THE NUCLEUS

January 2001

Vol. LXXIX, No. 5

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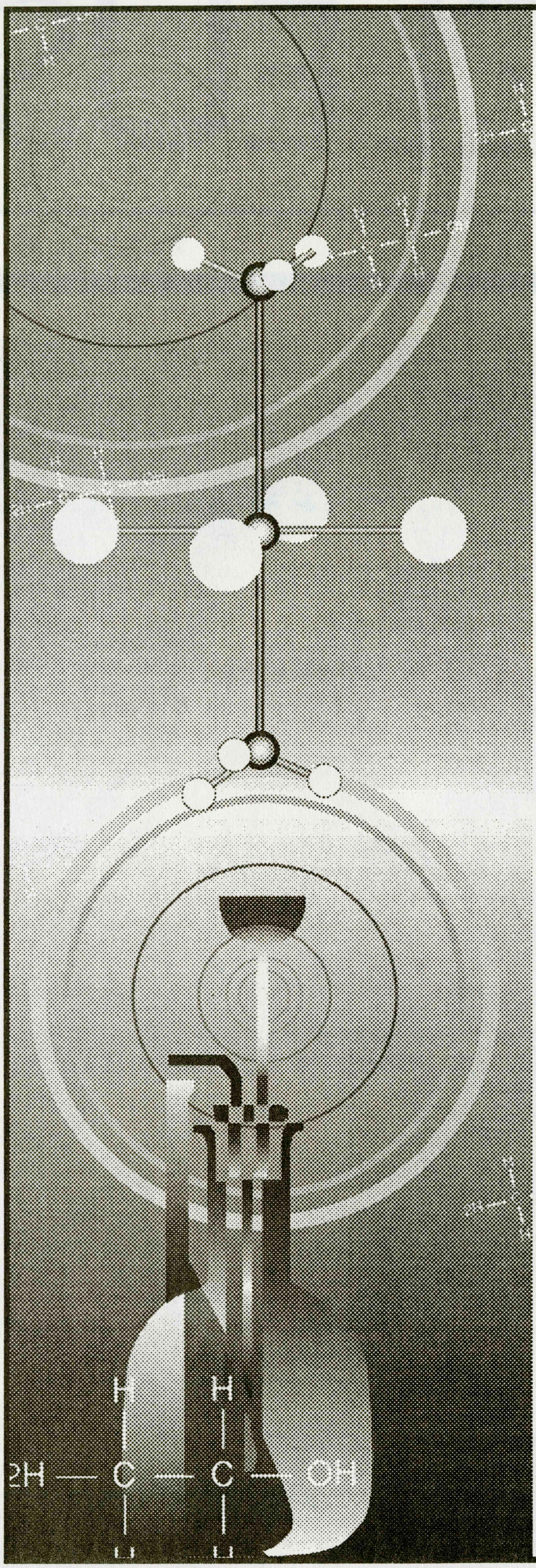

Call for Papers

❖ Deadline – March 31, 2001 ❖

2001 Eastern Analytical Symposium
Sept. 30 – Oct. 4, 2001
Atlantic City, NJ

The Eastern Analytical Symposium is the second largest meeting in the United States dedicated to the needs of analytical chemists and those in the allied sciences. Please help us to make the 2001 EAS the best ever–be a part of the program by contributing your own papers for inclusion in the oral or poster sessions.

To submit a contributed paper for the 2001 EAS Technical Program, you should submit a 200–to 250–word abstract of the proposed paper, indicating your preference for either oral or poster format, to EAS Program Committee, at the address shown below. Preliminary abstracts can also be submitted by FAX to 610-485-9467, at our web site (http://www.easorg/), or via e-mail (EASINFO@AOL.COM). *Please submit each preliminary abstract only one time and only use one method to submit it.*

Regardless of the method of submission, please include the following information on your abstract:

- Title of the Presentation
- Complete names, mailing addresses, telephone numbers, and fax numbers for all authors
- If the presentation is intended for the undergraduate research symposium, please indicate it clearly on the abstract and also please indicate which author is the student and which author is the faculty advisor
- Your preference for oral or poster format
- Approximately six keywords that can be used to categorize the subject matter of your presentation

If you have questions concerning the submission of presentations for the 2001 EAS please contact us at:

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Deadlines: *March 2001 issue: January 17, 2001*
April 2001 issue: February 23, 2001

THE
NUCLEUS

The Nucleus is distributed to the members of the Northeastern Section of the American Chemical Society, to the secretaries of the Local Sections, and to editors of all local A.C.S. Section publications. Forms close for advertising on the 1st of the month of the preceding issue. Text must be received by the editor six weeks before the date of issue.

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Greetings from the Chair.

First, I would like to thank the immediate past chair, Doris Lewis and all the section board members for guiding us through a splendid year of ACS activities. It has been a pleasure to work with Doris, and the board, while I served as program chair. Without their support, our section would not have had the successes it experienced last year.

Next, our section was recognized by the National ACS in several areas, and this deserves notice here. This includes receiving the top award for activity by a local section in government affairs (Grassroots Award from the ACS Office of Legislative and Government Affairs), the top award recognizing activities by a local section Young Chemists Committee, YCC (Outstanding Local YCC Section Award), and nominations for the Best Very Large Section Award, and the Public Relations Award.

During the past year, the section also had a joint celebration of National Chemistry Week with the Science Museum. Besides the well attended lecture demonstration by Prof. Shakhashiri, visitors were encouraged to visit several exhibits in the museum that had relevance to chemistry.

The year ahead looks to be an exciting year. With Prof. Morton Hoffman as program chair, we can expect an interesting and impacting program for each of our monthly meetings.

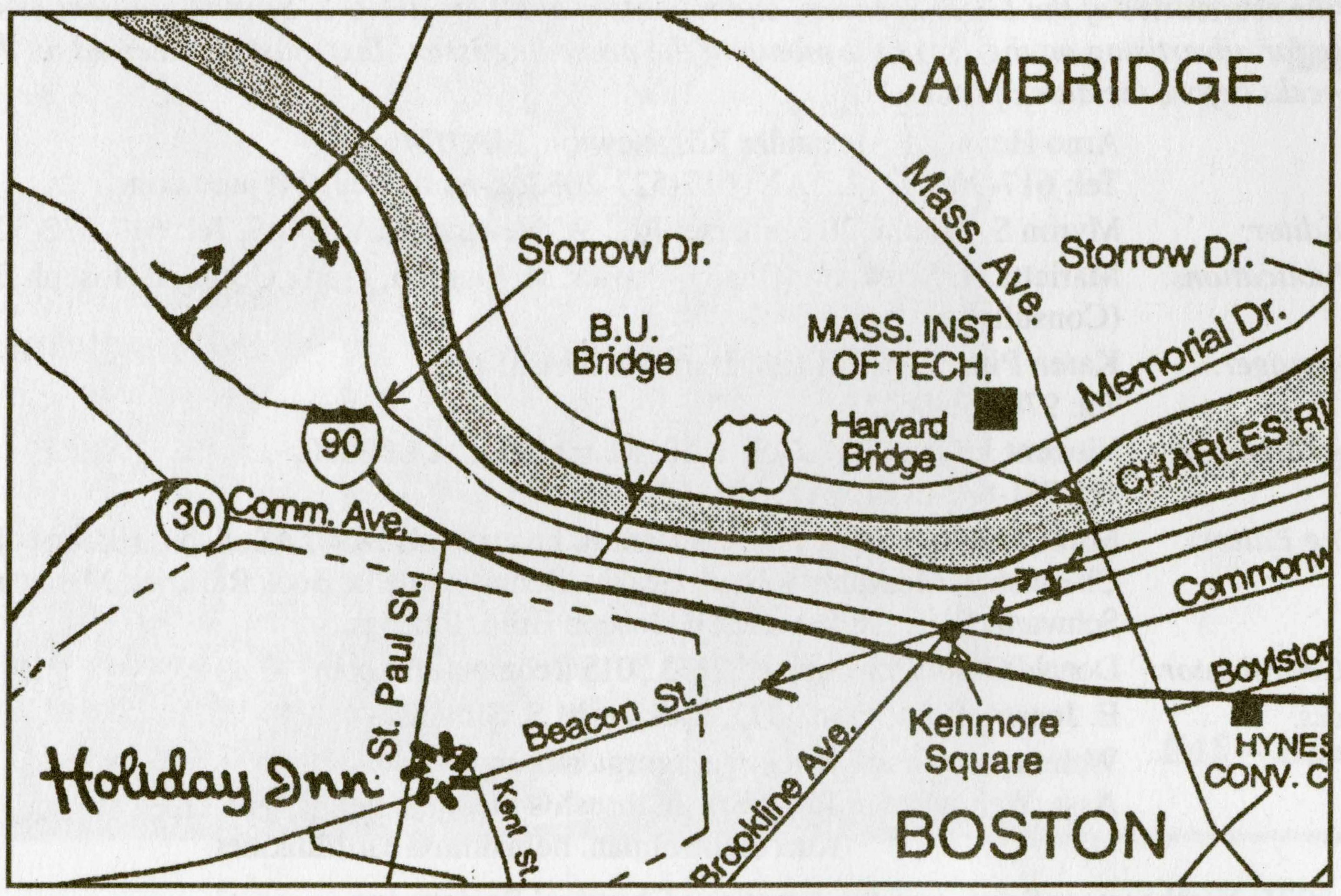
In 2001, our section will also conduct a German Chemical Society Student Exchange Program during April 28-May 3. In this event, our section will be helping to support the interaction of our YCC members with several young chemists from Germany, as they present work in Boston at the Undergraduate / Graduate Research Day. We also plan on extending our relationship with the Science Museum in 2001, for a new National Chemistry Week celebration at the Science Museum.

In 2001, the ACS will celebrate 125 years of existence. During the fall of 2000, we had our current ACS President-Elect, Attila Pavlath, visit our local section, to discuss the needs of the members of the ACS, and how the ACS must change to adjust to the new millennium. I hope you will support Attila's e-mail polling effort so we can address what the best direction is for the ACS (see C&E News, October 30, 2000 issue, p.67).

Please support your local ACS section by attending meetings, volunteering for the needs of the section, and helping other ACS members. As always, please contact me with any questions you may have about the local section.

Sincerely,

Tim Frigo ◇



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From the West: Take the Mass. Turnpike (I-90) to Exit 18. Exit left, follow signs to Cambridge. At the second set of lights turn right into Storrow Drive. Exit at the Kenmore Square Exit. Follow * below.

From the South or North: Take Rte. I-93 to Boston. Exit into Storrow Drive at Exit 26. Continue on Storrow Drive to the Kenmore Exit. Follow * below.

***From the Kenmore Exit off Storrow Drive:** At the first set of lights turn right into Beacon Street. In Kenmore Square stay in the center lane and take the center road, which is Beacon St. The Holiday Inn is about 0.6 Mi. on the right at St. Paul St. Enter the driveway into the garage at the in-town end of the building. Bring parking ticket to dinner desk for validation. Parking at meters on Beacon Street may also be available, should the garage be full (no meter charge after 6:00 pm).

