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The Sudden Selector's Guide to Physics Resources

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ALCTS/CMS SUDDEN SELECTOR'S SERIES, #5

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to Physics Resources

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Series Editor

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Collection Management Section of the Association
for Library Collections & Technical Services
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FOREWORD

Is subject-area knowledge for collection development still necessary or even important in these days of tightening budgets, vendor selection, and nearly-instant access? My answer is a resounding “Yes!” It is vital for selectors to have an understanding of how their subjects “work,” in terms of research, publication, and selection; selectors link a library’s collection to its local audience, meeting the needs of researchers and faculty as well as the broader community. Selection by vendors, in the form of approval plans, can indeed create workflow efficiencies, but it takes a knowledgeable selector to set up an effective plan that can account for local needs as well as budgetary and space restrictions. The time saved by such plans allows selectors to both hone the margins of a collection to strengthen it, and to conduct increasingly valuable liaison work with user groups. The ongoing purpose of the Sudden Selector series is to provide current information on selection in specific subject areas, to assist selectors in creating a manageable process in unfamiliar subject territories.

Helene Williams
Editor, Sudden Selector’s Guide Series
April 2013

PREFACE

On the Sudden Selector's Series

The Sudden Selector series was created by the Collection Management Section (formerly Collection Management & Development Section) of the Association for Library Collections & Technical Services division of the American Library Association. It is designed to help library workers become acquainted with the tools, resources, individuals, and organizations that can assist in developing collections in new or unfamiliar subject areas. These guides are not intended to provide a general introduction to collection development but to quickly furnish tools for successful selection in a particular subject area. However, there are many tools that are pertinent for all subject areas and although not explored in detail in the guides, the following should be mentioned.

GUIDES TO COLLECTION DEVELOPMENT

Evans, G. Edward, and Margaret Zarnosky-Saponaro. *Developing Library and Information Center Collections*, 3rd ed. Westport, Conn: Libraries Unlimited, 2005.

This text serves as an authority on all areas of collection development, from user assessment, collection development policies, evaluation, deselection, and legal issues. This popular resource, in its many editions, has served as a standard text in collection development training.

Johnson, Peggy. *Fundamentals of Collection Development and Management*, 2nd ed. Chicago: American Library Association, 2009.

This guide by one of the key authorities in collection development covers many of the same areas as Evans and Edward. Johnson provides a comprehensive overview of the issues such as policies, planning, developing and managing collections, marketing and outreach activities, and collection analysis. The writing is engaging and its information is useful for both beginning professionals and seasoned selectors.

Disher, Wayne. *Crash Course in Collection Development*. Libraries Unlimited, 2007.

This title is part of the Crash Course series from Libraries Unlimited, and is aimed toward a new selector without any selection experience or for those with little to no professional experience. Although the general concepts covered may be useful for beginning academic librarians, it is focused toward the needs of public librarians.

Gorman, G. E., and Ruth H. Miller. *Collection Management for the 21st Century: A Handbook for Librarians*. Westport, Conn.: Libraries Unlimited, 1997.

Although a bit older than the other texts in this list, the essays address many crucial issues and challenges still of critical concern in collection development. The handbook provides a thorough review of the trends and emerging issues in the field.

Burgett, James, John Haar, and Linda L. Phillips. *Collaborative Collection Development: A Practical Guide for Your Library*. Chicago: American Library Association, 2004.

This guide provides first-hand experience and advice for successful collaborative collection building. The guide provides models and strategies for research, budgeting, promotion, and evaluation.

Alabaster, Carol. *Developing an Outstanding Core Collection: A Guide for Libraries.* Chicago: American Library Association, 2002.

This handbook provides instructions on how to build an adult public library collection from the ground up as well the tools to maintain an existing collection. The guide provides a wealth of resources for public library collection development as well as sample core lists.

REVIEW SOURCES

Choice
www.ala.org/ala/acrl/acrlpubs/choice/home.cfm

Reviews in *Choice* magazine, published monthly by the American Library Association, and *Choice Reviews Online* are targeted to academic library collections and reviews emphasize the importance of the title in collection development and scholarly research. *Choice* includes approximately 600 reviews (per month) organized by subdiscipline for books, electronic media and internet resources and as well as publisher advertisements and announcements for new and forthcoming publications. *Choice Reviews Online* provides access to issues from 1998 to the present. There are added features to the online version of the magazine including personalized profiles and title lists and an advanced search screen.

Library Journal Book Reviews
http://reviews.libraryjournal.com/

Library Journal Review Alerts
http://reviews.libraryjournal.com/category/prepub/

Library Journal magazine provides brief reviews of titles on all topics and is aimed for both public and academic libraries. The reviews provide a brief summary of the title and recommendations for library audience and selection. Reviews are available in print issues of the magazine and online through various databases and as an RSS feed for new review title alerts.

Booklist
www.ala.org/ala/booklist/booklist.htm
www.booklistonline.com/

Booklist, a publication of the American Library Association, publishes more than 8,000 recommended-only reviews of books, audio books, reference sources, video, and DVD titles each year. *Booklist* also provides coverage of ALA award-winning titles and is available online with enhanced content such as advanced searching options and personalized profiles and lists.

Publisher's Weekly
www.publishersweekly.com/

This magazine is also available through an online subscription and serves as a trade publication for professionals in the library and publishing fields. Its coverage includes industry news, trends, events and book reviews. More than 7,000 book reviews are published annually and written by both freelance reviewers as well as well-known authors. The reviews are divided by fiction and non-fiction.

ELECTRONIC DISCUSSION LISTS AND WEBSITES

ACQNET-L
http://serials.infomotions.com/acqnet/

ACQNET serves as a moderated forum for the discussion of any topic of interest to acquisition librarians and other library professionals involved in acquisitions of all types of materials. The listserv maintains a searchable archive.

COLLDV-L
http://serials.infomotions.com/colldv-l/

COLLDV-L includes issues of acquisition but also covers more broad issues of collection management, such as policy development, deselection issues, and collection evaluation. It is a moderated discussion directed towards library collection development professionals, bibliographers, selectors, and others involved with library collection development.

ERIL-L
http://listserv.binghamton.edu/archives/eril-l.html

ERIL-L's purpose is to cover all aspects of electronic resources in libraries. In addition to collection management librarians, participants include reference personnel, systems librarians, and vendors with topics ranging from usage statistics to product issues to licensing. The list is moderated and archived.

Association for Library Collections & Technical Services (ALCTS) Collection Management Section (CMS)
www.ala.org/alcts/mgrps/cms

> The purpose of CMS is to contribute to library service and librarianship through encouragement, promotion of, and responsibility for those activities of ALCTS relating to collection management and development, selection, and evaluation of library materials in all types of institutions. The section develops publications, online courses, and other tools for the training and further development of collection management.

ACQWEB
www.acqweb.org

> Although the website has not been recently updated and is under revision, it is still valuable in providing links to publisher and vendors as well as to other online resources of interest to acquisitions and collection development librarians.

This list is not meant to be exhaustive, but simply an introduction to some of the resources available for getting up to speed in collection development. As the Sudden Selector guides are subject-specific, most of the above resources are too general for inclusion in the main text. However, personnel responsible for collection development should ultimately be familiar with most of them. Additionally, for the most exhaustive bibliographies for further research, consult the guides to collection development listed above.

Doug Litts
Smithsonian Institution Libraries
American Art Museum & National Portrait Gallery
Editor, Sudden Selector's Guide Series 2006–2009
Updated 2011

INTRODUCTION AND OVERVIEW

If you are picking up this book, you have likely just taken on responsibility for providing information services for the physics community at your institution or company. Welcome to the community of physics librarians! Although merely uttering the word *physics* reliably elicits groans at cocktail parties, you will soon find that physics is a very dynamic discipline, filled with interesting ideas and people. Most people experience physics in their first year of college, learning mechanics and electricity and magnetism. Unfortunately, those courses are often steeped in difficult mathematics and are taught in lectures with hundreds of students. It is no wonder that physics has developed a bad reputation. However, there is a secret—first-year physics is the physics of 150 years ago. Physicists now are creating invisibility cloaks, quantum computers, and teleportation devices and are trying to solve the world's energy crisis.[1]

As a librarian, you get to work with people researching these interesting problems and, best of all, you do not have to do the math. Also, while having a science background can help you understand your users and their information needs, it is by no means a prerequisite. If you, like 41 percent of the librarians in the Physics-Astronomy-Mathematics Division of the Special Libraries Association (SLA), do not have a science or engineering degree, you are certainly not alone.[2] Some of the best physics librarians have art history or English degrees, and some librarians with technical degrees struggle with the user-centered attitude needed to be effective librarians. The most important qualities for a librarian are an interest in finding out about users and their needs and a willingness to become an expert in the literature. You do not have to be an expert on the content itself, but you need to know where the content exists and how to get to it effectively. That is where this book comes in.

This book provides a foundation to the resources and services unique to physics librarianship that will help you work successfully with your users. The first part of the book includes an overview of the discipline, including current hot topics of research (chapter 1), a brief introduction to the library liaison role (chapter 2), an analysis of the life cycle of information in physics and how physicists use different kinds of information (chapter 3). The second part of the book delves into the different types of information resources (books, journals, websites, and data sets) and describes which resources you need to develop and maintain an effective collection for your users (chapters 4, 5, and 6). Professional organizations in physics and resources for professional development for physics librarians are discussed in chapter 7. The final chapter provides a glimpse of some of the changing roles and opportunities for new services for physics librarians. After reading this *Sudden Selector's Guide*, you will have a much better understanding of what physics is, what physics librarians do, and how they build their collections.

Reference Notes

1. Tolga Ergin, Nicolas Stenger, Patrice Brenner, John B. Pendry, and Martin Wegener, "Three-Dimensional Invisibility at Optical Wavelengths," *Science* 328, no. 5976 (2010): 337–39; Artur Ekert and Richard Jozsa, "Quantum Computation and Shor's Factoring Algorithm," *Reviews of Modern Physics* 68 (1996): 733–53; Dik Bouwmeester, Jian-Wei Pan, Klaus Mattle, Manfred Eibl, Harald Weinfurter, and Anton Zeilinger, "Experimental Quantum Teleportation," *Nature* 390 (1997): 575–79.
2. Special Libraries Association, Physics Astronomy and Mathematics Division, *About the Membership* (2012), http://pam.sla.org/about/about-the-membership/.

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What Is Physics?

Physics traces its roots in the Western tradition back to ancient Greece. At the time, philosophers attempted to understand how things work, from human behavior and interactions to physiology to the constitution of the night sky. Philosophy attempted to find answers through a rational approach, that is, through observation and experiment, rather than intuition and conjecture. A branch of philosophy, *physikos,* which means "nature," focused on the physical world rather than the mind, and this natural philosophy encompassed all branches of science. As specialties like chemistry, biology, and geology split off into their own disciplines, what was left in natural philosophy focused on the most fundamental interactions of nature. Indeed, physics is often referred to as the fundamental science.

According to *AccessScience*, "physics is concerned with those aspects of nature which can be understood in a fundamental way in terms of elementary principles and laws," and physicists are motivated to find unifying, elegant principles to explain wide varieties of behavior of natural systems.[1] Physicists also tend to identify their science as focusing on matter and energy and their behavior under different conditions. The branches of physics attempt to determine the basic principles that govern how things work in particular types of systems. For example, the motion of everything from planets to race cars to amusement park rides can be explained using Newton's three laws of motion and his law of gravity. The interactions of the smallest known particles can be summarized by a relatively compact Standard Model. All the materials we observe with our own eyes can be described by understanding the interactions of three particles: electrons, protons, and neutrons. This reductive philosophy discards irrelevant information like the color, shape, density, or composition of a planet and focuses only on its mass, which allows physicists to predict the motion of planets well enough to send spacecraft to the edges of our solar system. To that end, the physicist's governing principle is Ockham's Razor—if two possible explanations exist for a phenomenon, the least complicated one is likely to be the correct one, and certainly the most useful.

Aristotle, in his *Physics*, provides an illustrative example of the beginnings of the discipline by postulating four forms of matter: earth, water, air, and fire. He also postulates that these forms of matter are governed by a fundamental interaction—that they want to get to their natural state, which is as close to the center of their sphere as possible. The spheres are concentric and build up from earth at the center of the universe, then water, then air, and finally fire as the farthest away. For example, a dropped rock naturally falls down to its center, on the ground. Similarly, water sits on top of earth but does not go through it. When water evaporates, it becomes air, moving upward toward that sphere. In this way, Aristotle attempts to describe how all matter behaves in terms of four fundamental particles, and one fundamental interaction. In the 2,500 years since *Physics* was written, the physics community has found that accurately predicting the motion and interactions of matter is a little bit more complex, but the idea of describing the laws of the universe in the simplest way possible has been the goal of physicists ever since.

Asimov, Isaac. 1984. *The History of Physics*. New York: Walker.
Isaac Asimov is famous for his science fiction and is often underappreciated as a popular science writer.

Gamow, George. 1940. *Mr. Tompkins in Wonderland: or, Stories of c, G, and h*. New York: The Macmillan Company.

Kaku, Michio. 2008. *Physics of the Impossible: A Scientific Exploration into the World of Phasers, Force Fields, Teleportation, and Time Travel*. New York: Doubleday.

Suplee, Curt, and J. R. Franz. 1999. *Physics in the 20th Century*. New York: Harry N. Abrams.

MAJOR BRANCHES OF PHYSICS

Physics seeks to explain the interactions of the universe at all length scales, from the smallest (quarks and leptons) to the size of the universe itself. Many times the laws that govern behavior of objects at one length scale are not important at a different scale. For example, it is not necessary to calculate the motion of all the electrons, protons, and neutrons in a metal to figure out how it conducts electricity. It turns out that branches of physics naturally divide, to first approximation, on length. Consequently, this tour of physics starts from the smallest and goes to the largest size.

High-Energy Physics

What used to be called particle physics is now typically known as high-energy physics (HEP). This reflects the idea that mass and energy are interchangeable, so the word *particles* is insufficient to describe the field. The terms *quark*, *gluon*, *lepton*, *neutrino*, and *QCD* are part of the language of high-energy physicists. High-energy physics is the kind of physics being done at the large particle accelerators, such as the European Council for Nuclear Research's (CERN) Large Hadron Collider (LHC) in Switzerland, Stanford's Linear Accelerator (SLAC) in California, and FermiLab outside of Chicago. When they say high energy, they really mean high energy. The LHC accelerates protons to 99.99 percent of the speed of light (nothing can go faster than the speed of light) and when those fast protons collide with each other, they create temperatures one hundred thousand times hotter than the center of the sun.[2] The goal of high-energy physics is understanding how the universe works at the highest energies. One reason this is of so much interest is that a high energy corresponds to a small wavelength, so by going to higher energies physicists can look at smaller and smaller length scales in an attempt to uncover how physics works at the most fundamental level. Currently, the LHC at CERN is the highest-energy accelerator, which recently announced the preliminary discovery of the Higgs Boson.[3] Further study of the Higgs Boson will help explain why fundamental particles like electrons and quarks have the masses they do, and the future experiments may give a glimpse of more particles that only exist at much higher energies.

Halpern, Paul. 2009. *Collider: The Search for the World's Smallest Particles.* Hoboken, NJ: John Wiley & Sons.

Ne'eman, Yuval and Yoram Kirsh. 1996. *The Particle Hunters.* 2nd ed. Cambridge: Cambridge University Press.

Particle Data Group. 2009. *The Particle Adventure.* http://particleadventure.org.

Nuclear Physics

Where high-energy physics generally deals with energies of single particles, nuclear physics focuses on the structure, properties, and interactions of the nuclei (protons and neutrons) that make up atoms. Nuclei are more complex than single particles in that several protons and neutrons make up a typical nucleus, so the interactions of many particles need to be taken into account at the same time. Since even a collection of three interacting particles can yield very complicated, chaotic motion, nuclear physicists who work with nuclei comprised of hundreds of protons and neutrons have a quite daunting task. Nuclear physicists do things like create increasingly heavy elements, measure decay (fission) properties, and smash heavy nuclei together at high speeds to create new states of matter (i.e., quark-gluon plasmas at the Relativisitic Heavy-Ion Collider [RHIC]).

Mackintosh, Ray, Jim Al-Khalili, Bjorn Jonson, and Teresa Pena. 2001. *Nucleus: A Trip into the Heart of Matter*. Baltimore, MD: Johns Hopkins University Press.

Rife, Patricia. 2007. *Lise Meitner and the Dawn of the Nuclear Age*. Boston: Birkhäuser.

Atomic and Molecular Physics

Zooming out from the nucleus to include its surrounding electrons, one enters the realm of atomic and molecular physics. Atomic and molecular physicists are interested in the properties of atoms or molecules and how they interact with each other and with electromagnetic or other fields. Atoms and molecules are largely governed by quantum mechanics, which can lead to interesting properties, including the structure of the periodic table itself. Some active areas of research in atomic and molecular physics are ultrafast processes (interactions that occur at femtosecond, 10^{-15}s, or attosecond, 10^{-18}s, timescales, which is the amount of time it takes light to travel from one side of an atom to the other), Bose-Einstein condensates (where atoms remain in a gaseous state at very low temperature instead of freezing, but are all in the same quantum state), and ultraprecise measurements of fundamental quantities. Atomic cluster physics is a related field in which the behaviors and properties of small groups of atoms are analyzed to determine how materials change from their atomic characteristics to those of a bulk solid. Chemical physics is an allied field that focuses on the physical properties of chemical reactions.

