IN MEMORIAM

CÉCILE DEWITT-MORETTE

Professor Emerita Cécile DeWitt, née Morette, died on May 8, 2017. She had been on The University of Texas at Austin faculty since 1972.

Cécile Morette was born in Paris, France, on December 21, 1922. Her parents were André Pierre Ernest Morette and Marie-Louise Claire Ravaudet.

During most of World War II, Cécile's family lived in Caen, west of Paris, near the Normandy coast. She attended local schools, then the University of Caen, planning for a career as a surgeon. She completed her undergraduate *Licence des Sciences* at the University of Caen in 1943. Since there was no functioning graduate university near Caen, Cécile went to study physics at the University of Paris. She returned weekly to visit her family in Caen. On June 6, 1944, Cécile was in Paris to take her final exam in physics. That day was the beginning of the D-Day invasion in Normandy, and there was heavy Allied bombing in Caen. Cécile's mother, grandmother, and a sister were killed in the bombing.

Cécile received her *Doctorat d'État* in Paris, in 1947, on meson production in nuclear collisions, under the supervision of Louis De Broglie. The destruction France suffered during the war left few employment options for Cécile, so she took a position with Frederic Joliot-Curie, who encouraged her to move to Walter Heitler's group in Dublin, while remaining in communication with Joliot-Curie. In 1948, she took a position at the Niels Bohr Institute in Copenhagen. While there, she received an offer from Robert Oppenheimer for a postdoctoral position at the Institute for Advanced Study in Princeton, which she accepted. There, she met a young American, Bryce Seligman DeWitt, who had been a U.S. Naval Aviator during WWII and was returning to his

studies. Not long after, Bryce asked Cécile to marry him. She initially said "no," since she wanted to return to France and assumed that Bryce wouldn't. But after sleeping on it (i.e., literally the next day), she reversed her decision and accepted. She reported that her reversal was prompted by the idea of creating an advanced summer school to support Physics in France, which she could do without moving to a permanent position there. Bryce and Cécile were married on April 26, 1951. Thus began a fifty-plus-year marriage of equals, which produced four daughters and ended only with Bryce's death on September 23, 2004. During her time at Princeton, Cécile became aware of the path integral approach to quantization due to Feynman, a subject to which she returned repeatedly during her career.

Pursuing what ultimately made her reputation, Cécile proceeded to establish a summer school in physics. This school would be residential, and sessions would last for significant periods of time. It would be in an isolated but beautiful location, and its lecturers would be outstanding, well-known scientists who would present not just a lecture, but entire courses, on current significant topics.

How could Cécile accomplish this? She was a recent Ph.D., with little reputation, and a woman; so, she turned her gender to her advantage. She visited the *Direction Générale de l'Enseignement Supérieur* (Ministry of Education) to find support for the school. All the other women in the building were secretaries or assistants. When she entered Ministry offices, officials assumed Cécile too was a secretary, so, she could walk into the offices of power, unimpeded, to present her idea.

Remarkably, or perhaps not, she succeeded in creating *L'Ecole de Physiques des Houches*. The two-month-long first session of the school met in summer of 1951. The subject was quantum mechanics and quantum field theory. Thirty-five students attended (there had been over 120

applications). There was a very distinguished group of lecturers: Léon van Hove, Walter Kohn, Rez Jost, Bruno Rossi, Emilio Segre, M. R. Schafroth, T. Kahan, Viktor Weisskopf, Cecil Powell, Wolfgang Pauli, S. Hayakawa, Walter Heinrich Heitler. There have been a total of sixty-eight schools, which continue to this day. When Cécile retired from the directorship of the schools in 1973, she was made a Trustee and continued to be involved in the school for years after that.

In 1953, Bryce wrote an essay for the Gravity Prize Competition, which was sponsored by the Babson Foundation. Roger Babson was a wealthy industrialist who was convinced of the prospects of antigravity. The Prize Competition had existed for several years, but the submissions had been of a type that can be very generously categorized as science fiction. But by 1953, Babson had convinced some known experts in general relativity to act as referees. Bryce's submission, which was serious science that argued that the search for antigravity was unscientific, won first prize. Babson and his friend Agnew Bahnson were so impressed by the essay that Bahnson offered to establish an Institute, the Institute of Field Physics, to be chaired by Bryce, at the University of North Carolina at Chapel Hill (UNC).

Consequently, in 1956 the family moved to Chapel Hill, where Bryce eventually became a Professor. Because of "nepotism" rules at UNC, however, Cécile could not be given a permanent position. She continued to organize and lead the *Les Houches* summer schools, and was renowned as a world-class Mathematical Physicist. She was a dominant contributor to the field she made mainstream: quantum mechanics via a path integral formulation. But she had no permanent university position.

