Why I became a scientist?

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Title: My Journey to Becoming a Scientist:

"New laser technology sheds light on solving environmental issues“

What comes to mind when you think of light? It might be sunlight, artificial lightning such as LED light or lamps, beautiful natural phenomime such as rainbow or aurora. In this essay, I’m going to introduce my research topic, vortex beam, newly developed laser in this past 30 years.

My love for physics began in high school, where I was captivated by the subject's inherent beauty and its ability to explain the complexities of the universe through elegantly simple principles. Physics, to me, was not just a branch of science; it was a language through which the universe communicated its most intricate secrets. As I deepen my academic studies about physics, I began to gain confidence that physics is not only beautiful, but also could provide practical solutions to real-world problems, particularly in the energy-efficient technology.

Going deeper into my physics education, I discovered the concept of vortex beams—twisted beams of light that carry orbital angular momentum. Intrigued by their potential applications, I dedicated my research to exploring how these beams could be harnessed as a tool for sustainable technology.

Then, what is a vortex beam? Imagine you have a flashlight that shines a straight beam of light, like when you point a laser pointer and see a dot. Now, imagine if instead of shining straight, this light twirls around like a mini tornado or a spiral staircase. That's what we call a vortex beam. A vortex beam is a special kind of light that doesn't just travel straight; it spins around an invisible center point as it moves forward. This spinning creates a spiral pattern, and at the very center of this spiral, there's a spot with no light at all, which we call the "dark core."

The cool part about vortex beams is that because they carry something called "orbital angular momentum" – it's a bit like how the Earth carries momentum as it orbits around the Sun. This spinning quality can be used in many amazing ways, like helping scientists to study tiny particles or even to send more data over internet connections by using the light's spiral path to carry extra information.

In communications, vortex beams can transfer data faster using fewer resources, potentially lowering energy use and helping to cut down on electric energy. By utilizing vortex beams, it is possible to significantly increase the data capacity of communication systems. This is achieved by multiplexing multiple data channels within the same spatial mode, leading to higher bandwidth efficiency. Consequently, this can reduce the number of required transmission channels, lowering the overall energy consumption.

Moreover, vortex beams are less susceptible to scattering and diffraction effects, which makes them ideal for long-distance communication. Improved signal integrity over long distances reduces the need for repeaters and amplifiers, leading to lower energy consumption in the communication infrastructure.

I personally focused on researching the interactions between materials and vortex beams. The interactions between vortex beams and matter are still not fully understood. This understanding is vital to explore the possibility of optical technology using vortex beam. I expected that if I could find new properties of vortex beams or matter, the realization of photonics or vortex beam-based communication should evolve further.

Researchers are tackling several issues to realize highly efficient communication using vortex beam. Optical communication systems often encounter loss and scattering due to imperfections in materials and environmental factors. Research into low-loss materials and improved beam shaping techniques can help mitigate these issues. The sensitivity of receivers to detect and decode the OAM states of vortex beams accurately is crucial. Innovations in photodetectors and signal processing algorithms can enhance receiver performance.

We aim to address these challenges to some extent to advance the practical application of vortex beams in optical communication. By improving the stability and propagation of vortex beams, enhancing receiver sensitivity, and developing robust alignment, we hope to overcome some of the key obstacles. Additionally, focusing on reducing complexity and cost, mitigating atmospheric turbulence, and promoting standardization and interoperability will further our efforts. Addressing these issues will bring us closer to realizing the full potential of vortex beam technology in creating efficient, high-capacity, and scalable optical communication systems.

Becoming a scientist was not merely a career choice; it was a response to the urgent need for action against environmental degradation and a natural progression of my passion for physics. Through my work with vortex beams, I hope to bridge the gap between theoretical research and practical environmental solutions, contributing to a sustainable future. As I continue this path, I am driven by the knowledge that each discovery not only advances our understanding of physics but also brings us one step closer to healing the planet. This synergy of motivations—love for physics and a commitment to environmental stewardship—continues to inspire my journey in science.

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