Bransden, B. H. and C. J. Joachain. 2002. *Physics of Atoms and Molecules*. 2nd ed. New York: Prentice Hall (Technical).

Gamow, George. 1960. *Mr. Tompkins Explores the Atom*. Cambridge: Cambridge University Press.

Condensed-Matter Physics

Moving up from individual atoms to large collections of atoms means entering condensed-matter physics. This field studies the dynamics and interactions of collections of atoms, which may be solids, liquids, or plasmas. Not only does condensed-matter physics include the study of the properties of bulk materials, like a hunk of copper, but also surface properties, phase changes (the way materials go from solid to gas, or one crystal structure to another), and collective phenomena, such as superconductivity. Building quantum dots and wires and other nanostructures to discover novel physical states are some of the more active areas of research in condensed-matter physics. Quantum computing and entanglement are also hot areas of research that could allow us to defy Einstein and communicate faster than the speed of light, or to find huge prime numbers quickly and subvert the encryption technology that underlies the security of the Internet. In order to reduce the effects of thermal noise that can ruin an experiment, many physicists run their experiments at very cold temperatures, close to absolute zero (-273 degrees Centigrade).

Dahl, Per. 1992. *Superconductivity: Its Historical Roots and Development from Mercury to the Ceramic Oxides*. New York: American Institute of Physics.

Leggett, Andrew. 1987. *The Problems of Physics*. Oxford, England: Oxford University Press.

Strogatz, Steven. 2004. *Sync: How Order Emerges from Chaos in the Universe, Nature, and Daily Life*. New York: Hyperion.

Optics

Optics deals with the behavior and properties of light. It is crucial as a detection and analysis tool for other branches of physics, but it is also interesting as a fundamental subject of study. Some physicists study optics at small length and time scales, where nonlinear phenomena take over; others create metamaterials with strange optical properties (such as a negative index of refraction, meaning that it bends light the opposite way than normal materials do). Holography and quantum optics allow physicists to probe the fundamental nature of light under extreme conditions and make light do things that were once thought impossible. Recently, scientists have even developed a crude invisibility cloak.

Sobel, Michael. 1989. *Light.* Chicago: University of Chicago.

Weiss, Richard. 1996. *A Brief History of Light and Those That Lit the Way.* Singapore: World Scientific.

Gravitation and Relativity

Our understanding of gravity and relativity is quite well developed, as witnessed by our ability to send people to the moon and steer spacecraft into orbit around asteroids. Current areas of research are largely centered around the unification of gravity with the other fundamental forces of nature (finding one theory of everything). String theory and quantum gravity have been proposed to do just this, with the one drawback that it is very difficult to test the theories experimentally because the energies at which observations can be made are much higher than what can be produced in the laboratory. Some recent experiments, such as Laser Interferometer Gravitational-Wave Observatory (LIGO), attempt to detect gravity waves, which are the ripples in the space-time continuum caused by the motion of large masses. Gravity waves are a phenomenon predicted by Einstein almost one hundred years ago, but have not yet been directly observed.

Greene, Brian. 2003. *The Elegant Universe: Superstrings, Hidden Dimensions, and the Quest for the Ultimate Theory.* New York: W. W. Norton & Co.

Smolin, Lee. 1997. *The Life of the Cosmos.* New York: Oxford University Press.

Astrophysics, Geophysics, and Biophysics

These interdisciplinary branches focus on the physical underpinnings of astronomy, geology, and biology. For example, biophysics might involve understanding how proteins fold or how molecules move around a cell. Biophysicists might also use physics tools, such as spectroscopy or microscopy, to visualize a biological system. Biomechanics, ultrasound, and medical physics are other areas where biology and physics interact. Geophysicists might seek to understand how rocks fracture or how the circulation of material in the earth's core gives rise to its magnetic field. Astrophysics includes the formation, structure, and dynamics of astronomical objects, such as quasars, novae, black holes, stars, and planets. Cosmologists try to determine how the universe was formed and why it looks the way it does now. Astroparticle physicists analyze the high-energy particles (some of which are more energetic than what we can create in our earth-bound accelerators) that are always raining down on us from the cosmos.

Cotterill, Rodney. 2002. *Biophysics: An Introduction.* Chichester, West Sussex: John Wiley.

Hawking, Stephen and Leonard Mlodinow. 2005. *A Briefer History of Time.* New York: Bantam.

Marshak, Stephen. 2008. *Earth: Portrait of a Planet.* 2nd ed. New York: W. W. Norton.

Sagan, Carl. 1985. *Cosmos.* New York: Ballantine.

Mathematical and Computational Physics

Although not formally disciplines, mathematical and computational physics refer to the study of techniques for solving different kinds of physics problems, many of which can be applied in several areas of physics. For example, computational physicists may focus on finding algorithms that solve problems in increasingly efficient and accurate ways. These might include genetic algorithms, which use survival of the fittest concepts to evolve the best solution, or simulated annealing, which uses an energy analogy to repeatedly heat up the parameters in the problem and then cools them down, assuming that eventually it will cool down to the correct lowest-energy solution. Other scientists try to find more efficient ways of directly solving equations with thousands or hundreds of thousands of interacting particles so they can simulate complex situations and determine why real-life phenomena occur. With ever-increasing computational power available, the ability to solve increasingly complex problems and the challenges of making sense out of these complex systems continue to expand.

Giordano, Nicholas and Hisao Nakanishi. 2006. *Computational Physics.* 2nd ed. Upper Saddle River, NJ: Pearson/Prentice Hall.

An introductory textbook with some technical spots, but it can be skimmed to see a sample of the variety of computational techniques applied to gravity, earthquakes, protein folding, and the human brain, among other topics.

Gleick, James. 2008. *Chaos: Making a New Science*. New York: Penguin.

Physics Education

With the recent emphasis on student learning outcomes in higher education and making sure students learn what we expect them to know, physics education is a discipline in its own right. Some physics concepts are difficult to master because they are counterintuitive, abstract, or are built upon concepts that students have not already mastered. Physics education attempts to understand which concepts are most difficult for students to learn and to create interventions (instruction) that will help students create appropriate mental models to successfully understand the concepts. Physics education research frequently is done throughout the preschool through undergraduate grade levels.

Arons, Arnold. 1997. *Teaching Introductory Physics*. New York: Wiley.

Knight, Randall. 2002. *Five Easy Lessons: Strategies for Successful Physics Teaching*. San Francisco, CA: Addison-Wesley.

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1. William G. Pollard, "Physics" in *AccessScience*, (New York: McGraw-Hill, 2008). www.accessscience.com.
2. CERN, *LHC Facts and Figures* (2010). http://public.web.cern.ch/public/en/LHC/Facts-en.html.
3. CERN. 2012 "CERN Experiments Observe Particle Consistent with Long-sought Higgs Boson." CERN Press Release, July 4, 2012. http://press.web.cern.ch/press/PressReleases/Releases2012/PR17.12E.html.

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Physics Librarianship

Liaison Roles

What does it mean to be a physics librarian? What needs do physicists have, and what services can librarians provide? The answer depends on the culture of individual departments, but this chapter provides hints and trends to take into account when constructing liaison relationships with a physics department.

Librarianship is fundamentally about connecting users with the resources they need in order for them to efficiently solve their problems. To do this effectively, librarians have to understand their users and the users' interests and needs. Contrary to the popular depiction of librarians sitting behind a desk waiting for someone to ask a question, especially now that technology has made information ubiquitous, librarians have to be proactive and advocate for using the best information available to meet a need. Information evaluation and management has replaced information seeking as a primary need of users, and information literacy skills have become even more important as users have to sort through massive quantities of available information to isolate the high-quality information that comes from authoritative sources.

MEETING USERS

Nothing replaces talking to users to determine their needs. However, do your homework before speaking with them. Departmental websites typically list research interests of faculty and often include a list of recent publications. A quick search on Web of Science, Inspec, or Google Scholar will also yield some recent work by faculty. First find some recurring terms, like *high-temperature superconductors* or *quantum Hall effect* and then check Wikipedia or consult a scientific encyclopedia (*AccessScience*, for example) to get a basic understanding of the concepts—enough to ask faculty members about the topic.

When meeting faculty, have a list of questions prepared beforehand. Questions may include:

- What are your research interests? (Usually a good ice-breaker. Faculty members devote their careers to their research and naturally enjoy talking about their work.)
- What journals do you read?
- Are there conferences you regularly attend? If so, do you read the proceedings? Are there conference proceedings you think the library needs to acquire?
- What kinds of information do you need on a recurring basis (for example, materials properties, mathematical functions)?
- Where do you find the information you require?
- How do you interact with the library and the physics collection provided by the library?
- Is there any kind of information you have difficulty locating?
- What courses are you teaching?
- Do you require students to find information not included in their textbooks in your classes? If so, how do the students perform on these tasks?
- Do you consider your students information savvy?
- Do you have reading lists or put materials on reserve for students in courses you are teaching?
- What questions do you have about the library and how it works?

These kinds of questions can be a guide to start conversations. If a faculty member requires a term paper for a class he is teaching, for example, and is not happy with how the students write the paper, you can follow up and ask why or which parts gave students the most trouble. This can lead to future instructional opportunities for you. When talking to a faculty member for the first time, bring a bookmark or small sheet of paper with the most basic information about the library, including URLs for the physics online subject guide, direct links to e-journal finders, subject indexes, and electronic reference materials, information about interlibrary loan, and instructions for putting an item on course reserve. If your library provides scholarly communication, data, or other services that a faculty member might not think of in relation to a traditional library, make sure that they know you are willing and able to help them or refer them to the area of the library that handles those kinds of activities. Leaving a quick reference behind allows faculty to access the information they need as quickly as possible. Some libraries have created disciplinary toolbars that push this information onto faculty members' browsers, so the library links are only a click away from wherever the faculty member is browsing. Also make sure faculty members know how to access the library's subscriptions through Google Scholar, so those who use it as a locating tool can get to your content as easily as possible.

Meeting Undergraduates and Graduate Students

While meeting faculty is crucial to developing a good relationship with the physics department, be sure to engage with physics students. Often an institution will have undergraduate physics student organizations, such as a Society of Physics Students and its honor society, Sigma Pi Sigma. Graduate students typically have their own organization as well. To connect with the student organizations, offer to visit one of their meetings and make a presentation. Discussing an interesting topic such as RSS feeds, Zotero, connecting to the library's journals through Google Scholar, or some piece of social networking technology will help students view the library as a cutting-edge, dynamic place and not just a warehouse of books. Alternatively, ask the students what they think about the library, the collection, and what their biggest frustrations are in finding information. Focus on information rather than the library, since students have preconceived notions of what a library is, which could limit the discussion to physical books and print journals. The latest generation of subject guide software, such as LibGuides or Library à la Carte, provides dynamic content that can be easily targeted to specific audiences as well.

WORKING WITH THE DEPARTMENT

It is also important to meet with the department head. The head is paid to deal with administrative issues for the department, and is a good source of knowledge about how the department operates, the strengths and interests of the faculty, and the department's strategic goals. This includes knowing how the department has interacted with the library in the past. Perhaps there is a library advisory committee or an individual who acts as the official departmental liaison to the library. Understanding the history of the relationship between the library and the department will help you navigate the people and politics that will impact any decisions you make. If the physics department does not have a liaison or advisory committee, your first task can be advocating for one (or implying that the department head would have to take on that role). Having a single person or small committee in the department to discuss ideas, gather advice, and act as a conduit to communicate with the entire department is very useful. Furthermore, having the backing of some members of the department will make your suggestions for a new service or a fair process for rightsizing journal subscriptions more easily accepted.

It is equally as important to develop a good working relationship with the head's administrative assistant. Although not a member of the faculty, the assistant is involved in implementing or keeping track of the work of the department, and often has the best understanding of the practical workings of the department. An assistant can quickly answer routine questions or requests or refer you to the group or person who can answer your question. Assistants are also aware of departmental activities that you can participate in to get to know the department better.

WORKING WITH PHYSICISTS

Scientists and librarians actually have similar Myers-Briggs personality types that tend toward introversion, thinking, and judging personality characteristics.[1] Generally speaking, physicists like to know the reasons why decisions are made and that there is a good rationale for those decisions. To influence a physicist, then, make sure you have assembled data (like usage statistics or cost per use analyses) and can articulate the process for decision making. Expect a discussion of the assumptions that went into your model, whether any other information might be relevant, and feedback about the most logical way to proceed. Certainly, you should not take these kinds of questions personally. Physicists are almost hopelessly intellectually curious; after all, they are trying to understand the universe, and that takes a great deal of curiosity!

Physicists like to tinker with ideas, and that tends to spill over from physics into everything else they do. Physicists can be supportive throughout this process of examining ideas. Ultimately, they like to get to the best answer. While it might mean having to go back and find more data, physicists tend to treat these challenges as collaborative ventures rather than adversarial competitions. Consequently, it is important to marshal your arguments and to be prepared before making proposals, but ultimately to enjoy the intellectual process of discussing the proposals.

EMBEDDING IN THE DEPARTMENT

Larger institutions often have a history of branch science libraries, perhaps even a library for each department. However, with the increased amount of content available in electronic format, the constant desire for new space by growing departments, and the changing nature and resources needed for managing electronic content, many branch libraries are closing or have been closed. Librarians accustomed to having a space next to their users can feel less connected if they are moved from a departmental branch into a main library or consolidated science and engineering library.

Embedded librarianship, office hours, or other models where the librarian spends face time in the physics department have been successful in some settings to retain a connection to their primary users. Purdue University still has a stand-alone physics library, which is the ultimate in being embedded, but has also been successful having the engineering librarians provide office hours in their liaison departments, which are spread out across the campus. The departments know that for a few hours a week they have the librarian's undivided attention and a reserved window to schedule appointments or impromptu instruction sessions. Faculty use these times to send their graduate students to visit the librarian for orientation and specialized help with thesis topics. One can argue that having specific hours available helps focus the attention of faculty and students as well. If a librarian is always available then there is no reason to visit now, whereas if the librarian has a window of availability, visitors have a more defined decision to go now or wait until next week.

Other than office hours, there are often opportunities to interact with the department in informal ways. Hanging out before seminars at the cookie table has led to many reference transactions and collections inquiries for me, since many faculty have partially formed questions lingering in the backs of their minds, which are only catalyzed into action when the faculty member sees the librarian. Similarly, some departments have weekly coffees, weekend social hours, or intramural teams, which provide ways to interact with individuals on a social level, building a level of comfort with the librarian that makes it easier for users to ask questions when information needs arise. Do not join an intramural team if you hate sports, but find an enjoyable activity that the department engages in that will help you develop networks that make you more approachable as an information professional.

Faculty meetings provide another robust venue to connect with faculty and the work of the department. Whether a librarian is invited to faculty meetings depends to a large degree on the culture of the department and how much they think the contents of the faculty meeting should remain in-house. Do not be surprised if you are either invited with open arms or politely but firmly declined entrance to the meetings. It is almost certainly not about you, but rather about the department's own culture of openness. That said, make a strong argument for attending the meetings. Typically, faculty meetings involve the discussion of changes to the curricula, requirements of the larger college that have implications for the department, or even new areas of research emphasis for the department. By articulating specifically how you, and they, can benefit from listening to the conversation (or, if they allow, participating as well), you have a better chance of persuading them to allow you to attend. Even if you are unable to attend the faculty meetings, asking for agendas and minutes of the faculty meetings (or finding out where they are posted) can give you guidance on where to follow up to get the details on a topic that was discussed.

Departmental newsletters can provide grist for conversations with faculty being profiled or initiatives being announced. Their email lists also help keep you connected with the department, the ebb and flow of activity, and concerns of the members of the department.

Volunteering provides an opportunity to make connections with members of the department. For example, I have volunteered as a science fair judge, alongside several physics faculty and grad students, for several years, evaluating elementary and high-school students' physical science projects. Departments also often have an outreach arm, which may coordinate traveling demonstration programs, open houses, summer camps, or continuing education activities for teachers. Finding opportunities to participate in these activities in any fashion can lead to collaborations where information becomes a component. However, it is important to take the time to understand how a program works before making suggestions to incorporate an information component.

Reference Note

1. Gerald Macdaid, Mary McCaulley, and Richard Kainz, *Myers-Briggs Type Indicator Atlas of Type Tables* (Gainesville, FL: Center for Applications of Psychological Type, 1986) and Mary Scherdin and Anne Beaubien "Shattering Our Stereotype: Librarians' New Image," *Library Journal* 120, no. 12 (1995): 35–38.

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The Information Cycle of Physics

Physicists have a long history of sharing information informally, at least in certain areas of physics. Indeed, physicist Tim Berners-Lee developed the first web browser while trying to create an easy way for participants across the globe to stay connected with all the happenings of a high-energy physics experiment. High-energy experiments typically involve teams of hundreds of scientists, so communication is imperative in constructing, installing, running, and analyzing experiments.

The formal information cycle in physics is similar to that of many other branches of science. Experiments are conceived and carried out and data taken, analyzed, and organized. Informal communication among collaborators takes place, conclusions are developed, conferences attended, and papers written. Secondary publication of monographs, handbooks, encyclopedias, and other reference works follow. Technical reports may be written depending on the requirements of a particular grant, and most grants now contain educational reporting requirements as well. This chapter introduces the different stages of the information cycle and the roles they play for physicists.

