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The Life and Work of Charles James

A professor emeritus of history writes about her father, a UNH professor and prominent chemist.

By Marion James '40

One hundred years ago, Charles James arrived at New Hampshire College to teach chemistry and begin a distinguished career.

Early Years

Charles James was born in England on April 27, 1880. His father died when he was 6, and he was brought up by his mother, Mary Diana Shatford-James, in Holly House in the small village of Broughton, Northamptonshire. He was educated first by a governess and later at a school in the neighboring town of Wellinborough, where he took the program run by Cambridge University. He said he was introduced to chemistry through reading his father's books on the subject. He also may have taken a chemistry course at school.

Becoming fascinated with the field, he set up a laboratory at home at age 15 for his own experiments. A friend of his later remembered seeing him making bombs to blow up decaying tree stumps in the area. [1]

Around the same time, his studies encouraged him to establish connections to the scientific world. He collected the names and addresses of great English chemists, and wrote to Sir William Crookes and Sir William Ramsey, the latter about to win the Noble Prize and who "was considered the greatest chemist of his time." [2] Both men replied, and he and Ramsey continued to correspond. "Charlie" besieged him with scientific questions. Impressed, Ramsey invited him to visit his laboratory.

When James graduated from school in Wellingborough, his mother persuaded him to take a job with a business firm in Northampton. He was not a dedicated employee—he constantly demanded to be allowed to study chemistry with Ramsey at the University of London. In those days, around 1900, the programs of Oxford and Cambridge did not see fit to include chemistry. Mrs. Shatford-James did not approve of her son's choice. Chemistry was not considered a noble profession. To her, a chemist was a dispenser of drugs in an apothecary shop. But one suspects that Charlie was irritatingly persistent. In the meantime, his older brother, William, became a gentleman farmer and bought the very large estate of Pytchley Grange. Charlie set up a laboratory there. But William, living beyond his means, lost the property.

Finally, his mother gave in. Arriving in 1899, he studied constantly with Ramsey, who was James' close friend and mentor to the end of his life. In his second year, James won the Ramsey silver medal. Along with his studies, he obtained considerable industrial experience. In 1904, he passed the examinations for associate in the Institute of Chemistry. And in 1907 he earned the rank of fellow after another set of examinations. By that time, he had decided that his life would center on the study of the rare earths.

After receiving his associate's degree, he informed Ramsey that he was planning to go to Egypt. Ramsey, thinking this was not the best start in life for his prize student, tried to steer him in a more rewarding direction. Suddenly, in 1906, James received an offer of a position with the National Refining Company at West Chester, New York, which he accepted. In 1906, he found himself in America.

Arrival at New Hampshire College

Soon after his arrival in the United States, James mysteriously received an offer of a position as an assistant professor in chemistry at the New Hampshire College of Agriculture and Mechanic Arts in Durham, N.H. The college had been in Durham for only 13 years, housed in a handful of buildings, including T-Hall, Conant Hall, Hewitt Hall and Morrill Hall. There were 26 faculty members and 26 students graduating that year.

Although the college was a fledgling institution, it had one unusual feature that appealed to Charles James. When the college was established in Hanover, N.H., in 1866, it started with one faculty member, a chemist named Ezekiel Dimond. He became instrumental in the development of the whole institution, taking on many administrative tasks. As a chemist, he created the only department in the college, the chemistry department. After his death in 1876, other chemists took over.

When New Hampshire College was moved to Durham in 1893, there was still only that one department--chemistry, located in Conant Hall. One important member was Charles Parsons, a distinguished chemist in his own right, who had just made the offer to James. An academic career in an institution and a department that were just taking shape, where he might participate in the making of policy, and where there was the opportunity to develop his own laboratory and research interests, was persuasive. James accepted the job. But he was an adventurer at heart anyway.

