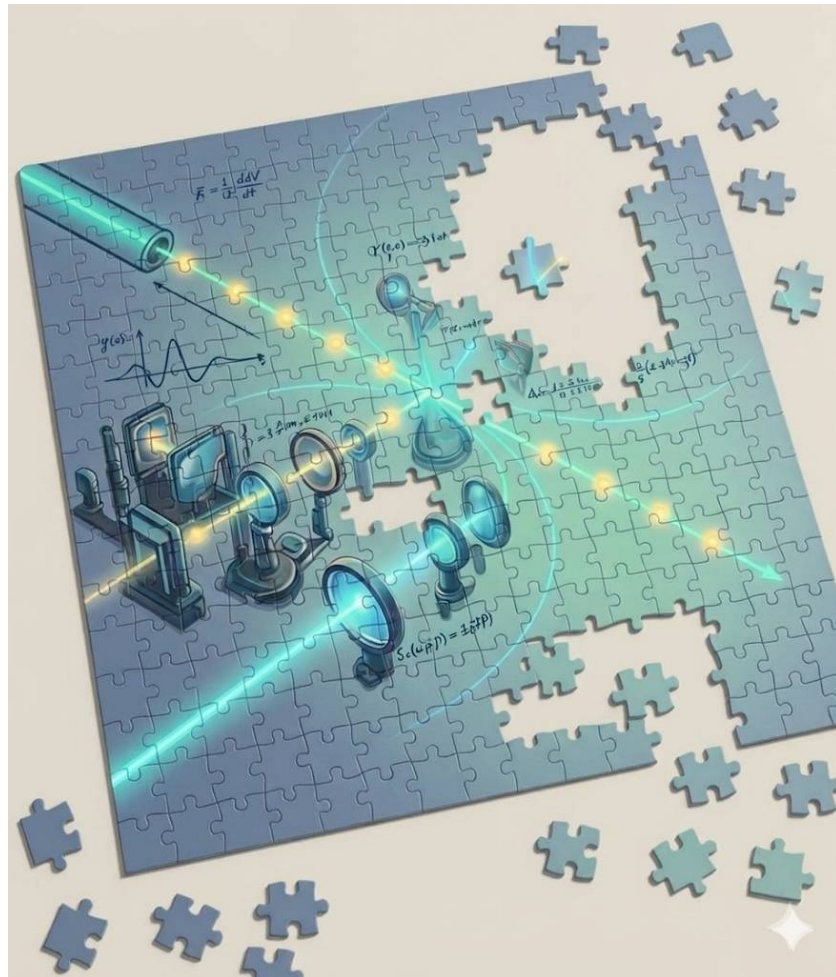


Controlling curious particles of light

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Have you ever wondered what light really is? We use it every day—turning on a lamp, looking at our phones, or enjoying sunshine—but its true nature is surprisingly mysterious. I became fascinated by this mystery, and now I am a graduate student studying photons, the tiny particles that make up light. In this essay, I want to share how I became interested in this strange world and why I decided to become a researcher.

Right now, I study photons, which are pieces of light. Imagine turning on the lamp in your room. At that moment, countless particles fly out into the room. Those particles are photons. But a photon does not behave like a ball. It behaves in a very strange way. If you throw a ball, its path is already decided the moment it leaves your hand. It might change a little because of the wind, but the overall path is fixed. But a photon is not like that. Before we find out what happened, we cannot say which path it took. All we can know are the chances of each possible path. If we want to know the exact result, we have to check what happened in the end. This is not because our theory is incomplete. It is because, in the world of photons, the path is not fixed until the result appears. And it is not only photons. All the tiny particles that make up the world behave in this strange way. They are called quantum. In my research, I try to control this quantum nature of photons.

But you might wonder why I chose such a strange topic. When I first learned quantum physics, I thought only a small part of the world behaved strangely. But actually, everything around us is made of quantum particles. In other words, if you zoom in on any object, you will find this strange quantum behavior. Even though everything around us feels real and solid, the particles inside it behave probabilistically, as if their existence is not clear. It was confusing and hard to accept. Because I like solving complicated puzzles and dislike leaving them unsolved, the more I learned, the more I wanted to understand this strange behavior properly. That is why I study photons—the quantum of light.

As I learned more, I became fascinated by the idea of controlling such strange behavior. Especially, I became interested in quantum computing, which uses the probabilistic nature of quantum for calculation. It is completely different from classical (normal)

computing which is used in cell phone, video game, and so on. A quantum computer uses the strange probabilistic behavior of quantum particles to try many possibilities at the same time. Because of this, it can run special kinds of calculations that normal computers cannot. For example, quantum computers can solve cryptography used in online telecommunication much faster than supercomputers. This is because prime factorization problems are used in the cryptography and quantum computer can find prime factor using a probabilistic algorithm. However, building such a computer is a very difficult puzzle because it requires high-precision quantum control. When I learned this, I wondered how researchers control such strange quantum behavior.

Then, I found and read a book about optical (photonic) quantum computing written by a famous researcher, Akira Furusawa. This book became the moment that truly set me on the path toward becoming a researcher. In his book, he describes what it feels like to control photons with his own hands. For example, he explains how precisely he arranges hundreds of optical components such as mirrors and lenses. If even one of them is misaligned by one millimeter, the experiment might fail. He also says that it is important not to think only in terms of calculation, but to “think like a photon”. I felt that this unique attitude led him to succeed in many experiments, such as quantum teleportation, which means transferring the information of one particle to another like a fax. After reading his book, I started to think: “If I can understand the mind of a photon, maybe it will no longer feel strange, and I will be able to control it like he does.”

His words also strengthened my desire to follow this path. He wrote, “A special skill is an advantage in society but you may feel nervous doing something others do not. That is

why it is important to choose what you are really interested in. For me, research is no different from windsurfing. I do it because it's fun." Encouraged by these words, I decided to go to graduate school to get a special skill: controlling photons.

If you ever find a scientific puzzle that you truly want to solve, I hope you jump into that world without hesitation. I believe that following such curiosity will eventually give you a unique strength of your own and make your life richer.

I used ChatGPT and Google Gemini to improve the language or grammar.