By Public Transportation: Take (or change at Park St. to) the Green Line, "C" train. Exit at the St. Paul St. stop (3rd. stop after Kenmore) across from the Holiday Inn ◇

Monthly Meeting

The 821st Meeting of the Northeastern Section of the American Chemical Society

Thursday, January 11, 2001
Holiday Inn, 1200 Beacon St., Brookline, MA

4:00 pm YCC Career Workshop, Panel Discussion
Dr. Tony Fernandez, Merrimack College; Dr. Daniel DeOliveira, Dyax Corp.; Dr. Elizabeth Nugent, Choate, Hall & Stewart; Dr. Patricia Hamm, Suffolk University
For more information, visit the website http://people.bu.edu/nsycc

5:30 pm Social Hour; a table of Career Services Literature and Aids will be available

6:30 pm Dinner

8:00 pm Evening Meeting, Dr. T. Frigo, Chair, presiding
Prof. Guilford Jones, Boston University
Chemistry in the Fast Lane – It's All About Time

Dinner reservations should be made no later than noon,January 4, 2001. Please call or fax Marilou Cashman at (800) 872-2054 or e-mail at MCash0953@aol.com. Reservations not cancelled at least 24 hours in advance must be paid. Members, $25.00; Non-members, $28.00; Retirees, $15.00; Students, $ 8.00.
THE PUBLIC IS INVITED.
Anyone who needs special services or transportation, please call Marilou Cashman a few days in advance so that suitable arrangements can be made.
Free Parking Enter from westbound Beacon St. Obtain parking voucher at dinner desk.
***Next Meeting:** February 8, 2001, MIT Faculty Club, 50 Memorial Drive (6th floor, Sloan Building). Prof. Jeffrey I. Steinfeld, MIT: "Challenge in Environmental Science"*

Abstract

The interrogation of chemical and biological systems using pulsed-light technology has advanced to a very mature state of development. All of the important "short" time intervals from milliseconds to femtoseconds have now been invaded using laser pump-probe and other modern technologies in efforts to track and to record chemical reactions "on the fly". The important events that occur in the sub-picosecond to microsecond time domains associated with natural photosynthesis have been recorded with precision for some light harvesting species. In recent years, a large array of artificial photosynthetic model systems have been constructed in order to uncover mechanistic details of key electron transfer events. One novel type of photosynthetic model employs synthetic peptides that "bundle" in such a way as to produce scaffolding for the deployment of electron donor and acceptor groups in light-activated, vectorial, multi-step, charge transport events. Other types of linked donor-acceptor molecules are designed to serve as light-induced switches that operate through deployment of combinations of electrical and light pulse technology to bring device-like characteristics to the molecular level. These systems show promise in the development of nanoscale photonic devices that include molecular rectifiers, gating systems, optical limiters and other photonic devices.

Commercial applications of pulsed-light technology are sure to bring many opportunities for the development of new markets and the launch of new businesses. For the adventuresome, the lure of entrepreneurial efforts has increasing appeal for academics, consultants, new graduates seeking less charted waters, and other chemical professionals. Tales that can be told regarding the triumphs and the pitfalls experienced by a recent start-up will provide fodder for some discussion of small business opportunities in the new economy. ◇

Biography

Professor Jones is a native of Tennessee. He completed undergraduate work at Rhodes College and was awarded the B. S. in Chemistry (with distinction) in 1965. His interest in photochemistry was kindled during graduate studies, carried out under the guidance of Professor Howard Zimmerman at the University of Wisconsin, Madison (Ph.D., 1970). His studies were complemented by an appointment as National Institutes of Health Postdoctoral Fellow (1969-71) at Yale University, where he was directed in physical organic research by Professor Jerome Berson. Professor Jones joined the faculty of Boston University in 1971 and rose to the rank of Professor of Chemistry in 1982. His other assignments at B.U. include a stint as chairman of the Department of Chemistry (1989-93) and an adjunct appointment at the B.U. School of Medicine (Department of Biophysics). He was involved in the early planning and development of the Boston University Photonics Center that was created in 1995 and now continues his activities in photochemistry/ photonics research as a Faculty Affiliate. He is author of 120 publications, most dealing with research in organic photochemistry. Professor Jones is also a Co-Founder of PhotoSecure, Inc, a business launched in 1998 as a Photonics Center "spin-out" to bring to market new photonic chemicals and detectors for product marking and to address needs for product authentication and tracking. Other recent professional activities include his appointment to the International Organizing Committee of the International Conference on Photochemical Conversion of Solar Energy and his election as Co-Vice-Chair of the Gordon Research Conference on Electron Donor-Acceptor Interactions. ◇

Book Review

Green Chemistry: Theory and Practice, by Paul T. Anastas and John C. Warner (ACS Books and Oxford University Press;) 152 pp., ISBN 0-19-850698-8; $25.00 (paperback)

Reviewed by Kenneth R. Metz, Ph.D.
Metz Research Instruments and Department of Chemistry,
Merkert Chemistry Center, Boston College Chestnut Hill, MA 02467

"Out of sight, out of mind." We are all familiar with this phrase and its implications. Unfortunately, in the context of chemical waste, "out of sight" often signifies the beginning of a problem and not the end. For millennia, human communities disposed of waste by, in effect, tossing it over the fence into the neighbor's back yard. This approach worked rather well for a widely dispersed, largely agrarian population, but by the time of the Industrial Revolution, the quality of life was significantly degraded in many urban centers. Society, though slow to react, now accepts that traditional attitudes and practices must be changed to control pollution. Much of this awakening was stimulated by Rachel Carson's *Silent Spring* and related publications of the 1960s, yet similar concerns were also expressed much earlier. For example, in his famous Christmas, 1860 lectures on "The Chemical History of a Candle," Michael Faraday noted that respiration by the inhabitants of London alone expelled 5,000,000 pounds of carbon dioxide into the atmosphere each day and, but for the restorative action of plants, the consequences for human life might be disastrous. Clearly, the implications of chemical pollution, whether from natural or artificial sources, have troubled thinking people for a long time.

The response to this problem has evolved through several stages. First came recognition that simply dispersing wastes into the general environment, the so-called dilution solution, was no longer adequate. The logical answer was to concentrate them in designated waste sites. That approach continues to be used but, without very careful management, still has the potential to create debacles (witness Love Canal and Times Beach, for instance). A far more sophisticated and efficient solution is to avoid producing deleterious agents in the first place. Progress in that area has accelerated in the past few years and is the subject of *Green Chemistry: Theory and Practice* by Paul T. Anastas of the U. S. Environmental Protection Agency and John C. Warner of the University of Massachusetts at Boston. This interesting little book was published initially in 1998 by Oxford University Press and was reissued in 2000. The authors define "green" chemistry as a suite of methods that reduce or eliminate the use or generation of hazardous substances in chemical processes. Most of the book can be divided into two sections, one dealing with general principles and the other containing specific examples. The philosophical heart of the first section is chapter 4, which outlines twelve practical principles for minimizing the quantity and environmental impact of chemical waste products. The second section (chapters 7-9) reviews common classes of synthetic organic reactions with regard to their "greenness" and describes several dozen green alternatives to traditional methods, with about fifty literature citations. The emphasis is on industrial-scale synthetic organic processes, an appropriate choice since these are typically the most serious offenders from an environmental point of view. However, the same techniques can usually be applied directly to bench-scale syntheses, often with higher yields and better stereoselectivity than conventional methods provide. Surprisingly, microscale techniques are barely mentioned, even though they have been adopted by many research and teaching laboratories to minimize cost and waste. A brief final chapter projects future trends in green chemistry. The text is virtually free of errors aside from one incorrect structural formula (p. 141), and the adequate index is supplemented by an unusually detailed table of contents. Four pages of student exercises have been provided, which would be useful if the book were chosen as the text for a short course on the subject.

Our little world has a finite capacity to absorb and recycle toxic wastes. Chemists, who hold the power to generate extraordinarily dangerous materials, also have an obligation to avoid doing so whenever practical. *Green Chemistry* provides a concise, informative introduction to environmentally-friendly methods that will be appreciated by those who wish to implement more responsible practices in their own work. With the widespread adoption of the principles outlined in this book, there is a chance that, with regard to chemical wastes, "out of sight" might come to imply "peace of mind." ◇

Calendar

For additional information, call:

Boston Glycobiology - (781) 642-0025
Northeastern Univ. - (617) 373-2822
Check the NESACS Homepage for late additions: http://www.NESACS.org

Jan 11

Prof. Rahul Ray (Boston Univ. Medical School)
"Steroid Hormones to Cancer: A Chemist's Viewpoint"
Northeastern University
129 Hurtig Building, 4:00 PM

Jan 18

Prof. Noorjahan Panjwani (Tufts-New England Medical Center)
"Novel regulation of posttranslational modifications: From basic science to disease"
Boston Glycobiology Discussion Group
MIT Faculty Club, 6 PM
Call (781) 642-0025 for dinner reservations

Notices for the Nucleus Calendar should be sent to:
Dr. Donald O. Rickter, 88 Hemlock St., Arlington, MA 02474-2157
e-mail: 72133.3015@compuserve.com

Nominations

Aula Laudis

The Northeastern Section annually honors teachers of chemistry at the secondary level in our region by choosing several for selection to the honor society, *Aula Laudis.* Election to membership in *Aula Laudis is* a recognition of excellence in the teaching of chemistry at the secondary school level. This recognition is based on both qualitative and quantitative criteria that involve the totality of an individual's participation in and contribution to the teaching profession. Inasmuch as teaching is a skilful art with a wide range of marks of excellence, no one criterion for election to *Aula Laudis is* sufficient and no one criterion is necessary. The following criteria, in their broadest sense, shall be considered by the Selection Committee:

- Having taught chemistry to students who have won state-wide, regional, or national chemistry competitions, such as the Ashdown Examination Award;
- Having received awards for excellence in teaching from state-wide, regional or national organizations;
- Having advanced the scholarship of chemical education, including curriculum design, laboratory development, and the introduction of pedagogical methods and techniques through publication in recognized chemical education journals and/or through presentations at scientific meetings and continuing education symposia;
- Having served as the adviser of extra-curricular activities, such as clubs, science programs and science talent searches, in which the interest of chemistry students in the subject is advanced and developed;
- Having performed special service to the chemical education community, such as through the organization of continuing education symposia in chemistry;
- Having demonstrated excellence in classroom teaching as evidenced from written in-class evaluations by supervisors;
- Having had a significant personal impact on students as evidenced by letters from alumni/ae on behalf of the nominee.

The Selection Committee will accept nominations on behalf of active and retired secondary school chemistry teachers; the length of teaching service is not a criterion. The criteria for each final recommendation shall be recorded in the minutes of the Selection Committee.

Nominations, including a one-page summary of the nominee's relevant accomplishments, are to be sent to:

David Olney
PO. Box 559
Mattapoisett, MA 02739
e-mail: djolney@ma.ultranet.com

Nominations are due:
February 15, 2001. ◇

Philip L Levins Memorial Prize

Nominations for the Philip L. Levins Memorial Prize for outstanding performance by a graduate student on the way to a career in chemical science should be sent to the Executive Secretary, NESACS, 23 Cottage St. Natick, MA 01760 by **March 1, 2001**. The graduate student's research should be in the area of organic analytical chemistry and may include other areas of organic analytical chemistry such as environmental analysis, biochemical analysis, or polymer analysis.

Nominations may be made by a faculty member, or the student may submit an application. A biographical sketch, transcripts of graduate and undergraduate grades, a description of present research activity and three references must be included. The nomination should be specific concerning the contribution the student has made to the research and publications (if any) with multiple authors.

The award will be presented at the May 2001 Section Meeting. ◇

Connections To Chemistry

On October 19, 2000, NESACS sponsored **Connections to Chemistry**, a program to connect high school chemistry teachers to the educational resources of the ACS and the Northeastern Section. The program, hosted by Burlington (MA) High School, drew over 100 teachers from 72 different high schools in all six New England states.

The high school chemistry teachers were welcomed to the program at an opening ceremony by Ruth Tanner (University of Massachusetts Lowell), Chair of the NESACS Education Committee. Doris Lewis (Suffolk University), Chair of NESACS, also welcomed the participants and encouraged them to utilize the most important resource of the section, its members. Morton Hoffman (Boston University), Program Chair for the ACS Division of Chemical Education (CHED), gave an overview of the organization of the ACS, showing the location of CHED, the Northeastern Section, and the ACS Education Division.

Four afternoon workshops were offered to showcase the ACS resources for high school chemistry teachers and students. They included workshops on laboratory experiments from ACS publications (*J. Chem. Educ.*, *ChemCom*, and *ChemMatters*), on ACS computer software and Web-based programs, and on National Chemistry Week (NCW). An important feature of the program was the *Chemists to Classroom* workshop that brought together the chemistry teachers with industrial chemists from the Northeastern Section to discuss the possibilities of classroom visits to connect the high school curriculum with current chemical technology. The workshop leaders were Susan Buta, a chemistry teacher from Lincoln-Sudbury (MA) High School (*Chemists to Classroom);* Jerusha Vogel, a chemistry teacher from Lexington (MA) High School (*Experiment with the ACS*); John Mauch, a chemistry teacher from Belmont (MA) High School assisted by Wallace Gleekman, a chemistry teacher from Oak Hill Middle School (*National Chemistry Week*); and Michael Tinnesand, Head of K-12 Sciences, ACS, Washington, assisted by Daniel Damelin, a chemistry teacher from Lincoln-Sudbury High School (*Integrating ACS Computer Resources into the High School Curriculum).*

The evening program included dinner and a talk by Michael Tinnesand, entitled *Science Teaching Resources from the ACS.* Following his address, several items were raffled, including subscriptions to *J. Chem. Ed.*, affiliate memberships in CHED and NESACS, ACS Chemical Education Division CD's and software, and several ACS logo products such as mouse pads, T-shirts, and mugs. To conclude the program, participants were given a certificate awarding professional development credits and NCW "nanomoles."

