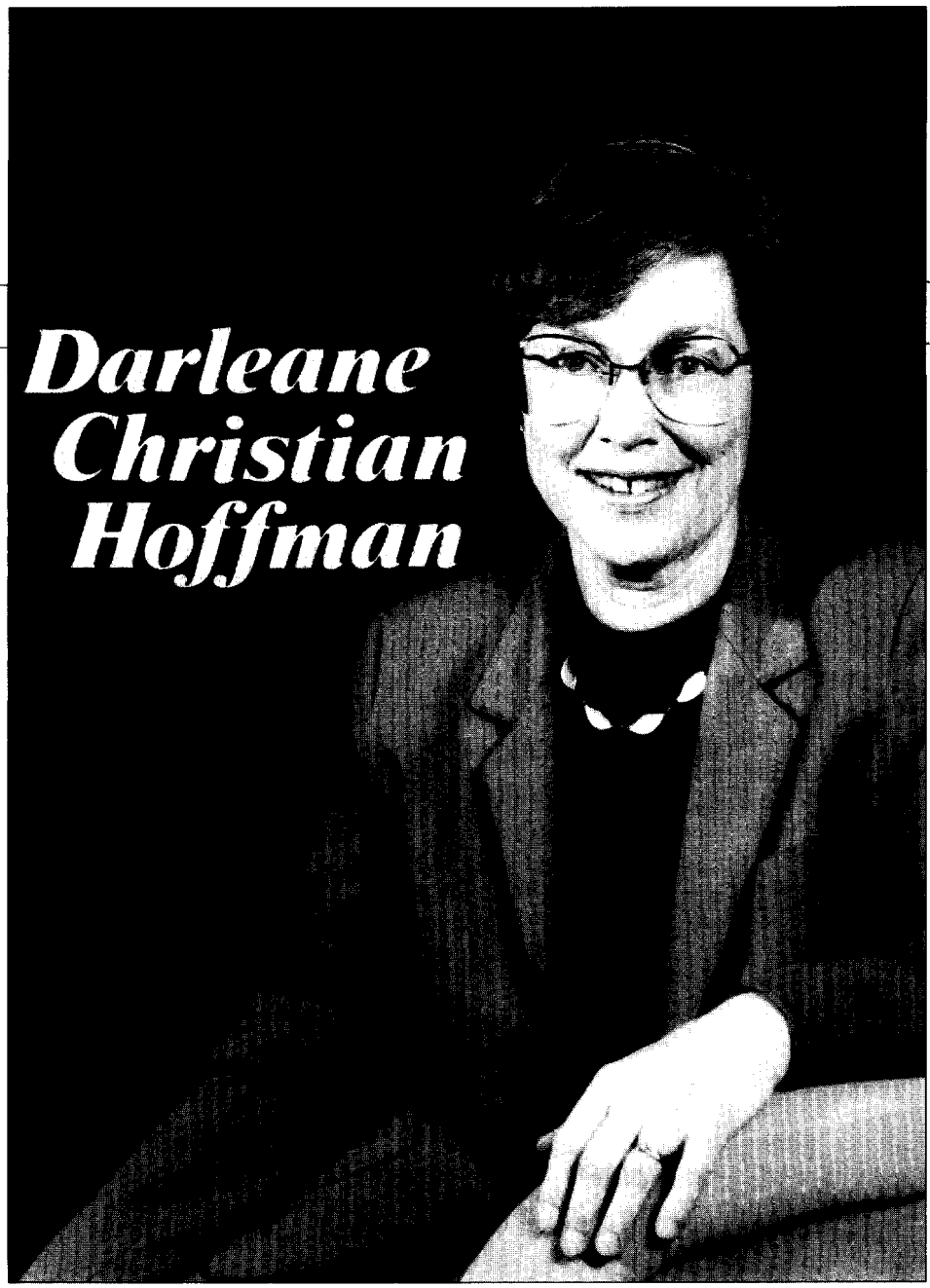

Darleane Hoffman has been Division Leader of Isotope and Nuclear Chemistry at Los Alamos since her return from a Guggenheim Fellowship at Lawrence Berkeley Laboratory in 1979. Despite more than twelve years in management and generous service in community, state, and international organizations, she remains preeminently a scientist. At Los Alamos since 1953, her research includes rapid separation of short-lived fission products, separation chemistry of lanthanide and actinide elements, nuclear spectroscopy, transuranium element research, studies of the fission process, the search for heavy elements in nature, and studies of radionuclide migration in geologic media.

She has testified before Congress on the problems of nuclear waste isolation, has helped arbitrate international claims to the discovery of elements, is chairperson of the Committee on Nuclear and Radiochemistry of the National Research Council, and is coordinating the program of the 1984 Pacific Basin Chemical Conference of the American Chemical Society.*

She is the 1983 recipient of the American Chemical Society Award for Nuclear Chemistry.

Do what you think is night and what you want to do.

The Iowa State freshman listened to her art adviser's vigorous protests regarding a change in major. What could she do with chemistry? Didn't she know it would be a lonely field for a woman? What about her talent in art? The student was Darleane Christian, and she could feel herself becoming more determined with each and every protest.

"It all happened that spring of '45 because of Professor Nellie Naylor's beginning chemistry class. 1 had lots of math in high school (it was my favorite subject) and some physics. but no chemistry. When 1 decided to study applied art, the university still required me to have one year of chemistry. It turned out that I liked Dr. Naylor's class best of everything I was taking, and I attribute that to her teaching skills. After two quarters of chemistry with her, there was no longer any doubt in my mind."

Darleane majored in physical chemistry and even dared, in her junior year, to apply for a research assistant's job at the Institute of Atomic Research at Iowa State. "I started working right away in nuclear and radiochemistry with young Professor Don Martin, with whom I later did my graduate study. My very first task was to construct Geiger counters. The tricky part was splitting mica into very thin yet airtight pieces for the windows."

