International Journal of Mass Spectrometry 300 (2011) 72–73

Contents lists available at ScienceDirect

International Journal of Mass Spectrometry

journal homepage: www.elsevier.com/locate/ijms

Foreword

This issue of the *International Journal of Mass Spectrometry* is dedicated to honor the science and impact of John B. Fenn (June 15, 1917–December 10, 2010), who was awarded the 2002 Nobel Prize in chemistry for his work on electrospray mass spectrometry which has revolutionized the development of new pharmaceuticals and promises to advance disease diagnosis.

John's career, his originality, scientific contributions, and impact are truly remarkable in both their depth and their diversity. Fenn's pioneering work on supersonic jet expansions, nozzle molecular beams and electrospray ionization has led to the development of new instrumentation and techniques for chemical analysis, spectroscopy and dynamics with applications in clusters, polymers, biomolecules, proteins and pharmaceuticals.

John received a B.A. in chemistry from Berea College, Kentucky in 1937 and a Ph.D. in physical chemistry from Yale in 1940 under the direction of Professor G.C. Akerlof. He worked as a research chemist with Monsanto in Anniston, Alabama (1940–1943) and with Sharples Chemical in Wyandotte, Michigan (1943–1945). He then joined Experiment Inc., a contract R&D Company, in Richmond, Virginia working on developing fuel and combustion technologies (1945–1952). From 1952 to 1962, John was the Director of US Navy Project SQUID, administered by Princeton University to sponsor research related to jet propulsion systems. John then became a Professor of Mechanical Engineering (1959–1963) and of Aerospace Sciences (1963–1966) at Princeton University. He returned to Yale as Professor of Applied Science and Chemistry (1967–1980) and of Chemical Engineering (1981–1994). In 1994, John returned to Richmond to join the Chemistry Department of Virginia Commonwealth University (VCU) as a Research Professor. John passed away on December 10, 2010 at the age of 93.

John liked to say that the keystone of his scientific career has been a love affair with big leaks in vacuum systems. John's research has turned these vices into rewarding virtues. Gas entering a vacuum through such a leak undergoes a supersonic free jet adiabatic expansion during which its pressure, density and temperature decrease to tiny fractions of their starting values. The time scale of such expansions is directly proportional to the effective flow diameter of the leak, i.e., the source orifice. With typical diameters of tens to hundreds of microns, cooling rates of a few K per picosecond are readily achieved, so fast that the various internal degrees of molecular freedom depart widely from equilibrium. Moreover, the terminal jet densities are so low that all collision-dependent processes cease and the terminal states of the jet gas can be "frozen" in various kinds of non-equilibrium states.

In their seminal research of the 1960s and 70s, John and his colleagues characterized these terminal gas states in terms of the effective diameter of the leak and the initial temperature, pressure and composition of the entering gas. Due in large measure to their work, these small supersonic free jets have become a remarkably versatile tool in many branches of science. Such free jets and molecular beams have made possible the kinds of reactive scattering experiments that contributed to understanding the dynamics of elementary chemical processes that led to the Noble Prize in Chemistry in 1986 (Dudley R. Herschbach, Yuan T. Lee and John C. Polanyi). Free jet expansions have become almost routine experiments for the formation of atomic and molecular clusters of virtually any size and any material. Thus, they have played a major role in the explosive growth of activity in studying the chemistry and physics of clusters and subsequently nanoparticles and nanotechnology. The same supersonic free jets have also become essential for high resolution molecular spectroscopy because of the effective cooling of polyatomic molecules which allows for the acquisition of high-resolution rotational and vibrational spectra.

On March 14–15 of 1983, in anticipation of his mandatory retirement from Yale, John was honored by a "Fennfest" attended by over 100 of his friends and colleagues. The program comprised 18 invited talks and 20 poster presentations centered on the properties and applications of John's "big leaks in vacuum systems". Twenty-three of those Fennfest papers were published in the November 1984 issue of the *Journal of Physical Chemistry* which was dedicated to John. One of those papers was his first publication on electrospray mass spectrometry, subtitled "A New Variation on

1387-3806/$ – see front matter
doi:10.1016/j.ijms.2010.11.015

the Free Jet Theme". His successive 25 or more papers on this "Variation" ushered in the so-called "Electrospray Revolution". The trickle comprised of his two papers in 1984 has become a flood of 1000 or more papers per year on the subject since 1996. Electrospray mass spectrometers are now the detectors of choice for liquid chromatographs. The world population of these instruments is tremendous and they are used for a diverse array of analysis from the analysis of crude oil to screening for inborn errors in metabolism. Moreover, all other types of atmospheric pressure ionization sources use free jet expansions to deliver ions to a mass analyzer. Indeed, they comprise the hyphen in most GC–MS systems in which they serve as the vehicle for introducing effluents from gas chromatographs to the in-vacuum ion sources of their mass spectrometers. In summary, John's "Big Leaks" have really become "Big Business" in chemical instrumentation.

The 15 research papers included in this issue provide only a few illustrative examples of mass spectrometry work that became possible because of Fenn's pioneering research in nozzle molecular beam and electrospray ionization. The authors want to dedicate this issue to the memory of John who has inspired many colleagues and students by his joyful and exemplary enthusiasm for science and love of learning.

M. Samy El-Shall *
Department of Chemistry, Virginia Commonwealth University, Richmond, VA 23284-2006, United States

David C. Muddiman
North Carolina State University, Raleigh, NC 27695-8204, United States

* Corresponding author. Tel.: +1 804 828 3518; fax: +1 804 828 8599.
E-mail addresses: mselshal@vcu.edu (M. Samy El-Shall), dcmuddim@ncsu.edu (D.C. Muddiman)

Available online 25 November 2010