Parsons in 1893 was more than a chemist. His great talent was that of an organizer. He had designed the classroom and labs when Conant was built. The building became James' professional home for the rest of his life. In fact, in 1999, the American Chemical Society named Conant as a National Historic Chemical Landmark, the first such award in New England, and the 23rd such building in the country. Parsons, seeing in the early 1900s the importance of the field of chemistry, was in the process of founding a national organization—the American Chemical Society—in Durham. For a time the national society had its headquarters in Conant Hall. Parsons continued to hold a long tenure as the National Executive Secretary. In addition, Parsons and James were the founding members of another national organization, a chemical fraternity: Alpha Chi Sigma.

Parsons was made head of the department, but left Durham in 1911 to become chief mineral chemist of the U.S. Bureau of Mines. He asked James to come with him, but without success. In 1911, James himself became full professor and the head of the department. The two men were very different, but James was fortunate to have worked with Parsons, who was a remarkable man.

Life in Durham

For his first nine years in Durham, James was a bachelor and lived in a rented bay-windowed house on Main Street that he shared with three other single instructors. They called their house the Faculty Club [3]. Besides his classes, James spent six nights a week from 6 p.m. to midnight on his research. At midnight he served tea to any one who might be there. He found time to play bridge, spent time in the official Faculty Club, and become a 32 degree Freemason. He also took up other interests: collected stamps, and visited central America to collect orchids and study butterflies.

In 1915, at 35, he married Marion Templeton, built a house and became an ardent gardener. He specialized in delphinium propagation and was well known for the beauty of his garden. He had 14 hives of bees, the social life of which fascinated him. He became a well known expert in this field.

During this time, he got to know the local residents and the college community. Everyone appreciated his fine mind; he was outstanding in the original nature of his thought. Sir William Ramsey wrote, "James is certainly able to take his place with any of the [American chemists], allowing for his age, in originality and power for work. He was always original ever since he came as a youngster to my laboratory." [4] The word "original" appears many times in references to him.

He was romantic. He loved the mysterious, the unknown and the rare. Thus he pursued the rare earths. He was interested in strange lands. He talked of going to Egypt, Australia and Tonga. He read travel books, particularly books on and by Laurence of Arabia. All of this affected his work and accomplishments, or perhaps one should say that his accomplishments were the result of his romanticism and intellect combined. He was very hard-working and self disciplined, and was a perfectionist.

On a casual level, people who knew him said he was always courteous and charming and possessed a great sense of humor. He was thoroughly likable. He was also extremely kind, and helpful to students and people in general. He would put aside his own work to help someone else.

He was also retiring, shy and very modest. If he ever spoke of his work, it was as if he were mowing the lawn. This modesty was in some ways a detriment, concealing his abilities and limiting his reputation. For example, although he participated in the Northeastern Section of the American Chemical Society, he never went to national meetings to give important papers or to meet other nationally distinguished chemists. What was exciting to him was a problem, no matter how simple; the process of research; and a correct solution.

Aside from his scientific accomplishments, he stood out as a decent, warm, human being. While these traits affected the community around him, they also colored his scientific career [5].

Very early in his life in Durham, he got the nickname "King"—"Charles" or "Charlie" disappeared. Being English was part of the reason. Another was that he had the names of the Stuart kings—two were Charles and two were James. There was also his height, at 6 feet 3 inches. But beyond even that, there was his particular kind of leadership.

His Professional Career

In James' professional career, both teaching and research were important. Some people have felt that teaching was his crowning achievement [6]. He was very interested in and sympathetic with his students. He could think as they did. Possibly he remembered battling with the same mysteries of chemistry at age 15. In class, he lectured with great clarity. But while in many or most chemistry courses of the time, experiments were demonstrated by the instructor, he pushed his students into the lab and set them to work. Some of them, in fact, were set to work on his own research. When the concluding paper was written and sent to the journal of the American Chemical Society, he insisted that the students' names should be listed before his own. At the graduate level, students were taught the requirements for research, accuracy and successful results. He was kind, but he always demanded perfection. In fact, his students were so well taught that other institutions came to him to find candidates for their own faculty. Afterward, most of these students acquired great distinction in their own careers.

