

**SPECIAL FEATURE:
TUTORIAL**

Internet Resources for Mass Spectrometry

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The growth of the worldwide collection of computer networks known as the Internet has led to a rapid increase in the quantity and variety of information available to scientists in mass spectrometry. It is now possible to learn about the latest mass spectrometric techniques, compare the capabilities of commercial instruments and participate in discussion with colleagues from around the world without ever leaving one's desk. The challenge that comes with the Internet information explosion is to learn how to navigate the various areas of the Internet and fully utilize these new information sources. It is also important to know how and where to find the most reliable information on a medium where quality cannot always be assured. The purpose of this paper is to provide a listing and brief discussion of on-line resources available for mass spectrometry. World Wide Web sites are tabulated for search pages, index pages for mass spectrometry research groups and companies, mass spectrometry societies, local discussion groups, journals and software. Usenet newsgroups and electronic mailing lists of interest to mass spectrometrists are listed and discussed. Copyright © 1999 John Wiley & Sons, Ltd.

KEYWORDS: mass spectrometry; Internet; World Wide Web; newsgroups; electronic mailing lists

INTRODUCTION

An internet is any collection of two or more computer communications networks.^{1,2} The Internet is the worldwide collection of interconnected computer networks that communicate using a number of set communications standards. The Internet had its beginnings in the early 1970s as the United States Department of Defense funded Advanced Research Projects Agency Network (ARPANET), a decentralized military research network. The early Internet made wide use of text-based communication such as file transfer, electronic mail and the system of distributed electronic discussion groups known as Usenet. The World Wide Web of linked information servers was developed in 1990 at CERN, the European Laboratory for Particle Physics, and the first graphical Web browser was released in 1992. The wide availability of graphical browsers has led to an explosive growth in the Internet that now rivals previous communications revolutions.

The growth in the quantity and variety of Internet resources for mass spectrometry has matched that of any other area. All major mass spectrometry journals have articles available at their Web sites. The American Society for Mass Spectrometry now has conference abstracts on their site and beginning in 1999 will require Web abstract submission.³ Most mass spectrometry

companies and many mass spectrometry research groups have Web pages.⁴ There is a Usenet newsgroup devoted exclusively to mass spectrometry discussion⁵ and there are several electronic mailing lists for mass spectrometry subfields and organizations.⁶

To exploit these resources to their fullest requires that people know that they exist and how to find them. The goal of this paper is to provide an introduction to the Internet for mass spectrometry students and researchers. Examples are presented of Internet resources for mass spectrometry on the Web, Usenet and electronic mail. Links to various Web resources such as mass spectrometry research groups, companies, organizations, journals, educational resources and software are presented. Usenet discussion groups and electronic mailing lists for mass spectrometry are also presented and discussed.

GETTING AROUND ON THE INTERNET

Throughout this paper, the location of documents and other resources on the Internet is specified by a uniform resource locator (URL). The URLs in this document can be entered directly into a Web browser as a location. Alternatively, a hypertext version of this paper is available.⁷ A URL consists of the name of the communications protocol, followed by the domain name and sometimes by the location and name of a file. Examples of protocols are hypertext transfer protocol (http), file transfer protocol (ftp) and Usenet (news). The final two or three letters of a domain indicate the organization or country of that domain. For example .edu indicates a

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US educational institution, .gov indicates US government, .ca indicates US government .ca indicates a Canadian site and .jp a site in Japan. The URL <http://www.nsf.gov/home/mps/start.htm> indicates that the hypertext transfer protocol should be used with the file start.htm in the directory/home/mps/ on the server at the domain www.nsf.gov and news:sci.techniques.mass-spec indicates that the Usenet news protocol should be used with the newsgroup sci.techniques.mass-spec. In the latter case, the server must be indicated elsewhere in the browser. URLs and other seemingly cryptic conventions become clearer when more is known about the development and operation of the Internet and the World Wide Web. Good starting points for learning more about the Internet are Hobbes' Internet Timeline,² the World Wide Web Consortium,⁸ Web pages for beginners classes⁹ and even television documentaries.¹⁰

