SCIENCE, ETHICS, AND GENDER

Priscilla Auchincloss
Department of Physics and Astronomy and The College
University of Rochester, Rochester, New York 14627

I. Framing the Question

My purpose in this paper is to relate the participation of women in science to issues of ethics in science, with some emphasis on physics. In most discussions of ethical issues in science, including some quite recent papers[1], explicit considerations of women and gender enter only in terms of the larger set of social ethical standards that scientists should observe, for example anti-discrimination laws and affirmative action policies. The issue of sexual harassment is usually cited. The principle of openness in science[2] might be interpreted as relating to inclusiveness regarding gender, race, and class, but no explicit connection between openness and gender is usually drawn.

To uncover how considerations of women and gender might enter into science ethics in a more central way, the first step is to define a domain in which issues of women and of gender intersect with ethics and science. By issues of women, I mean especially those social and intellectual controversies arising around efforts to bring about equal participation by women (in any area). By gender, I mean characteristics, roles, ideas, and values that historically or stereotypically have been identified with men or with women. By science, I mean a human process of creating knowledge -- a process associated on the one hand with particular professional activities and institutions, and on the other with particular values, methods, and ways of knowing. By ethics, I mean a code of moral conduct, which in science has the purpose of preserving the integrity of scientific knowledge and upholding the authority of science regarding knowledge claims.

Issues of women and science intersect in the social-political effort taking place in U.S. policy arenas in recent years to understand the low numbers of women in science and to attract and retain women in science. Insofar as it is construed as an effort to correct past wrongs -- namely, the systematic and subtle forms of exclusion of women from scientific practice -- this area intersects the domain of ethics. The question might be posed as, What is the responsibility, if any, of scientists to ensure that women are no longer excluded from the full range of scientific activity, as well as from the various types of rewards and consequences which may result from such activity?

Issues of gender and science intersect in the scholarly effort taking place in gender and women's studies to understand how scientific knowledge-making has influenced, and has been influenced by, the social status of women relative to men and beliefs about gender. Insofar as scientific methods and knowledge have been used to justify excluding women from science, not necessarily intentionally but also not arbitrarily, this area too intersects with the domain of ethics. The question here might be posed as, what is the responsibility, if any, of scientists to understand the potential for the use of science to exclude women and to try to minimize such potential?

Women/gender, science, and ethics thus intersect in the facts that (1) women historically have been excluded from professional scientific practices and (2) the methods, logic, data, and knowledge of science have been used to justify women's exclusion[3]. We think and are taught to think not only that science should be gender neutral, but that it is. This is particularly true in physics, where all signs of and references to gender are absent, as are signs of the historical and cultural "decisions" which excluded women. Yet in physics women are proportionally fewer in number than in the other disciplines of science, including mathematics. Gender-neutrality as a desirable quality of scientific methods, thinking, and knowledge has not translated into a gender-equitable or gender-inclusive scientific profession. And while it is difficult to say that individuals -- scientists -- have acted unethically in creating this situation, we may legitimately ask what circumstances and (ethical) assumptions fostered such an outcome, whether those circumstances and assumptions remain operative today, and whether they are adequate to science. The question for scientists, at the outset, is, what is their responsibility, if any, to create a situation of gender-equity and -inclusiveness in science?

II. Some Preliminary Ideas and Caveats

1. Ethical codes and practice in science depend both on social, human values and on specifically scientific or knowledge values. Social values apply because science is a social, human activity; scientists' values must support the society in which they live and work. Scientific values and methods of science serve the acquisition and dissemination of reliable knowledge of the world. The knowledge value most directly associated with science is objectivity. Objectivity as a knowledge value is based, in turn, on epistemological assumptions -- that is, assumptions about how the world is set up to be knowable and about the relationship of the knower to the world.

2. My point will be that the fact of women's participation in science accompanies and brings about a shift in values, both social values and knowledge values. Perhaps it is important to state that I am not going to claim that women affect science or science ethics because women are biologically or even socially different from men. "Gender" in this paper does not mean biological sex; it refers to characteristics that have been culturally, ideologically associated with males or females, men or women. "Gender" then also refers to culturally constructed categories, and from those to the ideologies (in particular, ideologies of power) which guide the constructing process itself. Insofar as the ways in which differences in biology or socialization have been assumed or construed to matter in the make-up and organization of the world, they have influenced science and its values. And as women's participation brings new understanding of the implications of biology (or non-implications, as in "biology is not destiny") and new forms of socialization, it also influences science and its values.