Of course, it was James' own research that won him his greatest respect and recognition. He was able to do extraordinary things at an institution that was just beginning to grow and was not prepared to give him much support. Nor did he expect it.

There was always the need for equipment, and to a degree he was able to make what he needed, glass blowing being one of his accomplishments. There were no grants, teams or research professors, but he created his own teams of enthusiastic students and teaching faculty, who were rewarded through their participation in important research and through his recognition of their accomplishments.

But the main key in his exciting research was his originality. It was a particular quality of his mind. The methods he used in experiments to get to a solution were unique. These came to be used by many other chemists and were called "the James Method."

In everything, he was very disciplined and focused on his work and endlessly patient. He would spend many years and go through steps a thousand times to get where he wanted to go. After his death, the newsletter *The Nucleus* summed up the basis of his successful research: "The record of his scientific life is one in which highly detailed, painstaking and exhaustive studies were coupled with brilliancy design and execution and both were influenced by a most comprehensive grasp of the science which he had made his own." [7]

The Rare Earths

For James' career, he chose the elements called the rare earths, officially named lanthanides, for his work. The number of rare earths has varied, but 17 seems to be accepted number. If not always rare, they were so similar that they were very difficult to separate, to see them as elements in a pure form, and to discover their properties. Charles Parsons noted that their discovery was "perhaps the most confusing and complex of any of the elements." [8] There was always the feeling that they had no use in the real world, so most chemists ignored them. But the presumed rareness, the mysteries, the difficult of separating them, the errors and the chaotic development of this group as a whole were the very things that drew Charles James. He sought good methods of identification, worked hard to reach purity, and found rational placement by atomic number.

It had taken about 100 years to identify 15 of the 17 elements. But by the time that James came to Durham, only two remained to be identified. And it was not clear that one of them even existed. These two unknowns now attracted many chemists, and Charles James was among them.

However, his main work for more than 20 years was the whole group of Lanthanides, to fill the gaps and bring them into a rational relationship. By the end of his life, the history and pattern of the rare earths and knowledge about them had been transformed. His 60 papers in the *Journal of the American Chemical Society* were the evidence. It was his greatest work.

Within that framework, there were many new things he discovered that were impressive in themselves. Foremost among his accomplishments was his method to get a separation of the elements. Here he resorted to fractional precipitation and crystallization. This was laborious, often involving five to 10,000 or more repetitive tests to arrive at the correct answer. His originality rested in his application of these techniques to the rare earths with their particular difficulties. His use of bromates and double magnesiumnitrates for fractional crystallization became known as the James Method, which was considered the best until World War II and the Ion Exchange.

Examples of his many discoveries through these methods can be mentioned. One example was James' separation of ytterbium (70) into two fractions: the second one was element 71 (to be mentioned later). Another rare earth was thulium, which was thought to consist of a mixture of thulium I, thulium II, and thulium III. James established the fact that thulium was a single element. His published papers on these things show that, one step at a time, he transformed the knowledge of the rare earths into a rational, intergrated picture.

He was also the major producer of the material rare earths, acquiring vast quantities of the individual elements, and an enormous collection of all them, the most important in the world. These he supplied to laboratories around the world. After his death, the collection went to the federal government but recently was returned to UNH.

The New Elements

At the time James began his work in 1906 in Durham, there were only two undiscovered elements among the rare earths. Since they were part of the rare earth group he was putting in order, their absence must have played a large part in his thinking. The following year, he began to examine ytterbium, number 70, then considered a single element. Using his newly created method, he discovered a new element appeared, atomic number 71. He then began to prepare it for publication, but still held back to go over the material carefully, as was his wont. At the same time two European chemists published their discovery of number 71. One was Georges Urbain of France, who named his version lutetium, after the ancient name for Paris. And the other was an Austrian, Carl Auer von Welsbach, who named his cassiopium.