The search pages listed in Table 1 are also useful starting points. There are many other pages available; however, those listed have some unique and useful features. The AltaVista site is one of the largest search pages¹¹ and also has options for searching for documents in a particular language. There is also a free utility for translating brief passages of text between English and German, French Italian, Spanish and Portuguese.¹² The Hotbot search page has a large number of configurable search options such as search by language, continent, domain or media type. The DejaNews site contains a searchable archive of Usenet newsgroup posts dating back to March 1995. It is the best resource for making sense of the often fragmented Usenet discussions. The Yahoo site is the largest Internet directory and contains over 750 000 listings.¹¹ Many sites of interest to mass spectrometrists are located in the Science:Chemistry:Spectroscopy subdirectory.

Several literature databases are available on-line (see Table 1). The American Chemical Society *Chemical Abstracts* and other databases are accessible using the specialized Scifinder or STN Express software. A Web interface to *Chemical Abstracts* and other selected databases is available at the STN Easy site. The Institute for Scientific Information's Web of Science site offers Web based searching of their *Current Contents*, *Science Citation Index* and other databases. A final search page worthy of mention is the Medline biomedical database site run by the US National Center for Biotechnology Information at the National Library of Medicine, National Institutes of Health. The Medline database contains bibliographic citations and abstracts from biomedical journals dating back to 1966 that are searchable at no cost. Mass spectrometry journals in the

database include *Biological Mass Spectrometry*, *Bio-medical and Environmental Mass Spectrometry*, *Bio-medical Mass Spectrometry*, *Journal of Mass Spectrometry*, *Journal of the American Society for Mass Spectrometry*, *Mass Spectrometry Reviews* and *Rapid Communications in Mass Spectrometry*.

World Wide Web

The WWW was developed in the early 1990s as a way for researchers at CERN to manage the large quantities of data and technical information generated in their experiments.^{2,8} The explosive growth of the Web came about after the first graphical Web document browsers were developed in 1992. A browser displays a Web document as a page containing elements such as text, pictures, sound, movies and links to other documents or files. Text containing such links is called hypertext and it is hypertext that gives the Web its potential for information delivery. A Web page can contain links to hundreds of other Web pages on computers around the world, which in turn contain links, ultimately forming the web of interconnected pages.

Research groups and companies

Among the first mass spectrometry sites on the Web were those associated with mass spectrometry research groups. Today there are scores of sites for mass spectrometry research groups or service facilities.¹³ Typical information that can be found on these pages includes research interests, publication lists, contact information, group and instrument photographs and, for service laboratories, sample submission information. There were only a few mass spectrometry company sites in the early days of the Web, but now sites can be found for nearly every mass spectrometry company.^{14,15} Company Web sites can be a useful on-line brochure, and many sites have reference data, tutorials and other resources in addition to product literature.

Mass spectrometry societies

Links to mass spectrometry society Web pages are given in Table 2. In addition to contact information, membership applications, information on scientific meetings and grant and award information, several mass spectrometry society sites have member directories and

Table 1. Selected Internet search pages

Site	Web page
AltaVista	http://www.altavista.com/
Chemical Abstracts	http://www.cas.org/
DejaNews	http://www.dejanews.com/
Hotbot	http://www.hotbot.com/
PubMed	http://www.ncbi.nlm.nih.gov/Entrez/medline.html
Web of Science	http://webofscience.com/
Yahoo!	http://www.yahoo.com/