The event was supported by the Northeastern Section as well as a minigrant from the ACS Membership Division. The program received material assistance from the ACS, and publicity support from the New England Association of Chemistry Teachers), the Massachusetts Association of Science Supervisors), the Massachusetts Association of Science Teachers, Science Teachers Area Resources Swap and the New England Science Teachers. The Program Conference Committee also wishes to acknowledge the support of the Planning and Program Associates from various high schools and industries. ◇

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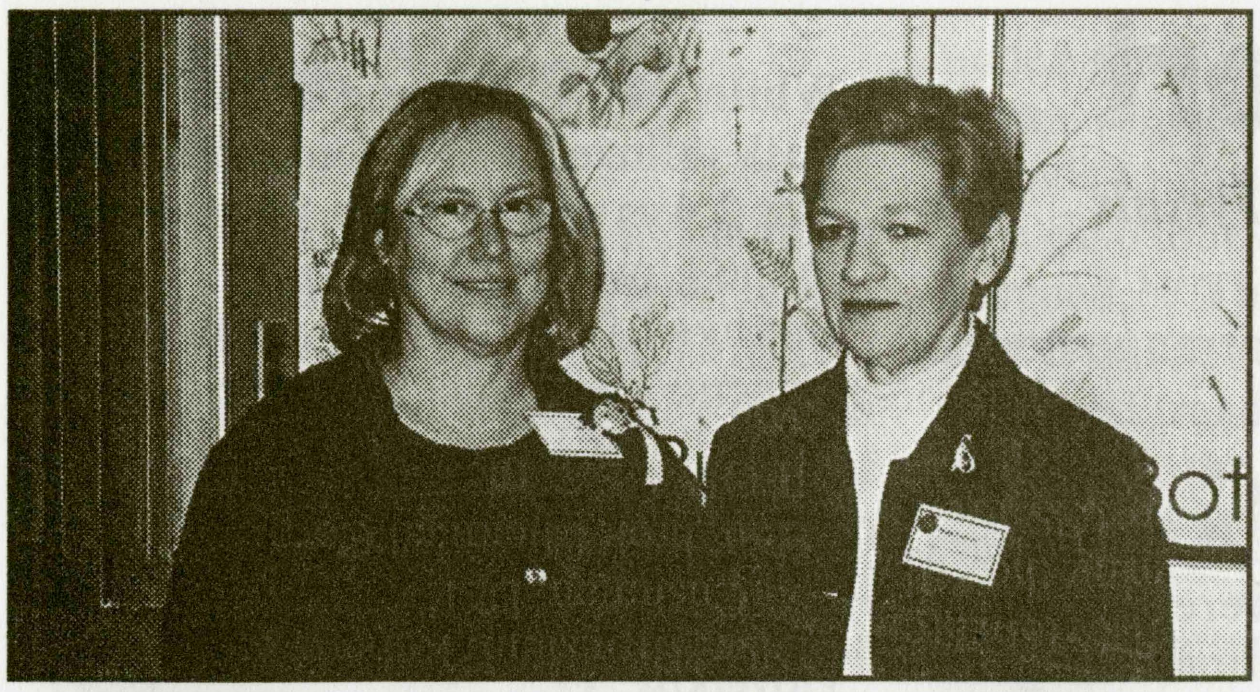
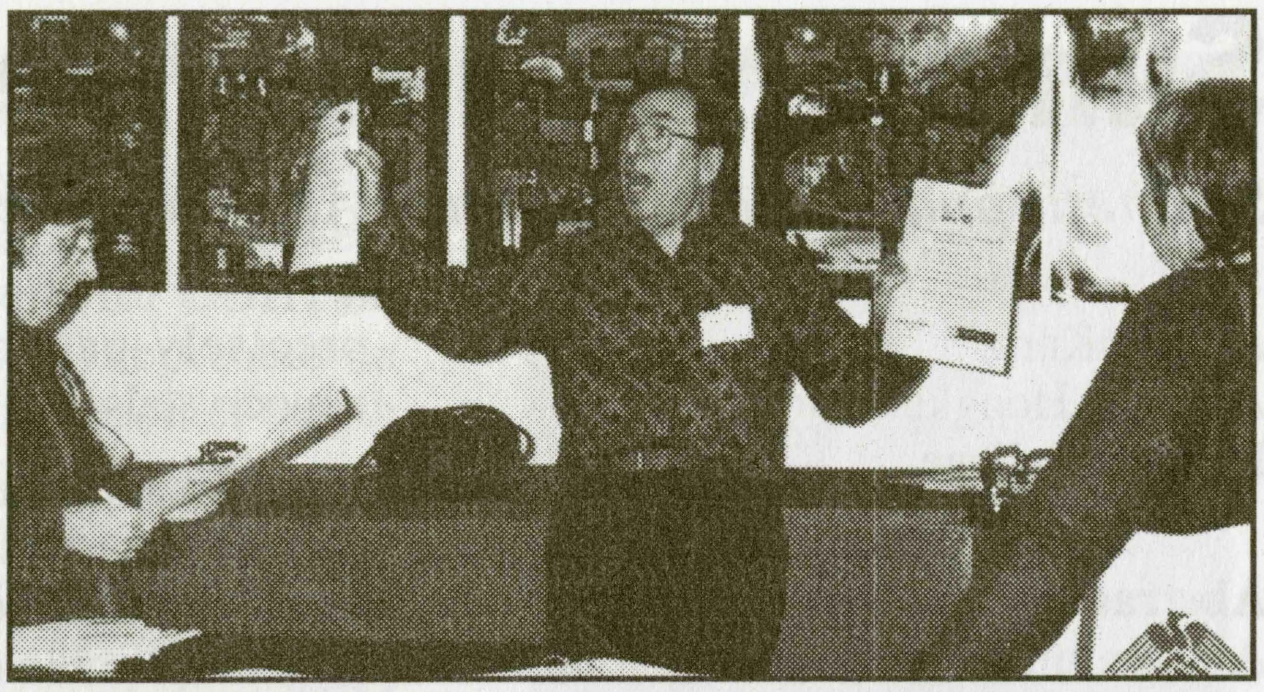
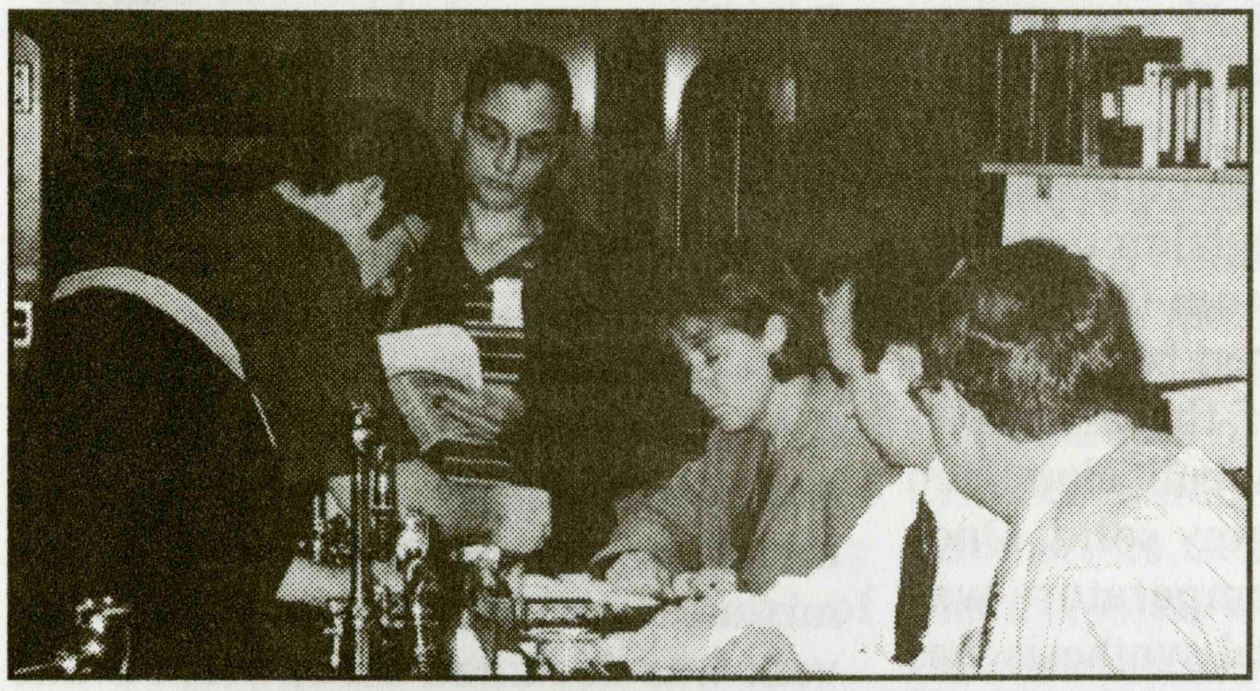


Doris Lewis, Chair, North Eastern Section ACS and Ruth Tanner



Wally Gleekman discussing the National Chemistry Program at the Museum of Science on Nov. 5, 2000



High School teachers trying experiments from ChemCom and the Journal of Chemical Education

"Integrating ACS Compatible Resources into the HS Curriculem" Workshop leader (standing) Michael Tinnesand, Head, Dept. of K-12 Sciences ACS Washington, D.C.

Summer Scholar Report

Synthesis and Characterization of Aluminum Nanocrystals

Andrea Kurtz
Advisor: Hongkun Park
Harvard College

Abstract
Aluminum nanocrystals capped with organic ligands have been synthesized by solution-phase thermal decomposition of trialkylaluminum compounds. Transmission electron microscopy and x-ray diffraction analyses show that nanocrystals with diameters ranging from 2-12 nm can be prepared using this procedure. Nanocrystal size and shape can be controlled by varying the chemical identity and concentration of organic ligands, such as *cis*-9-octadecenoic acid and *cis*-1-amino-9-octadecene. Refinement of this relationship between chemical conditions and uniformity of nanocrystal size will allow for the production of nanocrystal arrays suitable for electron transport studies.

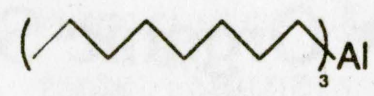
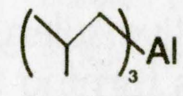
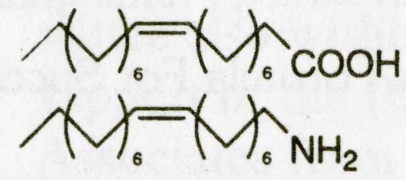
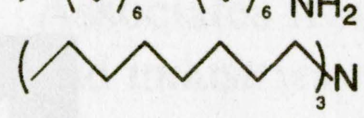
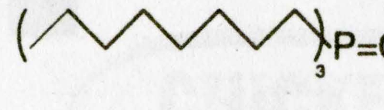
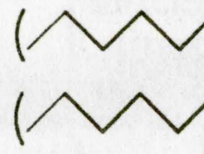
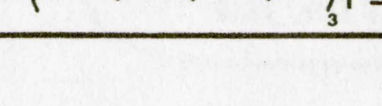
Introduction
Studies of nanoscale objects are currently at the forefront of materials science. These objects represent the building blocks of "bottom-up" assembly of quantum devices because they exhibit properties that are critically dependent on particle size and shape.[1-3] Size selection is therefore a key step in the synthesis of nanometer-sized crystals that can be used to explore the effects of quantum confinement of electrons.

This project uses solution-phase thermolysis of organoaluminum compounds to obtain aluminum nanocrystals suitable for template-directed assembly and electron transport studies. It examines the influence of variables such as reaction time, temperature, and ligand concentration upon nanocrystal size and shape. The production of stable, monodisperse samples is the first step in creating arrays that will allow us to extend single-nanocrystal electron transport studies[4] of superconductivity to a precisely-patterned arrangement of nanocrystals.

Experimental Section
Unless otherwise noted, all preparations and reactions were carried out under anaerobic conditions in a glovebox or under nitrogen with standard Schlenk-line settings.

