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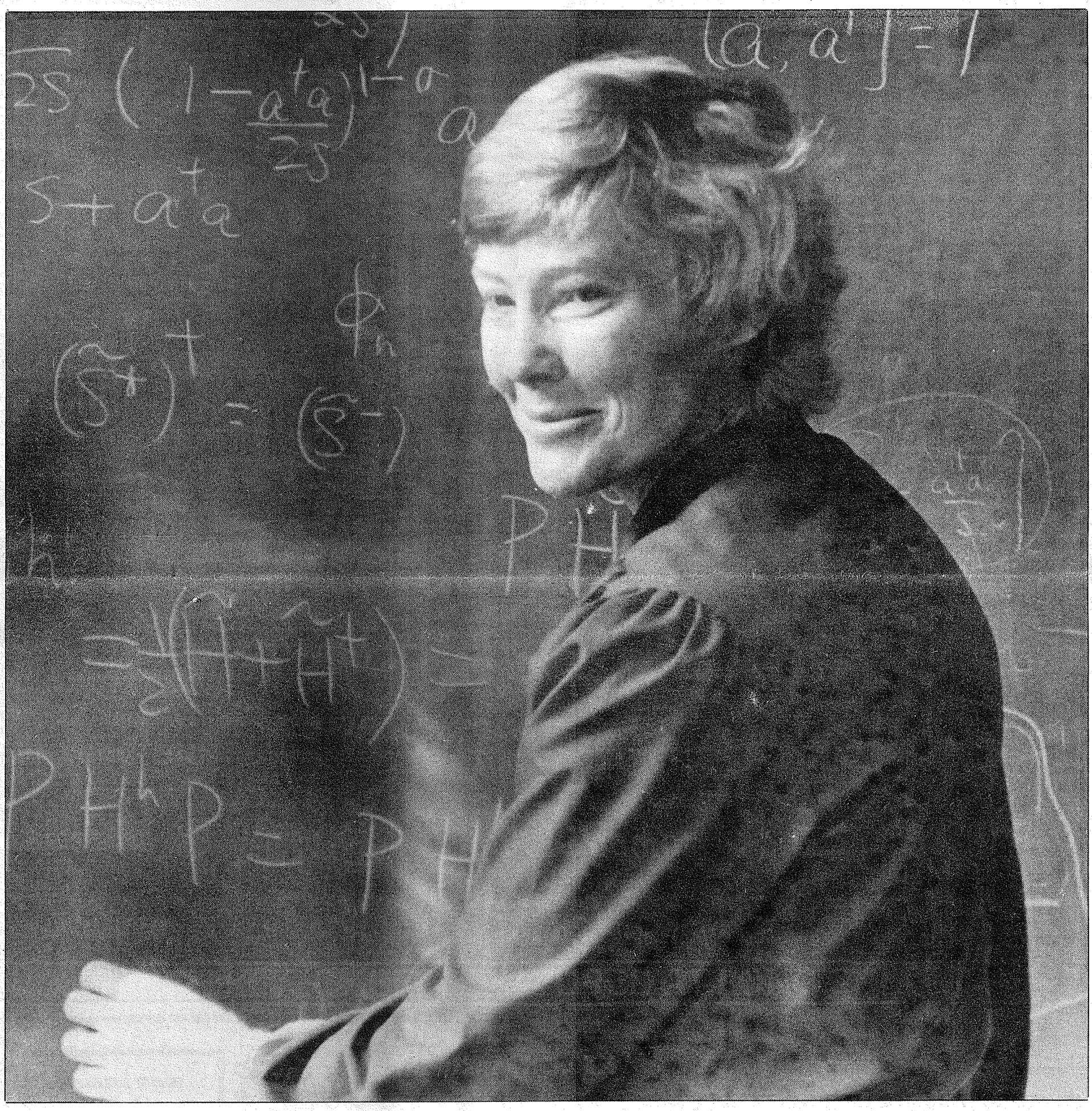

