
EDUCATION: Out of the Frying Pan . . .

THE ANOMALY OF A WOMAN IN PHYSICS

Evelyn Fox Keller

A couple of months ago I was invited to give a series of lectures at a major university as one of a “series of distinguished guest lecturers” on mathematical aspects of biology. Having just finished teaching a course on women at my own college, I somehow felt obliged to violate the implicit protocol and address the anomalous fact of my being an apparently successful woman scientist. Though I had experienced similar vague impulses before, for a variety of reasons arising from a mix of anger, confusion, and timidity, it had never seemed to me either appropriate or possible to yield to such an impulse. Now, however, it seemed decidedly inappropriate, somewhat dishonest, and perhaps even politically unconscionable to deliver five lectures on my work without once making reference to the multitude of contradictions and conflicts I had experienced in arriving at the professional position presumed on this occasion. Therefore, in a gesture that felt wonderfully bold and unprofessional, I devoted the last lecture to a discussion of the various reasons for the relative absence of women in science, particularly in the higher ranks. The talk formed itself—with an ease, clarity, and lack of rancor that amazed me. I felt an enormous sense of personal triumph. Somehow, in the transformation of what had always appeared to me an essentially personal problem into a political problem, my anger had become depersonalized, even defused, and a remarkable sense of clarity emerged. It suggested to me that I might, now, be able to write about my own rather painful and chaotic history as a woman in science.

Origins are difficult to determine and obscure in their relation to final consequences. Suffice it to say that in my senior year of college I decided I would be a scientist. After several years of essentially undirected intellectual ambition, I majored in physics partly for the sake of discipline and partly out of the absence of any clear sense of vocation; and in my last year I fell in love with theoretical physics.

I invoke the romantic image not as a metaphor, but as an authentic, literal description of my experience. I fell in love, simultaneously and inextricably, with my professors, with a discipline of pure, precise, definitive thought, and with what I conceived of as its ambitions. I fell in love with the life of the mind. I also fell in love, I might add, with the image of myself striving and succeeding in an area where women had rarely ventured. It was a heady experience. In my adviser’s fantasies, I was to rise, unhampered, right to the top. In my private fantasies, I was to be heralded all the way.

It was 1957. Politics conspired with our fantasies. Graduate schools, newly wealthy with National Science Foundation money, competed vigorously for promising students, and a promising female student was a phenomenon sufficiently unique to engage the interest and curiosity of recruiters from Stanford to Harvard. Only Cal Tech and Princeton were closed to me—they were not yet admitting women—and I felt buoyant enough to challenge them. I particularly wanted to go to Cal Tech to study with Richard Feynman—a guru of theoretical physics—on whose work I had done my senior thesis. In lieu of my being accepted at Cal Tech, an influential friend of mine volunteered to offer Feynman a university chair at MIT, where I would be admitted. Heady indeed.

Even then I was aware that the extreme intoxication of that time was transitory—that it had primarily to do with feeling “on the brink.” Everything that excited me lay ahead. I had fantasies of graduate school and becoming a physicist; what awaited me, I thought, was the fulfillment of those fantasies. Even the idea of “doing physics” was fantasylike. I could form no clear picture of myself in that role, had no clear idea of what it involved. My conception of a community of scholars had the airiness of a dream. I was intoxicated by a vision that existed primarily in my head.

Well, Feynman was not interested in leaving Cal Tech, and so I went to Harvard. More accurately, I was pressured, and eventually persuaded, by both a would-be mentor at Harvard and my adviser, to go to Harvard. At Harvard I was promised the moon and the sun—I could do anything I wanted. Why I was given this extraordinary sales pitch seems, in retrospect, all but inexplicable. At the time, it seemed quite natural. I dwell on the headiness of this period in order to convey the severity of the blow that graduate school at Harvard actually was.

The story of my graduate school experience is a difficult one to tell. It is difficult in part because it is a story of behavior so crude and so extreme as to seem implausible.

