X-rays, if we use a particle beam of protons or carbon ions, we can reduce the damage to other parts of the patient's body. This is illustrated by the image of "Proton Beam Therapy" in the upper figure.
The fact is that compared to usual radiotherapy which uses X-rays, proton or carbon therapy has the following advantages. Firstly, the particle beam accelerated by the particle accelerator is very concentrated. Thus, it can hit the tumor cell with high accuracy. Secondly, the feature of the proton can allow it to release its energy at a specific position which helps cure cancer. At last, for different types of cancers, we can use certain particles as a source of treatment, which gives opportunities to have more effective cancer treatment. However, there is still work that needs to be done. For example, the size of particle accelerators is normally big, so it needs to be built in more compactable if we want to put them in a hospital. Secondly, the cost is huge for building accelerators, some improvements are necessary for the purpose that everyone can afford it. Cancer treatment with particle accelerators has a bright future.
The particle accelerator was built fully in the interest of the science of particle physics. In addition to its great contribution to our understanding of nature, it can also be used as a great cancer treatment. Research about basic science can explore the deepest mysteries of our universe. At the same time, the utilization of basic science could also change our lives. Would you like to be a researcher in the basic science?

References

[1] Cms Collaboration. "Observation of a new boson at a mass of 125 GeV with the CMS experiment at the LHC." *arXiv preprint arXiv:1207.7235* (2012).

I thank Dr. Kate Harris and Dr. Ravindra Palavalli Nettimi and Kotani Yuki for their helpful feedback on my article. For my article, I have used "Grammarly" to correct spelling and grammar mistakes.