REFERENCE WORKS

Reference works in physics mimic those in other disciplines. Scientific dictionaries and encyclopedias typically are written for non-scientists, although some titles do expect the reader to have a general background in physics. Physicists may refer undergraduates or graduate students to dictionaries and encyclopedias to gain an awareness-level understanding of a concept, or even use them themselves if they are moving into new areas of research.

Directories of individuals have become almost obsolete, as up-to-date information on a scientist can be found from a simple web search. However, institutional directories, such as guides to graduate programs, still have value for a library collection.

Handbooks and tables provide the greatest value for physicists, as they compile data about materials, properties, instrumentation, analysis, or theoretical methods. Handbooks and tables compact the information from potentially thousands of reports, journal articles, or other books into a single monograph, so users can find the pre-digested and extracted information more easily. A physics library should contain a substantial collection of this type of (increasingly online) data. In the past ten years, the ability to search for data through online interfaces, often across hundreds of reference books simultaneously, has made locating needed information much easier.

In addition to these standard reference sources, your reference collection may also contain biographical dictionaries, style and writing guides, and career information. Some core physics reference titles are provided in the next chapter.

MONOGRAPHS

Several general classes of monographs are produced by the physics community, each of which has its own characteristics and usefulness for your collection. When evaluating whether to purchase a title for your library, it is helpful to ascertain what class of book it is to understand how it fits into the collection.

Textbooks

Most likely your experience with physics has involved a relationship with a ten-pound introductory physics textbook. Textbooks are designed to impart a certain corpus of knowledge, typically through explanation, derivation, worked examples, and problems at the end of the chapter. Although introductory textbooks are most familiar, physicists also publish many textbooks on advanced topics that are suitable for graduate students or others starting work in a subfield of physics. The *Lecture Notes in Physics* book series is an example of such advanced texts. It is nice to have a variety of introductory texts available for students so they can find alternate explanations of concepts, but collecting introductory textbooks that are not actively being used for courses should be a low priority, since most texts are remarkably similar in their treatment of topics. A few notable exceptions are *Conceptual Physics*, by Paul Hewitt, *Matter and Interactions* by Ruth Chabay and Bruce Sherwood, the *Feynman Lectures in Physics* (an iconic text) by Richard Feynman, Robert Leighton, and Matthew Sands, and *How Things Work*, by Louis Bloomfield. Lillian McDermott's *Tutorials in Introductory Physics* provides examples of activities that address concepts that are frequently misunderstood by students. While generic introductory texts are less interesting for a collection, collections that support a graduate physics program should include advanced texts. Graduate students starting their research programs use them as a bridge to get up to speed before they dig into the journal literature. Chapter 4 lists several book series that fit this description.

The decision to purchase introductory course texts for reserve is often made at the institutional rather than the individual level. These are typically the highest-circulating books, so why would a library not provide access to them? Until publishers move to fully functional e-textbooks, course reserves allow students to pop into the library between classes and perhaps do some homework or review a chapter without having to lug their huge textbooks around campus (a special problem for physics texts). Often, it seems,

Know the Authors

Physicists, attempting to be precise or maybe just showing a lack of imagination, often provide generic titles for their textbooks. Any physics collection might contain twenty different books called *Electricity and Magnetism, Solid State Physics,* or even just plain, *Physics.* Some authors jazz up their titles by adding an *Introduction to* or *College* to the title. Consequently, the most valuable identifier for a physics text is often the author's last name. Referring to "Halliday and Resnik" or "Serway" rather than *Physics* may get you bonus points from your faculty. Shelving reserve books by author may reduce confusion and aid quick retrieval.

librarians forget that undergraduates do not have offices, and many live off campus, so they need to bring all their materials with them for the day and cart them around campus.

Collected Works

Some publishers collect and reprint the works of eminent physicists, often with some commentary to provide context for how articles relate to each other and to the research community's evolving understanding of a concept. These works are not very popular because it is easier to find copies of a specific journal article online, and physicists are often interested in specific content rather than historical context. Purchase collections of only the most eminent physicists, such as Einstein, Pauli, Schrodinger, and Feynman. These works can also be useful in a pinch to locate a famous older paper that might not be in your journal collection, but those occasions are fairly infrequent.

Collected Articles and Chapters

Look at books comprised of collected articles with a high degree of suspicion. These books are often commissioned to review a particular subject, with the chapters being farmed out to experts in the field. Editing for these works is often uneven and, while some editors take pains to try to make the chapters fit together into a coherent whole, readers are often left feeling as if they have just read an issue of a journal rather than a book. If you are reading publisher or book vendor blurbs, one hint that a book is an article collection is that an editor is listed, rather than an author. Often, book vendors will correctly note that a book is a collection of articles, but not always, so it is good to double check. Collections of previously published articles are typically useless, as librarians have probably already spent a considerable amount of money to purchase access to the content through journal subscriptions.

FESTSCHRIFTS

A special case of the collected articles genre, festschrifts are a collection of papers written in honor of an eminent person, often as part of an advanced birthday celebration. Former graduate students, collaborators, and others influenced by the work of the individual being honored typically contribute. Festschrifts can provide context for understanding the impact and influence of the physicist, but they almost never contain any new information (i.e., anything citable). Generally, selectors will not have the budget or audience needed to justify the purchase of festschrifts, except in cases in which they were written for someone at their institution.

Dissertations

Some dissertations are still commercially published, often those from European countries. Since publishers do not always make it obvious that a publication is a dissertation, it pays to read the fine print on book announcements. While I occasionally receive requests for dissertations, I normally suggest patrons go the interlibrary loan or document delivery route, rather than have the library purchase dissertations proactively, especially now that most of them can be downloaded immediately through *ProQuest Dissertations and Theses*. Dissertations are also frequently available in institutional repositories, so it pays to check the author's home institution to see if a free copy is available. Since space is at a premium in journal articles, one advantage of dissertations is that they typically have the most extensive literature reviews of any document and provide great depth about the conceptual background, methods, and apparatus used. Thus, when reproducing or expanding on the work of an experiment, the dissertation can be quite valuable.

Popularizations

Popularizations of science topics have become quite, shall we say, popular, and are worth purchasing. Undergraduate physics majors enjoy these as ways to get a conceptual understanding of interesting and evolving areas of physics, and faculty may use these books to gather interesting anecdotes to use in their teaching. Some of the old popularizations, such as *Mr. Tompkins in Wonderland*, have aged quite well. However, there are some topics that have been oversaturated with popularizations, such as quantum mechanics and relativity, where not that much has changed since the 1930s. When deciding whether to purchase a popularization, check your holdings to see if there is already a substantial collection on the topic, and perhaps wait for a review (the next chapter includes a list of book review sources). Keep an eye out for interesting new topics, such as *The Physics of Baseball* or *Ice Physics*, to add interest to the collection and provide introductions for students interested in special topics of physics. Generally, these titles are cheap, in line with typical mass-market monographs, and are perhaps a tenth of the cost of a research monograph, so they are low-risk purchases. Avoid at all costs new-age physics texts like *Quantum Mechanics and the New Spirituality*. Nothing reduces your credibility with your user group more than putting books in the collection that are not science, but rather attempts to extend weak analogies from a physical system to a spiritual one. Those texts are best classed under metaphysics, religion, or philosophy and are inappropriate in the realm of the physics collection.

Biographies and Histories

Biographies and histories are quite valuable for physics collections, as they provide students with context for their discipline and help them understand how the scientific method works. These materials also show that progress often does not come immediately or in a straight line; rather, physicists explore different alternatives and run into dead ends until they finally arrive at the amazing discovery that everyone knows about. Overall, these resources, as well as being enjoyable reads, help the socialization and identity-building of students as part of the physics community. As with popularizations, one can easily be overwhelmed with biographies of well-documented physicists, such as Einstein. In those cases, it is advisable to consult book reviews before purchasing another of their biographies. An interesting recent trend in this genre is amalgams of histories and biographies, concentrating on one or two main figures, while describing how those figures interacted within society and how the politics of their time affected what they worked on and how they worked.

Conference Proceedings

Many conference proceedings are published in journals, often to the dismay of librarians who do not want to pay journal prices for proceedings that have less impact and typically a lower level of peer review. However, conferences are also frequently published in monograph form (and librarians get quite agitated when a publisher tries to publish it in both, especially if they do not

The Crackpot File

One of my physics librarian colleagues used to talk about his crackpot file of self-published and vanity press books that authors send him, complimentary of course, to put in his esteemed library so that others could benefit from the authors' great (and unappreciated) discoveries. He would occasionally share them with his faculty for entertainment value. Most of these books have some variation of the title *Why Einstein Was Wrong, The Real Theory of Everything,* or some metaphysical take on a physics principle. You will likely receive your share of these books and adding them to the collection would not be well received by your users. If you do not recognize the publisher or if the author's name appears in the name of the publisher, you are probably looking at a candidate for the crackpot file.

tell the librarians, so the library pays twice for the same content). These are low-priority purchases, except for the rare conference that is central to the work of a particular research group. For the most part, physicists do not cite conference proceedings, and unlike engineering and more technical disciplines where the conference proceeding is often the only publication of a research finding, in physics, it is expected that if a result is interesting, it will be formally published in a peer-reviewed journal. Conference proceedings are usually just announcements of works in progress or preliminary findings, and, especially since conference proceedings typically take a year or more to make it into print, often the follow-up journal article appears before the proceeding upon which it was based. Physicists such as Sir Michael Berry consider publishing a proceeding as merely a necessary evil to justify their attendance at a conference.[1] One should note that some conference proceedings are being made freely available on the web, including some streaming video broadcasts of presentations.

JOURNALS

Journal articles are the bread and butter of physicists. The traditional journal article is the official documentation of an experiment or research result. Journals have specific formats and structures that enable the reader wishing to understand, evaluate, or replicate the experiment to efficiently gather the needed information from the article.[2] Not all journals are made up of these traditional articles, however. Other options include review, letters, proceedings, and trade or popular journals.

Review Journals

Some journals contain only review articles. Indeed, some journal issues are comprised of only one review. Review articles typically do not include any new research results, but instead summarize the state of an evolving area of research. The review articles usually include a large number of references (often running into the hundreds), to facilitate a new researcher finding relevant, seminal papers. As such, review articles are often highly cited and review journals often have high impact factors compared to research journals.

Letters Journals

Letters and rapid communication journals specialize in short articles on topics of special interest to a research community. They are characterized by rapid turnaround and quick time to publication, so authors like to put their breaking news into letters journals for maximum impact and establishing priority of their results. Since there are usually strict page limits for their articles, only the most important details are included, and methods sections, for example, are minimal or absent. Often, but not always, a follow-up traditional article is published with more details of the experiment.

Proceedings

Like proceedings published as monographs, some journals publish proceedings as part or all of their content. Librarians often consider proceedings as filler, since proceedings often do not go through the same level of peer review as journal articles, and, as mentioned previously, the impact of a conference proceeding (as a statement of work in progress or preliminary results) is much lower than that of traditional journal articles. Consequently, when evaluating journal subscriptions, determining which ones publish a significant fraction of proceedings can help in the selection or deselection process.

Popular and Trade Journals

Some periodicals are better classified as magazines than journals. They often publish edited articles geared toward non-specialists and students. They might include sections such as Tips, News from the Field, Product Reviews, Historical and Biographical Information, as well as feature articles on hot topics in physics. While these journals do not typically advance the research frontier of physics, they do provide motivation and a current awareness function. These journals are also prime candidates for retaining in print format, as they are typical browsing journals. A list of core physics journals, broken down by subject area and category, can be found in chapter 5.

PREPRINTS

Preprints are a very important part of the information cycle for physicists. Indeed, in high-energy physics, virtually all journal manuscripts are deposited either before or after publication on an open-access preprint server, usually arXiv.org. While some publishers consider posting a preprint to be prior publishing and will therefore not consider these for publication in their journal, most publishers, led by the American Physical Society, encourage authors to post drafts on a preprint server. They find that feedback from the research community can help improve the quality of a paper before it goes through the formal review process. This saves time and money for publishers and ultimately yields a better-quality paper. Prior to the creation of arXiv, physicists had a strong history of print-based preprint distribution, with laboratories commonly mailing preprints to individuals and departments around the world. In this way, one can view arXiv as an evolutionary rather than revolutionary change in information practices for physicists. ArXiv did, however, revolutionize access to these preprints. Instead of having to be a member of an inner circle to receive one of a limited number of paper preprints, anyone can now access arXiv equally, democratizing the flow of information in the physics community. One note about preprints: arXiv is frequently referred to as an e-print server, as it contains both preprint articles (before peer review) as well as postprint articles, which traditionally would have been called reprints or the published version of the article. Indeed, one might find both the preprint and postprint version (and any version in between) of the same article on arXiv.

ArXiv.org

ArXiv.org, pronounced "archive" and typically referred to as arXiv, is a simple concept, created, and for a long time housed, on the desktop computer of Paul Ginsparg, a high-energy physicist at Los Alamos National Laboratory. Authors submitted drafts of their articles to his preprint server, and a daily email was sent out to subscribers with basic information about and links to the new submissions. With the quirky humor typical of the physics community, it was first known as xxx.lanl.gov (since xxx comes after www), but several years later, after many, perhaps apocryphal, complaints that software filters were blocking access to the site, it became known by its current name.

For a long time arXiv was funded by National Science Foundation (NSF) grants, but after the NSF indicated a growing unwillingness to continue support, both Ginsparg and the arXiv moved to Cornell University in 2001, with the Libraries there taking over financial and administrative responsibility for the service. In 2010, with an estimated annual budget of around $400,000 to maintain the service, arXiv began asking for donations, an NPR model of funding, to help spread out the costs of the service among members of the library and physics community. Perhaps the core message here with respect to scholarly publishing is that there is no such thing as a free lunch, but with good faith and robust ideas, one can create and maintain alternative publishing models at reasonable costs.

The rate of preprint submission varies greatly among disciplines, with disciplines like astrophysics and nuclear and particle physics, which have large research collaborations, having high adoption levels, while physics carried out by smaller research groups, like condensed-matter physics and nanophysics, have a more modest (although growing) uptake. The variation in uptake of preprints in different branches of physics is important to understand when considering how specific physicists communicate.

DATA SHARING AND SOFTWARE TOOLS

Large science projects require extensive sharing of data, and the recent NSF mandate that grant proposals include a data management plan only makes data issues more important across all branches of science. These issues are discussed in chapter 8. E-science and all of its inherent functionality and possibilities offer vast new opportunities for librarians to participate in the information cycle earlier than ever before. The National Virtual Observatory is one example of a robust data repository that allows anyone in the world to search through massive amounts of data to make discoveries about our universe. For the past decade, the Grid Physics Network (GriPhyN) provided a repository of data analysis software packages for use with high-energy experiments. Originally independent, GriPhyN is currently part of the OpenScienceGrid. In the area of computational nanotechnology, the NanoHUB provides a social networking platform for the community, enabling the sharing of simulation programs as well as a robust collection of educational materials. VIVO, a research and expertise discovery tool developed by the Cornell Libraries and currently being deployed at many universities nationwide, provides an example of how librarians can contribute to the development of tools for scientists. The National Science Foundation recently funded two major proposals, the Data Conservancy and DataOne, both of which are led by librarians. These proposals aim to create a robust infrastructure to enable sharing and curation of data. Another initiative organized by librarians is DataCite, a system for attaching digital object identifiers (DOI) to data sets to make them as easy to find, in principle, as a journal article.

At the institutional level, there has been much discussion about electronic lab notebooks (ELN). Basically, ELNs are a virtual version of the traditional lab notebook, where the work of the researcher is recorded. ELNs are heavily used in fields where intellectual property is important, as they provide a timestamp that can be used to prove primacy of discovery, and as institutions of higher education are increasingly concerned with monetizing the intellectual output of their faculty, ELNs are being increasingly considered as a way to document the institution's research enterprise. Since they are networked, content can be selectively shared within and among research groups, as appropriate. While some libraries have investigated negotiating site licenses for commercial e-lab notebooks for their research community, pricing is currently prohibitive, and interoperability with applications that different research groups might use for data acquisition, analysis, or visualization continues to be a challenge. While there is no clear winner in the electronic lab notebook arena, it is an area for librarians to keep an eye on, as they may be asked to comment on, administer, or acquire a system on behalf of an institution. For example, Cornell University's Libraries and Academic Technologies are currently piloting an ELN system for their users.[3]

INFORMAL COMMUNICATION

Web 2.0 technologies enable virtual discussions and dissemination of information with an ease heretofore unknown. Blogs can take the form of personal opinions, pointers to news, or sequential conversations about a posting. They are most frequently used for awareness and to enable conversations. They tend to not be permanent modes of publication, and are not typically archived. Lists of specific blogs, wikis, and websites can be found in chapter 6.

Blogs

Many physics blogs are written or sponsored by news or scientific organizations, others by motivated individual scientists. The blogosphere is a very dynamic space, with blogs coming and going as individuals' time and interests change. Indexes, such as Technorati, can uncover new and interesting science blogs.

Wikis

Wikis are editable knowledgebases, where authors with permission can modify, overwrite, or delete content. All versions of the content are cached so they can be restored if need be. Essentially, wikis allow for easy group editing of content. Other document sharing tools, like Google Drive (http://drive.google.com) or Microsoft Office Live Web (www.officelive.com/) are also used for group authoring of documents.