Moreover, it is difficult to tell because it is painful. In the past, the telling of this story always left me so badly shaken, feeling so exposed, that I became reluctant to tell it. Many years have passed, and I might well bury those painful recollections. I do not because they represent a piece of reality—an ongoing reality that affects others, particularly women. Even though my experiences may have been unique—no one else will share exactly these experiences—the motives underlying the behavior I am going to describe are, I believe, much more prevalent than one might think, and detectable in fact in behavior much less extreme.

I tell the story now, therefore, because it may somehow be useful to others. I *can* tell the story now because it no longer leaves me feeling quite so exposed. Let me try to explain this sense of exposure.

Once, several months into my first year in graduate school, a post-doctoral student in an unusual gesture of friendliness offered me a ride home from a seminar and asked how I was doing. Moved by his gesture, I started to tell him. As I verged on tears, I noticed the look of acute discomfort on his face. Somehow, I had committed a serious indiscretion. It was as if I had publicly disrobed. Whatever I said, then and always after, it somehow seemed I had said too much. Some of this feeling remains with me even now as I write this article. It is a consequence of the assumption in the minds of others that what I am describing must have been a very personal, private experience—that is, that it was produced somehow by forces within myself. It was not. Although I clearly participated in and necessarily contributed to these events, they were *essentially* external in origin. That vital recognition has taken a long time. With it, my shame began to dissolve, to be replaced by a sense of personal rage and, finally, a transformation of that rage into something less personal—something akin to a political conscience.

That transformation, crucial in permitting me to write this, has not, however, entirely removed the pain from the process of recollecting a story that retains for me considerable horror. If I falter at this point, it is because I realize that in order for this story to be meaningful, even credible, to others, I must tell it objectively—I must somehow remove myself from the pain of which I write. The actual events were complex. Many strands weave in and out. I will describe them, one by one, as simply and as fairly as I can.

My first day at Harvard I was informed, by the very man who had urged me to come, that my expectations were unrealistic. For example, I could not take the course with Schwinger (Harvard’s answer to Feynman) that had lured me to Harvard, and I ought not concern myself with the foundations of quantum mechanics (the only thing that did concern me) because, very simply, I was not, could not be, good enough. Surely

my ambition was based on delusion—it referred to a pinnacle only the very few, and certainly not I, could achieve. Brandeis, I was told bluntly, was not Harvard, and although my training there might have earned me a place at Harvard, distinction at Brandeis had no meaning here. Both I and they had better assume I knew nothing. Hence I ought to start at the beginning. The students they really worried about, I was informed, were those who were so ignorant and naive that they could not apprehend the supreme difficulty of success at Harvard.

These remarks were notable for their blatant class bias and arrogance, as well as for their insistent definition of me on the basis of that bias—a gratuitous dismissal of my own account that I experienced recurrently throughout graduate school. The professor's remarks were all the more remarkable in that I had expressed exactly the same intentions in our conversation the previous spring and had then been encouraged. What could account for this extraordinary reversal? There had been no intervening assessment of my qualifications. Perhaps it can be explained simply by the fact that the earlier response was one of someone in the position of selling Harvard, while now it seemed there was an obligation to defend her. (It is ironic that universities should be associated with the feminine gender.) Nor was it coincidental, I suspect, that this man was shortly to assign to one of the senior graduate students (male, of course) the task of teaching me how to dress.¹

Thus began two years of almost unmitigated provocation, insult, and denial. Lacking any adequate framework—political or psychological—for comprehending what was happening to me, I could only respond with personal rage: I felt increasingly provoked, insulted, and denied. Where political rage would have been constructive, personal rage served only to increase my vulnerability. Having come to Harvard expecting to be petted and fussed over (as I had been before) and expecting, most of all, validation and approval, I was entirely unprepared for the treatment I received. I could neither account for nor respond appropriately to the enormous discrepancy between what I expected and what I found. I had so successfully internalized the cultural identification between male and intellect that I was totally dependent on my (male) teachers for affirmation—a dependency made treacherous by the chronic confusion of sexuality and intellect in relationships between male teachers and female students. In seeking intellectual affirmation, I sought male affirmation, and thereby became exquisitely vulnerable to the male aggression surrounding me.