Prior to the mid 1950s, Einstein's general relativity was considered a perhaps beautiful, but essentially irrelevant, intellectual exercise. Theoretical studies had veered off into exotic special solutions—full nonlinear equations were impossible to solve without special assumptions.

Cécile and Bryce DeWitt decided to address the global questions confronting gravitation/general relativity at that time.

The conference on the role of gravitation in physics, which took place January 18-23, 1957, was the inaugural conference of the Institute of Field Physics. This meeting had an impressive line-up of then-current experts in the field: John Wheeler, Robert Dicke, Peter Bergmann, André Lichnerowicz, Charles Misner, Yvonne Foures (Yvonne Choquet-Bruhat, a lifelong friend of Cécile's with whom she wrote a very influential mathematical physics monograph; see below), Louis Witten, Herman Bondi, Nathan Rosen, Felix Pirani (who had received one of his two Ph.D.s from Alfred Schild, who later founded the Center for Relativity at The University of Texas at Austin), Richard Lindquist, Thomas Gold, Ryoyu Utiyama, Stanley Deser, Richard Feynman. This conference had a seminal role in the revival of the subject of general relativity; its *Proceedings* (edited by Cécile and Bryce) is still renowned as a foundational resource.

A similar role was played by the 1963 *Les Houches* school summer session, organized by Cécile and Bryce, entitled "Relativity, Groups and Topology." It had lectures from John Synge, Feza Gürsey, Robert Dicke, John Wheeler, Rainer Sachs, Roger Penrose, Bryce DeWitt, André Lichnerowicz, Joseph Weber. The subjects included general relativity; gravitational radiation and its possible detection; other experimental tests of relativity, cosmology and gravitational collapse (Wheeler had not yet strung together the words "black hole"); group theory; differential geometry; and the dynamical theory of groups and fields.

The 1957 Chapel Hill conference and the 1963 *Les Houches* school concerned subjects that blossomed into general relativity in the last third of the twentieth century and beyond, including gravitational wave detection (LIGO, Virgo, and other detectors at present close to, or slightly

farther from, initial functionality). Cécile was certainly one of the founders of the modern study of general relativity.

Bryce describes Cécile and his experience at the University of North Carolina in a chapter in *Women in Chemistry and Physics: A Biobibliographic Sourcebook,* edited by Louise S. Grinstein, Rose K. Rose, and Miriam H. Rafailovich (1993). According to this account, at

> the beginning, she and her husband both bore the title of *Visiting Research Professor.* Within a few years her husband was given a regular professorship, and later, upon the death of Bahnson, he held a chair named after the latter. She herself was demoted in 1967 from *Visiting Research Professor* to *Lecturer*, despite the fact that she had played a crucial role in attracting money to the university, in organizing conferences on topics ranging from advanced research to high school administration, and in serving, from 1957-1966, as the director of the university's Institute of Natural Science. As the reason for this discrimination, the university cited nepotism rules, which in fact had never been published in the official regulations and were legally nonexistent.

In 1972, Cécile and Bryce DeWitt moved to The University of Texas at Austin, becoming members of the Center for Relativity, which was then directed by Alfred Schild. Bryce DeWitt became a Full Professor in the Department of Physics; shortly thereafter he became director of the Center for Relativity. The University of Texas at Austin had nepotism rules also—people married to one another could not be hired into the same Department. (These rules *were* encoded, into the Texas *Regent's Rules Handbook.* This was then a thick, loose-leaf book of everchanging rule defining pages—now, of course, it is electronic.) So, Cécile DeWitt became a half-time Professor in the Department of Astronomy. Since she was renowned as a mathematician/mathematical physicist, the Astronomy position seemed to many to be an odd match. But Cécile threw herself into the subject, becoming expert in celestial dynamics and happily teaching introductory astronomy courses. She took on Ph.D. students, mostly from Physics; the topics were mostly mathematical physics.

At that time, the Chair of the Department of Astronomy was Harlan Smith, an energetic, imaginative leader, who had gladly, even enthusiastically, accepted Cécile into his Department. Harlan, Cécile, and Bryce created the idea, the proposal, and the reality of a modern "eclipse expedition" to measure the deflection of starlight by the sun during the June 30, 1973 total eclipse of the sun. Since this was 1973, it was a photographic proposal. It would be a reprise of the first validation of Einstein's theory of general relativity: photographic observation of deflection of starlight during the solar eclipse of 1916. (During a solar eclipse, the sky becomes as dark as a nighttime sky, so stars become visible, can be photographed, and can have their positions measured from the photographs.) Smith was initially dubious, but he became an enthusiastic supporter and devoted substantial Astronomy Department resources to the idea.

The 1973 solar eclipse was an opportune one since it was over six minutes in duration, almost the longest possible solar eclipse. The longest duration of this eclipse occurred when it was viewed from western Africa. The U.S. National Science Foundation (NSF), working with the National Center for Atmospheric Research (NCAR), organized a number of experimental groups at an oasis in the Sahara, a small village called Chinguetti, in Mauritania, a former French colony. Cécile had contacts in the government, which facilitated freedom of movement in the country.

