The Ethics Question

Reflections on Physics 95

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Late at night the lights of the physics building flicker to the tune of vacuum pumps rhythmically humming and grad students taking data. The steady march towards new physics never stops, for in the same rooms where a new era of general relativity began, today's researchers probe everything from dark matter to emergent phenomena. In a world with so much left to understand, it seems there is never any time to pause, for every second spent discussing, is a moment not collecting data or pushing the boundaries of the natural world.

Thousands of miles away from Harvard's underground labs, soil sits full of radiation, buildings explode, and precious natural resources are drained away. The legacy of physics echoes widely both in the blast radius of our most dangerous weapons and the consumption of enough water and electricity to fuel entire cities. For each new discovery, a world of great opportunity and perilous danger is created. The days of killing tens of thousands in seconds might have been paused, but ongoing research is threatening in ways as new as the science behind them.

For every possible misstep, however, there is also great hope for what is possible. The same discoveries that created nuclear weapons also opened the door to new forms of energy and medicine that have saved countless lives and helped propel scientific missions into space. The entire manmade world as we know it is the product of what was, at the time, groundbreaking research. So how can we fault the money spent, resources used, and lives lost if one day so much more could be created?

This side of physics, the one that asks if the risk is worth the reward, feels like an impossible question to surmount. For every fundamental law we uncover, we have yet to find an indisputable moral framework for the acceptable costs of scientific discovery. Over the course of the semester, we repeatedly asked visiting professors difficult questions about the ethics of their work and in their responses was an implied question: Is a researcher at fault for the harm their discoveries can unleash on the world? Reflecting on some of the labs we visited, I offer the following thoughts:

Visiting Weitz Lab

Early in the course we spoke to Professor Weitz and visited his lab. During our tour, we learned about using microfluidics to isolate single cells each in their own droplet "test tube." The lab develops devices capable of precisely sorting, mixing, and testing individual droplets on chips smaller than the palm of your hand.

While the development of microfluidics technology is application-agnostic, it would be imprudent to assume that all of its potential uses are ethically sound. On one end of the spectrum, concerns have been raised about microfluidics being used in chemical and biological weapons of mass destruction. On the other hand, microfluidics has the potential for creating cheap personalized tumor treatments. Weighing the fear of the worst case against the hope for the best case presents a whole new array of questions for a lab that is just developing new technology without a definite application in sight.

It is possible to argue that the potential of weaponization has no bearing on the work done in the lab. Almost anything from fertilizer to a metal pipe can become a weapon and yet we have not prevented research or usage of either material. And yet there are plenty of fields characterized by controlled substances and high security labs. So do microfluidics meet the mark?

Unlike highly dangerous viruses and radioactive materials, the simple existence of a microfluidics chip is not sufficient to classify it as a danger to society. It is the usage of such a chip that could cause harm to the world. Arguably, this, once again, removes all responsibility from a lab that is only charged with the device's creation.

Unfortunately, this is an oversimplistic view. Every microfluidics chip the Weitz Lab makes goes somewhere and the lab has a strong bearing on where that somewhere is. For every startup and graduating grad student allowed to take the technology into the world, the lab is partially responsible. While they cannot control all the evil that could possibly come from microfluidics chips, they hold responsibility for the people they allow to harness that potential.

Taking that responsibility seriously requires meaningful standards and conversations about what ethical applications look like. At the end of the day, as the head of a lab, the professor must carry the weight of whatever is done with the tools they have created for the world. That responsibility must be a driving force in the work that is done, even if the lab itself never engineers an application for their research.

Dinner with Professor Dvorkin

During one of our Tuesday evening classes spent eating dinner with Professor Dvorkin, a loud argument emerged: is it worth funding fundamental physics research? With two fundamental physics researchers present, one a theoretical cosmologist and the other a particle physicist, the question was unsurprisingly met with a passionate defense of the field. As the class ended without a true consensus, the underlying question of ethics was never truly answered.