Although most people think of Wikipedia, a huge collaborative encyclopedia, as the typical concept of a wiki, more often scientists use wikis as working collaborative spaces for internal documentation and for charting progress. Especially in larger research groups, wikis provide an environment to keep track of the different components, tasks, and specifications for experiments.

A few physics wikis attempt to reproduce the Wikipedia model, albeit on a much smaller and more focused scale, but often they suffer from not having enough resources to create and maintain the knowledgebase. Having a relatively small group of authors attempting to compose a lot of content, often in their spare time, typically leads to uneven coverage of topics and too many missing entries to make these information sources useful.

EDUCATIONAL RESOURCES

This odds-and-ends section of the cycle of information includes more popular and educational resources created by physicists to reach a broader audience. Several years ago, the National Science Foundation started requiring their grants to have an educational or outreach component, as a way of helping justify the money spent to the taxpayers funding the research and increasing the benefit of the research for society. Additionally, science, technology, engineering, and mathematics (STEM) education has become a priority for the NSF, as US children continue to underperform against the rest of the world in those subject areas. Consequently, physicists have developed a large variety of freely available educational web resources, such as *The Particle Adventure*, *The Nine Planets*, *Physics2000*, and *QuarkNet*.

Reference Notes

1. Michael Berry, "What's Wrong with All These Conference Proceedings?" *Physics World*, no. 7 (1991): 12–13.
2. Michael Fosmire, "Quick Tutorial on Reading Scientific Papers," West Lafayette, IN: Purdue University Libraries, www.lib.purdue.edu/phys/inst/scipaper.html.
3. Wendy Kozlowski, "The Electronic Lab Notebook: Piloting a Research Data Management Tool at Cornell University," presented at *Research Data Symposium*, February 27, 2013, http://hdl.handle.net/10022/AC:P:19168.

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Monographs

If you are coming to physics librarianship from the liberal arts, you might be in for a case of sticker shock. Although physics monographs cost about as much as books in other science disciplines, they average about double the cost of humanities or social science texts. According to *The Library and Book Trade Almanac 2010*, for academic books in 2008, physics monographs averaged a little more than $100 per title, much less than the $186 of chemistry, but substantially more than, for example, math and computer science ($83), and about 50 percent higher than the average for all academic disciplines ($70). Approximately one thousand books were published in physics and astronomy in 2008, which means that in order to purchase the entire corpus of knowledge, your monograph budget would need to be about $100,000. Doing the math, if you are at a Research I institution, you might be able to purchase from 10 to 20 percent of the scholarly output in physics, and, of course, the percentages go down from there for smaller institutions.

Consequently, it is important to make the best use of your collections money to be able to cover as much of the relevant literature as you can. The sections that follow provide some guidelines for selecting the best materials by choosing high-quality publishers, appropriate genres of books, and refining your approval plan to make the process as efficient as possible.

KEY PUBLISHERS

In the past ten years, many publishers of physics books have merged, been bought out, or subcontracted their monograph publishing operation to commercial entities. At the same time, some new publishing houses have been created, offering new opportunities for authors. In terms of publishing output, the field is dominated by a handful of publishers, including Springer, World Scientific, Wiley, Cambridge University Press, and Oxford University Press. Nova Scientific and Alpha Scientific Press are relative newcomers to the field of publishing, and are worth keeping an eye on, to see how well their publications stack up.

Springer
www.springer.com

Publishes more than 250 titles a year, many as a part of book series (the publisher's website lists more than 75 book series, not all of them current). Springer titles typically have an intended audience at the graduate student and higher level. They publish a large number of conference proceedings and edited collections of chapters, as well as a substantial number of graduate level textbooks (*Lecture Notes in Physics* and *Graduate Texts in Physics* are two important series). Springer also produces reference works and data compilations, of which the comprehensive but very expensive *Landolt-Bornstein* series, now known as *SpringerMaterials*, is the foremost example.

John Wiley and Sons
www.wiley.com

Wiley publishes a variety of books, ranging from popularizations such as the *Physics for Dummies* series, to undergraduate and graduate textbooks, as well as review monographs in specialized areas of physics. Wiley has significant strength in chemical physics topics.

Cambridge University Press
www.cambridge.org

Cambridge University Press (CUP) publishes high-quality monographs and reference materials in all areas of physics, although they are strongest in condensed-matter physics. They also publish a fair number of histories of physics and books that incorporate the social impacts of science.

Oxford University Press
www.oup.com

Oxford University Press (OUP) is one of my favorite publishers because the literary quality of their publications is typically very high. OUP publishes biographies, histories, and popularizations as well as graduate texts and review monographs. OUP stays away from conference proceedings and collected articles.

World Scientific
www.worldscientific.com

World Scientific publishes a large quantity of material in all areas of physics, the bulk of which are conference proceedings. World Scientific also publishes monographs and popular books, some of which are very nicely written.

Princeton University Press
http://pup.princeton.edu

Although the number of books published is relatively modest, Princeton University Press (PUP) books are typically very well written, bringing current topics in physics to life. PUP also has strength in history of physics and works about Albert Einstein.

BOOK VENDORS AND APPROVAL PLANS

Most libraries purchase their books through vendors, the largest of which for the sciences are YBP (which now owns Blackwell's and is a subsidiary of Baker and Taylor) and Coutts. Libraries typically receive a discount from the list price of a book in exchange for providing a certain volume of purchasing through the vendor. Vendors recently have offered shelf-ready options for purchasing materials, that is, books arrive already cataloged and marked, in response to the trend for libraries to outsource those functions. With the increase in availability of e-books, traditional book vendors have seen an erosion of their traditional business model of supplying physical artifacts to libraries. Some vendors provide assistance with managing purchasing and licensing agreements with various e-book vendors as a way to maintain their added value in the acquisitions market, while some of the larger publishers are bypassing book vendors and negotiating their own package deals, similar to journal subscriptions, to encourage libraries to subscribe to all their monograph content.

If you are at a smaller institution, your monograph budget may be very modest, and your purchasing might be limited to course textbooks for reserves, specific faculty and student requests, and perhaps a handful of the "best of" books being published. To make the best use of a small budget, consult book reviews to gain insight into the highest-quality monographs. If you are at an undergraduate-only institution, focusing on popularizations and hot topics provides the best chance that the books you buy will actually be read.

If you work at a larger institution, you likely have an approval plan, perhaps one already set up for your discipline. It is important to review the approval plan to make sure the books coming in are the ones your collection needs, and it is a good exercise to see what the previous physics librarian believed was important to the collection. Generally, you need to balance what comes in automatically with what you will be firm ordering, i.e., ordering title-by-title. If the approval plan is too broad, you might run out of money before the end of the year, or not have money available to make firm orders for needed materials that did not come in on the plan. However, if the plan is too narrow, you miss the power of the approval plan, namely, to automate the selection process, so you do not have to spend the time to order materials title-by-title. Some vendors assist in the selection process by labeling books as essential, recommended, or specialized, for example. This can be a good first cut to make sure you are receiving well-written materials of broad interest. Vendors often also classify the audience level of the monograph, so you can distinguish between materials appropriate for undergraduates and graduate students.

You can refine your approval plan using many different criteria. First, are there publishers whose books you definitely want or do not want? You can include or exclude them from the approval list. Perhaps there are book series that are important for your users. It is straightforward to include or exclude individual series. Also, if your department has strengths in specific subdisciplines (like nuclear physics or nanotechnology), you can tweak your profile so that it collects all publications in some areas, and only selectively in others. It is important to consult with your users, however, to determine their reading habits. They may not need a comprehensive monograph collection depending on how their community uses the literature.

You can also set price thresholds for approval plans. Many monographs may cost two or three hundred dollars, so purchasing just a few of them could devastate your collections budget. Although some high-priced materials, for example, reference books or compilations of data, justify the price, often expensive texts have a very limited scope and audience, and thus publishers produce small print runs. Not only are these texts expensive, they are also less likely to be used, unless your department specializes in that area. I set a relatively low price threshold for my monographs (around $150), and look over more expensive texts with a critical eye to make sure they are relevant to my users.

Conference proceedings tend to be expensive, highly specialized, and infrequently used. As mentioned previously, physicists generally think of the journal article as the literature of record in their discipline and therefore rarely use conference proceedings. When I ask my faculty which proceedings I should collect, I generally hear that they go to the conferences they want to attend and thus already get the proceedings. (Tip: you can supplement your collection by asking faculty members to donate their old proceedings.) Two other types of books, collections of articles and Ph.D. dissertations, also should be looked at with a degree of skepticism. They are generally very specialized, and edited collections of articles often suffer from a lack of editorial control, so that what is billed as a review of a topic is in fact just a collection of individual research groups' activities, rather than a systematic analysis of the topic.

CONSORTIAL AND COLLABORATIVE PURCHASING

Libraries have been purchasing electronic journals through consortial agreements for many years as a way of increasing their purchasing power in negotiations. With the increasing availability of e-books, publishers have begun offering package deals for monographs as well. You can stretch your collections budget by finding out which materials your institution already has access to and advocating for adding specific publishers to your consortial wish lists.

With the development of shared catalogs that allow patrons to request materials from one of several institutions, for example, Colorado Alliance of Research Libraries (CARL)'s Prospector, some consortia have collaborative agreements with book vendors, where core titles go to each institution in the consortium, but more specialized titles are only sent to one or two libraries in the system.[1] This provides maximum coverage of the body of literature while sharing the economic burden across a system of libraries. One interesting proposed model would be for books to be shelved at the last library from which they were borrowed, as a way to keep the books in the place where they are most likely to be used. If you are a part of a shared collection development program such as this, monitoring transaction reports can help you determine which books held at other libraries deserve a local copy at your institution.

E-BOOKS

E-books are very much in flux at this time. The most common way that e-books are made available is via PDF downloads from publisher websites or third-party vendors. Often, third-party vendors, such as EBSCO*host* (formerly known as NetLibrary) or ebrary, have better functionality than a publisher-supplied e-copy of the text, but they also often have more restrictive digital rights management (DRM). For example, you might have to click through a book page by page, instead of being able to download a chapter at a time, or the entire book, to print it out or view it on screen.

E-books add a level of complexity to the purchasing decision, since publishers, in an attempt to maximize sales through the broadest possible exposure, often provide their material to a variety of vendors as well as offer the material on their own website. Not only is your purchasing decision based on the content of the book, but also, potentially, the functionality of the platform, consistency across the library's collection, and use limitations (for example, check-outs vs. unlimited simultaneous users). Often, libraries have a preferred third-party vendor, so users are not faced with a plethora of different interfaces and policies for their books. My library has a couple of preferred vendors, one in the sciences and one for social sciences and humanities, to take into account that not only are books used differently in the different disciplines, but also that vendors have strengths in different disciplines.

I have found that faculty still appreciate a physical book for something that is a real monograph (as opposed to a collection of articles), so going completely e-only is not necessarily the best option. However, conference proceedings and many article collections are read like journal articles, so I have no qualms about purchasing those solely in electronic format. On the other hand, faculty love being able to access a book from home or their office, so I prefer to provide access to both print and electronic formats when possible.

Speaking of reading electronic texts, I do want to weigh in on e-book readers briefly. This is a constantly changing environment, but there are some considerations if you are thinking of, for example, providing e-readers to patrons so they can view your e-book content in the library without having to read it off a laptop or public terminal. The e-ink readers (like the pre-Fire Kindles) are still black and white, which makes some texts completely unreadable, especially in fields where color is used extensively as a way to encode information on a graph or chart. Also, those e-book readers often have a difficult time displaying graphs or images, and resizing those images can be impossible. The iPad and the new generation of multitouch color e-book readers, however, are the first to really do justice to sci-tech content.

PATRON-INITIATED SELECTION

A growing trend in libraries is the allocation of a substantial portion of collections money to materials that are selected by the users in a just-in-time model, rather than libraries' traditional just-in-case policy. This works best for electronic materials, since 'just-in-time' can be instantaneous, but the model has also been used in the print world.[2]

Bearing in mind that a substantial percentage of books purchased never circulate, and that information technology allows for on-demand access to materials, many libraries have leveraged their collections budgets by making agreements with one or more e-book vendors to load catalog records, but only pay for those books that patrons actually use. The library has a deposit account with the e-book vendor so that the patron has seamless access to the content, as long as the deposit account still has money. One download or browse does not necessarily constitute a purchase. Some agreements allow for one or two free looks at a book, but then at the third download, the library is billed for the material. Other agreements have a librarian intermediary in the process. For example, a book might be loaned to the user for a nominal fee and the librarian gets a notice asking whether they want to purchase permanent access to the work or just leave it in pay-per-view status.

The selection librarian needs to play an active role in developing collection parameters for these patron-initiated e-book agreements, similar to what you might do for approval plans. In general, you want to cast a wide net with these titles, since your users will be the ones determining whether a title is interesting. Only a small fraction of the eligible titles will ever be used, so excessive worrying about whether individual titles would be appropriate for the collection is not the best use of your time and energy. It is important, however, to make decisions on bigger-picture parameters. For example, are there publishers you want to exclude because they typically have low-quality materials? Are there subject areas you do not want to purchase at the research level (say, you do not have an active high-energy physics group), or do you want to exclude juvenile level or metaphysical physics books? Just like setting up an approval plan profile, setting up the profile for patron-initiated purchasing should be well thought out and tailored to your institution's needs.

One final word on patron-initiated selection: for more than a decade, Purdue has had a Books on Demand program that analyzes interlibrary loan requests against certain cost and subject parameters, and purchases qualifying requests from Amazon (for fast turnaround). Books are cataloged after they are returned by the requester, so they look like interlibrary loan requests and they get to the patron as soon as they are received by the library, rather than after they make it through the technical services department. Thus, the patron often receives material even faster than through traditional interlibrary loan channels. Recent analysis of usage statistics indicates that these patron-initiated requests are used slightly more often than books selected by a librarian.[3] Patron-initiated purchasing is not an e-only phenomenon, but can be incorporated in the physical environment as well.

THE BIG DEAL MOVES TO SCHOLARLY BOOKS

In the past few years, publishers have aggressively marketed their monograph collections through a pseudo-subscription model. Now that online journal packages have become pretty well established, many publishers have the infrastructure to offer access to monographs without additional technical overhead. Indeed, SpringerLink, for example, mixes its journals and monograph holdings, so that one can search both sets of literature at the same time. It can, in fact, be difficult to determine whether one is looking at a book chapter or a journal article. With this in mind, some of the collections decisions are being made at a level higher than the individual selector. Purdue, for example, signed agreements with Wiley, Springer, World Scientific, and Elsevier to provide access to several years of large swaths of their monographic publications. These agreements involve large amounts of money coming either from multiple disciplinary accounts, or from central collections money, and the institution often can only choose whether to buy the complete package or not, rather than picking and choosing specific disciplines. Your role as an individual selector then becomes that of an advocate for the value (or lack thereof) of the materials for your subject area, influencing, but not determining, whether a Big Deal should be signed. There are political and other reasons that decisions are made to acquire packages (being able to announce a major purchase at a steep discount over the cover price is a good public relations opportunity for the library), so be aware that many factors come into play when these decisions are made.

SOURCES OF BOOK REVIEWS

Consulting book reviews can help you decide which books you need for your collection, especially if your acquisitions budget is modest. While most reviews are of popular books, *Physics Today* also reviews advanced texts.

The following journals contain book reviews of physics titles (many of the following review books from other disciplines as well):

Physics Today

Physics World (UK based, covers a lot of European books not reviewed in the US)

Contemporary Physics

Physics Teacher

American Journal of Physics

Nature (and its spinoff titles: *Nature Physics*, *Nature Materials*, *Nature Photonics*)

Scientific American

Science

New Scientist

Sci-Tech Book News

CORE LISTS OF BOOKS

One way to assess your collection is to compare it with some of the standard reference and book lists. The following resources are guides for doing just that. These lists are, of course, not requirements for your own collection, since every community has different needs and interests, but these are good ways to get a rough estimate of the collection, and perhaps uncover some gems you might be missing.

Guide to Reference. Chicago: American Library Association. www.guidetoreference.org.

This subscription product contains descriptions and bibliographic information on more than 125 reference sources in physics and astronomy, and thousands more in allied fields.

Resources for College Libraries. Chicago: American Library Association. www.rclweb.net.

Another subscription product, the physics section of *RCL* contains about 600 core titles appropriate for four-year colleges. The astronomy section contains another 300 titles. The titles are organized by subject area and audience level.

Shaw, Dennis F. 1994. *Information Sources in Physics.* 3rd ed. London: Bowker-Saur.

This is a comprehensive collection of titles aimed largely at graduate students and professional audiences. Each chapter was written by a subject expert. If you want depth and a detailed analysis of each subfield of physics and its most important monographs and periodicals, this is a valuable, although dated, resource.

Stern, David. 2000. *Guide to Information Sources in the Physical Sciences.* Englewood, Colo.: Libraries Unlimited.

Although more than a decade old, this book provides a holistic and still modern view of physics resources, including general science resources that contain physics information. The book also focuses on process and emerging issues in collection development.

Walford, A. J. 1999. *Walford's Guide to Reference Material.* 8th ed. London: Library Association.

This older edition of the *Walford's Guide* contains a comprehensive collection of reference sources, with a truly international scope.

Lester, Ray. 2005. *The New Walford: Guide to Reference Resources.* 9th ed. London: Facet.