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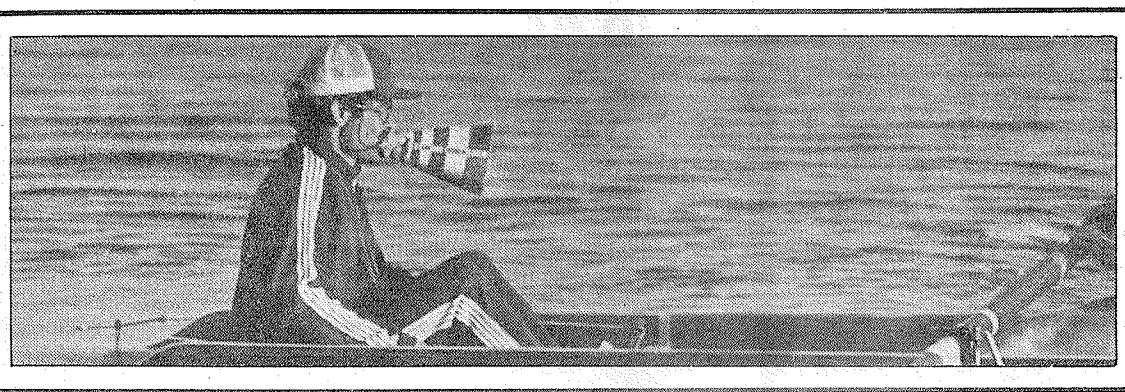


Stroking toward Olympics...p. 25

Hunting secrets of quarks and gluons

BY MARION SOFTKY

Her field is non-Abelian gauge field theory; it is one of the most difficult subjects known to man—or woman.

Theoretical physicist Helen Quinn of Portola Valley is one of a worldwide elite who try to understand what goes on inside of the insides of the atomic nucleus. With daunting equations, she and a handful of others try to figure out what the protons and neutrons which make up the nucleus are themselves made of.

"What are the building blocks from which everything is made, and how are they put together?" explains Dr. Quinn in her unassuming office at the Stanford Linear Accelerator Center (SLAC) just up the hall from the director. "We are trying to understand the nature of matter on the smallest possible scale."

Dr. Quinn is one of nine permanent members of the SLAC theory group. These are the people who try to make mathematical sense of the results churned out by the giant accelerators like SLAC that penetrate ever deeper into the heart of the nucleus.

"We are trying to formulate a theory of what goes on," she says. Like philosophy, it's part of the ancient and never-ending quest for understanding: "That's the name of the game—to understand."

The incisive Dr. Quinn also lives a varied life outside of physics. She and her husband, Dan, and their two children are active members of the Portola Valley community. She serves on the trails committee at Portola Valley Ranch, coaches the math team at Corte Madera School, and jogs every morning.

All of the awesome technology at SLAC ultimately produces data to feed into the human brain. Dr. Quinn's tools are primarily pencil and paper although her office chalk board is covered with inscrutable equations and she admits occasionally tapping into a computer.

"On a day-to-day basis, it's not that grandiose," she says. "As we put data together, we gradually build up an insight. Sometimes it's sudden; that's what's so fascinating.

"I'm happy if I can add a little to make the picture better understood," she adds.

Dr. Quinn operates in the obscure mathematical terrain called field theories. The particular mathematical framework that comes closest to describing the phenomena which have been observed is a non-Abelian gauge theory. More precisely, she explains, "These are theories that physicists recently found to have large numbers of properties that match what we see."

The problem physicists face is really like a backwards jigsaw puzzle, she explains. Instead of being given the pieces and trying to fit them together, you start with the completed puzzle and have to figure out both what the pieces are and what the rules are for putting them together. "The gauge theory is the theory of how these things fit together and the forces that bind them," she adds.

The complexity of these rules is hinted at by the whimsical vocabulary the physicists themselves have coined for their discoveries. Quarks, now thought to be the basic constituents of protons and neutrons, head the list. They derive their name from the phrase, "Three quarks for Muster Mark" in James Joyce's "Ulysses," and SLAC physicist Burt Richter won a Nobel Prize for discovering the fourth, or "charm" quark.