Table 2. WWW sites for mass spectrometry societies

Society	Web page
American Society for Mass Spectrometry	http://www.asma.org/
Australian and New Zealand Society for Mass Spectrometry	http://www.latrobe.edu.au/www/anzsms/
Belgian Society for Mass Spectrometry	http://masseroute.cico.ucl.ac.be/bsms/bsms.htm
British Mass Spectrometry Society	http://www2.ifrn.bbrsc.ac.uk/bmss/
Canadian Society for Mass Spectrometry	http://www.csms.inter.ab.ca/
Dutch Society for Mass Spectrometry	http://www.xs4all.nl/~pjacobs/nvms.html
European Society for Mass Spectrometry	http://masseroute.cico.ucl.ac.be/esms/esms.htm
International Mass Spectrometry Society	http://www.chem.purdue.edu/imss/
Italian Mass Spectrometry Home Page	http://www.cineca.it/hosted/mass_spectrom/
Mass Spectrometry Society of Japan	http://wwwsoc.nacsis.ac.jp/mass/
Polish Mass Spectrometry Society	http://ptsm.ichf.edu.pl/
South African Association for Mass Spectrometry	http://www.up.ac.za/science/saams/home.htm
Swiss Group for Mass Spectrometry	http://www.sgms.ch/

employment information. The American Society for Mass Spectrometry (ASMS) job page has a large number of posts and features a Web-based submission form. The British Mass Spectrometry Society and the South African Association for Mass Spectrometry have on-line advertisements for equipment wanted and for sale. Both the Australian and New Zealand and the Dutch Societies for Mass Spectrometry sponsor electronic mail discussion lists (see electronic mail resources below). One of the most useful components of these sites is meeting information: most sites have meeting calendars and many have abstract submission information. In 1998, the ASMS site began posting the conference abstracts on their site in hypertext, and in 1999 abstract submission itself will go on-line.³

Mass spectrometry discussion groups

A compilation of Web pages for local mass spectrometry discussion groups (MSDGs) is given in Table 3.

Contact information for many discussion groups without Web sites is available at the ASMS site and at other mass spectrometry society sites (see Table 2). One of the most important items on a local MSDG site is the local meeting information, often accompanied by directions to the meeting place. Most sites have e-mail and other contact information. Electronic mail is also used for distribution of meeting announcements, and at least two MSDGs have automated electronic mail discussion lists (see below). Employment information can be found on many of these sites.

Journals

In the past several years, an increasing number of scientific journals have established Web sites. Instructions for article submission, editor contact and subscription information are also found on these sites. Most of the sites offer table of contents and abstract search features. Many journal sites contain articles and other documents in portable document format (PDF),

Table 3. WWW sites for mass spectrometry discussion groups

MSDG	Web page
ASMS Discussion Group Page	http://www.asms.org/disgrp.html
Atlanta–Athens	http://userwww.service.emory.edu/~kmurray/aamsdg.html
Delaware Valley	http://science.widener.edu/svb/msdg/
East Tennessee	http://atom.chem.utk.edu/~etmsdg/
Madison–Chicago–Milwaukee	http://www.chem.uic.edu/mcm/
Michigan	http://www.geocities.com/capecanaveral/4149/
National Institutes of Health	http://sx102a.niddk.nih.gov/mass/mass.html
San Diego	http://masspsec.scripps.edu/sandman.html
San Francisco Bay Area	http://www.bams.org/
Washington–Baltimore	http://chem.1.nrl.navy.mil/analytical/msdg/

Table 4. WWW sites for mass spectroscopy and related journals

Journal	Web page
<i>Analytical Chemistry</i>	http://pubs.acs.org/journals/ancham/index.html
<i>Journal of the American Society for Mass Spectrometry</i>	http://www-east.elsevier.com/webjam/Menu.html
<i>International Journal of Mass Spectrometry</i>	http://www.elsevier.nl/inca/homepage/saa/ijmsip/
<i>European Mass Spectrometry</i>	http://www.impub.co.uk/ems.html
<i>Journal of Mass Spectrometry</i>	http://www.interscience.wiley.com/jpages/1076-5174/
<i>Mass Spectrometry Review</i>	http://www.interscience.wiley.com/jpages/0277-7037/
<i>Rapid Communications in Mass Spectrometry</i>	http://www.interscience.wiley.com/jpages/0951-4198/

although a subscription is typically required to view full articles. The PDF files can be recognized by the file extension '.pdf' and can be read using the free Acrobat Reader program.¹⁶ Unlike Web pages, PDF files maintain fixed fonts, page breaks and other document formatting when view on different computers.