The basic point (that women's participation in science accompanies and brings about a shift in values) is applicable to all socially- and culturally-identified groups who are underrepresented in the community of science. In this paper, however, I mostly limit my statements to women, and when referring to women historically or socially, I am speaking of the mostly middle class, mostly white women, who have constituted most of

the women in professional American and European science up to the present. *Woman* is a category into which we (as mostly middle class, mostly white, mostly male scientists) tend to group persons of extremely diverse experience and ideas. Historically, just as the pronoun "he" eclipsed women by claiming to represent humanity but actually representing men of the dominant class, the word "woman" has eclipsed, to begin with, working class women and women of color. I hope to gather arguments useful against this kind of erasure.

3. Feminism, as a movement and especially as a theme of scholarly research, has made possible the change in women's social status and made sense of the issues arising through that change. I think of "feminism" as meaning pro-woman, an idea needed when women as a category have been ignored or placed in a subjugated position. Feminism is, among other things, an explicitly value-laden, political group of positions and agendas, but it is not without responsibility. Feminism has to confront society with the fact that, until very recently, women as a cultural category have been ignored, devalued, and subjugated. Feminism has to reveal the various forms of subjugation operating through laws, institutions, customs, social theories, and cultural values. And feminism has to come up with a better design for society, based on a thorough review and rethinking of gender.

Historically, science has been a tool in the subjugation of women, if also a tool in their progressive liberation; therefore science does not escape feminist scrutiny. Feminism thus leads to a review and rethinking, not only of gender, but also of science. Feminist studies of science and epistemology range from criticism of traditional ideas to the construction of new conceptual frameworks, values, and methods. In this paper, the intended direction is constructive. That is, one of my objectives is to introduce to the physics community some feminist work that examines the ethical questions that arise and the scientific values that are served when we "add" women to the community of scientists.

4. This paper represents only a first attempt on my part to draw together gender, ethics, and science. From a background in high energy physics, science policy, and most recently issues of women and science, I have gathered an acquaintance with physics, politics, and feminist studies of science. In this paper I have drawn on the scholarship of others, but not necessarily in ways they intended or would approve.

A particular concern is the possibility of collapsing the domain of individual moral responsibility -- ethics -- into the domain of community responsibility, that is, the domain of policy, law, or politics. For instance, is it really the responsibility of each individual scientist to promote, or not discourage, the participation of women, in the same sense that it is it the responsibility of each individual scientist not to falsify data? While noting the risk in blurring a useful philosophical boundary (distinguishing individual from group responsibility), I want to point out that the answer to this question depends on where one assumes gender-equity and gender-inclusiveness fall in relation to the other boundary mentioned earlier, that between the "human" and "scientific" values that scientists are asked to respect. The usual assumption, I think, is that even if scientists, as citizens or as humans, might be morally obligated to encourage women, they would not be obligated to do so as scientists. In fact, one could argue that as scientists they might violate another science value, the ideal of an intellectual-merit-based reward system, by

encouraging women. This idea could be stated that society, or the leaders of society, have a responsibility to encourage women, but science, and scientists, do not.

Appealing to the scientist as a citizen or human being is not necessarily a weak form of moral obligation. After all, an experiment that objectively resolves a scientific question but results in anguish or death to other human beings violates the most basic ethical standards. But feminist scholarship offers another path (which I will describe at greater length in the next section), in which human and scientific responsibility come closer together. As stated above, the conduct of scientists is "coded" to support social values (such as humane-ness) and scientific values and methods (such as honesty, carefulness, openness). Scientific values and methods support the acquisition of reliable knowledge of the world; they also support assumptions about how the world is set up to be knowable. If we understand the participation of women in science to be valuable to science as a way of knowing (as well as to society), the conduct of scientists, as citizens and as scientists, should reflect this value. Thus, because it is knowledge values that scientists consider themselves obligated to respect in their activities as scientists, a key objective of this paper is to show how the participation of women in science is to be considered an important knowledge value.

III. What Is the Responsibility of the Scientists Regarding Women's Participation in Science?

Thus far, the ethical issue in science pertaining to women/gender has been posed as follows: How could or should members of the science community respond to the understanding that, as a professional community, they have unfairly excluded women? And how could or should they respond to the understanding that science has been used to justify women's social subjugation, including exclusion from professional science? A partial answer to this question has also been sketched, that scientists need to understand women's participation in science as being important, even critical, to science as a way of knowing. But first it is reasonable to look at how the science community has responded to society's call to bring into balance the numbers of men and women in science.