I had in fact been warned about the extreme alienation of the first year as a graduate student at Harvard, but both my vanity and my naiveté permitted me to ignore these warnings. I was confident that things would be different for me. That confidence did not last long. Coming from everywhere, from students and faculty alike, were three messages. First, physics at Harvard was the most difficult enterprise in the world; second, I could not possibly understand the things I thought I understood; and third, my lack of fear was proof of my ignorance. At first, I adopted a wait-and-see attitude and agreed to take the conventional curriculum, though I privately resolved to audit Schwinger's course. Doing so, as it turned out, seemed such an act of bravado that, daily, all eyes turned on me as I entered the class and, daily, I was asked by half a dozen people with amusement if I still thought I understood. Mysteriously, my regular courses seemed manageable, even easy, and as I became increasingly nervous about my failure to fear properly, I spent more and more evenings at the movies. In time, the frequent and widespread iteration of the message that I could not understand what I thought I understood began to take its toll. As part of a general retreat, I stopped attending Schwinger's course.

¹ My attire, I should perhaps say, was respectable. It consisted mainly of skirts and sweaters, selected casually, with what might have been called a bohemian edge. I wore little or no makeup.

I had begun to lose all sense of what I did or did not understand, there and elsewhere. That I did well in my exams at the end of the semester seemed to make no difference whatever.

Meanwhile, it was clear that I was becoming the subject—or object—of a good deal of attention in the Physics Department. My seriousness, intensity, and ambition seemed to cause my elders considerable amusement, and a certain amount of curiosity as well. I was watched constantly, and occasionally addressed. Sometimes I was queried about my peculiar ambition to be a theoretical physicist—didn't I know that no woman at Harvard had ever so succeeded (at least not in becoming a *pure* theoretical physicist)? When would I too despair, fail, or go elsewhere (the equivalent of failing)? The possibility that I might succeed seemed to be a source of titillation; I was leered at by some, invited now and then to a faculty party by others. The open and unbelievably rude laughter with which I was often received at such events was only one of many indications that I was on display—for purposes I could either not perceive or not believe. My fantasy was turning into nightmare. . . .

It is sometimes hard to separate affront to oneself as a person from affront to one's sensibilities. Not only do they tend to generate the same response—one feels simply affronted—but it is also possible (as I believe was true here) that the motives for both affronts are not unrelated. I went to graduate school with a vision of theoretical physics as a vehicle for the deepest inquiry into nature—a vision perhaps best personified, in recent times, by Einstein. The use of mathematics to further one's understanding of the nature of space, time, and matter represented a pinnacle of human endeavor. I went to graduate school to learn about foundations. I was taught, instead, how to do physics. In place of wisdom, I was offered skills. Furthermore, this substitution was made with moralistic fervor. It was wrong, foolhardy, indeed foolish, to squander precious time asking why. Proper humility was to bend to the grindstone and learn techniques. Contemporary physics, under the sway of operationalism, had, it seemed, dispensed with the tradition of Einstein—almost, indeed, with Einstein himself. General relativity, the most intellectually ambitious venture of the century, seemed then (wrongly) a dead subject. Philosophical considerations of any sort in the physical sciences were at an all-time low. Instead, techniques designed to calculate *n*th-order corrections to a theory grievously flawed at its base were the order of the day. . . .

My naiveté and idealism were perfect targets. Not only did I not know my place in the scheme of things as a woman, but by a curious coincidence, I was apparently equally ingenuous concerning my place as a thinker. I needed to be humbled. Though I writhed over the banality of the assignments I was given, I did them, acknowledging that I needed in any case to learn the skills. I made frequent arithmetic errors—reflecting a tension that endures within me even today between the expansiveness of conception and the precision of execution, my personal variation perhaps of the more general polar tension in physics as a whole. When my papers were returned with the accuracy of the conception ignored and the arithmetic errors streaked with red—as if with a vengeance—I wondered whether I was studying physics or plumbing. Who has not experienced such a wrenching conflict between idealism and reality? Yet my fellow students seemed oddly untroubled. From the nature of their responses when I tried to press them for deeper understanding of the subject, I thought perhaps I had come from Mars. Why, they wondered, did I want to know? That they were evidently content with the operational success of the formulas mystified me. Even more mystifying was the absence of any appearance of the humility of demeanor that one would expect to accompany the acceptance of more limited goals. I didn't fully understand then that in addition to the techniques of physics, they were also studying the techniques of arrogance. This peculiar inversion in the meaning of humility was simply part of the process of learning how to be a physicist.