A list of the Web pages for several mass spectrometry and related journals is given in Table 4. The *Analytical Chemistry* site has tables of contents and abstracts and, for subscribers to the Internet version of the journal, PDF versions of articles. The Web sites for the Elsevier journals *Journal of the American Society for Mass Spectrometry* and *International Journal of Mass Spectrometry* have tables of contents and selected articles. The *European Mass Spectrometry* site has searchable abstracts and articles available for on-line purchase. The Web sites for the Wiley journals *Journal of Mass Spectrometry*, *Mass Spectrometry Reviews* and *Rapid Communications in Mass Spectrometry* have tables of contents and searchable abstracts. Full articles are available for individual and institutional subscribers.

Educational resources

A selection of Web sites for mass spectrometry that fit into the general category of educational resources is listed in Table 5. Several mass spectrometry courses have Web pages that contain lecture notes, tutorials or exercises. The Scimedia Introduction to Mass Spec-

trometry is part of their on-line Encyclopedia of Analytical Instrumentation. A few of these sites make use of mass spectra in the JCMAP-DX data format that can be displayed using a free browser plug-in.^{17,18} Examples of the capabilities of JCAMP-DX and other chemistry data formats can be seen at the Jamaican Coffee Interactive GC/MS page.

A few examples of historical information on mass spectrometry available on the Web are listed in Table 5. Gary Siuzdak of the Scripps Research Institute in La Jolla, California, has created a site devoted to the history of mass spectrometry. Several pages are presented in the form of hyperlinked timelines: highlighted events from the past 100 years of mass spectrometry lead to further information and references. A page on great names in mass spectrometry contains brief biographies of famous mass spectrometrists from Thompson onwards and a page of contributed items chronicle specific events in the history of mass spectrometry. A few other sites are worthy of note. The National Museum of Science and Industry site has a page with photographs and information on Aston's 1919 mass spectrograph and other historical scientific instruments. A large number of digital images are available from the Lawrence Berkeley National Laboratory Image Library. Images of E. O. Lawrence's early cyclotrons and Calutrons will be of particular interest to mass spectrometrists. The Apollo Mission page at NASA has information on mass spectrometers deployed in lunar orbit and on the surface of the moon.

Table 5. Educational resources

Site	Web page
Interactive GC/MS	http://wwwchem.uwimona.edu/jm:1104/lectures/coffee.html
Introduction to Mass Spectrometry	http://science.widener.edu/svb/massspec/masspec.html
JEOL Mass Spectrometry Tutorial	http://www.jeol.com/ms/whatisms.html
Mass Spectrometry for Chromatographers	http://ull.chemistry.uakron.edu/gcms/
Organic Mass Spectrometry Tutorial	http://chipo.chem.uic.edu/web1/ocol/spec/Ms.htm
Science Hypermedia Introduction to Mass Spectrometry	http://www.scimedia.com/chem-ed/ms/ms-intro.htm
Apollo Mission Orbital Mass Spectrometers	http://cass.jsc.nasa.gov/pub/expmoon/Apollo6/A16_Orbital_massspect.html
History of Mass Spectrometry	http://masspect.scripps.edu/hist.html
Lawrence Berkeley National Laboratory Image Library	http://www-itg.lbl.gov/imglib/
National Museum of Science and Industry (UK)	http://www.nmsi.ac.uk/on-line/treasure/nuclear.html
NIST Chemistry Webbook	http://webbook.nist.gov/chemistry/
WebElements	http://www.shef.ac.uk/~chem/web-elements/main/index.html

Table 6. Software (index pages)