Preparation of Nanocrystals
The compounds used are shown in Table 1. The thermal decomposition temperatures of trioctylaluminum (**1**) and triisobutylaluminum (**2**) in each solvent were determined by heating a 50 mmol solution of the alkylaluminum compound until bulk aluminum precipitated out as a grey solid. Once the decomposition temperature was established, nanocrystal synthesis was carried out by first adding ligands (**3** and/or **4; 5,** or **6**) and tri-n-octylphosphine oxide (TOPO) (**6**), n-heptadecane (**7**), or di-n-octyl ether (**8**) to a 50 ml, three-necked, round-bottomed flask. The flask was transferred to a Schlenk line, where it was fitted with a condenser, placed on a heating mantle, and flushed with nitrogen. Its contents were then heated no more than 10-15° beyond the thermal decomposition temperature of the trialkylaluminum species in use.

Table1.

Compound	Structure	Boiling point
Alkylaluminum Species		
Tri-n-octylaluminum **1**		—
Triisobutylaluminum **2**		—
Ligands		
cis-9-Octadecenoic acid (oleic acid) **3**		194-195°C
cis-1-Amino-9-octadecene (oleylamine) **4**		348-350°C
Trioctylamine **5**		201-202°C
Trioctylphosphine oxide **6**		365-367°C
Solvents		
n-Heptadecane **7**		302°C
Di-n-octyl ether **8**		286-287°C
Trioctylphosphine oxide **6**		365-367°C

While the ligands and solvent in the flask refluxed, the required amount of **1** or **2** was drawn into a 1.0 ml syringe in the glovebox; the syringe was then removed from the glovebox and its contents were quickly injected into the solution of hot ligands. After being heated at constant temperature for 30 minutes, the flask was removed from the Schlenk line and returned to the glovebox.

Separation of Nanocrystals from Solution
After the completion of a reaction, various solvents, or flocculants, were added to the reaction mixture to precipitate nanocrystals out of the solution. Anhydrous methanol, ethanol, isopropanol, and acetonitrile were the flocculants used in this project. Mixtures containing nanocrystals became turbid upon flocculant addition; these mixtures were centrifuged, and the solvent was decanted off to yield a fine powder that was used to prepare samples for x-ray diffraction and transmission electron microscopy (TEM) analysis.

Results and Discussion
Nanocrystals of various sizes and shapes were produced by a number of different reagent combinations and reaction conditions. Selected results of nanocrystal synthesis by thermal decomposition of triisobutylaluminum in heptadecane are presented in Table 2.

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After it was determined that the reaction conditions in OOH1bi would produce nanocrystals with diameters between 2-4 nm, variables such as reaction time and molar equivalents of ligand were systematically altered to examine their effect on nanocrystal size. Other ligand choices, such as oleylamine or oleic acid alone, were tested. A combination of oleic acid and oleylamine yielded samples of highest monodispersity. This result is most likely due to their complementary affinities for aluminum. Oleic acid binds very strongly and impedes particle growth, whereas oleylamine binds reversibly to the metal, slowing growth but not preventing aggregation of the particles.[2] Variation of the chemical identity of ligands was the primary method of modifying the shape of nanocrystals in this synthetic scheme.

Nanocrystal size was altered by varying the concentration of ligands relative to the amount of alkylaluminum. As the core of a spherical nanoparticle increases, most of the aluminum atoms reside in the particle's interior, rather than on its surface, and so fewer equivalents of oleic acid and oleylamine are needed to coat a larger nanocrystal. As seen in Table 2, ligand concentrations below 0.45 equivalents produced no nanocrystals, giving bulk aluminum instead.

Reaction time was the third variable tested. Reaction length is a significant experimental parameter in nanocrystal synthesis, as it is desirable to separate the stages of crystal nucleation and growth to produce monodisperse products. However, the kinetics of nanocrystal nucleation are not well understood; hence, we used a method of rapid injection into a solution of hot ligands to ensure that the nanocrystal size distribution remained relatively focused.[5,6] The results for OOH14bi and OOH2bi (Table 2) represent an observed trend: as the reaction length increased, the narrowness of the size distribution of the products worsened.

The primary mode of nanocrystal characterization was transmission electron microscopy. Figures 1-4 are TEM images of various reaction mixtures taken on a Philips EM420T analytical electron microscope.

Figures 1 and 2 show nanocrystals produced under two different sets of reaction conditions. TEM imaging allows for the determination of approximate size, shape, and monodispersity of a sample of nanocrystals. Figure 1 shows nanocrystals with 10-12 nm diameters, whereas slightly smaller nanocrystals with diameters of 5-7 nm are present in Fig. 2. Also, a wider size distribution is seen in the sample in Fig. 2. In general, the use of TOPO as both a ligand and a high-boiling solvent produced nanocrystals of poorer quality than other reaction conditions.

A cluster of nanocrystals is shown in Fig. 3; the separation between particles indicates the presence of a ligand shell on the surface of each particle. Figure 4 is a high-magnification image of a spherical nanocrystal from the sample shown in Fig. 2.

The reaction scheme used here is effective for size-selective nanocrystal synthesis. Long-chain organic ligands provide steric bulk and prevent irreversible aggregation of the particles. They also limit growth and protect the nanocrystals from oxidation.[2,3] Current efforts are directed toward producing samples of different sizes and high

Reaction label and Al concentration (M)		Molar equivalents of ligand (oleic acid, oleylamine)	Reaction time	Nanocrystal (NC) size
OOH1bi	4.4	0.5, 0.5	30 min.	4 nm
OOH14bi	4.4	0.5, 0.5	30 min.	2-4 nm
OOH2bi	4.4	0.5, 0.5	100 min.	2-10 nm
OOH6bi	8.4	0.25, 0.25	30 min.	no NCs – bulk Al
OOH7bi	8.4	0.35, 0.35	30 min.	no NCs – bulk Al
OOH8bi	8.4	0.45, 0.45	30 min.	2-10 nm
OOH9bi	8.4	0.55, 0.55	30 min.	5-12 nm

Table 2. Reaction conditions and results for the thermal decomposition of triisobutylaluminum in heptadecane at 270 ° C

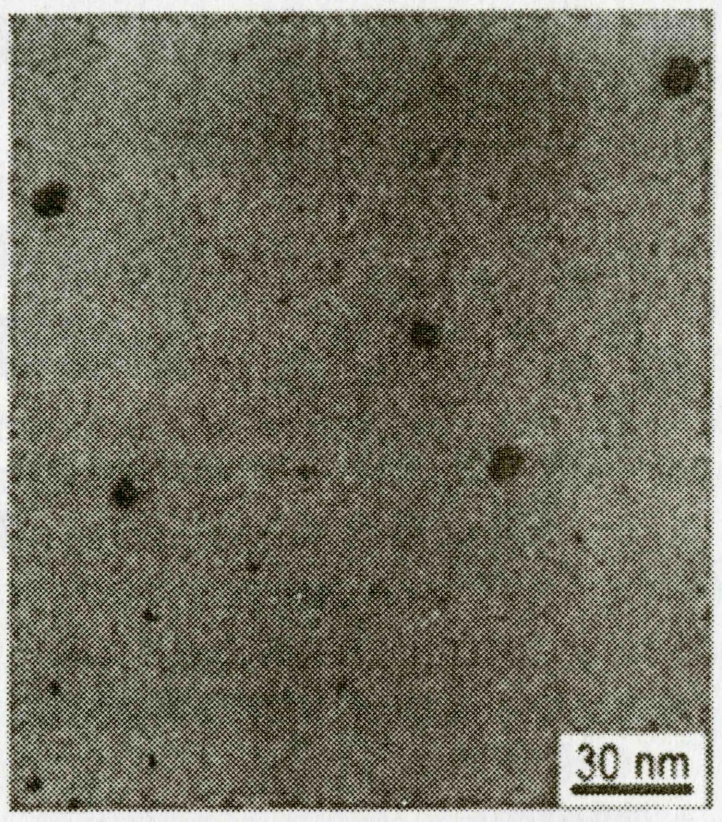

Fig. 1. Al NCs in heptadecane, capped with oleic acid

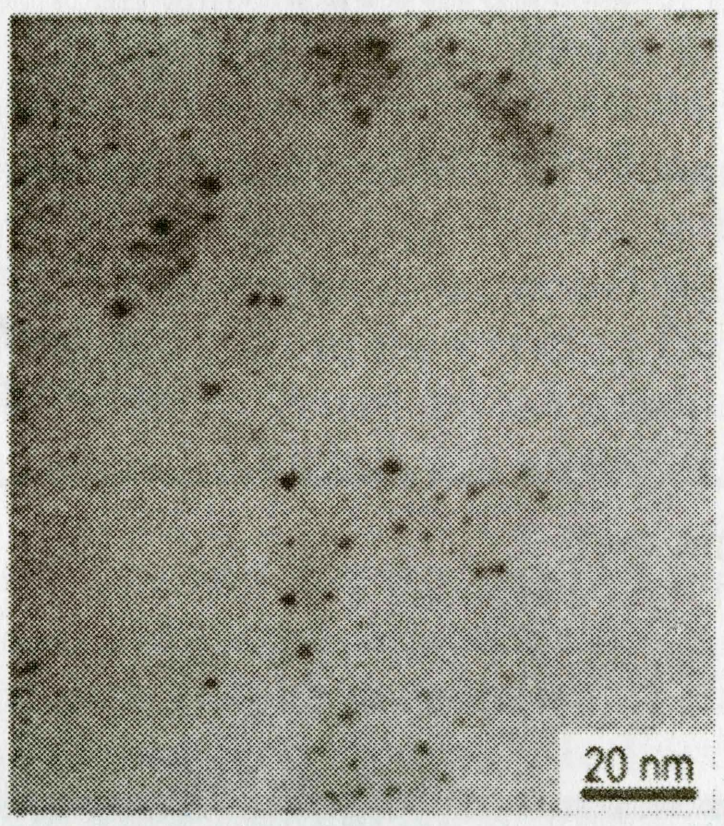

Fig. 2. Al NCs in tri-n-octylphosphine oxide.

monodispersity to be used in x-ray diffraction line-broadening studies and high-resolution transmission electron microscopy.

Conclusion

Aluminum nanocrystals have been synthesized by thermal decomposition of trialkylaluminum compounds in various mixtures of ligands and high-boiling solvents. Nanocrystals of different sizes, ranging from 2-12 nm, have been obtained by varying the relative concentration of ligands and reaction time. Ongoing efforts are directed at finding reaction conditions that will produce nanocrystals of uniform size and shape. With the production of monodisperse samples, template-based assembly methods using DNA-modified nanocrystals[6] will be used to create arrays of aluminum nanocrystals suitable for electron transport studies. The result will be the development of

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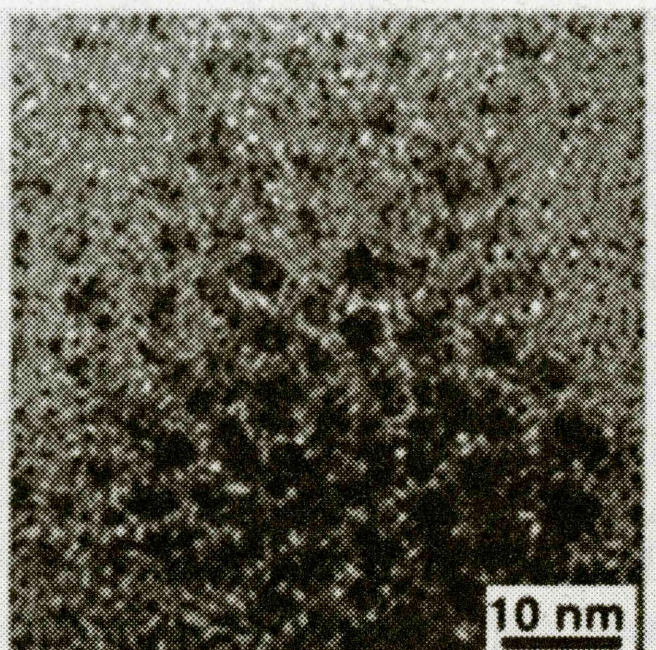

Fig. 3. A cluster of A1 NCs in tri-n-octylphosphine oxide

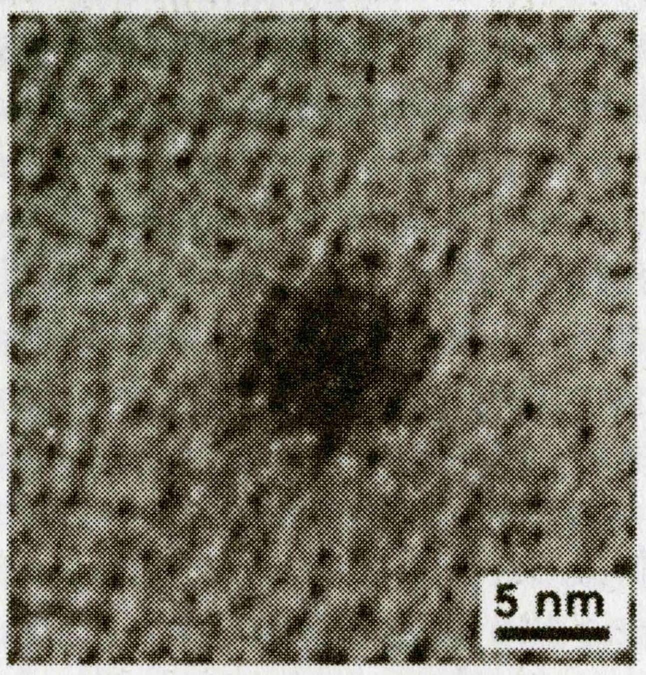

Fig. 4. High-magnification image of A1 NC from sample in Fig. 2.

both a tool for probing the fundamental nature of superconductivity and a technique for fabricating nanoscale elements of future electronic devices.