This guide complements the "old Walford," focusing on websites, general sources, and popular introductions to subjects, rather than traditional reference sources.

REFERENCE MATERIALS

With so much content available online, the print reference collection has diminished in importance. Reference works are primarily used to find specific pieces of information quickly, such as properties data, mathematical functions, or biographical or encyclopedic information. This is exactly the kind of information that the web provides so well, although often unevenly. A keyword search of an online handbook or, better yet, simultaneously searching hundreds of reference books at once is certainly easier than skimming through a two-thousand-page book looking for a piece of information. With that in mind, the following recommended reference materials focus on online resources and the very few print resources that remain useful. For more complete lists of reference materials, consult the guides to the literature listed in this chapter.

Dictionaries and Encyclopedias

AccessScience. New York: McGraw-Hill.
www.accessscience.com

The esteemed McGraw-Hill *Encyclopedia of Science and Technology* forms the backbone of *AccessScience*, but this resource also includes a scientific dictionary, biographical information, science news, and multimedia content. An excellent first source for beginning students to consult when learning about a topic.

Brown, Laurie M., Abraham Pais, and A. B. Pippard. 1995. *Twentieth Century Physics*. Bristol, England: Institute of Physics.

A collection of reviews of physicists' understanding of concepts in physics, especially as they evolved throughout the twentieth century.

Lerner, Rita G. and George L. Trigg. 2005. *Encyclopedia of Physics*. 3rd ed. Weinheim: Wiley-VCH.

A comprehensive introductory resource, with more than 500 articles written by experts in their fields.

There are also many specialized encyclopedias and dictionaries, for example, *Encyclopedia of Condensed Matter Physics*, written for graduate students or advanced undergraduates.

Handbooks

Knovel. www.knovel.com

Knovel licenses content from several publishers and "knovelizes" it, so one can search for property or other data across hundreds of reference books, making it much easier to find the information you need. You can search by property information (to see what substances have the properties you need) or by keyword search. You can subscribe to any number of twenty-three different collections, most of which concentrate on applied (engineering) topics. The information in *knovel* is especially valuable for experimental physicists.

CRCnetBASE. www.crcnetbase.com

Another compendium of reference books, CRCnetBASE, at least as of this writing, is not easily searchable, and the interface is difficult to navigate. However, CRC publishes a vast amount of data in a variety of physics and allied fields. CRC sells a variety of netBASEs in different subject areas, including physics.

Particle Data Group. http://pdg.lbl.gov/

Contains the current best estimates of particle masses, decay modes, and searches for particles. This is the bible of high-energy physics.

Cohen, E. Richard, David Lide, and George Trigg. 2003. *AIP Physics Desk Reference*. 3rd ed. New York: Springer.

Contains reviews of major branches of physics, including appropriate data sources. Covers emerging areas of physics, such as biophysics, environmental, and health physics, as well as traditional topics.

Arfken, George B., Hans J. Weber, and Frank E. Harris. 2013. *Mathematical Methods for Physicists*. 7th ed. Boston: Elsevier.

The standard text for graduate physics students, it contains integral tables and other useful mathematical functions needed for those first year graduate classes.

Gradshtein, I. S. and I. M. Ryzhik. 2007. *Table of Integrals, Series and Products*. 7th ed. Oxford: Academic.

A comprehensive compendium of integral tables and other mathematical functions. Useful for mathematical physicists and graduate students with homework assignments.

Data Tables

SpringerMaterials: The Landolt-Börnstein Database. www.SpringerMaterials.com

Landolt-Börnstein is the most comprehensive compilation of physical and chemical data available. It is quite expensive, and might be beyond the means of all but a few libraries, but when I have not been able to find information anywhere else, Landolt-Börnstein has had it.

National Nuclear Data Center. http://nndc.bnl.gov

A collection of databases, publications, and links to nuclear data networks. Includes Nuclear Wallet Cards (with information on parity, spin, half-lives, and decay modes) and databases compiling nuclear structure and decay data and reactions.

NIST Physical Reference Data. www.nist.gov/physlab/data/index.cfm

Provides atomic, molecular, material property, and nuclear data as compiled by the NIST Physics Laboratory.

Table of Nuclides. http://atom.kaeri.re.kr/

An interactive compilation of the properties of nuclei, including half-lives, decay modes, and spin states.

Thermophysical Properties of Matter Database. https://cindasdata.com

Compilation of properties data from more than 50,000 references, displayed in graphic and tabular form.

ThermoDex. www.lib.utexas.edu/thermodex/

A search engine maintained by the University of Texas Libraries. This finding aid does not contain any actual data, but rather indexes the properties and types of compounds found in different reference books.

Bass, Michael. 2010. *Handbook of Optics*. 3rd ed. New York: McGraw-Hill.

An encyclopedia as much as a handbook, this resource provides overviews of the major topics in optics, from linear to nonlinear and quantum optics, and also includes a substantial number of tables with specific data.

Palik, Edward D. 1998. *Handbook of Optical Constants of Solids*. San Diego: Academic Press.

This comprehensive resource provides values of optical constants of a wide variety of substances, over a large spectrum of wavelengths. Although specialized in scope, this is an important work for anyone dealing with optical properties of materials.

Dissertations

ProQuest Dissertations and Theses. http://search.proquest.com/dissertations

PQDT Open. http://pqdtopen.proquest.com/

Contains more than 2.4 million dissertations and theses mainly from US and Canadian institutions, including around 930,000 available for immediate download in PDF format. *PQDT* also offers more than 2 million dissertations and theses for purchase in microfilm or print format. *PQDT Open* provides a search interface specifically for finding open-access dissertations and theses.

Guide to Reference. www.guidetoreference.org

Provides an extensive list of resources to assist in locating non-US dissertations and theses.

Directories

With the ease of locating people via Internet searching, most directories of individuals have become obsolete. These directories provide some extra value-added information beyond mere contact information.

Graduate Programs in Physics, Astronomy, and Related Fields. New York: American Institute of Physics. www.gradschoolshopper.com/

This annual publication contains overviews of graduate programs in the United States and Canada, arranged geographically. Contains roster of physics faculty with subject interests and special facilities available at the institution. Also includes recent graduation statistics by length of time and subfield. The online version, GradschoolShopper, consists of the same content but allows students to search and sort graduate schools by areas of specialization, location, department size, and many other factors.

HEPNames. www.slac.stanford.edu/spires/hepnames/

Directory of scientists in high-energy physics, maintained by the Stanford Public Information Retrieval System (SLAC SPIRES).

Biographical and Historical Resources

Array of American Contemporary Physicists. www.aip.org/history/acap/

The Array "contains basic information pertaining to the lives, careers, and research of more than 850 physicists working in America from 1945 to the present." It is browsable by topic, institution, or author.

Emilio Segre Visual Archives. http://photos.aip.org/

Housed by the American Institute of Physics (AIP), the Visual Archives contain photographs of famous American physicists, as well as many from other countries.

Style Manuals

Day, Robert. A. and Barbara Gastel. 2011. *How to Write and Publish a Scientific Paper*. 7th ed. Westport, Conn.: Greenwood Press.

Finkelstein, L. 2008. *Pocket Book of Technical Writing for Engineers and Scientists*. 3rd ed. Boston: McGraw-Hill Higher Education.

Harmon, J. E. and A. G. Gross. 2010. *The Craft of Scientific Communication*. Chicago: The University of Chicago Press.

As scientific writing differs from other forms, these technical writing guides can help graduate students who are often writing professionally for the first time.

Physics and Astronomy Classification Scheme (PACS). http://publish.aps.org/PACS/

This classification scheme is used by most major publications, and indexed in Inspec, the primary index to the physics literature. Often the codes are author-supplied in published papers.

Careers

Physics Jobs. www.physicstoday.org/jobs/

A career portal, sponsored by the American Institute of Physics, that includes job fairs, classified ads, and career resources.

SLAC SPIRES Job Search. www.slac.stanford.edu/spires/jobs/

High-energy physics job board.

Abbreviations and Acronyms

Erb, Uwe and Harald Keller. 2001. *Scientific and Technical Acronyms, Symbols, and Abbreviations*. New York: Wiley-Interscience.

A standard reference work with more than 200,000 terms, covering all areas of science and technology. Also includes symbols, units, and fundamental constants.

SLAC-Speak. www.slac.stanford.edu/history/slacspeak/

Glossary of high-energy-physics acronyms and terms.

BOOK SERIES

The physics literature contains many prominent book series that faculty recognize by name. Several of the series are listed below, with the publisher in parentheses. Only series that are currently being published and the most well-known conference proceedings series are included. Whether these series are appropriate for your institution depends on the specific interests and demographics of your department.

That said, some of the more popular and important series that you would likely need to support your users (if you have a graduate program, that is;

none of these, other than Patrick Moore's series, are geared to the undergraduate) include *Lecture Notes in Physics*, the *Annual Reviews* series, *Graduate Texts in Physics*, and the Cambridge University Press book series.

Advanced Series on Directions in High Energy Physics (World Scientific)

Advanced Texts in Physics (Springer)

Advances in Astrobiology and Biogeophysics (Springer)

Advances in Atomic, Molecular, and Optical Physics (Elsevier)

Advances in Chemical Physics (Wiley)

Advances in Imaging and Electron Physics (Elsevier)

Advances in the Physics of Particles and Nuclei (Springer)

Advances in Solid State Physics (Springer)

AIP Conference Proceedings (American Institute of Physics)

Annual Reviews of Astronomy and Astrophysics (Annual Reviews)

Annual Reviews of Biophysics (Annual Reviews)

Annual Reviews of Condensed Matter Physics (Annual Reviews)

Annual Reviews of Fluid Mechanics (Annual Reviews)

Annual Reviews of Nuclear and Particle Science (Annual Reviews)

Astronomy and Astrophysics Library (Springer)

Astronomer's Observing Guides (Springer) (popular)

Astronomer's Universe (Springer) (popular)

Astrophysics and Space Science Library (Springer)

Astrophysics and Space Science Proceedings (Springer)

Atomic, Optical and Plasma Physics (Springer)

Cambridge Contemporary Astrophysics (Cambridge University Press)

Cambridge Lecture Notes in Physics (Cambridge University Press)

Cambridge Monographs on Particle Physics, Nuclear Physics and Cosmology (Cambridge University Press)

Cambridge Solid State Science Series (Cambridge University Press)

Challenges and Advances in Computational Chemistry and Physics (Springer)

Computational Fluid and Solid Mechanics (Springer)

ESO Astrophysics Symposia (Springer)

Experimental Methods in the Physical Sciences (Elsevier)
Fluid Mechanics and Its Applications (Springer)
Fundamental Theories of Physics (Springer)
Graduate Texts in Physics (Springer)
Handbook on the Physics and Chemistry of Rare Earths (Elsevier)
International School of Physics Enrico Fermi (IOS Press)
International Union of Crystallography Texts on Crystallography (Oxford University Press)
Lecture Notes in Applied and Computational Mechanics (Springer)
Lecture Notes in Nanoscale Science and Technology (Springer)
Lecture Notes in Physics (Springer)
Mesoscopic Physics and Nanotechnology (Oxford University Press)
Micro and Nano Technologies (Elsevier)
Monographs on the Physics and Chemistry of Materials (Oxford University Press)
Nanoscience and Technology (Springer)
Nanostructure Science and Technology (Springer)
Oxford Classic Texts in the Physical Sciences (Oxford University Press)
Oxford Lecture Series in Mathematics and Its Applications(Oxford University Press)
Oxford Master Series in Physics(Oxford University Press)
Oxford Series in Optical and Imaging Sciences(Oxford University Press)
Oxford Series on Nuclear Scattering in Condensed Matter (Oxford University Press)
Oxford Series on Synchrotron Radiation (Oxford University Press)
Oxford Series on Materials Modelling (Oxford University Press)
Oxford Studies in Nuclear Physics (Oxford University Press)
Particle Acceleration and Detection (Springer)
Patrick Moore's Practical Astronomy (Springer)
Progress in Mathematical Physics (Springer)
Progress in Optics (Elsevier)
Progress in Theoretical Chemistry and Physics (Springer)
Semiconductors and Semimetals (Elsevier)

Series on Semiconductor Science and Technology (Oxford University Press)

Solid State Physics (Elsevier)

Springer Proceedings in Physics (Springer)

Springer Series in Biophysics (Springer)

Springer Series in Chemical Physics (Springer)

Springer Series in Materials Science (Springer)

Springer Series in Optical Sciences (Springer)

Springer Series in Photonics (Springer)

Springer Series in Solid-State Sciences (Springer)

Springer Series in Optical Sciences (Springer)

Springer Series in Surface Sciences (Springer)

Springer Tracts in Modern Physics (Springer)

The Subnuclear Series (World Scientific)

Theoretical and Mathematical Physics (Springer)

Topics in Applied Physics (Springer)

Wiley Series in Pure and Applied Optics (Wiley)

World Scientific Series in 20th Century Physics (World Scientific)

Reference Notes

1. Michael Levine-Clark, "Building a Consortial Monographic Purchase Plan: The Colorado Alliance of Research Libraries Experience," in *Sailing into the Future: Charting Our Destiny, Proceedings of the Thirteenth National Conference of the Association of College and Research Libraries*, ed. by H. A. Thompson, (Chicago: Association of College and Research Libraries, 2007). Also see Cooperative Monographic Collection Development Recent Trends, session at the American Library Association's 2007 Annual Conference, http://connect.ala.org/files/34471/ala_slides_ccdc_program_ppt_4a57a7809e.ppt.
2. Leslie Reynolds, Carmelita Pickett, Wyoma vanDuinkerken, Jeanne Harrell, and Sandra Tucker, "User-driven Acquisitions: Allowing Patron Requests to Drive Collection Development in an Academic Library," *Collection Management* 35, nos. 3–4 (2010): 244–54.
3. Judith Nixon and E. Stewart Saunders, "A Study of Circulation Statistics of Books on Demand: A Decade of Patron-Driven Collection Development, Part 3," *Collection Management* 35, nos. 3–4 (2010): 151–61.

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Journals

As with monographs, providing robust, convenient access to the journal literature will endear you to your users, since articles are crucial to their success. Providing this service enables users to identify which articles they need, access articles the library has a subscription to, and acquire a copy of articles from journals to which the library does not subscribe. This chapter covers abstracting and indexing services, how to shape your physics collection, including a core list of physics titles, and finally, options for interlibrary loan and pay-per-view access to articles. Scholarly publishing issues related specifically to journals are also discussed.

COSTS

Physics journals are some of the most expensive in all the disciplines. According to *Library Journal*'s "2010 Periodicals Price Survey," the average physics journal costs a little more than $3,000, second only to chemistry in cost-per-title in the sciences. There is, of course, a wide variation in prices, which depends on volume of material published, kind of publisher (commercial or society, although with substantial variability within each), the type of articles, and the number of subscriptions. Henry Barschall, a physicist at the University of Wisconsin–Madison, in one of the first scholarly communication initiatives, published an article comparing the cost-effectiveness of more than 150 different journals in physics (based on cost-per-character and cost-per-impact) demonstrating the wide variety of cost-effectiveness of those journals.[1]

While cost inflation for physics titles has been lower than for other scientific disciplines recently (around 5 percent per year the past few years, compared to about 7 percent for the rest of the sciences), the high base cost of these journals means that total dollar increases for physics titles each year continue to be a challenge for libraries to accommodate. Factors that contribute to higher costs include increased volume of articles published, costs of materials and IT infrastructure, and decrease in the number of subscriptions supporting the journal. Some publishers understand that smaller institutions are least able to maintain their subscriptions and have responded with tiered or usage-based pricing models, which encourage smaller institutions to continue their subscriptions.

ABSTRACTING AND INDEXING SERVICES

Inspec
www.theiet.org/resources/inspec/

Inspec is a compilation of several databases, including *Physics Abstracts*, whose name pretty much says it all. It indexes more than 4,000 journals, including 1,600 cover-to-cover and more than 2,200 conference proceedings, book chapters, and dissertations. With more than 11 million records and indexing that goes back to 1898, Inspec provides the most comprehensive coverage of physics information. Inspec indexes electrical and computer engineering literature as well, and some other allied fields on a much more limited level. Inspec is produced by the Institution of Engineering and Technology (IET), which licenses its content to third-party database vendors rather than selling the database on its own platform.

Web of Science
http://thomsonreuters.com/web-of-science/

Web of Science (*WOS*) contains what used to be called the Science Citation Index, and its main competitive advantage is that it links citations, so that given a particular article, one can find all the articles that have cited it. With the CrossRef (www.crossref.org) protocol, the major publishers can now also point readers to articles that cite their articles. While some other databases have recently started providing citation linking functionality, the *Web of Science* indexes the literature as far back as 1900, while the other resources typically start indexing in the 1990s. Many faculty members, especially those who work in interdisciplinary areas, use the *WOS* as their database of first resort for not only citations, but for subject searching as well. If you have a choice, Inspec is available on the *WOS* platform, so both databases can be searched simultaneously.

Compendex
www.ei.org/compendex

Compendex is primarily an index of engineering resources, incorporating not only journal articles, but also technical reports, conference proceedings, and dissertations. Coverage starts in 1884, and, while useful for applied physics topics, this index does not replace Inspec for core physics coverage. Inspec can be licensed through Compendex's platform, Engineering Village, so it is possible to search these two databases simultaneously as well. Unfortunately, at present there is no way to search *WOS*, Compendex, and Inspec in a single native interface (i.e., not through a federated search engine).