Site	Web page
Charged Particle Optics Software Internet Services	http://wwwdo.tn.tudelft.nl/bbs/cposis.htm
EMBL software for biological mass spectrometry	http://mac-mann6.embl-heidelberg.de/massspec/software.html
ExPASy Proteomics tools	http://www.expasy.ch/www/tools.html
Mass Spectrometry on the Internet	http://userwww.service.emory.edu/~kmurray/mssw.html
PROWL Software Archive	http://www.proteometrics.com/links/software.html

Two searchable databases are listed in Table 5 that are useful for both students and researchers. The NIST Chemistry Webbook includes a searchable database of gas-phase ion thermochemistry and mass spectra, and the WebElements site has a clickable periodic chart with chemical and physical data of the elements. The WebElements site also has several on-line calculators, including an isotope pattern calculator. Links to other on-line mass spectrometry calculators can be found on the software index pages discussed below.

Software

There is such a quantity and variety of mass spectrometry software available on the Internet that there is insufficient space to cover all of it here. Instead, links to software index pages are given in Table 6. The Charged Particle Optics Software site has a software archive and other resources for particle optics. For biological mass spectrometry, the European Molecular Biology Laboratory Protein and Peptide Group software archive, the Swiss Institute of Bioinformatics ExPASy Proteomics Tools page and the PROWL Software archive have archives of software and links to other software pages. The Mass Spectrometry on the Internet site has links to shareware, freeware, commercial software and Web-based calculators for mass spectrometry.

Usenet

Usenet was created in 1979 at Duke University as a means of sharing information on Unix computers.^{2,19}

Usenet consists of various discussions newsgroups organized into subject hierarchies. Users can read messages on different topics and can join in the discussion by posting their own messages. Some newsgroups are moderated and messages are checked by one or more moderators before they are distributed. Most newsgroups are not moderated and users are urged to follow generally agreed upon standards of Usenet etiquette (often called netiquette).²⁰

The main newsgroup hierarchies are **comp.** (computers), **misc.** (miscellaneous topics), **news.** (Usenet itself), **rec.** (recreation), **sci.** (science), **soc.** (social issues), **talk.** (discussion of social and cultural issues) and **alt.** (alternative newsgroups).²¹ Note that the **alt.** newsgroups are not necessarily alternative topics, but can be created by an alternative (and less formal) method.²² Specialized and local hierarchies also exist, such as **aus.** for Australian newsgroups or **emory.** for Emory University newsgroups. Within each hierarchy are the different discussion groups, for example **sci.chem**, **sci.chem.analytical** and **sci.chem.electrochem.battery** are all within the science hierarchy.

The newsgroups that will be of the most interest to mass spectrometrists are given in Table 7: **sci.chem**, **sci.chem.analytical**, **sci.techniques.mass-spec** and **sci.techniques.spectroscopy**. The **sci.chem** newsgroup is the most general of the chemistry newsgroups and typically has the most messages. Discussion ranges from scientific to societal issues involving chemistry. The **sci.chem.analytical** newsgroup contains discussions about all aspects of analytical chemistry. There are fewer posts than in **sci.chem.**, but they are more focused. The **sci.techniques.spectroscopy** newsgroup is devoted to discussion of spectroscopy topics, but issues relevant to mass spectrometry often appear. The **sci.techniques.mass-spec** newsgroup was started in the summer of 1995 through the efforts of David Bostwick

Table 7. Usenet newsgroups of interest to mass spectrometrists with links to WWW pages or frequently asked questions (FAQ) information files for the groups

Newsgroup	Topic	WWW page or FAQ
sci.chem	Chemistry	http://www.cis.ohio-state.edu/hypertext/faq/usenet/sci/chem-faq/top.htm
sci.chem.analytical	Analytical chemistry	http://www.cis.ohio-state.edu/hypertext/faq/usenet/sci/mass-spec-resources/faq.html
sci.techniques.mass-spec	Mass spectrometry	http://www.chemistry.gatech.edu/stms/
sci.techniques.spectroscopy	Spectroscopy	http://lolita.colorado.edu/faq/default.htm