Funding fundamental physics research becomes an ethical question in a world of finite resources and money. Every dollar put towards CERN or a new telescope is a dollar not spent curing cancer or even building affordable housing. If the world is a zero-sum game of time, energy, money, and physical resources, then everything given to one field is also taken away from another.

While there is a great deal of logical justification for treating the world in this way, there is also the fundamental question of what it means to be human. While it is possible to believe the ultimate goal of a person is to live in the purest sense of the word, living in a sterile white room devoid of both illness and entertainment seems antithetical to the human experience. Even expanding the world beyond four white walls, living a life justified only by functionality and expediency would close the doors of human passion. In such a world there would be no art, literature, or music. There would be no beauty in understanding quantum physics or the stars. There would only be work, work, and more work.

Funnelling the world's resources into the most applicable fields, perhaps medical and environmental research, would create a future free from pandemics or rising sea levels but it would also rob us of the very joys of the world. The price of fundamental physics research is money, time, and resources but the services returned extend well beyond understanding gravitational lensing or quarks. Since the beginning of mankind, humans have longed to understand the universe. Even in times of astronomical child mortality and starvation, people still stared at the stars in wonder. Over four thousand years ago mankind was already tracking the stars, desperate for answers. Funding fundamental physics research is our way of finding the answers our ancestors could barely have dreamed of.

That deeply human pursuit can only be driven with meaningful material sacrifice. The money, energy, and resources required in the process of discovery are real costs that cannot be taken lightly. But they must be taken.

The responsibility of reducing the cost to society is in the hands of every researcher in the field and it is a task that key institutions seem to be taking seriously. While there is room to critique the balance of allocated resources and meaningful results produced, fundamental physics is a field where not pursuing research would be an ethical failing of humankind.

Mice in the Cohen Lab

There is no doubt that the conversation with Professor Cohen was the most ethically polarizing of the class. There were dead mice, there was mind control, and there were difficult questions about the cost

of learning about the brain. Being confronted with the realities of animal testing is a difficult hurdle despite a societal willingness to benefit from its results.

Hearing that the mice did not feel pain is difficult to reconcile with pictures of a mouse missing parts of its skull. Knowing that a review board approved it somehow does not make the experiment more palatable. Imagining your own head cut open only makes things infinitely worse.

Even with stringent controls governing experiments involving animals, there are still deep personal and ethical questions that can never systematically be answered. Most fundamentally is the question of whether a decision by a governing body is sufficient to justify the personal choice to do research which might cause a living being pain, even by accident? Every step of the process is defined by our current understanding of mouse consciousness and if the scope of ongoing research is indicative of anything, it is that there is still much to learn. One day, that learning could lead us to the fact that the mice being tested on were deeply in pain but their response looked so inhuman we completely missed it.

Unfortunately, that risk is impossible to mitigate and animal experimentation is the only field of physics we encountered that even tries to codify its own ethical lines. Being able to trust an ethical review board is the only thing that allows us to manage both the possibility for error and the great potential in conducting new research. While we may learn of grievous errors in our past treatment of mice, there is at least a framework to prevent the repetition of those mistakes while still allowing research that has the potential to generate huge improvements in treatments of debilitating human conditions.

Like all research, however, there is an ever-present threat of misuse. Professor Cohen introduced experiments that allow for the excitation of specific parts of the brain generating, among other things, violence and aggression. In a series of videos that could appear in a horror movie if they featured humans, mice began attacking whatever was in their cage until their human overlords turned off the stimulating light.

The expansion of such an experiment beyond laboratory mice harkens to a fundamental human fear of control being forcefully taken. Accepting the risk that such a technology could be expanded to humankind requires a belief that such unethical behavior would be stopped in its tracks. Regardless of personal beliefs on the existence of animal testing, review boards have paused unethical research in its tracks.

The standard of ethical review by a body of experts is the clearest acknowledgement of the moral obligations of a researcher in our class this semester. Expanding ethical reviews to other fields of physics is a compelling possibility for systematically expanding ethical standards and forcing true reflection on the worst applications of understanding the physical world.