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WOMEN IN PHYSICS: WHERE ARE WE NOW? WHERE DO WE GO FROM HERE?

Dr. Patricia Cladis received her PhD in physics in the field of superconductivity from the University of Rochester in 1968, six months after the birth of her twin sons. In 1969, she started post-doctoral work at the University of Paris-South (Orsay), France, doing research in liquid crystals with the Orsay Liquid Crystal Group. Dr. Cladis has been the author or co-author of more than 100 papers. Her current research interest is pattern formation in nonlinear, nonequilibrium, dissipative systems. Most recently, she and her coauthors discovered a fascinating breathing mode when a nonequilibrium driving force perturbs a system from its equilibrium structure. In 1972, Dr. Cladis was one of the first women hired to do physics research at AT&T Bell Laboratories, at least in the physics division. She remained the only woman Member Technical Staff in that division until approximately 1976. During her more than 20 years of physics research, she has seen incremental but positive changes in the status of women in physics, but much remains to be done.

"I must have been one of the first women to benefit from the founding of the APS Committee on the Status of Women in Physics by Vera Kistiakowsky and others. I came to Bell Labs in 1972 because my mother sent me (I was in France at the time) a copy of *Physics Today,* where it was reported what a panel discussion on Women in Physics at an APS meeting had to say about the status of women in physics. I was very encouraged, so I looked for a job in the U.S. There was a dip in the U.S. job market at the time (1971-1972). I was told that all the "Green's Function Experts" were walking the streets. But, in France, I had discovered *escape into the third dimension.* You can read about it in a recent edition of Landau and Lifshitz. *And,* I got a job at Bell Labs.

When you are a woman in physics, you tend to get very philosophical because people keep asking you "What's the matter with *you* that *you* are in physics?" or "What's the matter with *women* that they are *not* in physics?" So, I wrote things down to clarify my thoughts as I was ill-equipped to in terms of my education. I didn't know philosophy because I had only studied physics and mathematics. I didn't know much sociology—geography, even, until I actually went to physics conferences in some of these places. And now, here I was, expected to provide answers to *really* big questions, such as, "What is the meaning of life?" So, I wrote a couple of essays.

One of them is called, "Women in Science: How High the Moon," illustrated by Gary Larson's very first cartoon. The title is in reference to a nursery rhyme that I think everyone in the English-speaking world knows. The nursery rhyme is "Hey diddle diddle, the cat and the fiddle, the cow jumped over the moon..." In Gary Larson's cartoon, you see a cow that has tried to pole-vault—unsuccessfully—over a very high bar and is being throttled by the bar. In the corner, there's a little cat with a fiddle saying,"We still have another year of hard work before us before we can start on the moon." I thought it was a good illustration of the status of women in science. We have another year of hard work before us before we can start on the moon. But then, you know, that's not too bad. The cow has tried to vault more than her length. Even hanging by her head from the bar, her tail is still *far* from the ground.

My talk, "Women in Science: How High the Moon," was basically stimulated by friends at Bell Labs and many of my colleagues in physics. There was a women's support group in 1987, 1988. I was trying to understand why there are so few women in physics. People were saying, "You know the problem with women—they don't do mathematics. They don't know any math." All right. But I don't think it's true. Women can do math if they want to. But, perhaps, women can learn more from men than mathematics. The way I posed the problem is the essay was, "What can women learn from men, other than mathematics, that will help us gain recognition in a man's world?" I came up with 10 things I thought we could learn from men other than mathematics:

- Survival: *the inalienable right to life;*
- War: *We mutually pledge to each other our lives;*
- The naming of things: *consciousness;*
- Patterns of play: *carried into the workplace;*
- "They had the truth, and chose to fight for it": *David and Goliath;*
- Assertiveness: *You teach what you accept;*
- Law: *Injustices can be institutionalized by making them legal;*
- Sociology: *Thought style is a social product;*
- Dreams: *strategic intent!*
- Sagacity: *the specific genius of the explorer...Tragedy is not our business either.*