1. Perhaps the first type of response is to conduct scientific research into biologically-based differences between men and women that would explain the underrepresentation of women in science. At present, the fact that statistically men score slightly but significantly higher in tasks requiring visual-spatial ability is often cited as meaning that men naturally show higher aptitude for math and science than women. There are, of course, a lot of problems with this as an "explanation," and these are problems that afflict much of the research in this area. For instance, do the numbers match -- does the degree of implied difference in men's and women's brains correspond to the disparity in their representation in math and science fields? Is skill in visual-spatial tasks innate or acquired by exposure to certain experiences? Then there is the problem of "overinterpretation"; that is, does possessing higher visual-spatial ability actually mean that a person will be better at math and science? And if so, is this because as a community, scientists in a sense tailored science so that persons skilled in this area would succeed?

As a response to the issues of women in science, this approach tends to set aside (if not ignore) the historical exclusion of women from science and risks furthering the use of science in rationalizing, "naturalizing", and justifying women's past and continued absence from professional science. As a response by scientists, this approach carries the message that science is, indeed, free of cultural ideology and gender bias and that no special attention is warranted even though the research directly seeks to measure differences between males and females. It is conceivable, however, that research methods which account for gender bias could be devised, and in fact efforts in this direction have begun in some fields, such as psychology.

2. The next type of response has been to change certain ways of doing business, but leave the core activities (and values) of science alone. In this approach, the responsibility is on persons in charge of setting or implementing policy to ensure that the door is open, that standards for entering and undertaking science careers are the same for men and women, and that they enjoy the same opportunities and treatment. For example, university deans and department chairs may institute efforts to recruit women, according to the institution's interpretation of affirmative action. They may establish policies to ensure that the learning or work environment is not hostile (no sexual harassment) or "chilly" (no subtle forms of stereotyping behavior that cumulatively discourage women from continuing). Some departments may initiate or take part in special programs to encourage women to enter or stay in science, such as pre-college summer science programs, undergraduate research internships, and mentoring programs. Beyond this, a few chairs and faculty members may consciously try to foster the productivity and success of women, by, for instance, not overburdening a junior woman faculty member with committee assignments.

As a response to issues of women in science, this approach recognizes women's past exclusion as impinging on a current social or human value, the principle of equal opportunity, but not affecting science in a central way. Programs are aimed specifically at women, and the effort is to disturb as little as possible the work of scientists, including teaching and especially research. While providing equal opportunity for women becomes an added (ethical) responsibility -- to be carried by scientists, but only those acting in an administrative capacity -- scientific values and methods are unaffected, and consequently the vast majority of practicing scientists also is unaffected, by design.

3. The third and fourth types of response in this progression are more in the realm of what scientists could do than the realm of what they have done. The third level of response is to examine the history, modern sociology, and cultural traditions of science in relation to the participation and status of women. To respond at this level, one has to move across the boundaries that enclose (some might say insulate) science into fields that look critically at science, namely social studies of science and gender studies of science. In making such a move one becomes prepared to question the norms and values of the science world, a somewhat problematic position if one wishes or intends to continue to be an accepted member of the science community. Nonetheless, this level of response, if it eventually can be made by enough members of the science community, represents a kind of professional self-inquiry that can begin to uncover the force of gender ideology in science and hence lead to positive change as far as women's participation is concerned.

Alternatively, if policy-makers in the world of science can translate the findings of those who study the science world into policies, programs, professional or educational practices, curricula, and so forth, this also can lead to positive change.

Is science "gender-neutral"? Londa Schiebinger's historical studies of women and gender in the science of the 17th, 18th, and 19th centuries, for instance, reveal the gender bias of what was considered to be legitimate, objective (in other words "good") science. Her analysis shows how the exclusion of women foreclosed the possibility of challenging scientific assumptions and claims about sex and gender difference and thus maintained the subordinate status of women until well into the 20th century[4].