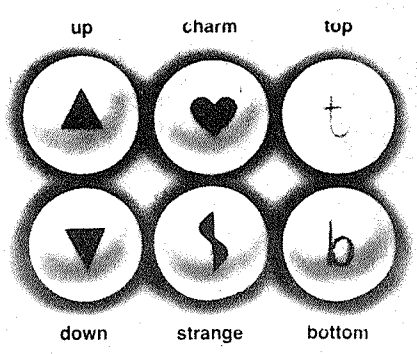
Quarks have properties designated by such terms as "strange," "up" and "down," "charm" and "color." Another family of particles called "gluons" is responsible for "gluing" quarks into combinations that might, for example, constitute a proton.

The words are misleading, Dr. Quinn warns. "The theory is clear not because of the words but because of the mathematical structures behind the words."

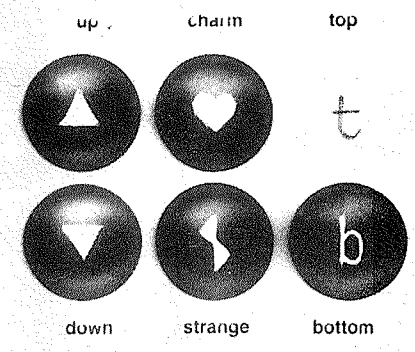
"Objects that don't exist tell us as much as those that do," she adds. For example you might theoretically have two or four quarks, but it turns out they only come in groups of three, six or nine. "They have different kinds of symmetries," she says.

When SLAC's new "linear collider" (SLC) being excavated now starts operating, the theoretical group will help interpret the results and suggest still further experiments. Operating at higher energy than the present PEP ring, SLC will produce the newly discovered "Z" particles that are part of the "weak" interaction governing radioactive decay. "These need more detailed studies," she says.

"Then there are more speculative things—particles that people talk about that haven't been discovered," Dr. Quinn concludes. Then she adds, "History has shown us that the most interesting thing is what we haven't thought of yet."



QUARKS



ANTIQUARKS

From the Stanford Magazine

FROM AUSTRALIA TO SLAC

How does an Australian girl raised in Melbourne achieve the rarefied ranks of theoretical particle physicists? Brains, luck and work all appeared to play a part.

By the end of high school, Helen knew she wanted to pursue science and math. After two years at the university heading toward meterology, her father, a design engineer, transferred with his family temporarily to his company's head office in Belmont.

The temporary became permanent. Dr. Quinn's parents still live in San Francisco. One brother, Richard Arnold, lives in Woodside. Her other two brothers live in Fremont and Zaire.

The problem physicists face is like a backwards jigsaw puzzle. You start with the completed puzzle and figure out what the pieces are.

Arriving in the Bay Area after two years of college, Helen looked in a book for a new college to attend. She went to Stanford "mostly by luck. Stanford was more flexible in offering credit."

She went straight through Stanford, getting her PhD in 1967 with James Bjorken, formerly of Woodside, as her thesis adviser. During this period she also married Dan Quinn, then a graduate student in experimental physics.

When they got their degrees, both Quinns spent two years at the big German physics center in Hamburg. Then Dan got a teaching position at Tufts University in Boston, and for the first time Helen was unemployed.

At that time she discovered she didn't like teaching and wanted to do research. So she borrowed Nobel Prizewinner Sheldon Glashow's office at Harvard and started work.

Dr. Quinn didn't stay unemployed for long. After six months working unpaid, she was offered a postdoctoral fellowship. She worked up to associate professor, and the only women on the Harvard physics faculty. "Once I had been there a while, they knew me. That makes easier sometimes," she comments.

Both children were born during Dr. Quinn's years at Harvard where she was the first faculty member to take maternity leave. Beth, now in eighth grade at Corte Madera School, and James, a fourth grader at Ormondale, spent their first six months in a basket on the floor of her office. "I used to take James to seminars and nurse him in the back of the room to keep him quiet," she recalls. "I was usually the only woman in the room."

When Dan Quinn tired of teaching physics and moved to SRI to take up a new field, decision analysis, Helen came along with two small children, a fellowship, and a leave of absence with partial pay from Harvard. Here she also volunteered to spend her year doing research at SLAC. Again her temporary position soon became permanent. "In both cases I didn't apply through regular channels," she says. "I just said, 'Here I am.' I was also known to people."

WOMEN IN PHYSICS

Are there problems being a woman in physics?

"Physics is a field where people are judged by performance," she replies. "It's a harsh and competitive career. If you produce results, people don't care whether you're a woman or what you look like."

