JOHN BENNETT FENN: A LATE BLOOMING NOBEL LAUREATE

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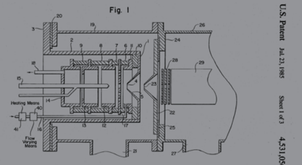
Michael A. Grayson, ASMS Archivist



John Bennett Fenn was born on June 15th, 1917 in New York City. He came from an educated background, both of his parents having earned baccalaureate degrees. His father, Herbert Bennett Fenn, had a degree in engineering from Rutgers and his mother, Jeanette Dingman a degree in home economics and nutrition from Rutgers. The Fenn family settled in New Jersey shortly after his birth and remained there until the loss of the family home in the depression. They subsequently moved to Kentucky in the late '20s where both of his parents were employed at Berea College and Allied Schools. John completed his grade school, high school and college education at Berea.

Fenn's interest in chemistry can be traced to his college freshman chemistry teacher, Julian Capp. He made the subject come alive and so exciting that John ignored the advice an earlier teacher had dispensed on his algebra final; "Don't ever try to become a scientist or an engineer!" Capp's teaching 'seduced' John into taking more chemistry courses and at the age of 20, Fenn opted for graduate school. Graduating from Berea in 1937, the depression was still stifling the job market. With the option to attend Yale or Northwestern, he decided on Yale, which at the time had a very perfunctory and uninspiring – at least for Fenn – graduate program in chemistry. Fenn's graduate work was under Gosta 'Gus' Akerlof, a physical chemist with an interest in electrochemistry. Thus began three years of "experiments (that) were a boring chore with few redeeming features . The results contained no surprises and nothing of much interest to anyone, least of all me."[Fenn, 2003 #7554]

Fenn's doctoral research was uninspiring. After completing his doctoral research, Fenn gave up on the idea of searching for an academic position. Akerlof had him perform a series of experiments that would hardly qualify for a Masters degree today. Fenn describes them in dreary detail:[Fenn, 1996 #7545]

Table 5. Standard Electrode Potentials of the Silver–Silver Chloride Electrode in Methanol–Water Mixtures

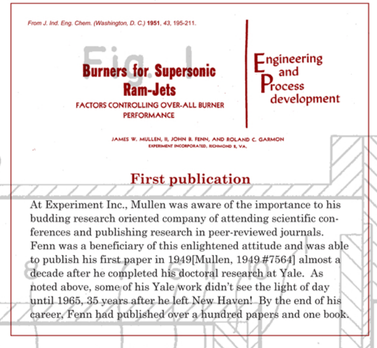
Methanol, wt %	Potential, volt, at temperatures shown					
	0°C	10°C	20°C	30°C	40°C	50°C
0	−0.23638	−0.23131	−0.22557	−0.21915	−0.21208	−0.20433
10	0.22716	0.22296	0.21798	0.21223	0.20569	0.19839
20	0.22013	0.21604	0.21110	0.20530	0.19964	0.19115
30	0.21495	0.21045	0.20503	0.19872	0.19151	0.18339
40	0.21086	0.20558	0.19940	0.19229	0.18429	0.17538
50	0.20648	0.20010	0.19293	0.18464	0.17457	0.16653
60	0.20001	0.19236	0.18391	0.17465	0.16459	0.15373
70	0.18912	0.17986	0.16990	0.15917	0.14795	0.13593
80	0.17100	0.16072	0.14792	0.13553	0.12284	0.10952
90	0.14227	0.12840	0.11425	0.09684	0.08517	0.07021

In essence what I had to do was measure the potential difference between electrodes of silver-silver chloride and platinum-hydrogen in solutions of HCl with molalities from 0.01 to 10.0 in solvents comprising methanol in water at intervals of 10% from 0 to 90, at temperatures from 0 to 50◦C. I think the total number of emf measurements was around 3000 . . . . My dissertation attested to the sterility of that project, consisting as it did of 45 pages of tables with only three pages of text!

Akerlof included some of Fenn's graduate research results in an article on Electrochemistry that appeared in the 2nd Edition of the Kirk-Othmer Encyclopedia of Chemical Technology in 1965!