Table 8. Electronic mailing lists for mass spectrometry

List	Topic	Type ^a	Address	Web page
AAMSDG	Atlanta–Athens Mass Spectrometry Discussion Group Announcements	D	LISTSERV@UGA.CC.UGA.EDU	http://userwww.service.emory.edu/~kmurray/aamsdg.html
ANZSMS	Australian and New Zealand Society for Mass Spectrometry Discussion	D	Listserv@latrobe.edu.au	http://www.latrobe.edu.au/www/anzsms/Listserv.html
ISOGEOCHEM	Stable Isotope Geochemistry	D	listproc@list.uvm.edu	http://geology.uvm.edu/geowww/isogeochem.html
LASAB	Laser Ablation Sampling	D	LISTSERV@TU-CLAUSTHAL.DE	http://www.immr.tu-clausthal.de/geoch/labs/icp-ms/lasab.html
MASS-SPEC	Mass Spectrometry Information	I	mass-spec@kkm02.chem.emory.edu	http://userwww.service.emory.edu/~kmurray/mslisterv.html
MSNET-L	Mass Spectrometry Internet Resources	D	LISTSERV@LISTSERV.CC.EMORY.EDU	http://listserv.emory.edu/archives/msnet-l.html
NVMS	Dutch Society for Mass Spectrometry	D	nvms-subscribe@egroups.com	http://www.egroups.com/list/nvms
PLASMACHEM-L	Plasma Chemistry (including ICP-MS)	D	listserv@listserv.syr.edu.	http://www.geo.cornell.edu/geology/white/icp-ms/icp-ms.html
STMSLIST	sci.techniques.mass-spec Usenet group	A	maiser@novell.chem.utk.edu	http://www.chemistry.gatech.edu/stms/listserv.htm
SIMS	Secondary ion mass spectrometry	D	sims@sims.arl.mil	http://www.simsworkshop.org/WWW/Forums/Listserve/Liststar.html
TIMS	Thermal ionization mass spectrometry	D	listproc@ripken.oit.unc.edu	http://www.geo.cornell.edu/geology/white/tims/tims.html

^a List types are announcement (A), discussion (D) or informational (I). See text for details.

and Sarah Shealy of Georgia Tech who are the newsgroup moderators. This newsgroup is used for general discussion, job postings, conference information and other announcements. Because hundreds of mass spectrometry experts worldwide read and post to the group, it is an excellent forum for asking questions related to mass spectrometry. Such a pooling of knowledge is difficult to replicate outside scientific meetings. A few notes of caution are in order. Anyone can post to Usenet and therefore the quality of information is varied. When seeking information, ask for or Web pages or literature references wherever possible. When answering queries, clearly state your qualifications and experience and provide adequate citations. For most information, the Usenet should be a starting point and not an end in itself.

Newsgroups can be accessed in a number of different ways. Specialized Usenet programs are available for Unix, Apple Macintosh, Microsoft Windows and other computer operating systems. Newsgroups can also be read using an Internet browser if the URL is formed with the protocol 'news:' For example `news:sci.chem` is the URL for the `sci.chem` newsgroup. The DejaNews site offers a Web interface for reading and posting messages.²³ The e-mail address `mass.spec@gatech.edu` can be used to post a message to the `sci.techniques.mass-spec` newsgroup and an electronic mailing list (see below) run by John Bartmess at the University of Tennessee in Knoxville distributes a twice weekly digest of the newsgroup posts.

ELECTRONIC MAIL

Electronic mail is one of the most basic Internet application and dates back to the ARPANET of the early 1970s.² Initially used for one-to-one communication, it was soon found to be useful for automated distribution of messages to a list. With an electronic mailing list, a message is sent to the e-mail address of the list server program and the list server forwards it to the list of subscribers. On a discussion list, any subscriber can send a message for distribution to the list. The result is an e-mail discussion forum similar to Usenet. With an announcement list, only the owner of the list can send messages for distribution. An information distribution list is an automated server that sends files to users based on simple commands contained in the incoming e-mail message.

