Blazing the Trail: Essays by Leading Women in Science

Emma Ideal

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physics at Stanford, I never really thought beyond the next step. I likewise advise my students to take things one step at a time – what would you most like to do next? What feels right? For one of my advisees who majored in physics and minored in materials science, it was taking a "gap year" to help restore a national park in Patagonia; she entered a Ph.D. program in applied physics afterward. For another physics major who minored in creative writing and poetry, it was teaching English in Japan for a couple of years; he then entered a Ph.D. program in physics. I encourage you to follow suit and do what feels right at the moment. Your path will find you.

CATHRYN CARSON

Bona Fides

Dr. Cathryn Carson studied physics, mathematics, and the history and philosophy of science at the University of Chicago. Her graduate work took place at Harvard, where she received a master's degree in Physics and a doctorate in the History of Science. After a postdoctoral year at Stanford, she joined the history department at the University of California, Berkeley. Her research focuses on the history of physics and philosophy in twentieth-century Germany and the United States. Most recently, she published Heisenberg in the Atomic Age: Science and the Public Sphere. She chairs the editorial board of the journal Historical Studies in the Natural Sciences and serves as Associate Dean of Social Sciences, the largest division at Berkeley.

Trajectories

My story is different because I am not a physicist. Rather, I passed through physics on my way to becoming a historian. As a historian, narrative is one of my tools, and so when I tell stories, I can't help but be conscious of how they are constructed and told. My story as a "woman in physics" is the narrative as I make sense of it now, meaning as I pick out an origin and a trajectory that leads to the present.

I am part of the generation that went through school and

college in the 1970s and 1980s, then graduate school in the early 1990s. Throughout this time I was hyper-aware of being a woman in science. Even though the formal barriers to women in physics were gone, the informal social relations around them were still in flux. In its own backhanded way, that was productive for my intellectual development, as I am someone who studies the social relations of science. I feel fortunate to have made the passage through physics, and at the same time I'm glad to have found something on the other side.

Steering into Math and Science

I don't know how early a child can become aware of gender roles. I have distinct recollections from nursery school of feeling that girls got the short end of the stick. Girls were supposed to be well-behaved and polite and play with dolls while boys got to run around. I have no idea where I got the sense that some people felt girls were naturally suited to doing only certain kinds of things. It was not from my family. My parents were completely sympathetic to a tomboy daughter; my father coached my soccer team back when a girls' league was still something new. My mother has a Ph.D. in economics, and my sister has a J.D. We are all, however, well-behaved and polite.

I first became existentially aware that gender intersected with science when I was part of a large research project called the Study of Mathematically Precocious Youth (SMPY). The core of the study back then was to have seventh graders sign up for a college entrance exam, the Scholastic Aptitude Test. I didn't realize there would be an awards ceremony after the results came out. I was completely surprised to be invited up on stage, together with another girl, to recognize our twelve-year-old SAT-verbal scores. Then I sat in my seat, my surprise turning to I didn't know what, as the researchers called up the other high scorers. Every seventh-grader that year who scored above 700 on the math section was a boy, and the researchers seemed excited, in fact determined, to drill this finding into the minds

of the assembled students and parents.

A twelve-year-old's fury can take you a long way. I was close enough to the math cutoff that I left the auditorium feeling I had failed. I don't know that I told anyone, but I was not going to let that happen again. It was a twelve-year-old's black-and-white view of the world, but it took hold at a moment when long-term trajectories were being set. SMPY offered accelerated summer math classes, and I took them. I learned to code in BASIC and Pascal and willed myself to play ultimate frisbee and juggle and do other things that mathematically gifted kids (boys) did. In the confusion of wanting to know my life's destiny, I decided that destiny was science. And not just science, but physics. Theoretical physics was the hardest thing you could do. Coupling fury with stubbornness and competitive ambition made for a considerable force – even when internalized social norms made it impossible to own those traits and express them out loud.

I was incredibly lucky to have great teachers in high school, a private girls' school. It felt supplementary at the time, but I got real preparation in history, literature, and languages. Before graduating I was able to take single and multivariable calculus. I took AP Chemistry and AP Physics in the company of some equally ambitious young women – and we took these classes at the boys' school down the street. Gender was always part of the picture. The first U.S. team for the International Physics Olympiad was chosen the summer I graduated from high school. I still have a commemorative photo from the training camp: the participants posing on the massive statue of Einstein outside the National Academy of Sciences, eighteen boys in suit jackets or shirtsleeves, two girls in a dress and a skirt with summer-white shoes.

Living in Physics

What I loved about physics, to start, was quantum mechanics, at least as far as it filtered through to an actual student of

physics. It was easy to be pulled in by the abstract clarity of classical mechanics, and when I first encountered the connection between Poisson brackets and canonical commutation relations, it was like some inner structure of the world was revealed. I was fascinated by turbulence and scaling laws, and I found a hard-to-describe pleasure in thinking with the tools of condensed matter theory. The frustration that had set in in high school, and only deepened as I settled into serious study, was just that a lot of the day-to-day work of physics was not really thrilling. Practically, physics came down to endless iterations of boundary value problems in electricity and magnetism, or painfully long solid-state problem sets worked out on rolls of dorm paper towels. In E&M lab sections I would propagate all the measurement errors while my partner made the equipment work, and I realized I was much more interested in rewriting the lab manuals than in learning the handiwork they were supposed to be teaching.

