Paladin of Truth

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When I was twelve, I dreamed of becoming a scientist—but not the kind who sits in a neat office wearing a white coat. I imagined physicists as modern paladins: people who step into the unknown and search for hidden truths. To me, that was a kind of modern chivalry.

When I began learning physics in high school, I imagined that I was traveling through a vast magical continent. Mechanics felt like fertile plains with clear roads and familiar rules. Electromagnetism resembled cold mountains shaped by invisible forces. Quantum mechanics was a dangerous wasteland where intuition often failed. I started drawing maps that connected the ideas I learned, almost like a traveler recording unknown territories in a journal. Physics no longer felt like memorizing formulas for exams. It became an adventure of exploring hidden structures beneath the world.

As my map of physics grew larger, I began to notice something strange. Areas that first looked completely different were often connected in unexpected ways. Ideas from one field would quietly reappear in another, sometimes in completely different forms. It no longer felt like collecting separate pieces of knowledge. Instead, it felt like exploring a living tree, where different branches grew from the same hidden roots.

Then I began to feel a strong emotion—not only happiness, but also a sense of mission. I became eager to reach the root of this huge tree of physics. If I could reach it, then the whole world would become transparent to me.

That's how I entered the field of particle physics. At first, I believed that if we understood the fundamental particles and the interactions between them, then we could predict the behavior of the matter they constitute. All properties of matter—mechanical characteristics, electrical properties, colors, flavors—could ultimately be explained by the motion of particles. In other words, concrete properties could emerge from abstract motions in spacetime.

Of course, from my current perspective, the world is more complex than my naïve dream. The definition of a particle depends on certain favorable conditions in quantum mechanics, and different fields of physics have their own principles that cannot simply be reduced to one another. Still, particle physics remains special to me because it asks one of the deepest questions I can imagine: what are the basic rules and parameters that make our universe possible?

That's why neutrinos are so important to my exploration of the "tree of physics". The Standard Model is the most stable trunk at its center, but there are still side branches that do not seem to grow directly from it, and neutrinos are one of them. It seems that these phenomena, together with the Standard Model, may grow from a deeper root that we still do not understand.

The puzzle begins with mass. If we fully trust the Standard Model, particle masses arise from the Higgs mechanism. You can imagine the Higgs field as a kind of sticky water, where bugs swimming through it are slowed down and therefore appear massive. However, neutrinos are like water skippers: they do not interact with the Higgs field in the ordinary way, so they should be massless.

But this is not what we actually observe. There are three types of neutrinos, called "flavors," and neutrinos can change from one flavor to another as they travel. This is called neutrino oscillation, and it tells us that neutrinos have mass. Through oscillation experiments, we can measure how neutrino flavors change and learn about the differences between their masses. They may also give us clues about unknown particles or forces hidden beyond the Standard Model. These results may reveal deeper structures in particle physics.

In reality, thousands of brilliant theorists are already working on this problem. They try to incorporate massive neutrinos into more general theoretical frameworks. The difficulty is that different theories can produce almost identical predictions within a given level of experimental precision. If we want to distinguish between them and get closer to the truth, we must improve the accuracy of experiments.

The challenge is that reality itself is complicated. Underlying structures do not reveal themselves automatically; they only emerge through the tremendous effort we put into instruments and analysis. One major difficulty is that we detect neutrinos through their interactions with oxygen nuclei, which are extremely complex. My current research tries to build better computer tools for predicting what happens when neutrinos hit oxygen nuclei, so future experiments can measure neutrino properties more accurately.

Today I am still trying to get closer to the structure of the world, even as those structures become harder and harder to imagine. We are facing a chaotic world, yet we continue uncovering the order hidden beneath it. The difficulties do not make us afraid; instead, they make the journey more exciting.

So, if you are twelve and reading this, I want to tell you that science is not merely a collection of facts. It is a kind of chivalry: the courage to ask questions even when there are no prepared answers, the generosity to share your understanding with anyone fascinated by nature, and, most importantly, the loyalty to a strange phenomenon that refuses to disappear.

So do not wait until you feel ready or brilliant. If one question has already captured you, follow it. Keep your resolve, stay faithful to it, and the tools you need will come to you along the way. That will be your own adventure.

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