Electronic mailing lists related to mass spectrometry are contained in Table 8. The e-mail address in Table 8 is in most cases the address of a list server that can serve many different lists. A typical subscription e-mail message contains

SUBSCRIBE *listname* *firstname* *lastname*

as the first and only line of the e-mail message. Here *listname* is the mailing list name in the first column of Table 8 and *firstname* and *lastname* are the given and surname of the list subscriber. An automated reply message will contain information about posting to the list and other features. It is often useful to visit the Web

page associated with the list for detailed subscription instructions. In some cases, an archive of list messages can be found.

Electronic mailing lists can be more convenient than Usenet groups for regular e-mail users because no browser or newsreader is required. Information is delivered directly to an electronic mailbox rather than a server where it must be downloaded to be read. Additionally, Usenet articles are stored on a server for a limited period of time. However, the high volume of mail from large e-mail lists can be overwhelming and make it difficult to follow the thread of discussions. In general, e-mail discussion lists are well suited to small groups of users and specialized topics and Usenet newsgroups are suited for general topics and more users.

FUTURE DIRECTIONS

The future of mass spectrometry on the Internet will see more users of existing resources, better use of existing resources and implementation of new technologies. Use of existing resources will expand as user awareness increases. Electronic mail for one-to-one communication is nearly universal and electronic mailing lists for discussion and distribution are appearing in greater numbers. Usenet discussion of mass spectrometry topics is active and participation will undoubtedly increase as more people become aware of its potential. The Web is rapidly becoming the first choice in searches for many kinds of information related to mass spectrometry. Locating the desired resource in the sea of information is often a challenge and there is a continuing need for high-quality directories and databases.²⁴ As more mass spectrometry Internet resources become available, it is important to remember that access to these resources is not equal throughout the world. Where possible, resources should be offered in readily accessible forms such as text files available by electronic mail.

Perhaps the most obvious place for better use of existing technologies is the mass spectrometry journals. Every major mass spectrometry journal has a Web page that offers abstracts or articles taken from the print version. However, on the Web there are many ways to present data other than text and black and white figures. For example, raw data files, color figures, animations, movies, 3-D rotatable images, clickable mass spectra or computer programs are all possible ways to display data on the Web. The journal *Analytical Chemistry* now encourages the submission of supplemental information in electronic format²⁵ and it is likely that the mass spectrometry journals will follow suit. The future may even bring an entirely on-line mass spectrometry journal with hyperlinked references to the full range of electronic data options.

On-line mass spectrometry conferences can also be implemented with existing technologies. The obvious advantages are low cost, ease of participation and an electronic record of the proceedings. Presentations could be in the form of Web pages or distributed as Internet audio or video²⁶ and discussion could take place in text chat format or as a video conference.

Internet video conferencing could also be used with existing conferences.

Devices connected to the Internet have been among the most popular sites since a camera connected to the Internet was first pointed at the now famous Cambridge University coffee pot.^{27,28} To our knowledge, there is only one mass spectrometer now connected to the Internet: an ion trap instrument at the Environmental Molecular Sciences Laboratory at Pacific Northwest National Laboratory.²⁹ The site has a robotically controlled camera and remote Internet instrument control and data acquisition are possible. Although the main goal of the project is to develop the technology for remote collaborative research, there are obvious applications as a teaching tool.

In just the past few years, the Internet has transformed the way mass spectrometrists share information, removing many barriers of time and distance. In the coming years, we must endeavor to get the maximum number of users on-line worldwide, educate users already-on-line to the full potential of the existing resources, utilize existing technologies to their fullest and exploit new technologies as they become available. By taking an active role, we can better utilize the opportunities provided by this new way of communicating.

GLOSSARY

Many glossaries of Internet terminology are available on-line.¹ A few of the more important terms are given below.