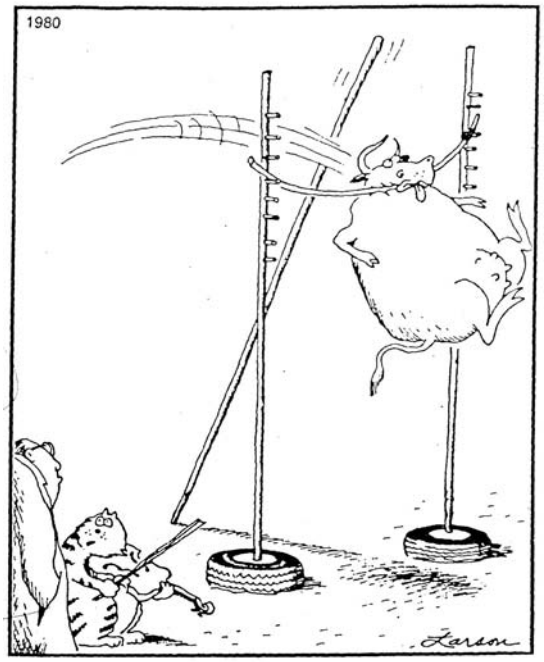
Obviously, I can only touch on one or two of the topics here but am happy to send a preprint to anyone interested. I am sure that you can all add to this list. As you can see, these are topics outside the traditional domain of physics and math. *But,* being a physicist interested in "complex, nonlinear, dissipative systems," I didn't let that stop me from tackling the problem.

"What can we women learn from men, other than mathematics, that will help us gain recognition in a man's world?"

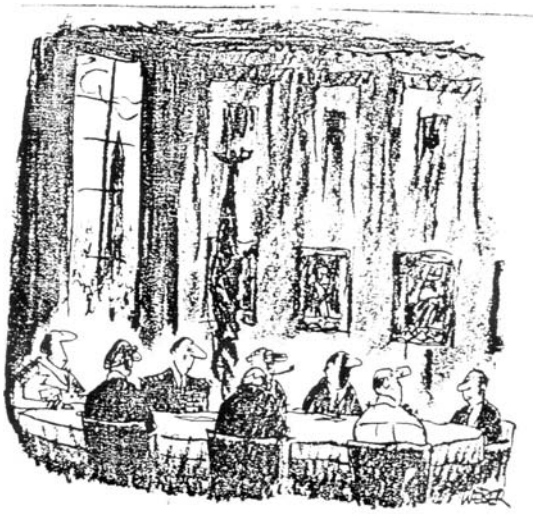
To me, physics is a way of thinking. It is not one thought. It is a powerful way of thinking because it creates new knowledge. Like art and love, it's a universal language. A truth in physics is the same around the world, on the moon, in heaven and hell, that bootstraps us onto the next truth. A question that has been raised is, "Yes, but are there male

(Continued on Page 8)

CSWP Gazette **12.** 8 (1992).



„Wir haben noch einige Jahre harte Arbeit vor uns, bevor wir zum Mond starten können."



"In my plan, the atomic bomb is used only for emphasis."
New Yorker 1988

Gary Larson**,** *Tut mir leid, Sie haben Kühe***,**
Goldmann Verlag, Munich (1991)

Cladis/Where Are We Now?

(Continued from Page 5)
physicists and female physicists?" This is a very good question. I think the answer, in physics at least, is "no," but the traditional socialization of women is different than the traditional socialization of men. It's an historical feature of humanity, not a particular culture. In any culture, there are differences between male and female socialization. In "broad brush" terms, historical "feminine" socialization is: "Look to men—existing power groups appointed by *canon* law—for answers to problems. Don't trust yourself. Do not, for one minute, believe you can solve the problem or, more importantly (certainly in physics), DEFINE the problem. In return, men will tell you how to think of yourself. Depending on the correlation between male expectations and your performance, you will be rated on their 'good girl spectrum'."

This is not an anti-male diatribe. I love men, individually and generally. I'm just trying to explain in a few words what I see as historical "feminine" socialization because, historically, a culture based on this kind of "religious thinking" has been the kiss of death for any creative endeavor. Original thinking is essential for expanding the knowledge base of physics. It's a creative field. But to think creatively, you have to believe in yourself, that it's okay for you to do physics, that you don't have a problem doing physics. *You* are not the problem. So, what is the problem? Well, I think, as many members do, that it's social expectations. And I am really encouraged. Society is changing. There have been significant changes in U.S. society since 1972.

Just before I left Bell Labs to come to this meeting, Lou Lanzerotti handed me an NRC Report: "More Women in Science: A Goal for the 1990s." This is Millie's [Dresselhaus] committee where she says,"We're looking at strategies at all levels, long term and short term. Our goal is to have impact into the next decade and beyond." Well, the interesting thing that struck me about this report was that it wasn't about giving money to people to study what is wrong with women. You know: "What is wrong with women that they aren't in physics?" The feature that struck me about this report was the change in emphasis from programs geared to providing women with survival skills for living in hostile territory towards ones to effect long-lasting social changes from hostile to friendly for *all* people. Society *is* changing now. As society changes, the roles of women and men will change and adapt. In a sense, it's a tremendous opportunity for every woman and every man to influence how changes will happen; an opportunity to define oneself without taking away the right of other people to "feel good about themselves."