Three years after her Bachelor's degree, Darleane acquired her Ph.D. and married Marvin Hoffman. She then worked a year at Oak Ridge while her husband completed his Ph.D. in physics at Iowa State. The underlying principle she followed for this and the rest of the professional career is

The National Research Council, the principal operating agency of the National Academy of Sciences and the National Academy of Engineering, serves both government and educational organizations.

expressed in the advice she later gave her children: "I don't care what other people are doing. What I do care about is what you do—and that you think about what you do—and that you do what you think is right and what you want to do."

Certainly there was one thing Darleane didn't want to do in her career. "I determined when I decided to go into chemistry that I wasn't going to allow myself to become the stereotyped woman scientist of that day. At the university I saw spinsters who had essentially given up everything to pursue their professions. After all, if men could marry, have families, enjoy other things, I saw no reason why women couldn't, too. And that doesn't mean I didn't work hard, because in those days graduate students worked days, nights, and weekends. But I always took time for the things I enjoyed, things like tennis and music. As for marriage, both partners have to agree on what they are doing. If a woman is going to have a career and a family and so forth, she has to have a very supportive husband, or she might as well forget the whole thing. "

. . . *her scientific intelligence . . . her dedication*

An unexpected result of Mike, the first thermonuclear test at Eniwetak in the summer of '52, was the discovery of new elements. It may have been one of the few times in Darleane Hoffman's life when her determination failed to overcome obstacles. "Marvin was hired and in Los Alamos by October '52. I terminated at Oak Ridge and joined him in December. For a while I couldn't even locate the job allegedly available to me. Once I found the job, the security office couldn't find my clearance, which had been stashed in New York. For three frustrating months I sat and waited while others were discovering einsteinium and fermium in the test debris."