It was intrinsic to the professionalization, and what I might even call the masculinization, of an intellectual discipline.

To some extent the things I describe here are in the nature of the academic subculture. They reflect the perversion of academic style—familiar in universities everywhere—a perversion that has become more extensive as graduate schools have tended to become increasingly preoccupied with professional training. My experiences resemble those of many graduate students—male and female alike. What I experienced as a rather brutal assault on my intellectual interests and abilities was I think no accident, but rather the inevitable result of the pervasive attempt of a profession to make itself more powerful by weeding out those sensibilities, emotional and intellectual, that it considers inappropriate. Not unrelated is a similar attempt to maintain the standards and image of a discipline by discouraging the participation of women—a strategy experienced and recounted by many other women. Viewed in this way, it is perhaps not surprising that the assault would be most blatant in a subject as successful as contemporary physics, and in a school as prestigious as Harvard.

Perhaps the most curious, undoubtedly the most painful, part of my experience was the total isolation in which I found myself. In retrospect, I am certain that there must have been like-minded souls somewhere who shared at least some of my disappointments. But if there were, I did not know them. In part, I attribute this to the general atmosphere of fear that permeated the graduate student body. One did not voice misgivings because they were invariably interpreted to mean that one must not be doing well.² The primary goal was to survive, and, better yet, to *appear* to be surviving, even prospering. So few complaints were heard from anyone. Furthermore, determined not to expose the slightest shred of ignorance, few students were willing to discuss their work with any but (possibly) their closest friends. I was, clearly, a serious threat to my fellow students' conception of physics as not only a male stronghold but a male *retreat*, and so I was least likely to be sought out as a colleague. I must admit that my own arrogance and ambition did little to allay their anxieties or temper their resistances. To make matters even worse, I shared with my fellow classmates the idea that a social or sexual relationship could only exist between male and female students if the man was "better" or "smarter" than the woman—or at the very least, comparable. Since both my self-definition and my performance labeled me as a superior student, the field of sociability and companionship was considerably narrowed.

There was one quite small group of students whom I did view as like-minded and longed to be part of. They too were concerned with foundations; they too wanted to know why. One of them (the only one in my class) had in fact become a close friend during my first semester. Though he preached to me about the necessity of humility, the importance of learning through the tips of one's fingers, the virtue of precision—he also listened with some sympathy. Formerly a Harvard undergraduate, he explained to me the workings of Harvard and I explained to him how to do the problems. With his assistance, I acquired the patience to carry out the calculations. We worked together, talked together, frequently ate together. Unfortunately, as the relationship threatened to become more intimate, it also became more difficult—in ways that are all too familiar—until, finally, he decided that he could no longer afford the risk of a close association with me. Out of sympathy for his feelings, I respected his request that I steer clear of him and his friends—with the consequence that I was, thereafter, totally alone. The extent of my isolation was almost as difficult for *me* to believe as for those to whom I've attempted to describe it since. Only once, years later in a conversation with another woman physicist,

² Indeed, most people then and later assumed I had done badly—particularly after hearing my story. Any claims I made to the contrary met with disbelief.

did I find any recognition. She called it the “sea of seats”: you walk into a classroom early, and the classroom fills up, leaving a sea of empty seats around you.

Were there no other women students? There were two, who shared neither my ambition, my conception of physics, nor my interests. For these reasons, I am ashamed to say, I had no interest in them. I am even more ashamed to admit that out of my desire to be taken seriously as a physicist I was eager to avoid identification with other women students who I felt could not be taken seriously. Like most women with so-called male aspirations, I had very little sense of sisterhood.