At least fifty NSF sponsored researchers were involved, housed in a local "hotel" (a traditional mud structure which had formerly been a French fort). With the many observational experiments at the desert site outside the village, it itself resembled a bustling town. The Texas expedition established an observatory, an insulated pre-fab hut with a hinged roof that could be opened to view the sky. The expedition installed a "camera," a 2.1-meter focal length refractor telescope with 16.5 cm aperture. During the eclipse, three 30 cm^2 photographic plates recorded the position of stars around the eclipsed sun; 150 measurable images down to $m_{pg} = 8.5$ stars were

recorded. This was fewer than originally expected because there was a sandstorm in progress, which produced a high, thin haze of sand, reducing the detectability of fainter stars. Cécile, on the roof, operated the vibrationless shutter during the eclipse photos—she moved a blackened cardboard in front of the lens and removed it on command. In order to accurately measure the light deflection, the camera was left with the same configuration (with the same focus adjustment, in particular) in place after the eclipse. A crew returned in November to take photographs of the same region of the sky. Since the sun had moved on, the sky was now viewed in nighttime. Comparing the location of the images on eclipse plates to those on non-eclipse plates allowed a measurement of the deflection. The experiment achieved a measurement of 0.95 of the Einstein prediction, with a standard error of approximately 11%. This was the most accurate observation to that date (1973), though it was quickly superseded by interferometric radio observations, which shortly thereafter produced 0.1% results.

In 1977, Cécile, Yvonne Choquet-Bruhat, and Margaret Dillard-Bleick published *Analysis, Manifolds, and Physics*. With Yvonne Choquet-Bruhat, Cécile wrote a revised, substantially enlarged edition in 1982. The two published a second volume, *92 Applications*, in 1989; it was expanded and renamed *Volume II* in 2000. These books define the gold standard in mathematical physics texts. In 2006, Cecile published a number of path integration results in *Functional Integration, Action and Symmetries*, with another long-term collaborator, Pierre Cartier.

In the 1980s, Texas nepotism rules began to be relaxed. In 1983, Cécile DeWitt was made a (half-time) Professor of Physics at The University of Texas at Austin and eventually became the Jane and Roland Blumberg Centennial Professor. While remaining a trustee of the *Les Houches* school, she continued and extended her work as Ph.D. advisor, and both semesters of her

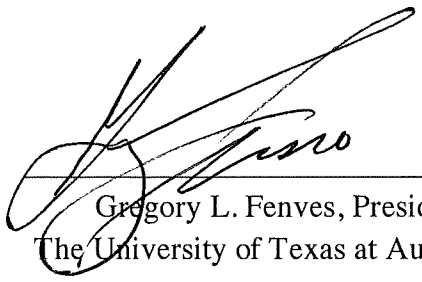
mathematical physics course were heavily enrolled. In 1987, she became a full time Professor of Physics.

In 2000, she became Professor Emerita. Also, in 2000, the International Center for Relativistic Astrophysics awarded Bryce DeWitt and Cécile DeWitt-Morette its highest honor, the Marcel Grossman Award, putting them in the company of such other luminaries as Stephen Hawking and John Wheeler.

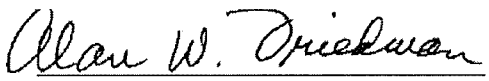
In honor of her continuous work to advance physics in France, the U.S., and globally, Cécile was made *Chevalier de l'Ordre National du Merite* in 1981 and *Chevalier dans l'Ordre de Palmes Académiques* in 1991, and she was awarded the *Prix du Rayonnement Français* in 1992. In 2007, she was awarded membership in the French Legion of Honor. In 2011, she was promoted to Officer in the French Legion of Honor. Yvonne Choquet-Bruhat spoke and presented that award.

On January 30, 2018, the French government and The University of Texas at Austin established the Dr. Cécile DeWitt-Morette France-UT Endowed Excellence Fund to support research collaborations between students and faculty at UT Austin and institutions in France. Also, in 2018, the Cécile DeWitt-Morette and Bryce DeWitt Endowed Graduate Fellowship in Physics was inaugurated at The University of Texas at Austin.

Cécile DeWitt-Morette guided twenty Ph.D. students and numerous undergraduate and Masters thesis students, even after her retirement. She is survived by her four daughters: Nicolette, Jan, Christiane, and Abigail; by their families; and by her seven loving and beloved grandchildren.



Gregory L. Fenves, President
The University of Texas at Austin



Alan W. Friedman, Secretary
The General Faculty

This memorial resolution was prepared by a special committee consisting of Professors Richard Matzner (Chair), Austin Gleeson, and Harry Swinney.