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Acknowledgments

I thank the Northeastern Section of the American Chemical Society and the Harvard University Materials Research Science and Engineering Center for financial support, and Professor Hongkun Park and Jeffrey Urban for helpful discussions and experimental assistance. ◇

The Foundation of the Metric System in France in the 1790s*

The Importance Of Étienne Lenoir's Platinum Measuring Instruments

By William A. Smeaton, Ely, Cambridgeshire, United Kingdom

On 22nd July 1799 the definitive standards of the metric system, the platinum meter and the platinum kilogram, were ceremonially deposited in the French National Archives (1), and on 10th December 1799 a law was passed confirming their status as the only legal standards for measuring length and mass in France (2). The accurate determination of these standards had occupied a number of outstanding French scientists for ten years, using elaborate equipment partly made from platinum by Étienne Lenoir, a skilled instrument maker. This work had been undertaken after more than a century of discussion. The events surrounding this momentous occasion which now affects all our everyday lives are described here.

Before the Revolution in 1789, France, like most European countries, used weights and measures derived from those of the Romans. The standard weight was the pound of 16 (sometimes 12) ounces which in France was divided further into 8 gros, each of 72 grains. The unit of length was the foot of 12 inches, each divided into 12 lines, though for many purposes a longer unit was preferred — such as the French toise of 6 feet or the British yard of 3 feet. However units with the same name varied in size from country to country for example, the French pound and foot were each larger than their British equivalents. In Britain most standards had been fixed nationally since the sixteenth century, but in France there were many local variations. This situation caused difficulties for internal and international commerce, made worse by the need to calculate in twelfths, sixteenths or other fractions when converting from one system to another.

When the metric system was first introduced all units were divided decimally, making calculation easier. However, this had become possible only in the late Middle Ages, after 'Arabic' numerals, probably of Indian origin, began to replace Roman numbers. Arabic numerals became common about 1500, but it was not until 1585 that Simon Stevin, a Flemish mathematician showed in his book, "De Thiende", how fractions could be expressed in Arabic numerals using a decimal point. His book was soon translated into French, with an English translation, "Disme: The Art of Tenths", appearing in 1608. As well as explaining decimal arithmetic, Stevin advocated the decimal division of weights, measures and currency (3).

Other mathematicians adopted the decimal fractions. In 1656 in England, Robert Wood, of Oxford, proposed to Oliver Cromwell, the Lord Protector of the Commonwealth after the execution of King Charles I, that the pound sterling should be divided into 'tenths, hunds and thous', but no action was taken and Britain, like other countries, retained a currency with awkward divisions, complicating international trade (4). Wood's interest, however, was solely with currency.

A Decimal System of Measures

The Seconds Pendulum: A Standard Length

An early proposal for a decimal system of measures came in 1670 from a Frenchman, Gabriel Mouton (1618—1694), a parish priest in Lyons with a good knowledge of astronomy and mathematics. He deplored the variety of units of length and proposed a natural unit based on the size of the Earth. This was the length of a minute (a sixtieth of a degree) of longitude, to be called the 'mille' and divided into tenths, hundredths and so on. One thousandth of a mille was called the 'geometric foot' and Mouton suggested that a pendulum of this length set up in Lyon, which would oscillate 3,959.2 times in 30 minutes, would be a convenient and easily verified standard of length.

Mouton's work was known in Paris, where Jean Picard (1620—1682), an astronomer at the Observatory, proposed that the length of a pendulum beating seconds in Paris should he the standard (the seconds pendulum). One third of this, to be called the 'universal foot', would differ only slightly from the existing Paris foot. However, Picard did not advocate its decimal division. By now it was suspected that the Earth was not a perfect sphere and that the length of both a degree of longitude and the seconds pendulum (which depends on its distance from the center of the Earth) might vary from place to place (5). This later became an obstacle to international acceptance of the metric units determined in France.

Varying Standards of Mass

During the eighteenth century the lack of an international system of weights and measures affected the development of science as well as commerce. In 1783, for example, James Watt, an amateur chemist as well as an engineer, complained to the chemist Richard Kirwan that he found it difficult to compare some of Kirwan's quantitative results with those of Antoine Laurent Lavoisier (1743—1794), the French chemist, because both had used units with different values. Watt proposed that all chemists should adopt the same pound, preferably that of Paris which was the most widely used in Europe, and that it should be divided decimally (6). In 1789 Lavoisier published his book, *Traité élémeritaire de chimie*, which marked the origin of modern chem-

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* Reprinted with permission from *Platinum Metals Review*, **2000,** *44* (3), 125-134.
Note: Several figures have been omitted

Metric System

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istry. Quantitative data are present in abundance and in its English edition, *Elements of Chemistry* (1790), the translator, Robert Kerr, added an appendix with rules for the conversion of French units to British, see Figure1. It is noteworthy that Lavoisier expressed some weights as decimal fractions of a pound, as well as the ounces and grains that he had measured in the laboratory.

Commission of Weights and Measures

In France, public discontent with many aspects of life in an absolute monarchy forced King Louis XVI and his government to call elections to the States-General, the only elected parliamentary body, for the first time in 175 years. It met in May 1789 with the new name of National Assembly and assumed the powers of government. Although the Assembly received many complaints about the lack of uniform weights and measures, it was unable to act immediately. In June 1789 the Paris Academy of Sciences independently appointed several members to a Commission of Weights and Measures, with the task of producing a national system. However, as no progress had been made by May 1790, the Assembly formally asked the Academy to act and provided the necessary funds. One member of the Assembly with a special interest in the project was Charles Maurice Talleyrand (1754—1838). He was not a scientist but was almost certainly advised by members of the Academy. He favored a system based on the length of the seconds pendulum, with the unit of weight defined as the weight of water filling a cube of side equal to a specified fraction of that length. He did not, however, recommend the decimal division of the new units. Talleyrand hoped that the system would be adopted by other countries and proposed that the pendulum should be measured at a place that would be internationally acceptable: sea level half-way between the North Pole and the Equator. This was the 45th parallel, which conveniently crossed the French coast near Bordeaux.

RULES *for converting French Weights and Meafures into correfpondent Englifh Denominations* *.

§ I. *Weights.*

The Paris pound, poids de mark of Charlemagne, contains 9216 Paris grains; it is divided into 16 ounces, each ounce into 8 gros, and each gros into 72 grains. It is equal to 7561 Englifh Troy grains.

The Englifh Troy pound of 12 ounces contains 5760 Englifh Troy grains, and is equal to 7021 Paris grains.

The Englifh averdupois pound of 16 ounces contains 7000 Englifh Troy grains, and is equal to 8538 Paris grains.

To reduce Paris *grs.* to Englifh Troy *grs.* divide by . . . To reduce Englifh Troy *grs.* to Paris *grs.* multiply by . .	1.2189
To reduce Paris ounces to Englifh Troy, divide by . . . To reduce Englifh Troy ounces to Paris, multiply by . .	1.015734

* For the materials of this Article the Tranflator is indebted to Profeffor Robertfon.

Fig. 1 The first of Kerr's conversion tables in A.L. Lavoisier's "Elements of Chemistry", translated by Robert Kerr, William Creech, Edinburgh, 1790, p.485. Professor Robertson has not been identified. English avoirdupois weights were generally used in commerce; troy weights, used for pharmaceuticals and bullion, were preferred by most chemists

Discussion in Other Countries

The reform of weights and measures was also discussed in the British Parliament, and in July 1789 Sir John Riggs Miller (c.1730-1798) advocated a system based on the length of the seconds pendulum at the latitude of London. When he raised the subject again early in 1790 Talleyrand wrote to him, proposing that Britain and France might collaborate, but Miller's plan was not put to the vote before the dissolution of Parliament on 10 June 1790. Miller lost his seat at the ensuing election and the matter was not raised again in Parliament. At Talleyrand's suggestion the National Assembly made a direct approach to the British government, but on 1 December 1790 the Foreign Secretary informed the French Ambassador in London that the proposed collaboration was not practicable (7).

In 1785 the United States of America, soon after becoming independent from Britain, adopted a decimal currency, and by 1790 Congress was considering a decimal system of measures based on the pendulum. This was proposed by the Secretary of State, Thomas Jefferson, who had an interest in science, but after much discussion it was decided to retain the British weights and measures (8). Spain was the only country at this time to show an interest in the French proposals.

The Meridian as a Preferred Standard

Back in France, in September 1790, the Academy of Sciences instructed several members to determine the length of the seconds pendulum and the measures derived from it, but before work was started there was a dramatic volte-face. On 16 February 1791, acting on a proposal by Jean Charles Borda (1733—1799), the Academy appointed a new five-member committee to re-examine the proposed fundamental unit of length and on 19 March they reported that they favored a unit equal to a ten-millionth of the Earth's quadrant, the part of the meridian from the North Pole to the Equator, measured at sea level, and this unit and the units of weight and volume derived from it were to be divided decimally. No explanation was given for the rejection of the pendulum, which had been the preferred unit for more than a century. The academicians pointed out that the Paris meridian passed almost exactly through Dunkirk, on the north coast of France, and only a short distance from the Spanish city of Barcelona, both at sea level, which differed in latitude by 9 degrees and 40 minutes, just over a tenth of the quadrant. The latitudes could be determined by astronomers with the best available instruments and the linear distance by the well established method of triangulation, starting from a carefully measured base line. The total length of the quadrant could then be calculated and the fundamental unit derived from it.

Much of the meridian had been measured in the 1740s, when a large-scale map of France was being prepared, and since then surveying instruments had been improved. Borda, an engineer with a distinguished naval

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career as a navigator, had recently perfected his repeating circle, which in skilled hands enabled celestial or terrestrial angles to be determined to within a tenth of a second of circular measure. There have been suggestions that the desire of the Academy to demonstrate its effectiveness may have been partly responsible for the abandonment of the pendulum as a standard (9). However, as well as measuring the meridian, the Academy decided to determine very accurately the length of the seconds pendulum at Paris, and the task was undertaken by Borda and Jean Dominique Cassini (1748.-1840), director of the Paris Observatory. They completed it in the summer of 1792, before the meridian survey was started. The archives of the Academy are sparse for this period, so nothing is known about any discussions that went on behind the scenes, but it is possible that the measurement of the meridian was intended to draw attention to the importance of the Academy at a time when, like many institutions of the old regime, it was under attack from extreme revolutionaries (10).