Also discovered in the Mike debris was plutonium-244. Searching the earth's crust for postulated residual plutonium-244 was to become one of Darleane Hoffman's most serious and best known efforts. "Because even the most sensitive mass spectrometric measurements require $\approx 10^7$ atoms ($\approx 4 \times 10^{-15}$ g) of plutonium for positive detection, it is necessary to process very large samples of ores which are highly enriched in plutonium" *[Nature* 234: 132 (1971)]. After two years of laborious work, Darleane and her co-workers found the 244 isotope in plutonium isolated from 260 kg of Precambrian bastnasite.

Francine Lawrence of the nuclear and radiochemistry group worked with Darleane on that project and remembers many others. "For thirty years I've been privileged to watch a gifted, hard-working scientist in action. Darleane's work on decay schemes for some of the rare earths, on heavy ion investigations, on the discovery of plutonium-244 in nature are all indications of her scientific intelligence and of long hours of effort. Many times she worked through the night and well past dawn. She earned the recognition that has come to her. and science has benefited from her dedication."

In the 1960s both Livermore and Los Alamos had success making heavy element isotopes in nuclear tests. "But we never found anything beyond fermium-257, even though predictions based on its 100-day half-life indicated that fermium-258 and -259 should also be detectable. However, we were able to isolate the fermium-257 from the debris, and it provided us material for study of the fission properties of fermium. We discovered something we hadn't known, namely that spontaneous fission could occur by fission into two nearly equal parts. In this isotope both symmetric and the more usual asymmetric fissioning were occurring—we had come upon a new mode of spontaneous fissioning."

Next, scientists at Livermore and Berkeley discovered a different piece of the puzzle. "They produced fermium-258 at the Savannah River reactor and measured its half-life at 380 microseconds instead of the predicted 45 days. So a disaster in the half-life for spontaneous fission occurs right there at fermium-258."

Los Alamos and Livermore later combined their expertise in a project that in 1976 produced fermium-259 at the Los Alamos Van de Graaff. Jeremy Wilhelmy, who is now a Fellow at Los Alamos, took part in the effort. "The project was very much headed by Darleane in a coordinating role. Not only did she negotiate and coerce whatever was needed, her enthusiasm was very contagious. The eventual success of the project was probably largely due to her warm concern for everyone and to the mechanical genius of Josef Weber, our post doc from Munich. (Josef was also extremely hard working and couldn't believe people went home from the Lab at 5 or 6 p.m.)

"We decided it might just be feasible to produce fermium-259 via the (t, p) reaction on fermium-257. We obtained from the Transplutonium Production Program at Oak Ridge the largest amount of fermium available ($\approx 10^9$ atoms) and formed a liaison with Ken Hulet's Livermore group, which provided us the talents of Ron Lougheed to prepare the target as well as a collection wheel and a microprocessor system. All in all we had ten days of beam-on-target time at extremely high average currents of 10 to 15 microamps of 16-MeV tritons. A grand total of 497 events were recorded, but they showed us a spectacular symmetric fission distribution and that a new regime was with us—one that didn't tit the systematic of less heavy elements."

Perils of a woman scientist!

Of necessity Darleane Hoffman worked in a man's world. "In the early days of the Laboratory, the number of women holding Ph.D. degrees could be counted on the fingers of one hand, and I was very conscious of the need to do my best so that other women would be accepted. If a woman

wants to be treated equally, especially in the work place, then she has to do certain things she may think are men's work. I feel fairly strongly about that. You can't expect to be treated as an equal one minute and then demand special consideration the next."

Colleagues like Charles I. Browne remember that Darleane insisted on doing her share, whatever the work. "I wonder if she's forgotten the time we used the CPC (card programmed calculator) computer? We were just beginning to use multichannel analyzers and were overwhelmed with data. In the evenings we would all head north over the 'bridge of sighs' (the overpass across Trinity) to the theoretical building. There we took turns feeding batches of IBM cards carefully into the machine and then just as carefully retrieving them. The input hopper was about four feet above the floor, and Darleane is not exactly what one would call tall. I can still see her stubbornly climbing up on a chair to put those cards in that hopper when she felt it was her turn. "

George Cowan, long her division leader, recalls trips to Nevada. "We treated her with a special consideration which nowadays would probably be regarded as chauvinistic. But although she was accustomed to the admiration of men, she obviously wanted to be accepted as one of the boys. She worked twenty-four hour days whenever the testing program required them.

