The Uncompleted Answer Book: Revealing New Particles with My Own Hands

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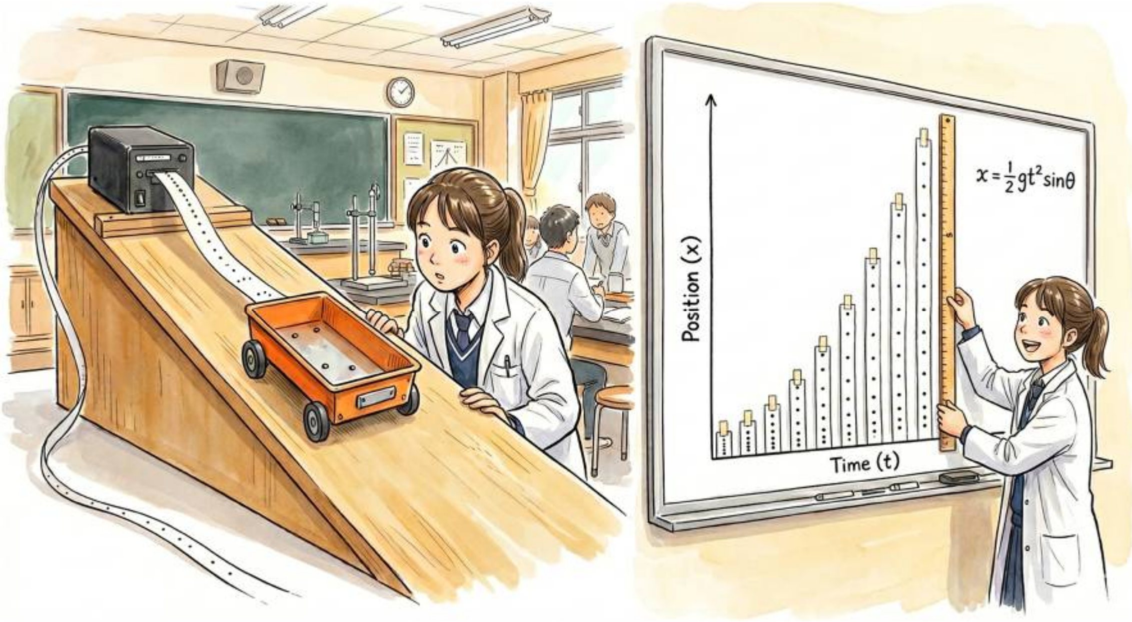
Have you ever finished solving a math problem in a textbook only to find it doesn't have an answer book? I personally have experienced the situation and had a strong frustration. I really like the process of checking my answer no matter my answer is correct or not. If my answer is correct, that of course gives me a great satisfaction, and if it's not, that's also interesting because I can think which process was wrong in my answer. Science is a continuous cycle of solving a problem and checking its validity, same as a math exercise. The biggest difference is the answer book for science is nature, the world we live in, and the answer is not written in a plain text; we need to translate the natural phenomena to the language we can understand with experiments.

My research takes charge of the last part of the cycle; observing natural phenomena with experiments so that we can check the validity of the theoretical prediction. I chose to experimentally contribute to science under the great influence of my high school physics teacher. He always started his classes with small experiments and let us visualize the results. One experiment I vividly remember is the one with a cart running down a slope. The cart had a long paper ribbon attached to its rear-end, and the ribbon was continuously stamped with dots at a constant frequency at the top of the slope. Once the cart began running down the slope, the interval between the dots got longer according to the increased cart velocity. After cutting the ribbon at every five dots, which corresponds to the time interval, we aligned the strips in order. What we saw was a quadratic function; $x = \frac{1}{2}gt^2 \sin\theta$. I remember the great excitement to recognize that the cart is driven by gravity and really follows the quadratic equation I calculated. There were many more experiences like this that made me realize my eagerness to do experiments to observe the phenomena with my eyes.



(This image was created by Gemini.)

My high school physics teacher also taught me to consider the physical phenomena by looking at their smaller components. For example, the internal energy of the air can be explained by the kinetic energy of the constituent particles. This idea fascinated me so I looked for the smallest components of the world and got obsessed with the elementary particles that can explain most of the physical phenomena observed today. My current research deeply connects to the elementary particles; I am searching for the new candidates of the elementary particles called SUSY particles, which have not detected by any experiments yet. My ambition is to detect these unknown particles with the detectors I created on my own.

One very common and naive way to find these new particles is to use huge machines called colliders to literally collide and crash known particles together at a very high energy to create new ones. If the total collision energy is high enough, new particles could be produced in the collision. However, if the total collision energy is not enough for the desired new particle, it's impossible to produce it in the collision. Thus, the particles we can observe are limited by the energy range human can reach. The problem is; my targeted SUSY particles do exceed this energy range. Then shall I give up seeing these particles? -- No, I won't! Even though It's impossible to actually produce the desired SUSY particle, there is a very smart way we can indirectly confirm their existence; to search for a reaction mediated by SUSY particles. There are many theoretically predicted low-energy phenomena that cannot happen without the existence of SUSY particles in the intermediate phase. Although the probability of these phenomena is very low, observing such very rare reaction will be the direct evidence of their existence. This is very exciting and clever because this method enables us to indirectly search for the SUSY particles in the energy scale we cannot reach.

As you can see, science is not a rigid set of rules where everything is already known. When we hit a wall—like the energy limits of current colliders—we don't give up. Instead, we invent smarter ways to ask nature for the answer. Using my own hands to build detectors and searching for these rare phenomena gives me the exact same thrill I felt when I measured the paper ribbon from the cart in high school. By continuing to collect the answers to our questions, I believe human can finally weave a thick answer book of our profound nature.

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