Being a woman in physics didn't make this harder; it probably made me stick with it longer than I would have otherwise. When I declared my major as the history and philosophy of science (to my great good fortune, Chicago had this option, and I stumbled on it), it felt like a declaration of independence. The fact that I avoided majoring in physics probably made sense to my undergraduate friends and the department staff who heard me muttering about how ambivalent I was. But I kept taking the classes to satisfy all the requirements, and as long as you do the work for a degree in physics (Chicago didn't allow double or triple majors back then), you might as well do the work for a degree in math, too. I had some degree of awareness about the bind I was putting myself in. It was just easier to be reflective in sociological terms than personal ones: these are the dilemmas marginal groups face, convoluted with this is how upper-middle-class white women behave. If I stopped taking physics, I would have had to really figure out what I wanted. I would also have felt like I was letting down the cause.

As an undergraduate I had only occasional experiences of feeling out of place as a woman. There was the lab tech at a university in the Southeast who told me, smilingly, that he didn't think women belonged in physics, which didn't trouble me, because I was visiting to do research (I eventually published two papers in computational condensed matter) while he was building bookcases with his degree. In graduate school it was harder to avoid. That was not because of any hostility I picked up on, but because of the starker difference of perspectives, and because of the numbers narrowing down. There were male students, friends, even, who didn't get that it might feel odd to be the only woman in a condensed matter graduate seminar. (At that point I was already a refugee from another department; I had decided to go for my Ph.D. in the history of science.) I still have the old flyer – I was thrilled when it went up, and I quietly took down a copy and saved it – announcing the party to celebrate Melissa Franklin's tenure, the first woman in the history of the Harvard department.

I was glad for the chance to watch that history happen, and to have a sideways foothold in the department as it did. And still it was gendered. A wonderful mentor pointed me to Evelyn Fox Keller's reflections on her much earlier experience at Harvard. A lot of things about social relations had changed, and then others seemed just the same. To someone with a background in feminist theory, the department's "family" meetings seemed like sites of gender-reversed parthenogenetic self-reproduction in the ironic absence of women. A friendly person on the third floor of Jefferson Lab pointed out it was easy to tell when I was coming around the corner because other grad students wore sneakers and I wore clickety flats.

Passing Through

In graduate school the understanding slowly came to me that my mind worked differently from those of the grad students who had offices in Jefferson Lab. They didn't remember formulas as strings of syllables; they didn't live in language the

way I did. Running up against my limits – looking for answers to problem sets in the old volumes of journals in the storage room – let me admit that this didn't have to be my calling. Fortunately, I had already found my way to something I cared about, thinking about human affairs unfolding in time.

I was trained as a historian, specifically of physics, understood as a human affair unfolding in time. That is now what I teach, and part of what I do. As I have spent more time as a historian, I have tried to line up my "internal" interests in how the science developed with questions of understanding human choices and institutional structures. I get mildly frustrated when I bump up against some scientists' assumption that being a historian (or a humanist or social scientist in general) is somehow soft (and therefore coded female). There is a critical rigor that animates some work in the "soft" fields, certainly my own, exactly in how it deals overtly with the limitations of knowledge, perspective, contingency, and method that the natural sciences don't have to address.

My husband, who was my E&M lab partner, says it makes sense that the possibility of recognizing structure in turbulence would appeal to someone who was cut out to study the complexity of human behavior. Condensed matter metaphors underwrite how I think about history, and the ways of parsing reality that physics teaches have become a kind of conceptual shorthand. I don't use my physics training anymore, except occasionally to put people on notice. When I work with quantitative social scientists (or scientists and engineers) it helps diffuse the unspoken skepticism that a woman and a historian sometimes encounters. I once put it this way to a colleague in engineering: having trained in theoretical physics doesn't mean I know everything, but it means I'm confident there's nothing I can't learn. That's not true for the reasons physicists may think – because physics can handle everything, or because physics is the hardest thing to learn – but it's become true for me.

Reflections

I now talk about my encounter with physics with a historian's distance. I tell it as a larger story about social and cultural transformations in the United States after World War II. As the nation geared up for an era of massive international competition, it invested all-out in scientific and technical training. Students with those aptitudes were seized upon as gifted and steered into professions that gained a cultural premium they had never had before. Women and other marginal groups were only slowly added to the human resource pool; that happened fairly late in the game. But we are still dealing with the 1950s tinges to our notion of a scientific career. These don't just impinge on the way we think about individual trajectories. They're also built into pipeline models that integrate over individual choices to give some idealized lossless flow.

This system was incredibly effective in recruiting physicists. It did not exactly adjust, though, to the complexities of the people who were fit into the mold. And it was not respectful or attentive to other things an individual might find fascinating. The smart, ambitious women from my AP Physics class are now working on Wall Street, practicing law, editing, and teaching and writing about comparative literature and history. I can appreciate the frustration other women have felt trying to stay in physics, but I can't think of passing through it and leaving as solely a bad thing.

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To all those devoted to advancing the store of human knowledge: the trailblazers, for their courage and inspiration; today's scientists, for their stewardship and leadership; and the next generation of explorers, whose efforts will enable discovery beyond our imagination.

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