"Darleane and I shared a fondness for potato pancakes. I will never forget the night at a favorite Las Vegas restaurant when she set what must be the all-time record for potato pancakes demolished at one sitting. It was awe-inspiring; she must have trained by skipping meals for days."

You can stretch yourself too thin.

"I did not take the job of division leader reluctantly," Darleane Hoffman says, "but I'm glad I didn't become a manager at an early age, I really am. And I feel sorry for some of the men who have to make that career decision so early. After all, we are trained as scientists, we have a profession. On the other hand, I think it's important for scientists to become managers, because most scientists don't want to be managed by someone they feel is scientifically incompetent, someone who tries to solve scientific problems by edict."

Darleane has no complaints of discrimination in her current position. "To most of the people in my division, I'm just a colleague." She also feels lucky to have her children already grown. "The current demands of a management job are not compatible with raising a family—or with doing research, for that matter. The idea of a five-year rotation of management jobs from group leader up is not without merit. When I am not traveling, I spend all day on the care and feeding of the division, sometimes until 8 p.m. Then at night and on the weekend I try to do my research. Science has become my avocation.

"When I had children at home, I was much more careful of my time. I always had help and someone to start the evening meal. I didn't travel nearly so much as now, and my evenings were spent with the children. " She encourages young women to seek education for careers that will be "more than just a job" and that will also enable them to afford help as needed. "Women should organize their careers thoughtfully. For example, I've always been glad I chose to work at the Laboratory rather than at a university. I think discrimination against women in universities has been severe. "

Although Darleane enjoys many aspects of her present responsibility and especially the opportunity to help develop the potential of her division and of the Laboratory, she nevertheless finds the multiple layers of today's management burdensome both to her and to her people. "When a proposal goes somewhere these days, the group leader looks at it, I look at it, a program manager looks at it, and people from various of the associate directors' offices look at it. I'm not sure all that processing helps in the end—not that much. Now, I think policy-level decisions do need to be made and are crucially important: 'Are we going to work in this field, in that field, or in some other?' But once you've set the stage and hired good people, then you ought to let them do it."

Doing science.

Doing science to Darleane Hoffman can mean either basic or applied research, as long as the work is excellent. "In applied research projects you bring all your intelligence, all your knowledge, all the experimental data to bear on solving a problem—and that's stimulating. On the other hand, in basic research you are discovering fundamental truths of nature—which is very exciting.

"To my mind, one of my division's most important projects in the applied area has been nuclear waste isolation, because I happen to believe very strongly that we have to have nuclear power and that we will one day want retrievable storage. We began in 1977 with only a $30,000 part in the Nevada Nuclear Waste Storage Investigations. (It wasn't called that then; the name keeps changing.) When we got into it, it was still being regarded simply as an engineering problem. All you had to do was decide how big the shaft had to be and how big the tunnels had to be and how close you could place the spent fuel. There was not much thought being given to the possible breaching of the repository, possible leakage, or how the radioactivity that was released might interact with the geochemical environment. I feel our principal contribution has been to look at the interaction of the various nuclides in spent fuel or other nuclear waste with the geochemical environment and to try to devise ways for ascertaining what will happen to them under various conditions. We have methods for finding which elements will sorb under which conditions, which ones won't, and what forms they might be in,

Darleane Hoffman at the 88-inch cyclotron at Lawrence Berkeley Laboratory. With her is co-worker Diana Lee of Professor Seaborg's group. The wheel is the "MG" [merry-go-round] system, an "economy model" for measuring properties of short-lived spontaneously fissioning isotopes.

from minute details to gross calculations.* It's a problem we can solve and are solving, and I want to see us continue to do it—in an orderly fashion. We are beginning to amass the information to make people comfortable about storage. I'm a lot more optimistic about the common sense of the general public than many people are."