James was very disappointed and never published his process for isolating number 71. However, his work was known, and he has often been given credit as co-discoverer. Three years later he received the Nichols Gold Medal for his impressive work on the rare earths. Probably his discovery of element 71 played a part in the award.

Suddenly, in 1911, he decided to apply for a job in Australia. This, after becoming full professor and head of the department, and after receiving the gold medal! Was this the old longing for the unknown? He did apply, but in the end nothing happened—a mystery. He remained in Durham.

Now there was only one undiscovered element in the rare earths, and that was the mysterious 61. The question was: did it exist at all? That it probably did was suggested by the fact that 60 and 62 had already been discovered. Sir William Ramsey had written James as early as 1912 that gaps in atomic weights between known elements suggested that another element did exist. Since this was his main research area, James took the hint and worked in it for 13 or 14 years. However, in the 1920s, it became the favorite quest for almost everybody. There were two Americans that stood out, Charles James and B. Smith Hopkins of the University of Illinois. Interestingly Illinois had offered Hopkins' position to James first, and James had refused it. Was there a rivalry there? This historic struggle was recently reexamined in 2006 by Clarence Murphy, retired faculty member of the University of Pennsylvania. He wrote an article in the *Bulletin for the History of Chemistry*, called "Charles James, B. Smith Hopkins, and the Tangled Web of Element 61." [9] He writes, "The history of the search for and discovery of Element 61 is one of the most complex and confused of any of the elements in the periodic table." [10] But early in 1926, both men felt that they had found 61. [11] And James took time out to send his sample to J.M. Cork at the University of Michigan to provide the X-ray spectrum of his material.

But at the same time, Hopkins sent his paper on his discovery of 61 to *The Journal of the American Chemical Society*, to be published as soon as possible. Arthur B. Lamb, the editor, then sent the paper to Charles James—the expert, to see if he approved its publication. This was a crisis. If Hopkins' work were to be published there, the publishing of James' paper would represent a conflict of interest. James, the man he was, approved the acceptance of the other man's work. And it was published. At the end of 1926, James published his version in an obscure *Proceedings of the National Academy of Science*, where it was scarcely noticed.

However, element 61 became the great battleground—in fact, a nationalistic battleground for European chemists. [12] James' version sat unchallenged and ignored. In the end, when 61 was discovered, all these versions were thought to be incorrect because their arguments were based on the natural world.

One cannot leave the issue here, because there is another chapter during World War II. James, who had by then passed away, still had a part. It was the James Method that was used to purify the uranium used for the atomic bomb. And not to leave out Number 61, it was the exploding of the atom bomb that released that mysterious element, found for the first time hidden among other radioactive results. It took the use of ion exchangers to separate out 61. This provided the unequivocal proof of the identification of 61 in 1947 by Jacob Marinsky, Lawrence Glendenin, and Charles Coryell at the nuclear research laboratory in Oak Ridge, Tenn. They named 61 promethium; it was radioactive, never appearing in nature and having the half-life of 17 years. At this time it does not exist at all, except on a distant star And it sits apart from the other rare earths.

However, the Oak Ridge laboratories in 1949 published the L Spectrum (element 61) isolated at Oak Ridge and compared it with the spectra obtained by James and Hopkins. The six spectral lines reported by James and the two by Hopkins were remarkably close to those determined from the authentic sample of element 61. [13] This opens up a mystery. It appears that the American chemists, particularly James, had touched on 61 in nature.

James's Last Years

After the battle over 61 in 1926, James began a study of uranium, refining it by his method. In 1927, the college (by then a university, as of 1923), awarded him an honorary doctorate in science. This was remarkable, since the university did not give such degrees to active faculty. He was very proud of this honor. This was also the year in which James persuaded the university to build a new building for chemistry, which he helped design. Eric Huddleston was the main architect.

In 1928, he obtained a discarded greenhouse from the university and attached it to a new garage (he had never had a car). The greenhouse would house his plant-growing ambitions. And the construction of the important new chemistry building had begun in the fall. A glowing future was ahead.