Why did I stay? The Harvard Physics Department is not the world. Surely my tenacity appears as the least comprehensible component of my situation. At the very least, I had an extraordinary tolerance for pain. Indeed, one of my lifelong failings has been my inability to know when to give up. The very passion of my investment ruled out alternatives.

I had, however, made some effort to leave. At the very beginning, a deep sense of panic led me to ask to be taken back at Brandeis. Partly out of disbelief, partly out of the conviction that success at Harvard was an invaluable career asset, not to be abandoned, I was refused, and persuaded to continue. Although I had the vivid perception that rather than succeed I would be undone by Harvard, I submitted to the convention that others know better; I agreed to suspend judgment and to persevere through this stinging “initiation rite.” In part, then, I believed that I was undergoing some sort of trial that would terminate when I had proven myself, certainly by the time I completed my orals. I need be stoic only for one year. Unfortunately, that hope turned out to be futile. The courses were not hard, never became hard in spite of the warnings, and I generally got A’s. But so did many other students. Exams in fact were extremely easy.

When I turned in particularly good work, it was suspected, indeed sometimes assumed, that I had plagiarized it. On one such occasion, I had written a paper the thesis of which had provoked much argument and contention in the department. This I learned, by chance, several weeks after the debate was well underway. In an effort to resolve the paradox created by my results, I went to see the professor for whom I had written the paper. After an interesting discussion, which incidentally resolved the difficulty, I was asked, innocently and kindly, from what article(s) I had copied my argument.

The oral exams, which I had viewed as a forbidding milestone, proved to be a debacle. My committee chairman simply failed to appear. The result was that I was examined by an impromptu committee of experimentalists on mathematical physics. Months later, I was offered the following explanation: “Oh, Evelyn, I guess I owe you an apology. You see, I had just taken two sleeping pills and overslept.” The exam was at 2:00 P.M. Nevertheless, I passed. Finally, I could begin serious work. I chose as a thesis adviser the sanest and kindest member of the department. I knocked on his door daily for a month, only to be told to come back another time. Finally I gained admittance, to be advised that I’d better go home and learn to calculate.

My second year was even more harrowing than the first. I had few courses and a great deal of time that I could not use without guidance. I had no community of scholars. Completing the orals had not served in any way to alleviate my isolation. I was more alone than ever. The community outside the physics department, at least that part to which I had access, offered neither solace nor support. The late fifties were the peak of what might be called home-brewed psychoanalysis. I was unhappy, single, and stubbornly pursuing an obviously male discipline. What was wrong with me? In one way or another, this question was put to me at virtually every party I attended. I was becoming quite desperate with loneliness. And as I became increasingly lonely I am sure I became increasingly defensive, making it even more difficult for those who might have been sympathetic to me or my plight to approach me to commiserate. Such

support might have made a big difference. As it was, I had neither colleagues nor lovers, and not very many friends. The few friends I did have viewed my situation as totally alien. They gave sympathy out of love, though without belief. And I wept because I had no friend whose ambition I could identify with. Was there no woman who was doing, had done, what I was trying to do? I knew of none. My position was becoming increasingly untenable. . . .

I recognize that this account reads in so many ways like that of a bad marriage—the passionate intensity of the initial commitment, the fantasies on which such a commitment (in part) is based, the exclusivity of the attachment, the apparent disappearance of alternative options, the unwillingness and inability to let go, and finally, the inclination to blame oneself for all difficulties. Although I can now tell this story as a series of concrete, objective events that involved and affected me, at the time I eventually came to accept the prevalent view that what happened to me at Harvard simply manifested my own confusion, failure, neurosis—in short that *I* had somehow “made” it happen. The implications of such internalization were—as they always are—very serious.

Now I had to ask *how* I had “made” it happen—what in me required purging? It seemed that my very ambition and seriousness were at fault, and that these qualities—qualities I had always admired in others—had to be given up. Giving up physics, then, seemed to mean giving up parts of me so central to my sense of myself that a meaningful extrication was next to impossible. I stayed on at Harvard, allowing myself to be convinced once again that I must finish my degree, and sought a dissertation project outside the Physics Department.