Is success in science truly based on merit? Is the (informal) conduct expected of people in order to judge them "good scientists" biased such that it is easier for men to be and do them than for women? Beamtimes and Lifetimes, by Sharon Traweek, is an anthropologist's study of the culture of high energy physicists and investigates the messages transmitted to physics students "between the lines" of textbooks, the unspoken rules governing the approval and progress of graduate students and post-docs, and the gendered content of those messages and rules[5]. Deborah Tannen's You Just Donít Understand is a popularized version of her extensive study of how men and women display, through ordinary conversation, quite distinct language modes (competition versus agreement) and primary concerns (status versus connection). Pointing out the problems that arise when men judge what is being said by a woman according to men's primary concerns (and vice versa), Tannen indicates subtle difficulties that are likely to arise for women working in fields where men and men's language-culture prevail[6]. And Judith McIlwee and Greg Robinson devote a chapter of their study, Women in Engineering: Gender, Power, and Workplace Culture, to how the culture of engineers reinforces, through informal behavior and language, allegiance to the values of engineering and to the hierarchical structures of their workplace communities[7].

This approach involves cultivating the ability to look critically at science, particularly at gender as a variable, and translating any understanding gained into either one's personal judgments and actions or into policies and programs influencing the practices of one's community. As a response to issues of women in science, it recognizes that achieving equal opportunity for women in science requires re-evaluation of professional standards and practices, including informal standards and practices, though it leaves science as a way of knowing unaffected.

4. The last type or level of response to be considered here is to examine science as a way of knowing and the values and assumptions which form part of that way of knowing.

In this approach, one is looking not at science as a cultural institution and women's inclusion/exclusion in relation to that institution; rather one is looking at the principles which underlie scientific knowledge-making and how considerations of gender (or more broadly, human difference) figure among those principles. As stated above, ethical conduct in science upholds specifically scientific values and methods (what I have called knowledge values, as distinguished from human values); these knowledge values and methods support the acquisition of reliable knowledge of the world, and they also support assumptions about how the world is set up to be knowable. In science the highest

value is placed on obtaining "objective" information, and principles of conduct in science aim to secure such information and preserve its integrity. Almost all principles and values (ethical and otherwise) in science relate to objectivity: quantification, precision of measurement, faithfulness to experimental findings (or to "nature") in reporting, and so forth. Scientists are expected to use carefully designed instruments and methods in both the gathering and analyzing of objective information. In examining science as a way of knowing, one is asking, What is objectivity? What is the assumed "set up" of things in the world such that objective knowledge is possible? This is where gender and women's studies of science have been perhaps most constructive, revealing how the notion of objectivity needs to be developed (or transformed, depending on the writer) when women are included in the community of scientists and when that community seeks to respect the values of gender equity and inclusiveness.

Scientists traditionally think of objectivity as a quality of an individual mind (possibly aided by instruments), affecting the cognitive acts of observation (or measurement) and reason (or analysis and interpretation)[8]. In Aristotle's theory of what we would call sex or gender difference, for instance, both the physical and social characteristics of men, including their rationality, were explained by the prevalence in the male of hot and dry humors; females lacked sufficient heat to be rational creatures[9]. This fundamental assumption persisted in various forms until the 18th century, when the emerging science of anatomy laid the foundation for a theory of sex and gender difference based on comparative measurements of male and female bodies -- skull size and weight, for example. However, even the unexpected discovery that on average the woman's skull was larger than the man's in proportion to the overall size of the skeleton did not alter assumptions about the relative rational capacity of men and women; rather the larger skull was interpreted as linking the woman's proportions to those of the child and thus revealing her intrinsic immaturity relative to the man. The woman's skeleton was typically shown with an exaggerated pelvis, to emphasize her special role as child-bearer, and a small skull[10].

As modern science began to crystallize as a profession, rationality (and hence the capacity to be objective) meant "thinking like a man", to quote Evelyn Fox Keller speaking in reference to the writings of Francis Bacon[11]. Lorraine Code, in an exploration of feminist epistemology, What Can She Know?, draws attention to the underlying notion of the "knower" in philosophy since Descartes; the knower (which we may also read as the "scientist") is an autonomous, self-sufficient being, with authority to speak in the public domain[12]. Such "meta-analysis" is revealing of both the gender and the class of the knower, given the absence of legal autonomy in the lives of almost all women in the 16th through 19th centuries, the necessary role of caregiver filled largely by women, and the work of intellectuals resting on the labor of comparatively unprivileged persons. So we begin to see that the ground of this evolving Western philosophical tradition is a conception of the world (whether composed of "humors" or of "objects") as knowable to men's minds, but not to women's.