Astrophysics Data System (ADS)
http://adsabs.harvard.edu/basic_search.html

More than simply an abstracting and indexing service, the ADS is more of a digital library portal for astronomy and astrophysics information. It has a robust search interface that links results to publishers' articles, articles available through the ADS' own substantial collection of scanned material, and connections to other information systems, such as SIMBAD, NED, the arXiv, and HEP/SPIRES. Many astrophysicists consider ADS the one-stop shop for information in their field.

Google Scholar
http://scholar.google.com

Although librarians have a love-hate relationship with Google, it cannot be discounted when locating scholarly research. Google Scholar's strengths are that it is free, it is highly interdisciplinary, and it has a very robust method for locating copies of the full text of documents, including those residing in institutional repositories. Using Scholar Preferences, Google Scholar will also provide links through an institution's link resolver system, providing a seamless interface to the library's holdings while using the power of the Google search engine. Google's weakness has traditionally been in authority control and topical searching, but for free-text searching, Google Scholar works quite well. Google Scholar can be an easy first step in moving users' search habits beyond plain Google searches.

Scopus
www.scopus.com

A relative newcomer to the citation searching sphere, Scopus contains more than 40 million bibliographic records of journals, conferences, and books, as well as scientific websites and patents. The citation linking only goes back to 1996, however, and, although the database changes all the time, the historical indexing has gaps. In the specific discipline of physics, though, data from the major publishers such as American Institute of Physics (AIP), American Physical Society (APS), and Institute of Physics (IOP) are all included in Scopus.

OAIster
http://oiaster.worldcat.org

OAIster was developed at the University of Michigan to harvest bibliographic information from the growing collection of open-access material and provide a single search interface for those repositories. OAIster uses the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) to provide access to more than 25 million records contained in more than 1,100 repositories. If your institutional repository is OAI-PMH compliant, your records might already be in OAIster. Like Google Scholar, OAIster is not a physics index, but rather a general index of scholarly work in all disciplines. These resources can be used to identify open-access copies of articles.

O*pen*DOAR
www.opendoar.org

Created by Jisc (U.K.), *The Directory of Open Access Repositories* (*Open*DOAR) is a directory of the major institutional and disciplinary repositories around the world. One can search for specific repositories or for articles housed in the repositories. Similar in scope to OAIster.

Directory of Open Access Journals

www.doaj.org

Directory of Open Access Journals (DOAJ) provides a directory for open-access journals, including about 90 in physics and astronomy, many of which are regional or on a smaller scale than traditional scholarly journals. The directory is another resource for locating potentially freely available journal content. DOAJ is registered with many link resolver vendors, so the resolvers should automatically connect to journal titles listed in the repository.

Journal Citation Reports

http://thomsonreuters.com/journal-citation-reports/

Journal Citation Reports (JCR), derived from the *Web of Science* database, compiles bibliometric data about journals. With JCR, one can obtain information about how often a journal's articles are cited, how quickly they are cited, the h-index (an impact and productivity measurement of a journal), or how many total articles have been published in a particular time period. JCR compares journals by discipline, since disciplines have very different publishing and citing practices. This can help you determine which journals are the most important for your collection, but keep in mind that impact factors, for example, vary from year to year, so short term changes should not be overestimated; consistent, sustained decreases or increases are worth investigating further, and JCR's five-year impact factor rating helps to smooth out random fluctuations. Also, global impact factors are not necessarily indicative of local use, and there have been accusations of manipulation of impact factors by journals. Impact and other bibliometric data provide only one piece of information and should not be relied on solely in making journal selection and cancellation decisions.

DISCOVERY LAYER INTERFACES

Many libraries have recently implemented a discovery layer service to integrate their library catalog, local collections, and their journal holdings. At this time, journal aggregators (EBSCO Discovery Service), open source communities (AquaBrowser, VuFind), and integrated library system providers (ExLibris' Primo, SirsiDynix' Enterprise) all offer discovery layers to try and make the most information available with the least effort by the end-user. The services often allow you to create custom collections of databases to search;

for example, you could create a physics search button that allows for one-click searching of arXiv, INSPEC, the catalog, and a dissertation database or your institutional repository. While you tend to lose a little power and specificity compared to searching indexes in their native interface, users do not have to decide which database is right for them and can get on with their searching.

AWARENESS SERVICES

With the overwhelming amount of scientific information currently being published, researchers and students alike express frustration trying to keep up in their field. Most journals, abstracting and indexing (A&I) services, and even blogs and wikis have some form of current awareness service built into their functionality. A&I services allow you to save searches as RSS feeds or email alerts, so when a new article matches your search criteria, it automatically sends a notification. The Web of Science also provides alerts when someone cites a particular paper.

Journals and trade magazines, similarly, frequently offer table of contents services through RSS or email alerts. They also may provide some recommendation services, for example, most-downloaded, most-cited, or most-recent articles. Some publishers have started displaying tag clouds of keywords, for the reader to see which topics are most popular. Other journals provide synopses of their most interesting articles in order to make it easier for the busy researcher to understand the main points of the articles without having to wade through all the details. Some journals, like *Science*, have created podcasts and short videos to add another sensory dimension to the presentation of their publications.

PACKAGE DEALS

The Big Deal was made famous in the late 1990s, when Academic Press and Elsevier started offering blanket access to all of their journal content at deep discounts over the list price, in exchange for multiyear contracts that did not allow the library to cancel titles during that time. In such an agreement, the publisher is guaranteed a level of income for an extended period of time, and in return, the libraries are given a lower price for the content. Several universities and consortia who signed on to these contracts later ran into difficulties when the economy took a turn for the worse. The end result was that some higher-prestige journals had to be canceled because librarians were not able to cancel the titles from their Big Deals. Since that time, librarians have become savvier negotiators, and typically some accommodation for cancellation is written into the multiyear deals, including some escape provision in cases of financial exigency. However, multiyear deals are still the norm for the larger publishers, and licensing librarians require a substantial amount of time to negotiate the terms of these agreements. Thus, you need to be aware of the terms and windows of opportunity to manage subscriptions with the Big Deal provisions. If your institution can cancel up to 2 percent of titles, for example, you need to be ready with your titles when the time comes to renew subscriptions, and you may have to negotiate with your fellow selectors over who gets the priority to add or remove titles from the package.

Less onerous from the subscriptions management perspective are package deals, wherein publishers offer a discount for subscribing to several of their journals. The "all" or "complete" package, for example, is a subscription to all the content available from a publisher. The package deals are not multiyear, but they do constrain subscription management from the following perspective. If you need to cancel a journal, and in doing so you break up a package, you have to not only cancel the list price of the journal, but also the 15 or 20 percent you are no longer saving by having the package discount. Often, publishers have a collection of smaller packages with smaller discounts, so it can be a mathematical exercise to figure out exactly how much you are coming out ahead and how to combine and rearrange packages to save the most money while retaining as much needed content as possible. Publishers, of course, offer the package discounts to try and encourage librarians not to cancel single titles, and indeed subscribe to some non-core titles that they would not otherwise.

For the purpose of physics, the "American Physical Society-All"(APS-All) and "American Institute of Physics-All" (AIP-All) are typically very good deals. The *Physical Review* is the premier research journal in physics, so if you only subscribe to one publisher, the American Physical Society should be it. The AIP journals generally have very high impact as well, although the topics are more specialized and often applied. Almost all institutions would benefit from subscribing to AIP-All, depending, of course, on the size of the institution and their research interests. The Institute of Physics has many even more specialized journals, including those that might more properly be categorized as engineering, so that publisher merits closer scrutiny, perhaps in consultation with your engineering selector. Springer and Elsevier offer highly interdisciplinary Big Deals, so decisions about those journals often occur at a higher level than the individual selector.

PRINT VERSUS ELECTRONIC FORMATS

Many institutions have already made blanket decisions to only subscribe to the electronic version of journals, and indeed, most remaining print copies of journals are rapidly collecting dust, as students and faculty enjoy the convenience and extra functionality (and sometimes extra content) of the online version. Physics was one of the first disciplines to go electronic, with many society journals being born digital as early as 1997. Furthermore, since physics articles have a very long, useful half-life, physics society publishers, such as APS, AIP, and IOPP, were among the first to retrospectively digitize their content. Consequently, not only are recent print issues not needed, the vast bulk of your older print journals are likely no longer used either. Although commercial publishers have digitized their back issues as well at this time, the cost to acquire permanent access to them is often prohibitive enough that one has to consciously make a decision whether to acquire access, balancing the space and financial costs of maintaining a print repository with the upfront cost of the journal backfile.

In almost all cases, electronic-only access is the correct choice for your clientele, although there are a few classes of journals where the print version still has value. Journals in the general science and popular category above, review journals, and some letters journals are convenient to browse in print. Journals from publishers that do not have a robust perpetual access policy are also candidates for retaining in print, depending on the resources of your institution, although many institutions figure that someone will still have a copy if the electronic version disappears for some reason.

DOCUMENT DELIVERY, PAY-PER-VIEW, AND INTERLIBRARY LOAN

Since collections budgets increasingly cannot support subscription access to all the core material in a discipline, the traditional just-in-case model of libraries has given way in large part to a just-in-time model, in which users can access articles (more or less) when they need them. Some models of just-in-time access include traditional interlibrary loan, where the library requests a copy of the material from another institution; document delivery, where the library purchases a copy of the document from a third party fulfillment organization (Linda Hall Library, CISTI, and the British Library are major document-delivery providers in the sciences); and pay-per-view, in which the library purchases a copy of the article directly from the publisher. Libraries can set up deposit accounts with publishers so that it seems like the institution has access to the journal (the purchasing of a document is transparent to the user).

Librarians have traditionally been leery of pay-per-view access, and with unmediated patron-initiated purchasing in general, as it takes control of the budget out of their hands, and a collection librarian's greatest fear is running out of their allocation in the middle of the year and having to beg or borrow money from other selectors to make ends meet. With some libraries activating direct patron purchasing of articles, it would only take one person systematically downloading a few hundred articles to blow through the entire deposit account, ruining the best laid plans of librarians. However, one can either have a mediated process of approving patron requests, or set up a threshold with the publisher (or set it up internally with your institution's link resolving system), where, for example, if more than five articles in a single day are downloaded from a title, further purchasing is disabled until the library approves restarting the process.

By providing access through pay-per-view, the library can provide access to much more content than via traditional subscriptions. The drawbacks of this approach are that one has to purchase a copy of an article for each user who wants access to the article, and that the library has no permanent access to the content. But, in this case, the selector's role is to try and provide the best mix of subscribed content vs. just-in-time access to material to provide the best access to content for their end users. Creating a cost-per-use chart for your journals may help you decide which journals might be candidates for converting to pay-per-view.

JOURNAL SELECTION AND DESELECTION

In the current economic situation, libraries are more often faced with cutting content rather than acquiring new titles. However, opportunities do arise, and it is important to review your mix of journals to keep it current and focused on the evolving research interests of your department. Certainly, when new faculty members are hired, interviewing them about the journals they read and publish in will help you understand whether current subscriptions meet their needs. You can even ask, when position vacancies are first posted, whether the department has considered the level of resources available for a new hire, especially if they are hiring in a new area. Ideally, you can be proactive and assemble a collection of journal titles in that research area to let them know how well the library covers that subdiscipline, so they can determine whether they need to advocate for more resources for journal subscriptions or collaborate in changing the mix of subscriptions provided by the library.

It is useful to keep a list of desired journals on hand and up to date, so if money does become available, you will be able to advocate for your department's titles without having to start from scratch with the department. When cancellations exercises occur, one can also over-cancel and pick up new titles with the extra money liberated. By replacing more marginal titles—those not in alignment with the current interests of the department—with new content that hopefully will have greater use, you can turn a negative situation into an opportunity for a little goodwill with your department.

In terms of deselection, the more information you can bring to bear, the better, and information should be formatted in a way that makes sense to your users. For example, for a particular journal, the total cost, cost-per-article and cost-per-use are all valuable metrics, as are the number of the journal's articles written by your faculty and its overall impact factor. When comparing titles, separating the review journals from the research journals is important, as cost-per-article for review articles tends to be high, but the impact factors tend to be higher as well. One should also be wary of comparing journals across disciplines, as the branches of physics have different citation and publishing patterns.

As a selector, often it is your role to help faculty make the best decisions about what journals they need. By educating them about the financial constraints of the organization, their own usage patterns, and the overall impact of the journals, you provide the necessary guidance for them to make decisions about what is most important for the department. Sometimes, you have to be the person to make the tough decision, for example, if you have a vocal member of the faculty who will not compromise. In those cases, you need to shore up support, especially if you are new to the department. Explaining the situation to your head of collections or library director and soliciting the department head's support are essential, and you may have to pick your battles and know where your support lies. If you cannot solicit support from others, it may be an indication that the politics are not in your favor, and that you need to find a different opportunity at a later time.

OPEN-ACCESS JOURNALS IN PHYSICS

In the spirit of sharing information, physics has been the locus of several attempts at creating open-access journals, and the physics experience exhibits the spectrum of challenges with sustaining this business model. Most experiments with open-access publishing faltered or were too successful to be sustainable using the open-access business model. One of the highest-profile and most influential journals, the *Journal of High Energy Physics* (*JHEP*), began as an overlay journal, providing peer review for articles already housed on arXiv. The editors sought donations to maintain the infrastructure for the editing process, believing that by only taking on responsibility for the peer review function of the publishing process and not the actual dissemination, they could keep costs manageable for the publication. Unfortunately, the journal was not self-sustaining as an open-access publication, and it is now being published by Springer as a subscription-based journal with a list price for 2013 of more than $2,600 a year.

Currently, there are two different models of open-access publication in physics, both of which are author-pays models. One model allows authors to pay for their article to be open access within a subscription-based journal. Springer's Open Choice option and the American Physical Society's Free to Read are examples of this phenomenon, and almost all major physics journals, and many general science journals, such as *Proceedings of the National Academy of Sciences* (*PNAS*), provide this option to authors. The publishers in return are typically supposed to moderate journal prices to reflect the income they receive directly from authors so that, if all authors published open access, in theory they would no longer seek subscriptions. Interestingly, you do not need to be the author of an article to make it free to read; anyone can sponsor an article to make it open access. There are also a handful of completely open access journals, of which *Journal of High Energy Physics* used to be a member. The *New Journal of Physics*, *Optics Express*, *Physical Review Special Topics—Accelerators and Beams* (*PR-STAB*), for example, are funded through donations and author page charges, and thus are available to everyone.

In order to take advantage of the open-access content in physics, you should make sure the open-access journals, such as *Optics Express*, are in the database of your library's OpenURL linker so your users know they have access to them. In addition, if you do not subscribe to a traditional journal from which a patron needs an article, there is some chance that it is available as an open-access article (this would be more likely for recent articles), so you can try checking the publisher website on the off chance that it is available for free. Typically, the easiest way to try to find a freely available version of the article is through a Google Scholar search, which can uncover not only open-access article links, but also links to copies housed in an institutional repository.

CORE JOURNALS IN PHYSICS

Other core journal lists for physics exist, most notably, David Stern's *Guide to Information Sources in the Physical Sciences* (chapter 3), and "Core List of Astronomy and Physics Journals," a project of the Physics-Astronomy-Mathematics Division of the Special Libraries Association.[2]

Compiling a core list of journals is always a bit subjective, and, as stated previously, you should determine the expectations of your own faculty, rather than relying on a core list to dictate your collection. Physics is one of the more expensive disciplines, and as serials costs continue to rise, libraries increasingly cannot provide access to all the core material through subscriptions alone. Interlibrary loan and document delivery are important supplements to a physics collection, and one has to determine which journals demonstrate enough use to justify an on-site subscription instead of pay-per-view access.

In the spirit of the times of lower budgets for acquisitions, I provide a smaller list of core titles than the two mentioned above, divided by subject area, in an attempt to extract the most important titles in each discipline. If you have a more robust physics budget, or a specialization in a particular subject area, the above core lists can help round out your collection. On the other hand, if your budget is very small (in my first position out of library school, I worked at a place that subscribed to about five physics journals), the American Physical Society journals (*Physical Review* and *Reviews of Modern Physics*) are the premier research journals in the field, and they have tiered pricing, so if you are at a smaller institution, access to the content is typically affordable. If your budget is a little bigger, the American Institute of Physics (which also has a tiered pricing model) also provides good value, with many top-rated titles in more applied fields.

Although all of the physics journal titles listed here are important contributors to the publication of physics content, starred (*) titles indicate those on the ultra-core list that almost every library should have. Some disciplines do not have any starred titles, not because the journals are not important, but typically because the subtopic is specialized enough that an average physics department might not be doing research in that area. Similarly, I have not starred any multidisciplinary journals, since I have focused just on physics titles for the ultra-core list.

Most journal content is produced by just a few publishers. In the following core title list, publishers are referenced by their commonly known acronyms. Full publisher information is given in the first list.