I'd like to give you a small sample of my

1987 philosophical tome on women in science ("Women in Science: How High the Moon"), where I discussed some of the things that I thought we women can learn from men other than mathematics. The first thing I thought we could learn about is survival. This is crucial to the existence of any society. Yet in many of our cities, we don't have survival. Some inner city children have to risk their lives to go to school. Nobody thinks that's OK. We may not know yet what to do about it, but nobody in the U.S. thinks that's OK, and we will keep on trying to find solutions to this and other problems. Survival, the inalienable right to life. We all want it, and most of us take it for granted. It's written into our constitution. But, what happens when your survival is threatened or your values are compromised? Historically, society's response to that has been war. And in war—this is again taken from the Declaration of Independence—we mutually pledge to each other our lives. A strong bonding takes place among people at war that is very striking. In a small way, I've experienced that with colleagues in research. We had a collaborative effort going and we ran into other people, other physicists, who disagreed. They turned out to be provably wrong, of course, but there was a *fierce* fight. *We* were on one side and *they* were on the other and ...WOW! I can attest to the fact that one forms strong bonds with people you have gone to the wars with, even intellectual wars.

Historically, when men are in a situation where they cannot get their point across by reasoning, that's it. They get on with it, get armed, kill the guys threatening them. I was discussing this with a statesman of science, a very distinguished Bell Labbie who's since moved away from Bell Labs but knows a lot about statesmanship. I posed the problem the following way: "Here's this group of women. They want one thing, and here's this group of men saying, 'No way!' How do you get your point across? Maybe the solution is for women to have the atomic bomb. You know we wouldn't *use* it or anything like that. We love our husbands, sons, fathers, friends, etc. We love men. We couldn't *use* the bomb on you. It is only there to lend credibility to our argument." The statesman of science was appalled, naturally enough. He said to me: "No! No! That's not the way to go. You do not want the atomic bomb. What you should do is read this book *Weapons and Hope* by Freeman Dyson." I very much recommend the book to you. It's about war. It's a series of interesting essays about the philosophies of men to war, the reactions of people to war and other things. Basically, Dyson is a proponent of disarmament. No bombs at all. But Dyson is a *reasonable* person. Sometimes there may not be a "reasonable" way to protect your values *and* survive.

What else can I discuss in this short time from the long list I thought women can learn from men—other than mathematics. Maybe patterns of play. There was a sociologist, Harry Harlow, who came to Bell Labs and gave a talk about how he had induced depression in nine baby monkeys. The way he did it was to take the baby monkey away from the mother monkey at a very early stage and keep the baby separated from its mother by a glass partition. The baby could see its mother, but not get to her. This was amazing! One of the first big colloquia I attended at Bell Labs. Harlow then pointed out, "The *baby* monkey was depressed, but the *mother* monkey was not. What does *that* say about the speciousness of mother love compared to the love of a child for its mother?" Then all nine depressed monkeys—they were, indeed, all male monkeys—were turned over to nine psychiatrist monkeys, who were all female. Gradually, the psychiatrist monkeys got the depressed monkeys out of their depression. However, girl monkeys play entirely differently from boy monkeys. Boy monkeys go out, fight, define turf and don't just sit around giggling and primping their hair like girl monkeys watching all that fun." The recently cured boy monkeys were now playing like girl monkeys! Next, Harlow introduced this whole group of 18 monkeys into a larger group of monkeys. At first the boy monkeys continued to play like girl monkeys. But gradually, they noticed the other boy monkeys and started to play like them—"like the men they *really* were," he said.

People have studied human children at play. Carole Gilligan has written a book describing patterns of human boys' play and human girls' play. It has been observed that in boys' play, there is a lot of conflict, a lot of shouting back and forth, but eventually the conflict is resolved and play is resumed, even by the boys who felt badly dealt with in the conflict. In contrast, when conflict occurs in girls' play, girls are observed to separate and withdraw. They don't stand there and fight, resolve the issue and get on with it.

Yesterday [at the APS meeting] it was very interesting. In one of the sessions, someone was saying, "Here it is" very proud of his talk. And another guy shouted out from the back of the room, "That's wrong!" Just like that. Just an attack. Not terribly scientific, I thought, but very "macho." I think I (and probably many other physicists, both male and female) would have been too surprised to react immediately. But a classic male reaction (a male colleague seated next to me told me) would be to counterattack like "You're full of it" or something like that. You know, "punch the guy in the nose," at least figuratively. But society is changing. There may be a better way.

"Here's this group of women. They want one thing, and here's this group of men saying, 'No way.' How do you get your point across? Maybe the solution is for women to have the atomic bomb."

In short, what I have learned these past 20 years is that women can do physics if they want to. **You** can do physics if you want to. But *believe* in yourself. There is nothing wrong with you. You are all right! Physics is an exhilarating way of thinking. Nobody can take that power away from you. I think it's worth fighting for." □