After drifting for a year, I took advantage of an opportunity to do a thesis in molecular biology while still nominally remaining in the Physics Department. That this rather unusual course was permitted indicated at least a recognition, on the part of the then chairman, of some of the difficulties I faced in physics. Molecular biology was a field in which I could find respect, and even more important, congeniality. I completed my degree, came to New York to teach (physics!), married, bore children, and ultimately began to work in theoretical biology, where I could make use of my training and talents. This proved to be a rewarding professional area that sustained me for a number of critical years. If my work now begins to take me outside this professional sphere, into more political and philosophical concerns, this reflects the growing confidence and freedom I have felt in recent years.

Inner conflict, however, was not to disappear with a shift in scientific specialization. While it is true that I was never again to suffer the same acute—perhaps bizarre—discomfort that I did as a graduate student in physics, much of the underlying conflict was to surface in other forms as I assumed the more conventional roles of wife, mother, and teacher. The fundamental conflict—between my sense of myself as a woman and my identity as a scientist—could only be resolved by transcending all stereotypical definitions of self and success. This took a long time, a personal analysis, and the women’s movement. It meant establishing a personal identity secure enough to allow me to begin to liberate myself from everyone’s labels—including my own. The tension between “woman” and “scientist” is not now so much a source of personal struggle as a profound concern.

After many years, I have carved out a professional identity very different from the one I had originally envisioned, but one that I cherish dearly. It is, in many important ways, extraprofessional. It has led me to teach in a small liberal arts college that grants me the leeway to pursue my interests on my own terms and to combine the teaching I have come to love with those interests, and that respects me for doing so. It has meant acquiring the courage to seek both the motives and rewards for my intellectual efforts more within myself. Which is not to say that I no longer need affirmation from others;

but I find that I am now willing to seek and accept support from different sources—from friends rather than from institutions, from a community defined by common interests rather than by status.

As I finished writing this essay, I came across an issue of the annals of the *New York Academy of Sciences* (March 15, 1973) devoted to "Successful Women in the Sciences." The volume included brief autobiographical accounts of a dozen or so women, two of whom were trained in physics and one in mathematics. Because material of this kind is almost nonexistent, these first-person reports are an important contribution "to the literature." I read them avidly. More than avidly, for the remarks of these women, in their directness and honesty, represent virtually the only instance of professional circumstances with which to compare my own experience.

It may be difficult for those removed from the mores of the scientific community to understand the enormous reticence with which anyone, especially a woman, would make public his or her personal impressions and experiences, particularly if they reflect negatively on the community. To do so is not only considered unprofessional, it jeopardizes one's professional image of disinterest and objectivity. Women, who must work so hard to establish that image, are not likely to take such risks. Furthermore, our membership in this community has inculcated in us the strict habit of minimizing any differences due to our sex. I wish therefore to congratulate women in the mainstreams of science who demonstrate such courage.

Their stories, however, are very different from mine. Although a few of these women describe discrete experiences similar to some of mine, they were generally able to transcend their isolation and discomfort, and in their perseverance and success, to vindicate their sex. I am in awe of such fortitude. In their stories I am confirmed in my sense that with more inner strength I would have responded very differently to the experiences I've recorded here. The difficulty, however, with success stories is that they tend to obscure the impact of oppression, while focusing on individual strengths. It used to be said by most of the successful women that women have no complaint precisely because it has been demonstrated that with sufficient determination, anything can be accomplished. If the women's movement has achieved anything, it has taught us the folly of such a view. If I was demolished by my graduate school experiences, it was primarily because I failed to define myself as a rebel against norms in which society has heavily invested. In the late fifties, "rebel" was not a meaningful word. Conflicts and obstacles were seen to be internal. My insistence on maintaining a romantic image of myself in physics, on holding to the view that I would be rewarded and blessed for doing what others had failed to do, presupposed a sense of myself as special, and therefore left me particularly vulnerable. An awareness of the political and social realities might have saved me from persisting in a search for affirmation where it could not and would not be given. Such a political consciousness would have been a source of great strength. I hope that the political awareness generated by the women's movement can and will support young women who today attempt to challenge the dogma, still very much alive, that certain kinds of thought are the prerogative of men.