A Stint in Industry

Departing Yale in 1940 with his PhD and his interest in academic research considerably dampened, Fenn spent the next decade in industry, first with Monsanto in Alabama and subsequently with Sharples Chemical in Michigan. He spent less than two years at each of these positions and around 1945, he joined an ex-Monsanto colleague, Jim Mullen, II, who had formed his own company, Experiment Incorporated in Richmond Virginia. The company performed contract research for both private companies and government agencies; primarily in the area of combustion and propulsion. The research at Experiment Inc. was much more inspiring than anything he had experienced up until that time and he soon began attending scientific conferences, publishing research, and filing patent applications in the field.


From J. Ind. Eng. Chem. (Washington, D. C.) 1951, 43, 195-211.

Burners for Supersonic Ram-Jets

FACTORS CONTROLLING OVER-ALL BURNER PERFORMANCE

JAMES W. MULLEN, II, JOHN B. FENN, AND ROLAND C. GARMON
EXPERIMENT INCORPORATED, RICHMOND 2, VA.

Engineering and Process development

First publication

At Experiment Inc., Mullen was aware of the importance to his budding research oriented company of attending scientific conferences and publishing research in peer-reviewed journals. Fenn was a beneficiary of this enlightened attitude and was able to publish his first paper in 1949[Mullen, 1949 #7564] almost a decade after he completed his doctoral research at Yale. As noted above, some of his Yale work didn't see the light of day until 1965, 35 years after he left New Haven! By the end of his career, Fenn had published over a hundred papers and one book.

Fenn in Retirement

In 1983, Fenn's colleagues at Yale arranged for a conference in his honor; "Nozzle Molecular Beams – A Fennfest". Already 66 years old, the conference included papers by his colleagues, graduate students and post-doctoral researchers, each attesting to the powerful influence Fenn had in both their research and his importance to the field. His pioneering work would be recognized by Nobel Laureate Dudley Herschbach in his Nobel Lecture[Herschbach, 1992 #8079] ten years later. Normally, such a celebration would be taken as recognition that the honoree should hang up his lab coat and retire; certainly something that Fenn had earned and could easily have done. A year later the presentations at the Fennfest were published as a special issue of The Journal of Physical Chemistry[Kolb, 1984 #7363], and the first paper in that issue signaled that Fenn had no interest in retirement; "Electrospray Ion Source. Another Variation on the Free-Jet Theme"[Yamashita, 1984 #1480] In it, the authors stated,

"The intense and growing demand for interface between a mass spectrometer and a liquid chromatograph has motivated a vigorous search for such a route. This communication comprises our first report on the interesting and to-us-somewhat-unexpected results that we have obtained in our early studies."

I don't think anyone who read that sentence would ever think that Fenn's 'search for that route' would lead to Stockholm; least of all, Fenn.

Academia Calls

His scientific reputation led to an inquiry from Princeton if Fenn would be interested in heading up Project Squid – an Office of Navy Research (ONR) program looking into jet propulsion. Accepting the new job, Fenn oversaw the research of more than a dozen sub-contracts to university and industrial laboratories; thus providing an opportunity to become intimately familiar with the state of research throughout the country and also with the research agencies of the Navy, Army and Air Force. Thus, when ONR in London had an opening for a liaison officer in 1955, Fenn's name was at the top of the list. Accepting the offer provided Fenn the chance to interact with the best and brightest researchers in Europe on the subject.

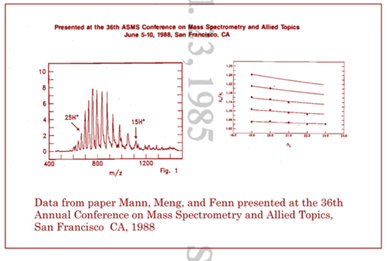
Although not actively engaged in research at the time, Fenn kept thinking about various ways to approach the nearly intractable problem of studying flames and combustion. It was during this period that he conceived of the idea of entraining heavy molecules in a lighter gas and pushing the mixture through a nozzle in a supersonic expansion – the molecular beam experiment. Upon returning to the States he promoted this concept and was able to obtain funding to explore it in 1959. Still at Princeton, he and his post-doctoral student, Jacques Deckers, created the famous 'monster' with dual 32 inch oil diffusion pumps for conducting molecular beam experiments. Over the next several decades, first at Princeton and later at Yale, Fenn and his students and post-docs performed research that formed a solid basis of knowledge about free-jet expansion and its use in molecular beam studies.