Physicists of today might say that neither "individual" nor "mind" is the issue in objectivity; rather, they might argue, objectivity consists in removing acts of individual judgment as much as possible from the processes of observation and analysis and instead

using instruments, measurements, and mathematical formulas to ask questions of nature and decipher the answers. Nonetheless, the underlying belief is that an individual observer, whether human or human-designed, is responsible for the degree to which an observation is reliable and accurate, and that individual rationality is responsible for the degree to which an observation is reliably and accurately interpreted. The sense of objectivity as an individual act or quality also shows up in the common translation of idea that "science is gender-neutral" as meaning that facts and knowledge obtained by scientific means are independent of the sex of the knower. We moderns believe, with Poullain de la Barre, that "the mind has no sex"[13], that men and women are equally capable of rationality.

But feminist studies have showed convincingly that our society, like almost every other, is organized along lines that separate and distinguish male from female, masculine from feminine. That is, though minds may have no sex, "society" sees sex in everything and labels everything with gender. The social use of sex and gender distinctions has been inextricably entwined with issues of dominance and subjugation. That science reflected and reinforced social inequity is not surprising; science is a human activity and, in some form, follows the cultural values of its society (though science also, sometimes, may shape cultural values). In this sense, science has been no more "gender-neutral" than society has been gender-equitable.

Helen Longino, a feminist philosopher of science, has argued that science is best understood as fundamentally social in character and that objectivity is intrinsically a social, interactive, accomplishment, not a quality of individual cognition[14]. Longino goes beyond the idea that scientists and science are influenced by social context to locate the most basic cognitive acts involved in objectivity, observation and reason, in a context of human interaction. To put her ideas into (perhaps overly) simple terms, it takes more than one person to validate any observation, and reasoning (analysis and interpretation) also must be replicated and subject to criticism by others. The social character of science is evident in the practice of peer review, formal channels for reporting results, efforts by other scientists to repeat experiments, and so forth.

Longino further stresses that objectivity is achieved to the extent that a community meets four criteria, as follows: "there are recognized avenues for criticism of evidence, of methods, and of assumptions and reasoning; the community as a whole responds to such criticism; there exist shared standards that critics can invoke; and intellectual authority is shared equally among qualified practitioners" (my italics)15 . The last criterion is most pertinent to the discussion of gender and ethical issues in science. As Longino says,

> The long standing devaluation of women's voices and those of racial minorities meant that [gender-biased and racially-biased] assumptions have been protected from critical scrutiny. Thus a community must not only treat its acknowledged members as equally capable of providing persuasive and decisive reasons and must not only be open to multiple points of view; it must also take active steps to ensure that alternative points of view are developed enough to be sources of criticism. That is, not only must potentially dissenting voices not be discounted, they must be cultivated.16

The greater the diversity of qualified, equally participating, mutually critical practitioners, the greater the degree of objectivity. It is the capacity of a community to examine evidence, reasoning, and assumptions from different perspectives, each admittedly partial but each able to challenge and critique others, that results in the making of better -- more objective -- knowledge. Longino concludes, "this criterion enables us to condemn the exclusion of women and racial minorities from the practice of science as an epistemological shortcoming and as a political injustice."[17] In the terms I have used in this paper, gender difference, like other culturally constructed human differences, is thus found to count as a knowledge value, and the cultivation of diverse perspectives becomes part of the ethical responsibility of scientists as scientists, not only as human beings.

In an essay entitled "Situated Knowledges"[18] Donna Haraway adds a number of important ideas to this redefining of objectivity. Haraway believes that science, and scientists, must abandon objectivity in the traditional sense as it promotes pretensions to absolute knowledge and, with those pretentions, a fantasy of a disembodied position above human responsibility. No single, all-encompassing, "objective" perspective exists; what is possible, according to Haraway, is a collection of positions of partial perspective, each position an observational mechanism embodied in a human being, organism, or device. By acknowledging their (and their devices') positions (with position taken both literally and metaphorically) and partial viewpoints, and acknowledging the legitimacy, indeed the value and necessity, of others' positions and partial viewpoints, scientists give up a kind of misguided "innocence." For example, it is no longer possible to believe that instruments produce complete, authoritative, "objective" evidence or that instruments remove the (ethical) responsibility of the persons who design and use them, in terms of the knowledge derived or any social or ecological side-effects of those instruments. Like Longino, Haraway thus finds ethics and epistemology grounded together in what she calls "responsible positioning"; that is, human moral responsibility is grounded in our (scientific) assumptions about how the world is organized, and how we can know it. To genuinely assume an ethical position in science which values different culturally-defined positions and seeks to end subjugation of any group of persons, we have to conceive the world -- the possibilities of what we can know about the world -- in a new way. To begin, we have to recognize the limits of what an individual, or a single culturally defined position, can "see" and the interdependency of multiple, partial perspectives.