Construction of the Apparatus

The apparatus used by Borda and Cassini was constructed by Étienne Lenoir (1744-1825), an instrument maker, born in Mers, a village near Blois in the Loire valley. After being apprenticed to a locksmith he worked in that trade until 1772. He then found employment with a mathematical instrument maker in Paris and studied mathematics by attending one of the free courses available to craftsmen. He set up his own business, supplying specialized astronomical instruments of high quality to leading scientists as well as making mathematical instruments for a larger market, and around 1784 he collaborated with Borda in perfecting the repeating circle (11). His close association with Borda made him an obvious choice to construct the pendulum apparatus at the Observatory, Figure 2. This consisted of a platinum sphere about 1.5 inches in diameter of mass 9911 grains (526.1 g) which was suspended by a fine iron wire about 12 feet long. This oscillated with a half-period of about 2 seconds. As air resistance affected the period, platinum was chosen because it was the metal with the highest specific gravity and thus occupied the smallest volume for a given mass. In order to eliminate errors arising from irregularities in the shape of the sphere, which would alter its center of gravity, it was, with the aid of a little grease, fitted into an inverted hemispherical copper cup at the end of the wire so that readings could be taken with the sphere in several positions and a mean result calculated.

The wire was suspended in front of the pendulum of a clock beating seconds, and the period of oscillation was determined by an observer who noted the number of seconds between the times when the wire and pendulum coincided, and divided this interval by the number of oscillations. The apparatus was enclosed in an airtight case which had a glass pane through which observations were

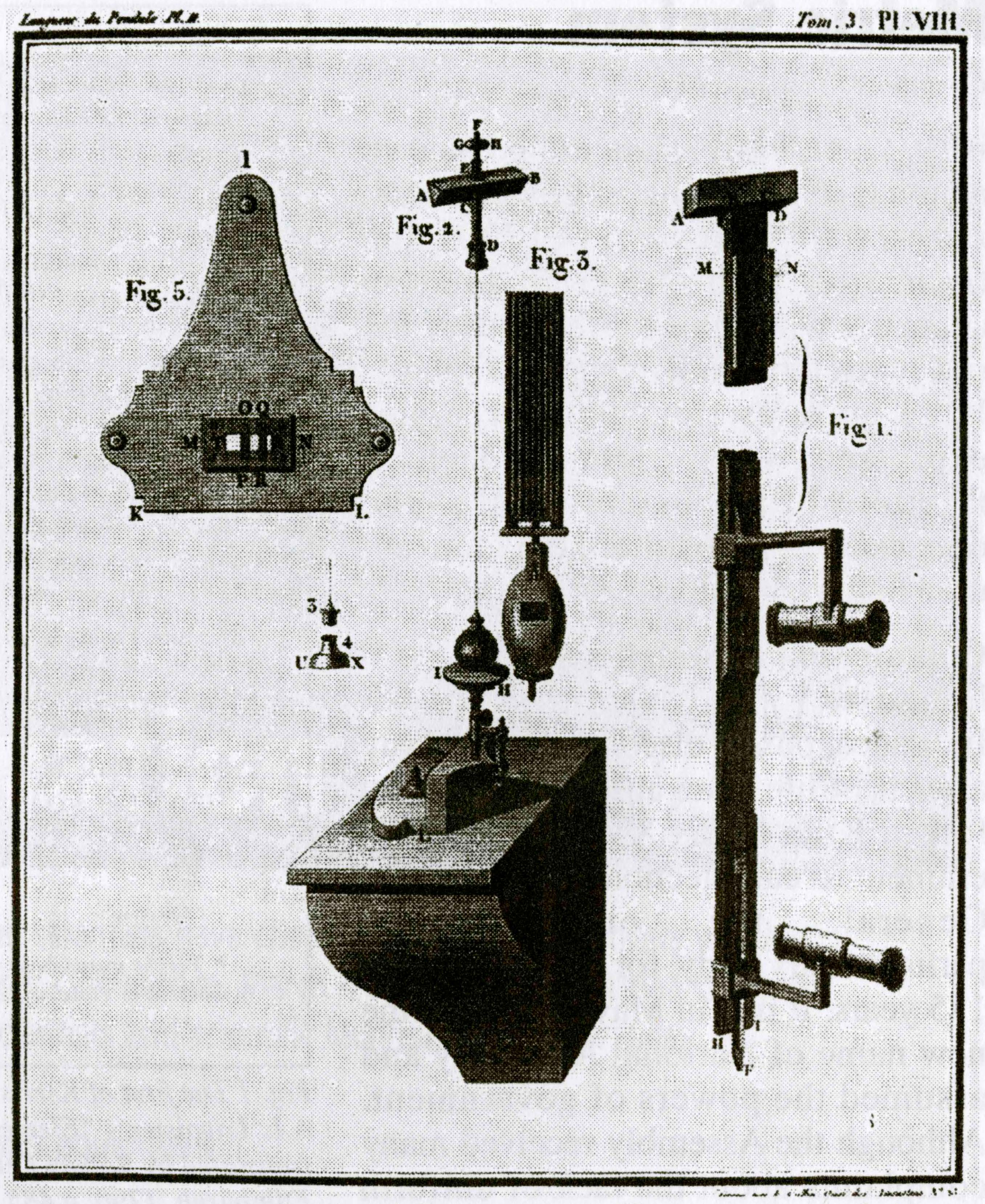

Fig. 2. Some parts of the pendulum apparatus. The measuring scale is on the right,. (Fig. 1). The metallic thermometer can be read through the upper microscope, while the vernier on the platinum scale can be read through the lower microscope (14)

made with a telescope and, as the aim was to determine the length of the seconds pendulum in a vacuum, allowance was made for variations in air temperature and pressure. There were other minor but significant corrections (12).

The total length of the wire and sphere was measured by means of a platinum scale about 12 feet long constructed by Lenoir. Like the sphere it was made of malleable platinum supplied by Marc Étienne Janety (1739-1820), who had recently perfected his process for its large-scale production (13). The scale, 6 lines wide and 1 line thick, was covered by a slightly shorter copper scale to which it was firmly attached by screws at one end. The metals had different coefficients of thermal expansion, so after calibration the device served as a metallic thermometer as well as a measuring instrument, see Figure 2. The platinum scale was finely ruled by Lenoir. At one end a graduated platinum tongue, sliding in a groove, made it possible to vary the total length, and a vernier scale enabled measurements to be made to within 1/116 line. Corrections were made not only for thermal expansion of the scale but also for its elongation under its own weight. After 20 sets of observations the length and period of oscillation of the wire and sphere were established, and from these figures the length of the seconds pendulum was calculated as 440.5593 lines (99.49 cm) (14). It is interesting to note that at this time the importance of the number of significant figures was not understood.

Borda and Cassini performed these experiments

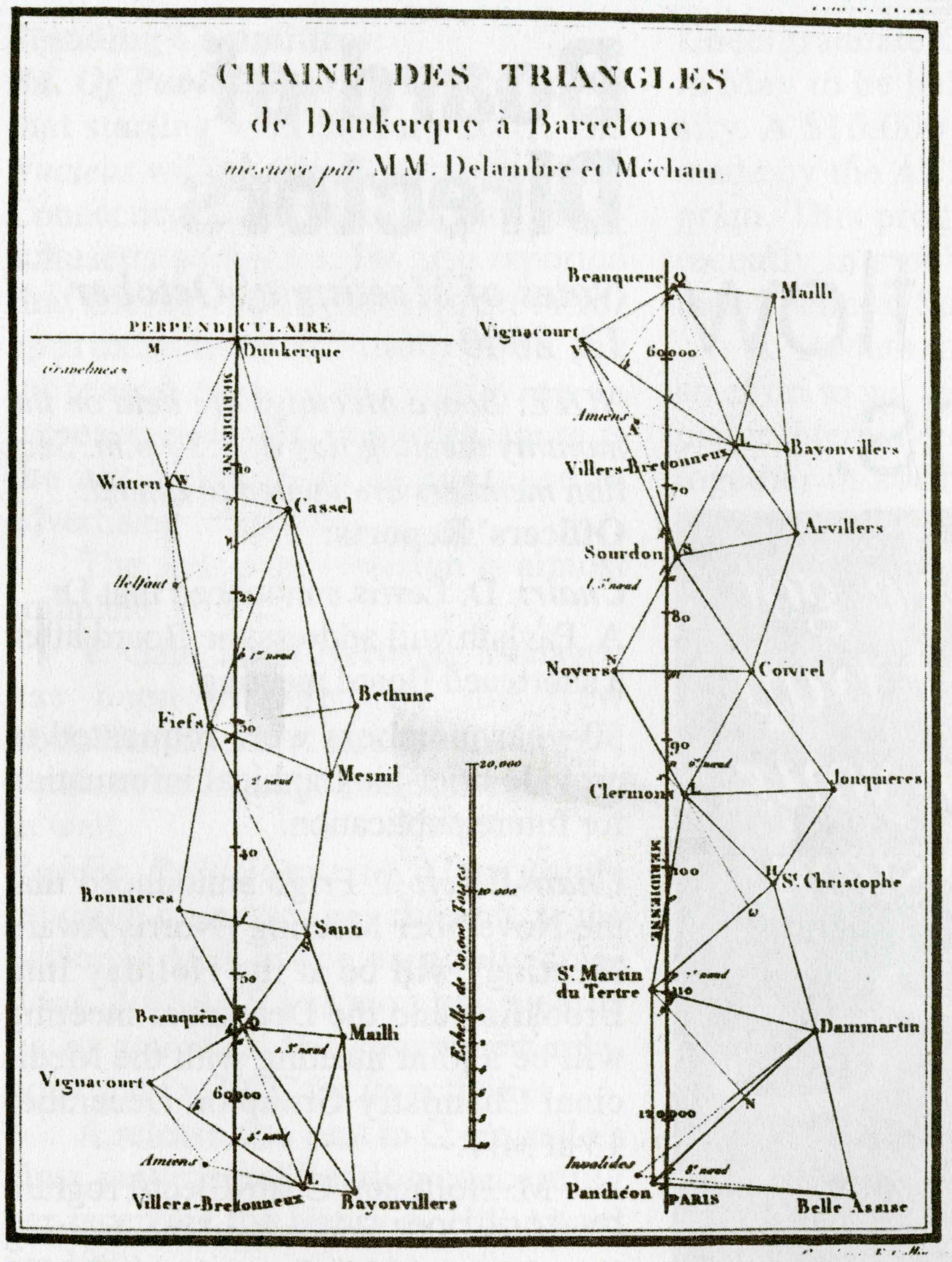

Fig. 3 The Northern part of the triangulation, from Dunkirk to Paris. In Paris the meridian is still marked on the floor and on the grounds of the Observatory. There were over one hundred triangles measured. The base lines for the northern triangles as Melun (south of Paris) and at Perpignan, respectively, were about 36,000 ft. long. The rods had to be moved about 3,000 times for each base line, then accurately aligned and measured (14)

between 15 June and 4 August 1792, but before work could begin on the meridian survey new instruments had to be made, and there was much work for Lenoir and his assistants, who probably numbered fewer than ten. Fifteen months were required for the construction of the four repeating circles needed by the two teams of surveyors. As Lenoir had experience of making parabolic mirrors for lighthouses he was asked to provide several powerful lamps to enable the surveyors to signal to each other at night or in fog. More importantly, he made four platinum and copper measuring rods similar in size and design to the rule used in the pendulum experiments.

Since the surveyors would have to work in all weathers the thermal expansion of the rods was significant. Borda therefore collaborated with Lavoisier, Treasurer of the Academy and a leading member of the Commission of Weights and Measures, in determining with great accuracy the coefficients of expansion of platinum and copper. At Lavoisier's house they measured very small changes in length by means of an accurate comparator, designed and made by Lenoir, who took part in the work. The work was done between 24 May and 5 June 1793 (15, 16). Being very thin and narrow (see above), the 12-feet long platinum rods had to be handled with great care. Each rested in a shallow groove cut in a wooden plank, and in use was covered by a wooden roof and cloth curtains to protect it from sunlight and minimize expansion and contraction. The planks bearing the rods were each mounted on two tripods, with elaborate precautions to ensure that they remained horizontal.

Dunkirk to Barcelona

The survey from Dunkirk to Barcelona required the accurate measurement of more than a hundred triangles from two base lines, near Melun, south of Paris, for the northern part and Perpignan for the southern, see Figure 4. The teams of surveyors, led by Jean Baptiste Joseph Delambre (1749-1820) in the north and by Pierre François André Méchain (1744-1804) in the south, took seven weeks to measure the base lines, each approximately 36,000 feet long and requiring about 3,000 movements of the platinum rods. At each movement two rods had to be precisely aligned, put in exact contact by adjustment of the sliding tongue on one of them, and then measured. Wherever possible the corners of the triangles were high points such as hilltops or church towers, and all the measured distances had to be corrected to allow for variations in height and the curvature of' the Earth.