But he began to feel ill and suffered increasing stomach pain. In December he entered Deaconness Hospital, where he had surgery for cancer. The surgeons realized that nothing could be done. He died on Dec. 10, 1928, at the age of 48. The doctors, perplexed by the nature of his cancer, requested an autopsy. What it revealed the author does not know. But without question his disease seemed to have been the result of his research, a fate suffered by Marie Curie and others before him. He had worked recently on 61 and on uranium. Both element 61 and uranium in all its forms were radioactive. But it is apparent that, while he had worked on 61 for 14 or 15 years, presumably he had never encountered 61 in its radioactive stage. And his contacts with uranium were seemingly too recent to have produced the consuming cancer that he had developed. There is no answer to this mystery. But it is generally accepted that for many years he had been working with radioactive materials, which had fatal consequences.

Fittingly, on the day of his funeral, the ridge pole of the new chemistry building was put up while the bells for the service were ringing. 14 The building was later named for him.

Still, in connection with his life, there was one more remarkable event to include—one that astounded people and found its way into the Boston newspapers. 15 Because James had died in the winter, the frost prevented his burial in the chosen cemetery lot. The reburial took place in April. A day or two later, a visitor found that suddenly a swarm of bees had appeared on the new grave. The bees belonged to Jesse Helper, two miles away. But these same bees had once belonged to Charles James—as recently as the fall of 1928.

There is an old legend on this subject, both English and American, that someone must tell the bees of their master's death or they will fly away (one view says that they will die). The poet John Greenleaf Whittier wrote a famous poem "Telling the Bees." But no one had told the James-Helper bees. They flew away—but they flew two miles straight to the grave of their former owner and master. ~

Editor's note: On Oct. 29, 1999, the American Chemical Society designated the separation of rare earth elements by Charles James a National Historic Chemical Landmark at UNH. The plaque commemorating the event reads:

Beginning in 1906, in a laboratory in Conant Hall, Charles James (1880-1928) devised novel fractional crystallization techniques for separating rare earth elements, which were widely adopted by other chemists. James used his method to separate large amounts of ytterbium, hitherto considered to be a single element, into two elements now known as ytterbium and lutetium. When the simultaneous isolation of lutetium was published in 1907 by Georges Urbain, James made no public claim for his own pioneering work. Despite his retiring nature, James was internationally recognized as an expert in rare earth chemistry. His highly purified rare earth specimens were in demand by research laboratories throughout the world.

End Notes

(1) H.P. Norris, letter to Mrs. James, May 7, 1929
(2) Mrs. James, scrapbook
(3) Ritzman, letter to Mrs. Charles James, June, 1929
(4) This comment from Sir William Ramsey was frequently quotes Melvin Smith, "Charles James, the man," in the Northeastern Section of the American Chemical Society, "the Life and work of Charles James, 1860-1928," p. 18.
(5) Letters to Mrs. James, 1929.
(6) B.S.Hopkins, "Charles James the Chemist," *The life and work of Charles James*, p. 20.
(7) *The Nucleus*, the newsletter of the Northeastern Section of the American Chemical Society, reprinted in one version of the Dedication of the Charles James Hall of Chemistry, no page.

(8) Parsons, "Charles James," Dedication.
(9) Clarence J. Murphy, "Charles James, B. Smith Hopkins, and the Tangled Web of Element 61," Bulletin for the History of Chemistry, Volume 31, Number I (2006), pp. 9-18.
(10) Murphy, p. 9
(11) Murphy, pp. 11-13. The Section: "The Papers on Element 61 of Hopkins and James."
(12) Phone conversation with Clarence Murphy, June 16, 2009. A.F. Daggett "Element 61, *Alumnus*, December, 1947.
(13) Murphy, p. 14.
(14) Alexander Amell
(15) *Boston Herald*

Return to UNH Magazine Fall '10 web extras