Browser	A software program for reading Internet documents. A browser converts Web documents written in Hypertext Markup Language (HTML) into pages containing hypertext, graphics, and other items.
Browser plug-in	A small program that is used with a Web browser to add a specific function such as displaying video or 3-D molecules.
Domain	An area of the Internet associated with a company, organization, university or other entity. For example, 'emory.edu' is a domain of Emory University and

	'asms.org' is the domain of the American Society for Mass Spectrometry.
Hypertext	Text that contains links to other documents or files. Most Web pages contain hypertext.
HTML	Hypertext Markup Language, the standard set of shorthand instructions that govern the appearance of a hypertext document and specify links.
HTTP	Hypertext Transfer Protocol, the protocol used to transfer Web pages.
Internet	The global collection of interconnected computer networks.
JCAMP-DX	A format for spectroscopic data. The JCAMP-DX protocol is one of many chemical MIME (Multipurpose Internet Mail Extension) types.
Newsgroup	A group for discussion on Usenet.
PDF	Portable document format, a formatting standard using for electronic distribution of documents such as journal articles.
Protocol	A set of rules for computer communication.
TCP/IP	Transport Control Protocol/Internet Protocol. The standard communications protocol for the Internet.
URL	Uniform Resource Locator, the address of an Internet document, for example http://www.ncbi.nlm.nih.gov/entrez/medline.html .
Usenet	A collection of discussion areas called newsgroups available on computer systems throughout the world.
World Wide Web	A global hypertext network that is part of the Internet. Also known as the Web or the WWW.

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REFERENCES

- For a glossary of Internet terms, see <http://www.browncs.com/wordsfrm.html> or <http://www.hotwired.com/web101/glossary/>.
- <http://info.isoc.org/guest/zakon/internet/history/hit.html>.
- http://www.asms.org/abstract_entry.html.
- <http://userwww.service.emory.edu/~kmurray/mslist.html>.
- <http://www.chemistry.gatech.edu/stms/>.
- <http://userwww.service.emory.edu/~kmurray/msres.html#listserv>.
- <http://www.interscience.wiley.com/>.
- <http://www.w3.org/>.
- For example, <http://artsci.wustl.edu/~langlab/new/webintro.html>.
- <http://www.pbs.org/opb/nerds2.0.1/>.
- <http://www.searchenginewatch.com/>.
- <http://babelfish.altavista.com/cgi-bin/translate?>.
- <http://userwww.service.emory.edu/~kmurray/msgroups.html>.
- <http://userwww.service.emory.edu/~kmurray/mscom.html>.
- S. A. Lammert, *Rapid Commun. Mass Spectrom.* **12**, 495 (1998).

16. <http://www.adobe.com/prodindex/acrobat/adobepdf.html>.
17. <http://wwwchem.uwimona.edu.jm:1104/software/jcampdx.html>.
18. <http://www.mdll.com/>.
19. Usenet Software: History and Sources, <http://www.cis.ohio-state.edu/hypertext/faq/usenet/usenet/software/part1/faq.html>.
20. <http://www.cis.ohio-state.edu/hypertext/faq/usenet/usenet/emily-postnews/part1/faq.html>.
21. Guidelines on Usenet Newsgroup Names, <http://www.cis.ohio-state.edu/hypertext/faq/usenet/usenet/creating-newsgroups/naming/part1/faq.html>.
22. <http://www.cis.ohio-state.edu/~barr/alt-creation-guide.html>.
23. See, for example, http://www.dejanews.com/home_bg.shtml.
24. D. Fenyő, W. Zhang, B. T. Chait, and R. C. Beavis, *Anal. Chem.* **68**, 721A (1996).
25. A. Newman, *Anal. Chem.* **69**, 551A (1997).
26. See, for example, <http://www.realaudio.com/>.
27. <http://www.cl.cam.ac.uk/coffee/coffee.html>.
28. http://dir.yahoo.com/computers_and_internet/internet/interesting_devices_connected_to_the_net/.
29. <http://198.128.64.33/>.