Darleane Hoffman vigorously supports, and takes part in, the fundamental research done by her division. Much of this work involves international funding and international cooperation. "One of the benefits I've greatly enjoyed throughout my career is the opportunity to meet and sometimes to work with scientists from many countries, The year Marvin and I spent in Norway in 1964-65 meant a great deal to me professionally and personally. Since then I've been able to visit and work with scientists from many countries."

Darleane cites as an example a collaborative effort of last March. She and others from Los Alamos. along with members of Glenn Seaborg's group at Lawrence Berkeley and a Swiss colleague, all traveled to the GSI [Gesellschaft fur Schwerionenforschung] accelerator at Darmstadt. There they joined a host of Germans under Gunter Herrmann, director of the Institute for Nuclear Chemistry at the University of Mainz. "Although the major portion of the effort was to try to produce superheavy elements via compound nucleus reactions (the complete fusion of projectile and target), we also measured yields of actinides produced in calcium-40 and -48 bombardments of curium-248. We provided our expertise in actinide separations and rare heavy-element target isotopes from the U.S. Transplutonium Production Program. The Germans helped fund our stay. In fact, Professor Herrmann's Institute has regularly supported several of our people there for three-month intervals. "

Whether fulfilling her role as a scientist or her role as an administrator, Darleane Hoffman says she tries always to remember advice given by I. I. Rabi at a Los Alamos colloquium: "YOU need to know what is important to do. Otherwise you can work your whole life away on unimportant experiments. It's not a matter of knowledge or competence so much as the recognition of the important things to do."

Those who work with and for Darleane Hoffman reveal her special qualities in the anecdotes they tell.

"She's so dedicated she once ran a guard gate to get to an experiment. . ."

"She'll do whatever needs doing. I've seen her shoveling snow from the sidewalk. ."

"Unlucky people are said to be snakebit. Well, one night last summer Darleane daintily) skipped right pasta rattlesnake coiled at her doorstep—that's the kind of luck she has. . . ."

But she is characterized most fully in the simple words Kurt Wolfsberg spoke when he introduced her at the award ceremony of the American Chemical Society: "Darleane is a friend, a colleague—and last and least—my boss." ■

'See "Migration of Radioisotopes in the Earth's Crust " in this issue.

☆U.S. GOVERNMENT PRINTING OFFICE: 1983 — 676-111/33

Errata for the 40th anniversary issue (Number 7):

Since we are now labeling successive issues by sequential numbers, “Volume 4“ should be deleted from the banner on page 1.

We apologize for the misspelling of “Bettmann” in the photo caption on page 41 and for the omission of credit, to Frederick H. Rick of the Laboratory’s Public Affairs Office, for the photo on page 55.

The “unidentified guide” in the photo on page 48 has now been recognized as Livermore test director Phil Randolph.

The photograph on page 115 is not that of the Cockcroft-Walton accelerator requisitioned during the war from the University of Illinois but of one developed at the Laboratory about ten years later.

In the discussion on page 121, column 2, about measuring the cross section for fusion of tritium and deuterium, the roles of target and projectile were interchanged; tritium ions, not deuterons, were used to bombard a target of deuterated, not tritiated, water. The measurements were performed in 1945 rather than 1944, and the cross section for fusion of tritium and deuterium was found to be greater than that for fusion of deuterium and deuterium by as much as a factor of 100 rather than a factor of 10.

On page 161 the Mark 7 and the Mark 8 were misidentified; captions (b) and (c) should be interchanged, In caption (d) on the same page, the Mark 17 is incorrectly described as the first deliverable thermonuclear weapon; that distinction belongs instead to the Mark 14.