Not surprisingly, the field work and ensuing calculations required far more time than was anticipated, and the surveyors were also handicapped by the fact that after the execution of Louis XVI in January 1793 the French Republic was at war with most of Europe. With their unfamiliar instruments they were sometimes thought to be spies and were harassed by the local population.

In 1794, even though the work was far from complete, the National Convention, the republican successor to the Assembly, wanted to introduce the new weights and measures and the decimal system as soon as possible. Therefore a provisional value for the ten-millionth of the Earth's quadrant was calculated from the results of the survey done in the 1740s and from the best available figures for the latitudes of Dunkirk and Barcelona. This unit, equal to 3 feet 11.44 lines, was named the 'meter', from the Greek 'metron' (measure). After some discussion the Greek prefixes, 'deca', 'kilo' and so on were adopted for multiples of the meter and Latin prefixes such as 'deci' and 'milli' for sub-multiples. These had been proposed by Claude Antoine Prieur (1763-1832), a former engineering officer who was an early advocate of decimal units and was now a member of the Convention (18). Some time was needed for agreement to be reached about names for the other units, but eventually the cubic decimeter became the 'liter' and the weight of a cubic centimeter of water at its temperature of maximum density was named the 'gram' [named in French mètre, litre, gramme, respectively].

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Board of Directors

Notes of Meeting of October 12, 2000

NOTE: Board Meetings are held on the monthly meeting day at 4:30 p.m. Section members are invited to attend.

Officers' Reports:

Chair: D. Lewis announced that Dr. A. Pavlath will address the Board after a shortened Board meeting.

50-year members were requested to provide brief biographical information for future publication.

Chair-Elect: T. Frigo announced that the November Meeting (Norris Award Meeting) will be at the Holiday Inn, Brookline and the December meeting will be a joint meeting with the Medicinal Chemistry Group on December 13 at MIT.

M. Hoffman, Chair-Elect/Program Chair for 2001 announced the meeting line-up for 2001: January 11, 2001: Joint Meeting with Younger Chemists Committee – a Career Workshop in the afternoon. February 8: MIT Faculty Club, Dr. Jeffrey Steinfeld (MIT). March 8: At Arqule in Woburn, to be joint-sponsored with Am. Institute of Chemical Engineers and the Soc. of Pharmaceutical Engineers. April 19 will be the Esselen Award Meeting at Harvard, May 10, Education Night, at Boston Univ. with Dr. John Fortman (Wright State Univ.)

Secretary: M. Singer thanked M. Hoffman to be the first to submit a written report prior to the board meeting and encouraged other Board members also to submit written reports for circulation prior to the board meeting.

Treasurer: J. Piper presented the September Report which was ACCEPTED. J. Piper MOVED that the Treasurer's budget be increased by $5,000 to cover the costs of the 1999 CPA audit required by the Commonwealth, to be taken from current cash surplus. The motion was PASSED

Archivist: M. Simon is still searching for a permanent home for the archives.

Standing Committees:
Bd. Of Publications: J. Billo reported that starting with January 2001, *The Nucleus* will be sent to members of the Connecticut Valley Section with Massachusetts addresses. He also reported that the 2001 budget request is for approximately $65,000. With the increased readership, justifying an increase in advertising rates, there is the anticipation of an increase in advertising revenue.

The web-page redesign is almost complete.

V. Gale, the Advertising Manager, has been engaged by the New York/North Jersey, and the California Sections to manage their advertising, as well.

Public Relations: M. Chorghade reported on personnel changes at the national ACS office on public relations. NESACS has won two awards for its activities: For government relations and the YCC for its activities.

A release was sent to C. Costello's alma mater's publication concerning her receiving the Henry A. Hill Award for 2000.

Career Services presentations are scheduled at Suffolk Universitt and Georgetown University.

Chemistry Education: M. Hoffman, reporting for R. Tanner stated that the October 19 meeting for High School Teachers is in place, with the theme:"Making Connections with Chemists" The meeting is oversubscribed with over 100 registrants. M. Tinnesand from the National ACS K-12 Resource Office will be on the program. Also, the ACS Membership Division is providing $1000 to fund new memberships awarded at the meeting.

The 9th Annual Northeast Student Chemistry Research Conference will be held November 4, 2000 at Boston University, with B. Shakhashiri as keynote speaker on the joys of teaching (with chemical demonstrations).

M. Strem announced that there will be a German Chemical Society Student Exchange Program, with 10-15 students and 3-5 faculty mentors arriving April 28, 2001 for one week. The students will participate in the Undergraduate/Graduate Conference in May to be held at Boston University. A $10,000 minigrant has been made by the ACS to support the program. This program was announced recently in a publication of the German Chemical Society.

A. Pavlath mentioned that there is an effort to get the presidents of the six major international chemical societies together in 2001 to discuss issues of importance to chemists worldwide.

Local Arrangements: M. Burgess reported that arrangements were in place for the meeting tonight: H.A. Hill Award, 50-year member recognition, and address by Dr. Pavlath.

Other Committees:
Natl. Chemistry Week: D. Lewis reported for W. Gleekman that events will be centered at the Boston Museum of Science, featuring:
"Science is Fun" demonstrations by B. Shakhashiri and a Chemistry Passport Program hosted by the **Younger Chemists Committee**, in coordination with museum staff.
An award will be made for the High School class offering the most interesting Periodic Table.

Old Business: M. Strem announced that the Mass. Chemical Technology Alliance (see minutes of the September Board meeting) has advertised National Chemistry Week in its publication.

From the minutes of M. Singer ◇

Meeting Schedule 2001

January 11 – Holiday Inn, Brookline
February 8 – MIT Faculty Club
March 8 – ArQule, Woburn
April 19 – Harvard University
May 10 – Boston University
September 13 – location TBA
October 11 – Henderson House, Weston
November 8 – location TBA
December 13 – location TBA ◇

The Way it Was

Some thoughts on changes in the last 100 years.

by Arno Heyn

Quantitative Analysis

The Course which put fear into students' hearts!

Do you remember WEIGHING, TITRATING, scraping the last little bit of a precipitate from a beaker with a "rubber policeman"?

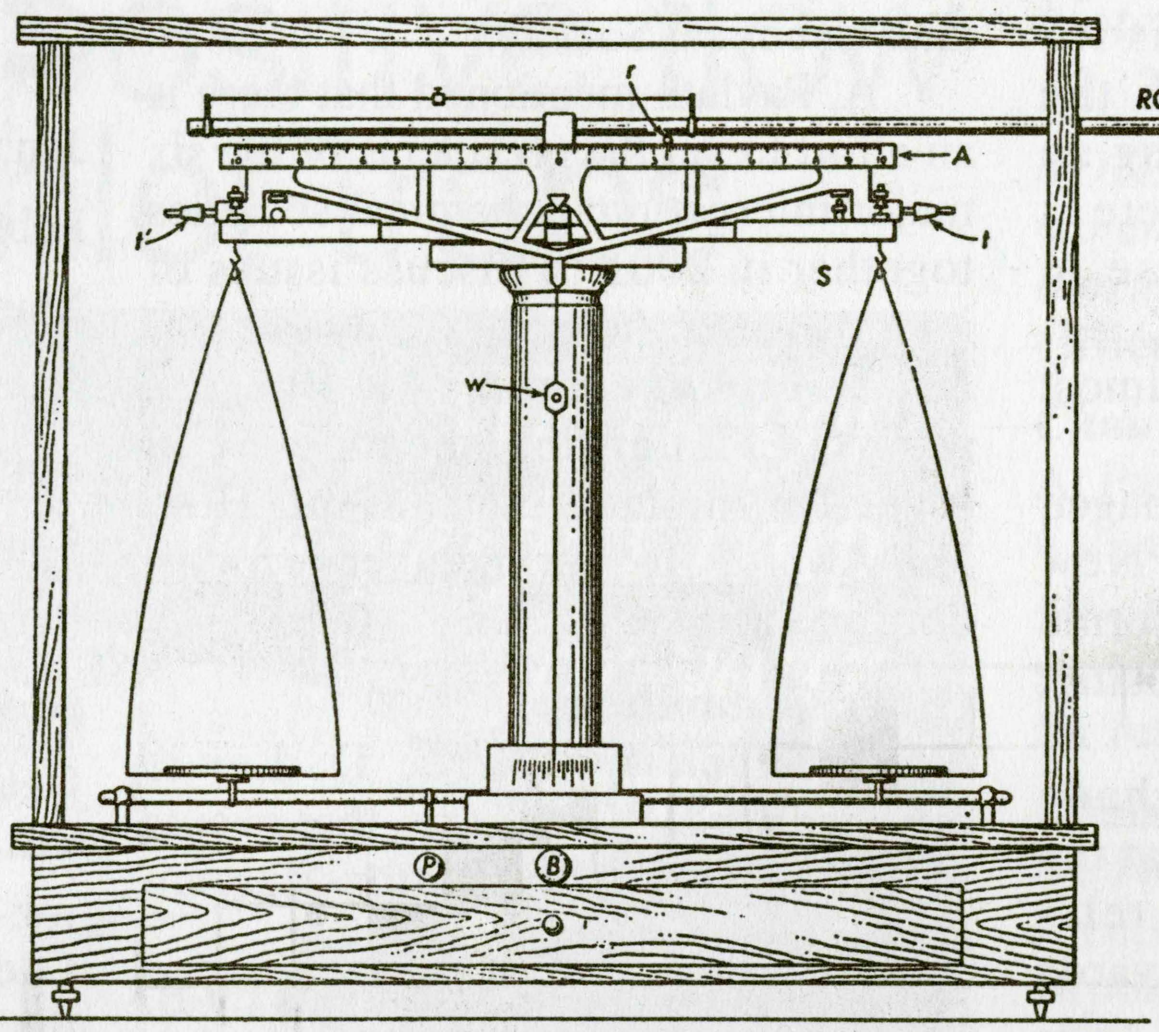


Fig. 3-1. Analytical balance.

I taught "quant" for over 40 years, first as an undergraduate assistant at the University of Michigan, then as a graduate teaching fellow, and after an interim in industry during the war, at Boston University.

Chemistry as an exact science couldn't have arisen if it hadn't been for good quantitative work by early chemists, and, at the basis of it all, was the means of measuring mass accurately, i.e. precision balances.

By the early 19th century, instrument makers had perfected accurate balances which remained pretty much unchanged until they were replaced after the middle of the 20th century by electronic balances, such as the Mettler balance.

The earlier balances were equal-arm balances on agate knife-edges, enclosed in a tight case to avoid errors from air currents. They had a long pointer which moved over a calibrated scale as the balance oscillated about the equilibrium point.

Having a 200 g capacity, one could weigh to within 0.1 mg, and with more delicate semimicro balances to 0.01mg, or microbalances, to 0.001 mg, at a total capacity of 20g. Do you remember taking down swings – two readings on one side and one to the other side, averaging, subtracting, etc. to get the exact reading while moving the 10 mg "rider" along the graduated beam to get to the last 0.1 mg? The average student required 10 minutes for a weighing, and often there was a line-up to use your balance, because, for consistency, you had to do the weighings of the sample and the resulting precipitates for an experiment with the same balance. At the start of the course, do you remember the excitement of being issued your own set of weights in its little polished wood box, with its shiny brass weights from 1 g to 50 g, and the small plastic insert tray with the fractional weights from 10 mg to 500 mg, all to be handled with the ivory- tipped tweezers in the set?

Gravimetric methods gave a unique satisfaction in actually having a presumably pure substance you could weigh to get your analysis; it was there, it was real.

But, it was slow, it was laborious, it required skill and patience. That was the time when an extremely meticulous chemist, such as T.W. Richards, could get a Nobel Prize based on the skill, unending patience, and attention to detail he and his students applied to analytical methods for establishing atomic weights of many elements.