New Research Direction

In the early '80s, just as he was being encouraged to retire, Fenn was approached by two Yale colleagues, Sandy Lipsky and Csaba Horvath to see if his molecular beam expertise could be applied to the problem of interfacing a liquid chromatograph to a mass spectrometer for the analysis of large biomolecules. They had seen his research referenced in papers by Malcolm Dole[Dole, 1968 #1735; Dole, 1968 #1733; Mack, 1970 #1722] in the late '60s on electrospray ionization of synthetic polymers. Dole had abandoned the research after several years and Lipsky and Horvath asked Fenn if he would take it up. With a better understanding of molecular beams and a better experimental setup than Dole had, Fenn took on the challenge.

By 1984 members of Fenn's group were attending the Annual Conference on Mass Spectrometry and Allied Topics, attempting to convince attendees that the electrospray ion source they had developed was an effective tool for interfacing the liquid chromatograph to the mass spectrometer[Whitehouse, 1984 #7724; Whitehouse, 1984 #7725]. However, the message wasn't well received until four years later when Fenn and coworkers presented the results of their work at the Annual Conference in two papers. The first showed mass spectra of compounds with molecular weights ranging from 6,000 to 40,000 daltons[Meng, 1988 #7731]. In these spectra, the preponderance of multiply charged ions made them complex and, some thought, too difficult to interpret. But in their second paper[Mann, 1988 #7732] they presented algorithms for deconvoluting the complex spectra to obtain the molecular weight of myoglobin. Fenn considers this the critical moment in recognition of his work on electrospray ionization.

"These findings . . . were first presented at the annual meeting of the American Society for Mass Spectrometry in San Francisco in 1988. Only 15 or 20 people were in the room but after that presentation what has been called the Electrospray Revolution spread rapidly." [Fenn, 1996 #7545]



Data from paper Mann, Meng, and Fenn presented at the 36th Annual Conference on Mass Spectrometry and Allied Topics, San Francisco CA, 1988

Recognition In ensuing years, the electrospray ionization technique became a tool of ever increasing popularity in research on large biomolecules. Continued evolution of liquid chromatographic column technology, high resolving power mass analyzers and the development of the field of informatics has led to an explosion in the application of mass spectrometry to problems in biology, biochemistry, and medicine that could hardly have been envisioned when Fenn and his colleagues took up the challenge put forward by Lipsky and Horvath in the early 80s.

Super Recognition Twenty years later, in 2003, John Fenn's contribution to the development of electrospray ionization was recognized by the Nobel Foundation. He, along with Koichi Tanaka were awarded the Nobel Prize in Chemistry "for their development of soft desorption ionisation methods for mass spectrometric analyses of biological macromolecules". It is generally thought that Nobel Prize winners do the research for which they are recognized in their youth; and that is borne out in many instances. However, Fenn provides us the exception to the rule, earning Nobel recognition for work done when he could have retired from an already highly accomplished career; a late-blooming Nobel Laureate indeed.

1917	1929	1937	1940	1942	1945	1949	1952	1955	1963	1965	1967	1968	1974	1983	1984	1986	1987	1988	1994	2002
John Bennett Fenn born in New York on June 15th	Fenn family moves to Berea Kentucky	Fenn begins graduate study at Yale	Fenn graduates with PhD from Yale	Fenn leaves Monsanto to go to Sharples Chemical Inc.	Fenn leaves Sharples to go work at Experiment Inc. to work on Project Bumblebee	Fenn co-author on first paper published in the scientific literature	Fenn leaves Experiment Inc. to accept position as head of Project Squid at Princeton University	Fenn serves as Scientific Liaison Officer for the US. Office of Naval Research in London	Decker & Fenn publish Review of Scientific Instruments article on molecular beam apparatus.	Fenn co-chairs Gordon Conference on "Molecular Beam Methods and Collision Processes"	Fenn moves to Yale University	Malcolm Dole publishes two papers on "Macroions" formed by electrospray process, referencing Fenn et al in one of them	Publishes "Rotational relaxation of molecular hydrogen" with Gallagher	"Fennfest" organized by colleagues for his 65th birthday	Publishes "Electrospray ion source. Another variation on the free-jet theme" with Yamashita retirement age at Yale	Dudley Hershbach acknowledges Fenn's contribution to research for which he receives 1986 Nobel Prize in Chemistry	Fenn reaches retirement age at Yale	Fenn & Mann present landmark papers at 36th Annual Conference on Mass Spectrometry & Allied Topics in San Francisco	Fenn joins faculty of Virginia Commonwealth University	Receives Nobel Prize in Chemistry for "for the development of methods for identification and structure analyses of biological macromolecules"