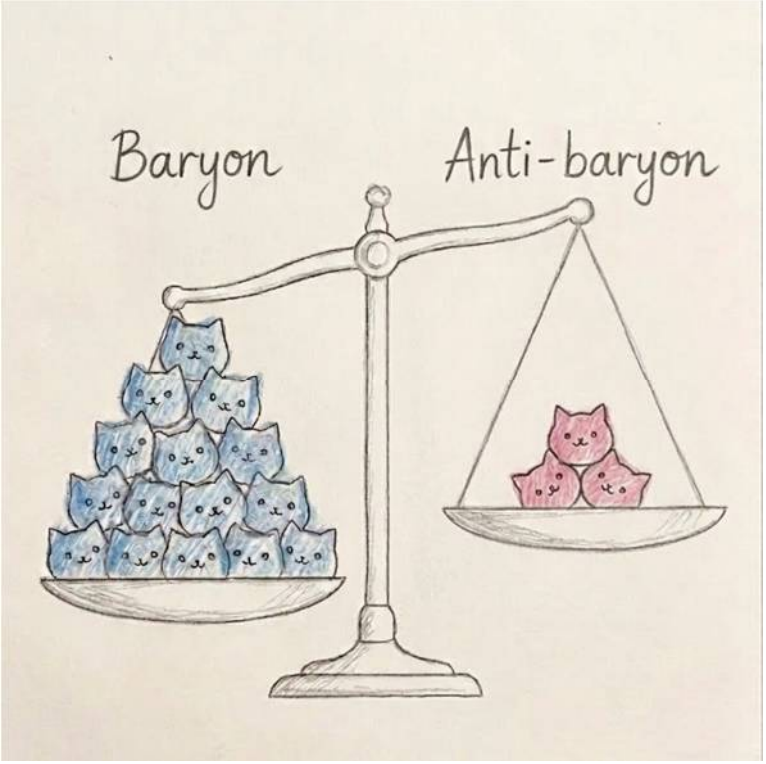
This beautiful and asymmetric universe

Ryuto AMADA



(generated by Gemini)

Have you ever wondered: What is the universe made of? How did it begin? Why is it the way it is? These questions are so interesting and attract many people including me and maybe you. How can we find the answers to those questions? Of course we can just imagine the answers, and we may be satisfied with that, but we have a more objective and powerful way: physics. This is why I study it.

My passion for physics started when I was in high school. At that time, I belonged to a mountaineering club and sometimes we climbed mountains. One day, we went to a high

mountain called Mount Tateyama and stayed there for several days. At night, I looked up at the sky, and I was amazed to find that it was full of stars! Because the mountain was so high and there were no city lights at all, I could clearly see the Milky Way and countless shining stars.

It was magnificent, and I was astonished by the beauty of nature and the universe. Since then, I have wanted to understand what this beautiful world is made of, how it started and why it is the way it is. This is when I became interested in physics, which motivated me to study it seriously in high school. While studying it, an equation made me even more fascinated. That is Newton's second law: the equation of motion.

In physics, nature's laws are expressed as mathematical formulas. For example, if you throw a ball up into the sky, it will first move up and eventually fall to the ground. This is the law of nature. The equation of motion, "$F = ma$" is a mathematical representation of such a law. F is force acting on the object and m is the mass of it, and a is acceleration of it. This looks quite simple but has great power. It can describe not only the motion of the ball, but also of the rocket and even the stars! The motion of almost any object can be predicted by this short equation. When I learned this, I was surprised to find that nature could be explained so beautifully and fundamentally through this equation. This experience made me more eager to dive deeper into this field and seek more fundamental laws of nature.

In college, this aspiration to find ultimate laws of nature motivated me to select the path to major in theoretical particle physics. In this field, people are trying to find all elementary particles which make up our world and to discover their properties. In other

words, theoretical particle physicists are searching for fundamental equations which explain how nature works. This perfectly suits me, who wants to know the answer to the fundamental questions about our universe!

In particle physics, there is a well-accepted theory called the “Standard Model”. It explains tremendous things about nature, but it is not complete: there are several problems which it cannot solve. One of such problems is “the baryon asymmetry”. Let me introduce this problem.

Our bodies are mostly made of particles called “baryons” (more precisely, protons and neutrons, and other similar particles), and they are also the important ingredients of stars and galaxies. Thus, baryons are essential ingredients of the universe.

According to particle physics theories, every baryon has its counterpart, called “anti-baryon”. It is like the twin of a baryon, and the properties of these two types of particles are almost identical. So, it is usually expected that the amounts of baryons and anti-baryons are the same. However, observations of the universe show that there are more baryons than anti-baryons! The difference in quantity, in other words, the asymmetry between the amounts of baryons and anti-baryons is a big problem, and this is so-called “the baryon asymmetry”.

Currently I am working on this problem. Because baryons are such important ingredients of our universe, solving this puzzle leads to answering one of the ultimate questions: “Why is the universe as it is?”. This is exactly an example of how physics answers the simple but profound questions I mentioned first. One of my goals is to reveal the mystery of baryon asymmetry, but I also have another goal: applying the

fundamental knowledge to technology.

Fundamental research itself might not seem useful in our daily life but sometimes brings breakthroughs in technology to society. For instance, Einstein invented the theory of general relativity to describe gravity, and this theory is an essential part of today's GPS technology. If there is no knowledge of general relativity, we could not use map navigation systems on our smartphones. Just like this, fundamental physics often leads to incredible technologies. My dream is to accomplish research that not only solves the mysteries of the universe but also eventually helps make our daily lives better.

If you have ever wondered about the universe, or if you want to change the world with new technologies, physics will be one of the best choices. You don't need to be a genius to do physics: just being curious about something is all you need. The universe is full of unsolved mysteries, and physics will help you reveal these mysteries and make a better future!

Acknowledgement

I would like to thank Shiyo Ra and Professor Vagins for their thoughtful reviews and feedback. Their comments were incredibly helpful in shaping the final version of this essay. Additionally, I used Gemini to correct the grammatical errors and polish the overall writing.