Major Publishers

American Association for the Advancement of Science (AAAS) www.aaas.org

American Association of Physics Teachers (AAPT) www.aapt.org

American Chemical Society (ACS) www.acs.org

American Institute of Physics (AIP) www.aip.org/pubs

American Physical Society (APS) http://publish.aps.org

Biophysical Society www.biophysics.org

Cambridge University Press (CUP) http://journals.cambridge.org

Elsevier www.elsevier.com

Institute for Pure and Applied Physics (IPAP) www.ipap.jp

Institute of Physics Publishing (IOPP) http://ioppublishing.org/

International Union of Crystallography (IUCr) http://journals.iucr.org

National Academy of Sciences (NAS) www.nationalacademies.org

National Science Teachers Association (NSTA) www.nsta.org

Nature Publishing Group (NPG) www.nature.com

Optical Society of America (OSA) www.osa.org

Royal Society of Chemistry (RSC) www.rsc.org

Sigma Xi www.sigmaxi.org

Society for Science and the Public (SSP) www.societyforscience.org

Springer www.springer.com

Taylor and Francis www.tandf.co.uk/journals/

Wiley www.wiley.com

Multidisciplinary Journals (All Sciences)

Science: AAAS. Flagship publication of the American Association for the Advancement of Science. It is one of the two most prestigious science journals, publishing arguably the most influential research in all areas of science.

Nature: NPG. Flagship publication of the Nature Publishing Group. One of the two most prestigious science journals, publishing, like *Science*, some of the most influential research. Over the past decade, *Nature* has spawned several spinoff titles, such as *Nature Physics* and *Nature Materials*, all of which have high impact factors and follow the *Nature* model of mixing popular and scholarly content.

PNAS: NAS. This is another high-impact journal, publishing in all areas of science.

American Scientist: Sigma Xi. Published by the Sigma Xi scientific research honor society.

Popular Journals

**Nature Physics*: NPG. Using the same format as *Nature*, *Nature Physics* contains letters, reviews, and original research papers.

**Physics Today:* AIP. This popular magazine is produced for the members of any of its member societies (for example, APS or OSA). Articles are written at a slightly more advanced level than a typical popular magazine. Advanced undergraduates and beginning graduate students are the target audience.

**Physics* (physics.aps.org): APS. This journal is freely available as an outreach effort of the American Physical Society. Sections in *Physics* include Viewpoints (commissioned articles from researchers providing commentary on single *Physical Review* articles), Trends (review articles of evolving fields), and Synopses (very short, staff-written commentaries of single articles).

New Scientist: Reed Business Information, Ltd. A commercially produced magazine similar in scope to *Scientific American*.

Physics World: IOPP. This popular magazine is produced for members of the Institute of Physics (UK). It includes many columns as well as a few very accessible reviews of topics of current interest.

Scientific American: NPG. Provides in-depth articles on topics of current interest in all areas of science as well as a variety of other sections, such as News, Jobs, and Book Reviews. First published in 1845, it is one of the oldest continuously published magazines in the US.

Science News: SSP. Contains newspaper-length columns written by staff reporters, focusing on currency over depth of coverage.

Review Journals

**Reviews of Modern Physics*: American Physical Society. Contains lengthy reviews written at the beginning graduate student level and colloquia, which are shorter essays on new or rapidly evolving areas of research.

Contemporary Physics: Taylor and Francis. Publishes review articles written for the nonspecialist, including articles accessible to undergraduate students.

Physics in Perspective: Birkhauser/Springer. Focuses on historical and philosophical topics, including biographical articles. This is a history and philosophy of physics journal rather than a physics research journal. Articles are written in an accessible style, as opposed to a professional historical or philosophical style.

Physics Reports: Elsevier. Each issue is a single, lengthy review of a topic in physics. Topics are generally broad in scope and of wide interest.

Reports of Progress in Physics: IOPP. Articles are commissioned from leaders in their fields. The journal publishes three kinds of articles: Full Reviews, Reports on Progress (rapidly evolving topics) and Key Issues Reviews (topics where the research is controversial or unsettled).

General Physics

**Physical Review Letters*: APS. This journal became its own section of the *Physical Review* in 1958. It contains short reports of important fundamental research in all areas of physics.

**New Journal of Physics*: IOPP. This open-access journal (author-pays model), began in 1999. It contains research articles in all areas of physics.

Annalen der Physik: Wiley. Started in 1790, *Annalen der Physik* published the famous papers of Einstein, Planck, and others. It is currently a less important title, but its historical articles are quite impressive.

Annals of Physics—NY: Elsevier. General physics.

Chinese Physics B + Letters: IOPP for the Chinese Physical Society. *Chinese Physics B* is the general physics section, with *Chinese Physics C* (nuclear and particle physics) and *Chinese Journal of Chemical Physics* the other sections. This journal was also known as *Chinese Physics* (2000–2007) and *Acta Physica Sinica*, overseas edition (1992–1999).

Europhysics Letters (EPL): a joint publication of the EDP, Italian Physical Society, and Societe de Francais de Physique. Publishes letters in all areas of physics.

Journal of Experimental and Theoretical Physics (JETP) and JETP Letters: MAIK Nauka, distributed by Springer. *JETP* is an English translation of a Russian-language journal. It focuses on fundamental research in all areas of physics.

Journal of the Physical Society of Japan (JPSJ): IPAP. Continues *Proceedings of the Physico-Mathematical Society of Japan*. General journal, covering most important work in all fields, includes sections for Letters, Short Notes, Invited Papers, and Special Topics.

Physics Uspekhi: Advances in Physical Sciences: IOPP for Turpion. Translation of the most popular Russian-language review journal, *Uspekhi Fizicheskikh Nauk*, 1993–, continues *Soviet Physics Uspekhi* (1958–1992).

Progress in Theoretical Physics + Supplement: Yukawa Institute of Physics and Physical Society of Japan. Covers all areas of theoretical physics and includes Letters and Papers sections. Quarterly supplements contain review articles and collections of articles on a themed topic.

Physics Education

**Physics Teacher*: AAPT. Publishes papers for an audience of teachers of high school and introductory university and college physics courses. Focus is on usefulness and interest rather than on reporting scholarly research, like a trade magazine for educators. Includes several sections such as YouTube Videos, Websites, Book Reviews, and Advice Columns.

**American Journal of Physics*: AAPT. Scholarly journal focusing on physics teaching and learning at the undergraduate and graduate level.

Journal of College Science Teaching: NSTA. Peer-reviewed journal of best practices in teaching science topics. Papers vary from scholarly to more popular in tone.

Acoustics

Several acoustics-related journals focus on engineering aspects of acoustics, for example, those produced by the IEEE and IOPP. These are the journals most focused on physics-related aspects of acoustics.

**Journal of the Acoustical Society of America*: AIP for ASA. Looks at acoustics from a very interdisciplinary perspective, covering physics, engineering, psychology, speech, and biology, among others.

Journal of Sound and Vibration: Elsevier. More traditional engineering and physical aspects of acoustics.

Wave Motion: Elsevier. Focuses on description and analysis of wave propagation in physical systems (not life sciences).

Biophysics

Only the most general biophysical journals are included in this list. There are many specialized journals, such as *Biomicrofluidics*, *Journal of Biophotonics*, or one of the sections of *Biochimica et Biophysica Acta* (BBA), for example, that might be useful if you have one or more researchers specializing in these areas. Many of the general physics journals have sections that include biophysics as one component as well.

**Biophysical Journal*: Biophysical Society. Focuses on molecular, cellular, and systems biophysics.

European Biophysics Journal with Biophysics Letters: Springer for European Biophysical Societies Association. As noted on the website, "the *European Biophysics Journal* publishes papers in the field of biophysics, defining biophysics as the study of biological phenomena using physical methods and concepts."

European Physical Journal E: Soft Matter and Biological Physics: EDP, Italian Physical Society, and Springer. Publishes content related to biomimetic systems, cellular and multicellular phenomena, biological structure, networks, and functions.

Physical Biology: IOPP. This journal focuses on physical components of biology, including mathematical and computational biology.

Quarterly Reviews of Biophysics: CUP. A review journal containing mainly invited reviews of biological function, structure, and mechanism.

Atomic, Molecular and Optical Physics

The optics titles in this section focus on fundamental optical physics rather than optical technologies, such as fiber optics and diffraction gratings. The Optical Society of America and the IEEE, among others, publish several good applied optics journals.

**Physical Review* A: APS. Atomic, molecular, and optical physics.

European Physical Journal D: EDP Sciences, Italian Physical Society, and Springer. Atomic, molecular, optical and plasma physics.

Journal of Physics B: IOPP. Atomic, molecular, and optical physics.

OPTICS ONLY

*_Journal of Optics_ (continues _Journal of Optics A: Pure and Applied Optics_): IOPP. Includes research papers and rapid communications, topical reviews, and Ph.D. tutorials, written at the nonspecialist graduate student level.

*_Journal of the Optical Society of America B: Optical Physics_: OSA. Includes atomic and molecular physics in addition to optics.

*_Nature Photonics_: NPG. Publishes in all areas of light generation, manipulation, and detection. Includes applied optics and optical engineering as well as classical optics. In addition to review articles and research papers, includes popular summaries and business and news information about the optics and photonics industry.

*_Optics Express_: OSA. E-only journal, focuses on rapid publication of important papers. It is an open access publication funded by page charges and subsidized by the Optical Society.

*_Optics Letters_: OSA. Letters journal covering all areas of optics.

Applied Physics B: Lasers and Optics. Springer. Includes some invited reviews, but comprised mainly of research articles.

Optics Communications: Elsevier. Focuses on research in modern optics, emphasizing fundamental advances, rather than engineering aspects.

Applied Physics

*_Journal of Applied Physics_ and _Applied Physics Letters_: AIP. The premier journals in applied physics.

*_Nanotechnology:_ IOPP. One of the first journals focused exclusively on nanotechnology. In addition to research articles, contains topical reviews and tutorials.

*_Nature Materials:_ NPG. A multidisciplinary journal focused on materials, using the _Nature_ journal format (commentaries, news, book reviews, and others).

Applied Physics A: Materials Science and Processing: Springer. This journal concentrates on nanostructured materials, surfaces, thin films, and advanced processing and characterization of materials.

Current Applied Physics: Elsevier for the Korean Physical Society. Focuses on advanced materials and devices.

Japanese Journal of Applied Physics and *Applied Physics Express:* IPAP. Includes Selected Topics that highlight current areas of research interest. Focuses on applications, such as photonic devices, semiconductor technologies, and superconductivity.

Journal of Nanoscience and Nanotechnology: ASP. Publishes in all areas of nanotechnology. ASP has a different approach to interlibrary loan and electronic licensing than most publishers, and they charge a hefty fee for per-article purchasing.

Journal of Physics D: Applied Physics: IOPP. Publishes in all areas of applied physics, includes Fast Track communications, research publications, and topical reviews.

Journal of Vacuum Science and Technology A: Vacuum, Surfaces, and Films

Journal of Vacuum Science and Technology B: Microelectronics and Nanometer Structures: Processing, Measurement, and Phenomena: AIP for the AVS. Although the name is a little strange for a physics journal, these publications cover standard applied physics topics, as indicated in the journal subtitles. Since many experiments take place in vacuums to reduce the effect of stray particles, these journal are important for experimental physicists.

Small: Wiley. Focuses on nanotechnology and covers all disciplines of science and engineering, including biological systems.

Chemical Physics

Journal of Chemical Physics: AIP. The premier journal in chemical physics covers all areas of chemical physics.

Chemical Physics and Chemical Physics Letters: Elsevier. Journal covers all areas of chemical physics.

Molecular Physics: Taylor and Francis. Self-described focus on chemical physics and physical chemistry, including surface science, spectroscopy, chemical dynamics, simulations, and electronic structure, among other topics.

The following titles are primarily focused on physical chemistry (and thus, the chemistry librarian should pick up the tab for them). These titles may or may not be of interest to your chemical physicists, so you should check with them.

ChemPhysChem: Wiley for ChemPubSoc. Publishes communications and articles, mini-reviews and reviews, highlights and concepts, news and comments, and book and multimedia reviews. High-impact journal covering physical chemistry and chemical physics.

Journal of Physical Chemistry A-C: ACS. This is definitely physical chemistry and less chemical physics, but these are very influential journals at the interface of the two disciplines.

Phys Chem Chem Phys: RSC. This journal focuses more on physical chemistry than chemical physics.

Condensed-Matter Physics

**Physical Review B: Condensed Matter and Materials Physics:* APS. Premier journal for condensed-matter physics.

**Journal of Physics Condensed Matter:* IOPP. Includes all areas of condensed matter including soft matter and nanoscale physics.

**Surface Science, Surface Science Letters, Surface Science Reports:* Elsevier. Focuses on physical systems and their behavior at interfaces, be it liquid/solid, solid/vacuum, soft matter, or nanostructures. *Surface Science* and *Surface Science Letters* were merged into a single offering, and *Surface Science Reports* is composed of review articles.

Acta Crystallographica A-F

Journal of Applied Crystallography

Journal of Synchrotron Radiation: IUCr. Premier journals in crystallography. Publishes crystal structures, techniques, and instrumentation. Each section of *Acta Crystallographica* focuses on a different class of materials, techniques or type of article (two sections are communications journals).

Advances in Physics: Taylor and Francis. This influential review journal covers all areas of condensed-matter physics with overlap into biophysics and statistical mechanics as well.

European Physical Journal B: Condensed Matter and Complex Systems; EDP Sciences, Italian Physical Society, and Springer. In addition to traditional condensed-matter physics, includes non-linear dynamics, statistical mechanics, and physics applied to social environments.

Philosophical Magazine, Philosophical Magazine Letters: Taylor and Francis. Founded in 1798 and a premier title of its time, it is less influential than it used to be. According to the website, contains "articles emphasizing experimental, theoretical, and modelling studies on solids, especially those that interpret behaviour on a microscopic, atomic, or electronic scale."

Physica B: Condensed Matter: Elsevier. Less noteworthy journal than other condensed-matter titles, and thus more marginal as a core selection.

Physica Status Solidi B +C: Wiley. These journals have strong historical importance, but their influence has flagged recently.

Progress in Surface Science: Elsevier. Invited critical reviews of topics of broad interest to surface scientists.

Solid State Communications: Elsevier. A letters journal.

Nuclear and Particle Physics

**Physical Review C*: APS. A premier research journal in nuclear physics.

**Physical Review D*: APS. A premier research journal in high-energy (particle) physics.

**Physical Review Special Topics–Particles and Beams*: APS. An open-access section of the *Physical Review*, this journal is sponsored by national laboratories and focuses on accelerator and beam technology.

**Journal of High Energy Physics (JHEP)*: Springer for International School for Advanced Studies (SISSA). This very important journal started out as an open-access publication, but outgrew its beginnings as a grass-roots initiative.

**European Physical Journal A+C*: EDP Sciences, Italian Physical Society, and Springer (there are three publishers due to journal mergers); *Section A: Hadrons and Nuclei*, and *Section C: Particles and Fields* publish research in all areas of nuclear and high-energy physics. Sections include articles, reviews, tools for experiment and theory, scientific notes and letters.

**Journal of Physics G: Nuclear and Particle Physics*: IOPP. Covers all areas of particle and nuclear physics. Includes the occasional conference proceeding.

Astroparticle Physics: Elsevier. A title that focuses on the elementary particles coming from the cosmos, rather than the laboratory.

Journal of Cosmological and Astroparticle Physics (JCAP): IOP Publishing for SISSA. Another high-impact journal spawned from the success of JHEP, this journal is published by IOP Publishing and focuses on cosmic particles.

Fluid Dynamics

**Physical Review E:* APS. Multidisciplinary journal that includes sections on fluid mechanics and plasma physics.

**Journal of Fluid Mechanics:* CUP. Publishes in all areas of fluid mechanics. This publication also takes one article a month and provides extra context and commentary on why the paper is important, to make it more accessible to a nonspecialist audience, calling it "Focus on Fluids."

Journal of Turbulence: Taylor and Francis. This journal focuses on "understanding, predicting and controlling fluid turbulence, either statistically or deterministically." It is an online-only journal that touts strong multimedia options to help readers visualize these complex systems.

Physics of Fluids: AIP. Publishes research papers in all areas of fluid dynamics. One developing area of fluid dynamics is micro-scale dynamics: how material, heat, or spin is transported, for example, across computer microchips, micromotors, or microscale drug delivery systems. The following are microfluidics titles.

Biomicrofluidics: AIP. Open access journal founded in 2007, focusing on micro- and nano-scale fluid dynamics and its applications to biological systems.

Microfluidics and Nanofluidics: Springer. Focuses on transport phenomena in small-scale systems. Includes both fundamental aspects and practical applications.

Plasma Physics

Plasmas are basically just collections of highly ionized particles. When talking about plasmas, one often thinks of nuclear fusion and very high-energy systems, like the surface of the sun or Star Trek weapons systems. That is one class of plasmas, but plasmas can also occur in low-energy systems as well; for example, if an atom loses an electron it is an ion. If you get a bunch of those atoms, at any temperature, they become a plasma. High-energy and low-energy plasmas have very different properties and uses (high-energy, potentially for energy production, and low-energy for constructing specially-designed materials), and many of the following journals have different areas of emphasis in plasma physics.

Contributions to Plasma Physics: Wiley. Covers all areas of plasma physics, from low-temperature to high-temperature, from local to astronomical-scale plasmas.

IEEE Transactions of Plasma Science: IEEE Nuclear and Plasma Sciences Society. Has a more applied focus than most physics journals, but publishes in all areas of plasma physics, from small-scale applied systems to astrophysical systems.

Physics of Plasmas: AIP. Publishes articles in all areas of plasma physics.