IV. Consequences and Conclusions

By examining and critiquing the underlying epistemological assumptions in science, gender and women's studies are redefining the social and knowledge values which ethical conduct in science is intended to support. As a consequence, gender and women's studies challenge several traditional notions relevant to ethical issues in physics.

1. First, we have to acknowledge that physics is not value-neutral with respect to women and gender. Women have been excluded from physics, perhaps more than from other

science disciplines, by means of norms within science culture that reflect the long-standing assumption that women were not rational and that feminine characteristics did not belong in science. Excluding women from science was part of a self-reinforcing set of assumptions in which characteristics believed to be essentially masculine were seen as more valuable (in general and to science in particular) than characteristics believed to be essentially feminine. Scientific evidence and reasoning gave authority to these beliefs, which went unchallenged because of the absence of significant numbers of women among professional scientists.

2. Second, we can't accept the idea that "physics is ethical by nature." The exclusion of women from physics can be considered an example of the fact that physics, like science generally, is not intrinsically ethical. Rather, science in a community that does not cultivate diverse and critical voices may end up following the social-political agendas of the dominant social group, at least for a considerable period of time.

3. Third, we have to question whether physics should be thought of as the model for all science. Physical science may be unique in studying phenomena that legitimately can be located outside of, separate from, and different from, the observer or observing apparatus. Physics typically studies non-human, non-living, discrete, and persistent or repeating phenomena. There may be ethical concerns about treating human or other living organisms "as if" they were the "subjects" of physical science.

To conclude, I invite you to entertain three interrelated statements relevant to the responsibility of scientists regarding the participation of women in science.

1. Women -- the increased presence and participation of women in social domains previously reserved to men -- are potentially, if not actually, transforming the world. The presence and participation of women have a paradigm-shifting effect -- not because women are essentially different from men, or even because women are socialized differently, but because this represents -- and perhaps causes -- a profound shift in social and scientific values and thinking.

2. Having women present and active in the domain of knowledge-production is valuable both to society and to science. It is a social value as it reflects the sense of social fairness and justice and as it improves conditions of life for women. It is also a knowledge value as it enhances the quality of scientific objectivity and as it bears on the expansion of human understanding. This, in turn, is important to society. As the conduct of scientists is coded to reflect both social values and knowledge values, there is a basis to expect scientists to regard as their personal responsibility the building of a community capable of a higher degree of objectivity than at present.

3. A shift in paradigm potentially allows us to "see" things that we couldn't see before. This is extremely valuable in science. New understanding comes about sometimes because of the involvement of persons who are "outsiders" to the entrenched science community and who therefore come with a different perspective. New understanding also comes about because the process of including formerly excluded persons requires the community to alter its value system. Characteristics formerly devalued are seen as valuable, and "difference" itself becomes valued. The new perspective may add new

knowledge in the light of which existing knowledge may have to be retheorized or reinterpreted.

Lest we think that this is all a utopian dream, it should be noted that women and revised ideas about gender already have had a transforming impact in primatology and some areas of anthropology. Not surprisingly, these are fields in which sex/gender distinctions have traditionally come under scrutiny; yet the transformations in these fields did not begin until women not only became involved in significant numbers but also articulated their findings in support of a new paradigm[19]. In physics, women enter a "world without women"[20], though now perhaps not so much literally as ideologically. Sex/gender distinctions are believed not to exist in the phenomena studied in physics. The possibility that beliefs about gender are embedded in the "facts" or laws of physics is explored only by feminist scholars, a few of whom were formerly active in physics. Women currently active in physics do not have the background, time, motivation, autonomy regarding choice of problem, or network of community support to investigate such ideas[21]. Although this situation appears to preclude the possibility of a feminist-engendered transformation in physics in the near-term (if ever), it also implies that the discovery of gender beliefs in physics could have profound effects on science and society.