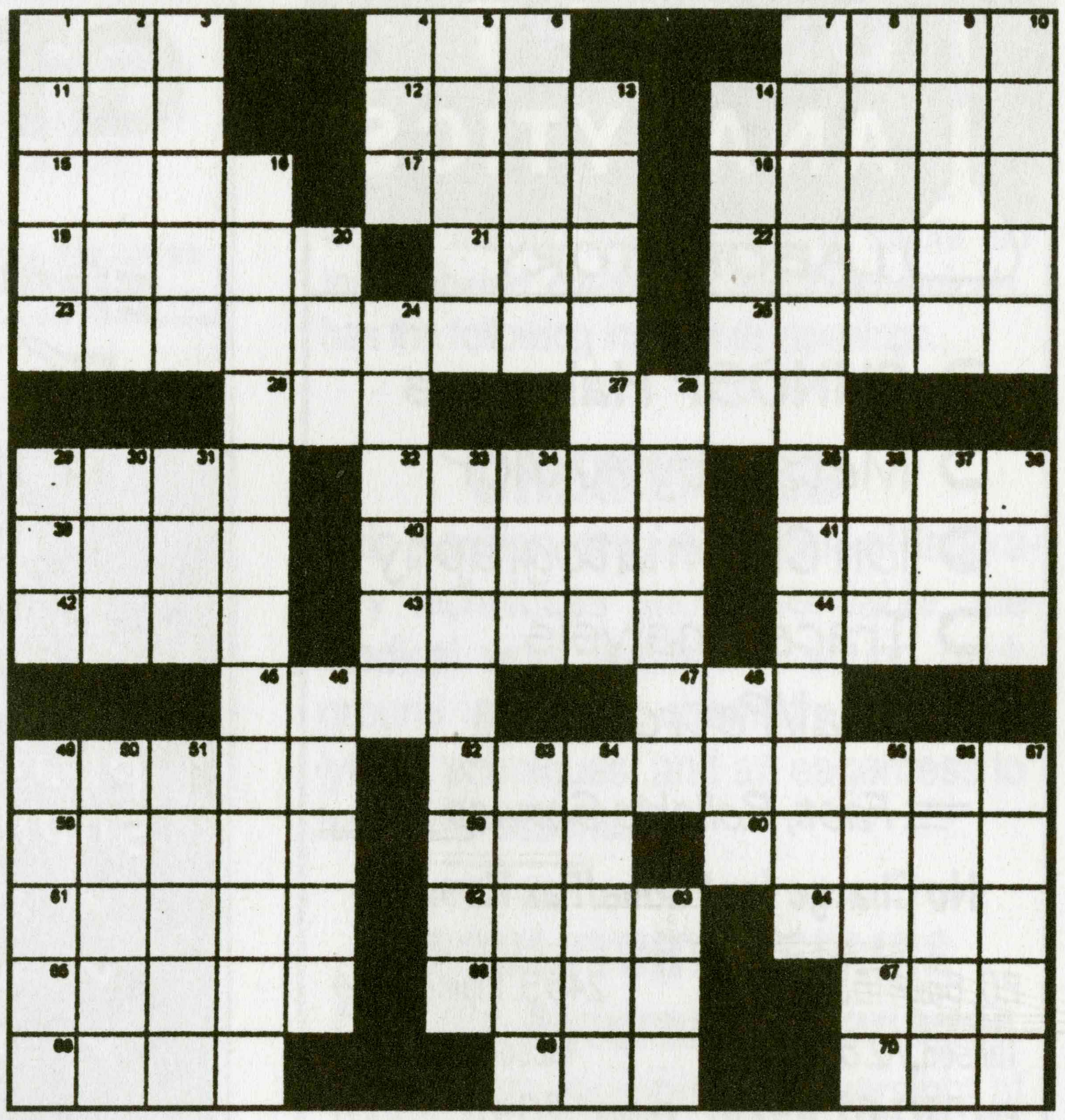
Minor crises arose, such as one time, at the old chemistry building at the University of Michigan when I as a student was dissolving a copper deposit from a platinum electrode after electrolytic deposition for further analysis with nitric acid. Because of fumes, I did this outside the double-hung window of the lab (the hoods had no artificial draft and were ineffective). When I tilted the beaker a bit too much, a little of the wanted solution dribbled onto the sand-stone window sill. What to do? I quickly got a clean beaker and another one with a little dilute acid and an eye-dropper and squirted some acid onto the sill, sucking it up with the eye-dropper and doing this a few times. I must have gotten pretty good recovery, because the results were accepted!

Another student in Advanced Quantitative Analysis had the bad luck of having a fly end up in the beaker as he was precipitating potassium perchlorate in ethyl acetate for the potassium determination. He was quite worried about the potassium content of the fly! He consulted Prof. Willard who, with a straight face, suggested he catch ten flies, ash them and determine their potassium content so he could correct his analysis.

Which reminds me of a probably spurious story told about Willard: One day a student who wanted to ask a question, happened to come in through the partly open door of Willards lab and saw the feared professor on his hands and knees on the floor carefully brushing a spilled precipitate onto a small card. When he saw the student, he looked up sheepishly and said: "If that happens again, we'll have to call it qualitative!" ◇

Puzzle Column

Reprinted by permission from the November 2000 issue of "The Indicator" of the New York and North Jersey Sections, ACS.



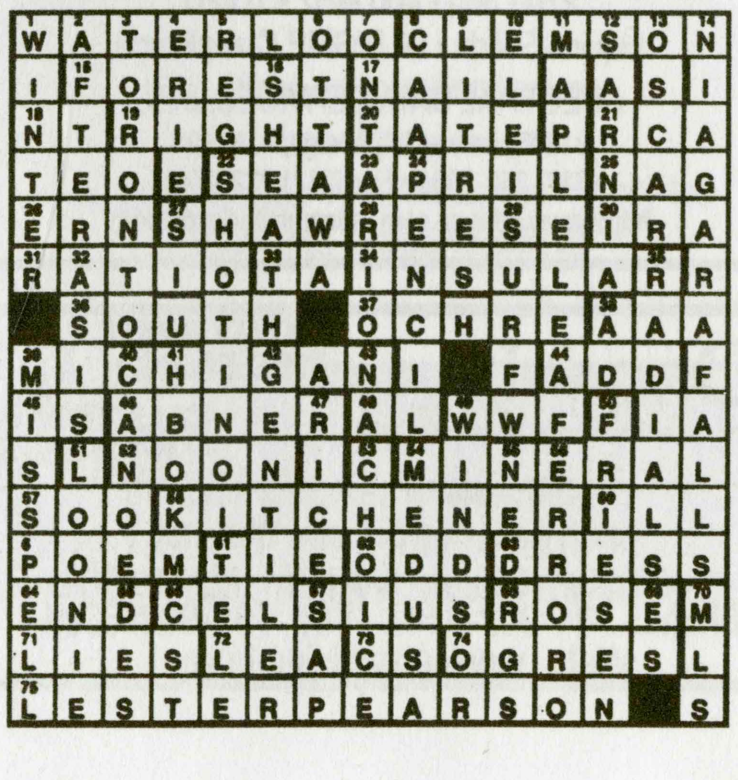
Across

1. Gaelic name prefix
4. Mature
7. Bird home
11. Combining form meaning shoulder
12. Twofold
14. Flinch
15. Metal cookie boxes
17. Existence: Latin
18. Garment worn under mail
19. New Delhi's country
21. Pekoe or herbal
22. Throws off center
23. Copper pyrite
25. Concise
26. Ending for health or wealth
27. Touch
29. The Iliad, for example
32. Detest
35. Mimics
39. Something you shouldn't do
40. Previous
41. Cruel Roman emperor
42. College VIP
43. _____ luego
44. Sketch
45. Weight measure for 19 across
47. Just a bit
49. Rock's "The ____and the Papas"
52. Implement for pressing clothes
58. __ ___ else fails.. . read the directions
59. 2001 computer
60. As I was going to St. Ives, _ ___ man...
61. Notes on the musical scale
62. Soothing gel
64. Devours a taco
65. Inuit pole
66. Out does
67. Combining form meaning whale
68. Remain
69. Gross minus deductions
70. Attempt

Down

1. Recurring theme
2. Type of acid
3. Purchased apartment
4. Citrus drink
5. Hearty enthusiasm
6. Painters stand
7. What an old car can do to you
8. Come in
9. Barge and rowboat
10. Taut
13. Fast driver
14. Trash
16. High-tech region of California
20. Ending for an enzyme
24. Plots
28. Printing mistakes
29. Finish
30. "The Masque of the Red Death" author
31. "I'm ___ NY State of Mind"
33. Top ranking naval officer
34. ___ and hers
36. Miles ___ hour
37. Geological time frame
38. Scatter seed
46. Muslim religion
48. Who ___ to argue?
49. Fogs
50. Walking
51. Mediterranean island
53. Eagle claw
54. Marry on the run
55. Respond
56. Aquatic mammal
57. Vicious
58. Superlative ending

Solution of the Puzzle in December 2000



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www.nesacs.org

The site can also be reached at: www.acs.org/localsections

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CAREER OPPS

BOOK REVIEWERS WANTED

The Nucleus is looking for people to review the following books:

Paul T. Anastas and John C. Warner, "Green Chemistry," Oxford University Press (1998)

John K. Borchardt, "Career Management For Scientists and Engineers", ACS Books (2000)

R.J. P. Williams and J.J.R. Fausto de Silva, "Bringing Chemistry To Life. From Matter To Man," Oxford University Press (2000)

Please contact Dennis Sardella, the Book ReviewEditor directly, either by phone, (617)-552-3621 or by e-mail sardella@bc.edu

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Calendar

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Metric System

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4. C. Webster, Decimalization under Cromwell, *Nature,* **1971**, *229*, 463.
5. W. Hallock and H. T. Wade, *op. cit.*, (Ref. 2), p.43.
6. R. E. Schofield, *The Lunar Society of Birmingham,* Clarendon Press, Oxford, 1963, pp. 256-257.
7. For a detailed account of the discussions from 1789 to 1791, see Y. Noël and R. Taton, La réforme des poids et mesures. . .1789-1791 in *Oeuvres de Lavoisier. Correspondance*, ed. P. Bret, Académie des Sciences, Paris, 1997, Vol. 6, pp. 439-465.
8. W. Hallock and H. T. Wade, *op.cit.*, (Ref. 2), pp. 110-114.
9. R. Hahn, *The Anatomy of a Scientific Institution. The Paris Academy of Sciences, 1666—1803*, University of California Press, Berkeley, 1971, p. 164
10. A.E. Ten, L'Académie des Sciences et les origines du système métrique décimal, in *Mètre et Système Métrique*, S. Debarbat, A. Ten, Eds., Observoire de Paris, Paris, 1993, pp. 15-32.
11. For Lenoir's life and times, see A. J. Turner, *From Pleasure and Profit to Science and Security. Étienne Lenoir and the Transformation of Precision Instrument-Making in France 1760-1830*, Whipple Museum, Cambridge, 1989.
12. For a brief account, see A. Wolf, *A History of Science, Technology and Philosophy in the Eighteenth Century*, 2nd ed., Allen and Unwin, London, 1952, pp. 78-79. All measurements of length are in French units:. 1 foot = 32.47 cm; 1 inch = 2.71 cm; 1 line = 0.23 cm. See also Ref 14.
13. W.A. Smeaton, Bertrand Pelletier, Master Pharmacist. His Report on Janety's Preparation of Malleable Platinum', *Platinum Metals Rev.,* **1997**, *41*(2), 86.
14. For full details of the pendulum experiments, see J.C. Borda and J.D. Cassini, Expériences pour connoitre la longueur du pendule qui bat les secondes à Paris, in J.B.J. Delambre, *Base du Système Métrique Decimal*, Baudouin, Paris, 1810, Vol. 3, pp. 336-401. This work in 3 volumes (1806, 1807, 1810), describes all relevant experiments, observations and calculations from 1792 to 1798 by Delambre, Méchain (who died in 1804) and others
15. J.C. Borda, Expériences sur les règles qui ont servi à la mesure des bases de l'arc terrestre, in J.B.J. Delambre, *op.cit.*, (Ref. 14), Vol. 3, pp. 313-316.
16. Borda did not mention Lavoisier's participation, to which attention was drawn by H.W. Chisholm, Lavoisier's work on the foundation of the metric system, *Nature,* **1874**, *9*, 185.
17. J.B.J. Delambre, *op. cit.*, (Ref. 14), Vol 3, p. 676.
18. W. Hallock and H. T. Wade, *op.cit.*, (Ref. 2), pp. 53-54.

The Author

William A. Smeaton is Emeritus Reader in History of Science at the University of London. He formerly lectured in chemistry at the Northern Polytechnic and in history of science at University College London. His main interest is science in 18th century France. ◇