Dr. Quinn is concerned at the subtle and not so subtle signals that deter girls from pursuing technical careers. Both at home and at school parents, teachers, counselors and peers expect different things from girls and boys. It's the boys that generally get pushed into courses heavy in math and science.

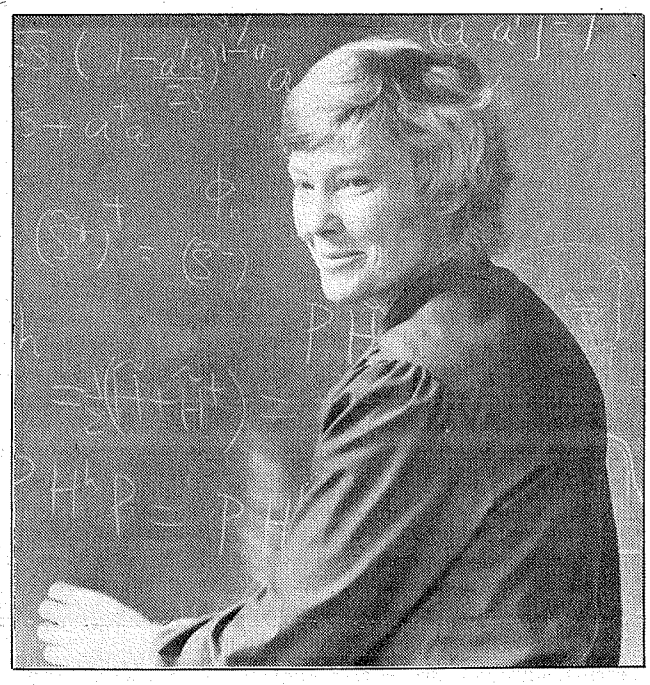
"It's not that they discourage girls. It's that they don't encourage them," she says. "I believe and hope that is changing."

Dr. Quinn herself is helping change some of these perceptions. Before school on odd-numbered mornings she is coaching students at Corte Madera School to participate in the national Mathcounts contest sponsored by the Society of Professional Engineers. After months of math enrichment the team was chosen: two seventh graders and two eighth graders; two boys and two girls.

The key to a technical career for girls or boys is a good math background in high school, Dr. Quinn says. "If you want a science career afterwards, keep up the math in high school and don't be afraid of it."

How does she keep all the elements in her life together?

It takes energy and organization, she says, and "my time for hobbies and activities is not very great. Even so, she finds time for backpacking and riding and doing things with the children. She helped landscape their Portola Valley home; and for three years she and her husband coached the soccer team; and last year she worked hard representing Portola Valley on the high school curriculum committee.



HELEN QUINN, theoretical physicist at SLAC, takes time out of a busy schedule of work, motherhood and community service to tell how she keeps it all together. Photo by Marion Softky.

She doesn't work "quite full time so I can feel comfortable leaving at 4 p.m. if the kids need me," she says. "I feel it's important they have some choices of activities after school. They shouldn't be deprived of richness because you can't get them there."

Further, her kind of research can be done just as well at home. "If a kid is sick, I can stay home and do research. Often my husband does the same thing."

Still, "you have to have energy to keep going all day," she admits. "You have to balance priorities. You have to be able to switch off, even if the house is a mess.. I have a mind that focuses on what I am doing right now. I turn off everything else.

"I keep everything together by keeping it all separate."

SLAC an engineering landmark

The Stanford Linear Accelerator Center (SLAC) is now officially a National Engineering landmark.

The honor was conferred by the American Society of Mechanical Engineers and the Institute of Electrical and Electronic Engineers at a ceremony Feb. 29.

SLAC is a national laboratory for subatomic research, funded by the U.S. Department of Energy. It has an international reputation for its work in discovering new subatomic particles and structures and in studying the forces which hold these building blocks together.

This is the first recognition of the inventive work of its engineers in building the immense, yet precise, machines needed in this work.

The two-mile-long linear accelerator, which produces an intense beam of energetic electrons, is the largest of its kind. It consists of nearly a quarter of a million precision pieces that were machined under exacting conditions and then assembled to be straight within a small fraction of an inch over the two miles.