Notes:

1. For example, see the National Academy of Sciences, On Being A Scientist: Responsible Conduct in Research, National Academy Press, Washington, DC (1995). See also Resnick, David, "Philosophical Foundations of Scientific Ethics", in Ethical Issues in Physics: Workshop Proceedings, Eastern Michigan University, July, 1993; Marshall Thomsen, ed.

2. Resnick, David, "Philosophical Foundations of Scientific Ethics", in Ethical Issues in Physics: Workshop Proceedings, Eastern Michigan University, July, 1993; Marshall Thomsen, ed.

3. Schiebinger, Londa, The Mind Has No Sex? Women in the Origins of Modern Science. Cambridge: Harvard University Press, 1989.

4. Schiebinger, Londa, The Mind Has No Sex? Women in the Origins of Modern Science. Cambridge: Harvard University Press, 1989. Also, by Schiebinger, Nature's Body: The Making of Gender in Modern Science. Boston: Beacon Press, 1993.

5. Traweek, Sharon, Beamtimes and Lifetimes: The World of High Energy Physicists. Cambridge: Harvard University Press, 1988.

6. Tannen, Deborah, You Just Don't Understand: Women and Men in Conversation. New York: Morrow, 1990.

7. McIlwee, Judith and Robinson, J. Gregg, Women in Engineering: Gender, Power, and Workplace Culture. Albany: State Univ. of New York Press, 1992.

8. The analysis of objectivity into observational and reasoning aspects follows Helen Longino's work, referenced below.

9. Schiebinger, Londa, The Mind Has No Sex? Women in the Origins of Modern Science. Cambridge: Harvard University Press, 1989. For Aristotle's and other historical theories of sex/gender difference, see specifically Chapter 6, Competing Cosmologies: Locating Sex and Gender in the Natural Order.

10. Ibid., Chapter 6 and Chapter 7, More than Skin Deep: The Scientific Search for Sexual Difference.

11. This quote comes from Science and Gender: Evelyn Fox Keller a video from the Bill Moyers series of interviews, A World of Ideas, produced by Public Affairs Television, 1994. Available through Films for the Humanities, Inc., Box 2053, Princeton, NJ 08543. Keller refers here to her collection of essays, Reflections on Gender and Science, which includes a discussion of Francis Bacon's concept of science as a masculine philosophy. Schiebinger, in The Mind Has No Sex?, Chapter 5, Battles over Scholarly Style, takes a

slightly different view of Bacon's use of the term masculine in this context; Schiebinger believes Bacon meant by masculine not male, but (in Schiebinger's terms) active, virile, and generative. Feminine, however, was a term of derogation. Both Keller and Schiebinger would agree with the interpretation that the outcome of these semantic arguments was the exclusion of so-called feminine qualities (as well as women) from science.

12. Code, Lorraine, What Can She Know? Feminist Theory and the Construction of Knowledge.

13. "Líesprit nía point de sexe", wrote Poullain de la Barre in 1673. Quoted in Schiebinger, The Mind Has No Sex?, cited above, p.1.

14. Longino, Helen, Science as Social Knowledge: Values and Objectivity in Scientific Inquiry. Princeton: Princeton University Press, 1990. Chapter 4, Values and Objectivity.

15. Longino, Helen, Essential Tensions -- Phase II: Feminist, Philosophical, and Social Studies of Science. Chapter 12 in A Mind of One's Own: Feminist Essays on Reason and Objectivity, edited by Louise Antony and Charlotte Witt. p. 266.

16. Ibid., p. 268.

17. Ibid., p. 269.

18. Haraway, Donna, Simians, Cyborgs, and Women: The Reinvention of Nature. New York: Routledge, 1991. Chapter 9, Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective.

19. Schiebinger, Londa, Nature's Body: Gender in the Making of Modern Science. Boston: Beacon Press, 1993; p. 113-4. Schiebinger refers to Donna Haraway, Primate Visions: Gender, Race, and Nature in the World of Modern Science. New York: Routledge, 1989.

20. The phrase comes from Noble, David F., A World Without Women: The Christian Clerical Culture of Western Science. Alfred A. Knopf, 1992.

21. This idea, that women are rarely able to engage in both scientific and feminist research, has been discussed both Evelyn Fox Keller, in Secrets of Life, Secrets of Death, New York: Routledge, 1992 (in Gender and Science: An Update) and Ruth Hubbard, in The Politics of Women's Biology, New Brunswick: Rutgers University Press, 1990 (in Introduction: Science and Science Criticism).