HIGH-TEMPERATURE PLASMA PHYSICS

Nuclear Fusion: IOPP with the International Atomic Energy Agency (IAEA). This is the highest impact journal focused on research related to controlled thermonuclear fusion.

Plasma Physics and Controlled Fusion: IOPP. Covers all aspects of the physics of hot, highly ionized plasmas.

LOW-TEMPERATURE PLASMA PHYSICS

Plasma Processes and Polymers: Wiley. Focuses on low-temperature plasmas (as well as polymers) from an interdisciplinary perspective. Includes fundamental research as well as applications for materials science researchers and chemists.

Plasma Sources Science and Technology: IOPP. Focuses on the fundamental science of low-temperature plasmas and ionized gases, as well as their sources and how they are created or maintained. Articles concerning plasma technology are supposed to be tightly related to the underlying fundamental science.

Mathematical and Computational Physics

Many topics are covered under the umbrella of mathematical and computational physics, and often journals specialize in a particular subtopic of the discipline. The following titles are broken out according to their main focus.

MATHEMATICAL PHYSICS

**Physical Review E: Statistical, Nonlinear, and Soft-Matter Physics*: APS. Publishes articles in computational physics, non-linear dynamics, complex systems, and biological physics.

**Journal of Physics* A: *Mathematical and Theoretical Physics*: IOPP. Publishes articles in all areas of mathematical and computational physics.

Communications in Mathematical Physics: Springer. Articles in all areas of mathematical physics.

Journal of Mathematical Physics: AIP. Publishes articles applying mathematical methods to physical problems.

COMPUTATIONAL PHYSICS

**Computing in Science and Engineering:* AIP with the IEEE. A magazine focused on educational aspects of computing and current awareness of new technologies. Articles are written very accessibly and include tutorials, research, and opinion pieces.

**Journal of Computational Physics:* Elsevier. Publishes articles in all areas of computational physics.

Communications in Computational Physics: Global Science Press. Focuses on computational techniques in all areas of physics.

Computer Physics Communications: Elsevier. Focuses on computational techniques in physics and physical chemistry.

NON-LINEAR SYSTEMS

Chaos: AIP. This is a multidisciplinary journal, exploring the application and consequences of non-linear dynamics in all areas of science.

Chaos, Solitons and Fractals: Elsevier. Focus on nonlinear science and non-equilibrium and complex phenomena, applied to physics topics.

Physica D (Nonlinear Phenomena): Elsevier. Publishes articles investigating non-linear physical systems.

STATISTICAL MECHANICS

Journal of Statistical Mechanics: Theory and Experiment: IOPP with International School for Advanced Studies, Italy (SISSA). Publishes in all areas of statistical mechanics, including experimental results in statistical mechanics.

Journal of Statistical Physics: Springer. Publishes in all areas of statistical physics and collective phenomena.

QUANTUM COMPUTING

Quantum Information and Computation (*QIC*): Rinton Press. *QIC* was the first journal devoted to quantum computation, and remains the highest impact journal in that field.

Quantum Information Processing (*QIP*): Springer. This journal focuses on the hot area of quantum computation and communication.

Gravitation and Astrophysics

One excellent source of historic astrophysical journal content is the Astrophysical Data System (ADS; http://adswww.harvard.edu/). ADS contains a significant amount of digitized content (http://adsabs.harvard.edu/journals_service.html), including older volumes of most of the journals listed here. ADS also includes observatory bulletins, reports and conference proceedings, and even a selection of books. If you do not have a significant astronomy and astrophysics collection, the ADS is a valuable resource for finding content for your users.

**Astrophysical Journal*, *Astrophysical Journal Letters*, and *Astrophysical Journal Supplement*: IOPP for the American Astronomical Society. Commonly known as *ApJ*, these are the premier astrophysics journals. The *Supplement* mainly includes data-intensive, very specialized, or mathematical articles.

**Astronomy and Astrophysics*: EDP Sciences. The journal publishes in all areas of astronomy and astrophysics. Contains several topical sections that are open-access, including Astronomical Instrumentation and Catalogs and Data.

Astrophysics and Space Science: Springer. This journal focuses on astrophysics and not general relativity or mathematical physics without a strong astrophysics context. The journal prohibits the publication of conference proceedings.

Classical and Quantum Gravity: IOPP. Contains sections for research papers, fast-track publications, topical reviews, brief reviews, comments, and notes. Occasionally includes special issues of conference proceedings.

General Relativity and Gravitation: Springer. According to the website, contains "letters, research papers, review articles and comments on all theoretical and experimental aspects of modern general relativity and gravitation."

Living Reviews in Relativity (*LRR*): Max-Planck Gesellschaft. *LRR* is an open-access online-only journal, completely subsidized by the publisher.

Articles are reviews of topics of current interest in any area of relativity, and authors are invited to continually update their articles.

Reference Notes

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2. David Stern, *Guide to Information Sources in the Physical Sciences,* (Englewood, CT: Libraries Unlimited, 2000) and Liz Bryson, Diane Fortner, and Pamela Yorks, comps. for Special Libraries Association, PAM Division, (Cambridge, MA: ADS, 2003). http://ads.harvard.edu/books/claj/.

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Preprints and Web Resources

E-PRINT SERVERS AND INFORMATION PORTALS

As mentioned in chapter 3, e-prints, especially in high-energy physics and astrophysics, provide a robust mechanism for rapid communication of important results. As such, e-print servers are very important components of the information lifecycle for physicists.

The major e-print servers are arXiv and the Astrophysical Data System (ADS), but several other e-print servers and search portals exist.

INSPIRE
http://inspirehep.net

INSPIRE supplants the long-standing SPIRES database, hosted by the Stanford Linear Accelerator (SLAC), integrating the library portals from SLAC, DESY, CERN, and FermiLab. It has become an integrated and more robust finding aid for preprints, technical reports, conference proceedings, and the journal literature in high-energy physics.

CERN Document Server
http://cdsweb.cern.ch

Contains the publications of the lab, including preprints, articles, books, experiments, archives, as well as videos, presentations, and educational materials.

E-print Network
www.osti.gov/eprints

Sponsored by the Office of Scientific and Technical Information (OSTI) of the Department of Energy (DOE) and part of the Science Accelerator system, this portal allows the searching of more than fifty repositories in all areas of science and engineering.

WEB PORTALS

Science Accelerator
www.scienceaccelerator.gov/

OSTI's federated search portal of materials of interest to the Department of Energy. These include technical reports, e-prints, data sets, conference proceedings, research projects, and even software developed by or for the DOE. One can search one component of the Accelerator, or the entire collection of databases simultaneously.

Science.gov
www.science.gov

A fairly slick information portal for government-sponsored science information consisting of more than "55 databases and more than 2,100 selected websites from 15 federal agencies, offering 200 million pages of authoritative US government science information." It allows for browsing by topic or collection and even provides faceted results, so one can limit by time period or topic, for example. A good place to start if you know there should be government information somewhere, but do not know who might have produced it. A recently added image search provides access to pictures of animals, plants, space, weather, and the earth, among other topics.

WorldWideScience.org
http://worldwidescience.org

Developed by the OSTI, this resource provides a portal to government information produced in participating countries. The collection provides a patchwork of coverage, as some countries only provide access to their journal literature, but it should continue to grow over time. The search interface is very similar to Science.gov, and it can be searched in several different languages.

Educational Resources

The following resources can help teachers and faculty provide effective instruction for students and the general public. I include a portal to educational resources and a smattering of educational resources that provide different kinds of assistance, from an FAQ database of practical questions that involve physics principles, to multimedia tutorials and a collection of materials appropriate for school teachers.

comPADRE
www.compadre.org/

This pathway of the National Science Digital Library (NDSL) (http://nsdl.org) focuses on physics and astronomy education. It includes a collection of resources, people, and events for educators from K–16, and includes resources aimed at physics students, teachers, and college and university faculty. The NSDL contains several other pathways that might be of interest to physics educators.

How Everything Works
www.howeverythingworks.org

Website created and maintained by Louis Bloomfield, author of *How Things Work*, contains more than fifteen hundred user-generated questions and professor Bloomfield's answers related to the physics behind interesting everyday phenomena.

Physics Central
www.physicscentral.com/

A multimedia resource created by the American Physical Society to present physics in an engaging and interactive way. The site includes materials for educators, profiles of physicists, and interesting and quirky news, all using video, text, and audio to create a dynamic learning environment.

Physics2000
www.colorado.edu/physics/2000/index.pl

An interactive, applet-infused, educational resource, this site focuses on topics in modern physics, such as how microwave ovens and lasers work. The text of the lessons is written as conversations between different characters.

Contemporary Physics Education Project
www.cpepweb.org/

Contains high-quality, introductory-level educational resources on topics such as fundamental particles, plasma physics and fusion, cosmology, and nuclear physics. Includes tutorial websites such as *The Particle Adventure* (www.particleadventure.org), *The Universe Adventure* (www.universeadventure.org), *The ABC's of Nuclear Science* (www.lbl.gov/abc), and *FusEdWeb* (http://fusedweb.llnl.gov/CPEP/), an online fusion tutorial.

The Official String Theory Website
http://superstringtheory.com/

Written in an accessible manner by physicist Patricia Schwartz, this website contains a brief summary of string theory. The site includes interviews with and presentations of prominent string theorists. A toggle between basic and advanced views allows you to read explanations with or without the underlying mathematics.

PHYSICS BLOGS

Physics blogs tend to be quite personal and ephemeral in their content, like blogs in any discipline. However, this makes them topically interesting and helpful for community building. The following list of the more active physics blogs illustrates the variety of content available. The blogs in this list are sponsored by societies, publications, and individuals. They are written by lone bloggers and communities of experts. Their perspectives vary from the humorous to the educational and political. While I would not consider blogs an important resource for academic content, they can be helpful and interesting ways to understand how physicists think and what is on their minds (topics to bring up at cocktail parties, for example).

Cocktail Party Physics: Physics with a Twist
http://twistedphysics.typepad.com/

A mixture of humor, back-of-the-envelope physics, and related topics (including physics-themed cocktail recipes), this blog is written by a handful of scientists and science writers.

13.7: Cosmos and Culture
www.npr.org/blogs/13.7/

This blog, hosted by National Public Radio and written by two physicists, two biologists and a philosopher, focuses on how science and culture interact and shape the development of one another. The title comes from the estimated age of the universe in billions of years.

Symmetry Breaking
www.symmetrymagazine.org/breaking/

Symmetry's blog of breaking news contains postings by the magazine's staff. This is a joint publication of FermiLab and SLAC and, as such, covers the particle physics community.

Back Re(Action)
http://backreaction.blogspot.com/

Written by Sabine Hossenfelder and Stefan Scherer, the blog chronicles "events on the world lines of two theoretical physicists, from the horizon to timelike infinity. A scientifically minded blog with varying amounts of entertainment, distractions, and every day trivialities."

Cosmic Variance
http://blogs.discovermagazine.com/cosmicvariance/

Hosted by *Discover* magazine, this blog is a compilation of several physicists' postings, which generally focus on current topics in physics and astronomy.

Uncertain Principles
http://scienceblogs.com/principles/about.php

Written by Union College physics professor Chad Orzel, this blog focuses on condensed-matter physics, philosophy, and culture.

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The Physics Community

PROFESSIONAL ORGANIZATIONS IN PHYSICS AND RELATED FIELDS

Physics societies provide a source of community for physicists. They offer professional development opportunities and forums for discussing topics of importance to the society. Societies maintain the group's ethical standards and organize conferences to facilitate the communication and dissemination of discoveries within and beyond the community.

American Institute of Physics
www.aip.org

The American Institute of Physics (AIP) was founded in 1931 amidst funding difficulties for scientific societies, as a society of societies, providing a variety of services with the ultimate aim of "promoting the advancement and diffusion of the knowledge of physics and its application to human welfare." The AIP provides a journal publishing platform for member and affiliated societies and publishing services for around fifty conference proceedings a year, maintains a site for career resources and social networking, and administers two history of physics collections: the Neils Bohr Library and Archives (www.aip.org/history/nbl/) and the Emilio Segre Visual Archives (http://photos.aip.org/). In addition, AIP publishes *Physics Today* magazine, which is sent to members of the ten member societies. AIP also packages physics information for the media and public and promotes physics education at all levels.

American Physical Society
www.aps.org

The American Physical Society (APS) was founded in 1899 at Columbia University by a group of thirty-six physicists who believed that "an understanding of the nature of the physical universe will be of benefit to all humanity," and resolved that "the Society shall have as its objective the advancement and diffusion of the knowledge of physics." The APS has grown to forty-six thousand members, and its focus has expanded from sponsoring four meetings a year to the publication of the *Physical Review* and *Reviews of Modern Physics*, sponsoring around one hundred meetings a year, and providing educational support and media and government relations on behalf of its members. Over the years, APS has embraced its mission of the diffusion of knowledge by promoting open access and authors' rights initiatives, providing support for the arXiv, and producing popular physics publications such as *Physics* (http://physics.aps.org).

European Physical Society
www.eps.org

The European Physical Society (EPS) was formed in 1968 to foster cooperation and collaboration of national physical societies. It represents more than one hundred thousand physicists from forty-one national societies and organizes conferences, publishes several journals, and coordinates educational and public policy discussions on topics relevant to physicists.

Institute of Physics
www.iop.org

The Institute of Physics (IOP) traces its roots back to 1874 and the founding of the Physical Society of London. In 1921, the Institute itself was formed to help coordinate the work of physics-related societies, and to advocate the role of physicists as professionals. Currently, the IOP consists of more than forty thousand members and provides organization, publishing services (through IOP Publishing), and education and outreach services. IOP publishes several reports a year on physics education and topics of interest to the public and policy makers, in addition to many scholarly journals and popular magazines. IOP Publishing also provides publishing services for other societies' publications, such as the American Astrophysical Society, the Chinese Physical Society, and the Russian Academy of Sciences.

International Union of Pure and Applied Physics
www.iupap.org

The International Union of Pure and Applied Physics (IUPAP) consists of members from more than fifty countries around the world and seeks to promote the cooperation of physicists across national borders. The IUPAP holds congresses every three years to discuss topics of interest to the community and review the work of commissions, which support conferences and workshops, provide input on large-scale physics facilities, and help to ensure that those facilities are open to physicists from a variety of countries.

American Association of Physics Teachers
www.aapt.org

Founded in 1930 as the result of a perceived lack of interest in teaching by the American Physical Society, the association endeavors to ensure "the dissemination of the knowledge of physics, particularly by way of teaching." It supports teachers at all levels from elementary school through graduate work, and publishes two journals, *The American Journal of Physics* and *The Physics Teacher*, the former scholarly and the latter more general in nature.

Scholarly Societies List—Physics
www.lib.uwaterloo.ca/society/physics_soc.html

This list is maintained by the University of Waterloo Library. The links in this directory are kept up to date, making it the best source for quickly locating physics and physics-related societies.

PHYSICS LIBRARIANSHIP AND THE PROFESSIONAL COMMUNITY

Several library societies and communities offer support to new physics librarians. The societies provide some resources that nonmembers can take advantage of, such as informational websites, and email discussion lists. However, for in-depth networking, joining a society and attending conferences offers excellent opportunities to make connections with colleagues at other institutions. Becoming involved in working groups and committees in societies also provides excellent opportunities to focus on specific, important issues that will help you improve and maintain your skills while contributing to the profession in our constantly changing information environment.

Most likely, in your position as physics librarian you will be expected to affiliate with some professional society. What follows are descriptions of the major organizations to help you choose which ones might be most relevant for your professional development.

Special Libraries Association, Physics-Astronomy-Mathematics Division
http://units.sla.org/division/dpam/

Special Libraries Association (SLA) is the one library organization that has a unit focusing explicitly on physics and related fields. The Physics-Astronomy-Mathematics (PAM) Division is moderate in size (around 250 members), so one can easily get to know other physics librarians at academic institutions, government labs, and specialized institutes. Additionally, many physics publishers are actively engaged with the division, so it is easy to develop relationships with their representatives and provide input on their products and services. Additionally, many PAM members serve on physics publication advisory boards.

In addition to its annual conference programming, which includes at least one session completely devoted to physics, the PAM Division provides a mentorship program, participates with other divisions in virtual poster sessions (which allow sharing of information without having to attend the conference), and maintains a very active archived electronic discussion list (https://listserv.nd.edu/cgi-bin/wa?A0=PAMNET) and resource list on the division pages. The *PAM Bulletin* (http://units.sla.org/division/dpam/pam-bulletin/index.html), a quarterly publication, provides a current-awareness and professional development function for the division.

American Library Association, Association of College and Research Libraries Division, Science and Technology Section
www.ala.org/acrl/aboutacrl/directoryofleadership/sections/sts/stswebsite

The Science and Technology Section (STS) of the Association of College and Research Libraries (ACRL) focuses on science and engineering librarianship. It is a much larger organization, and the scope of the section is much broader than SLA's PAM Division. In general, conference programming does not focus on particular disciplines within the sciences, but rather on bigger issues, such as e-science or science information literacy. If your focus is on science librarianship writ large, STS contains several committees that deal with issues such as information literacy, research, assessment, and continuing education. STS has a mentorship program, modeled after the PAM Division, and publishes not only a newsletter, the *STS Signal*, but also *Issues in Science and Technology Librarianship*, an open-access peer-reviewed journal. The section also hosts an electronic discussion list, STS-L (http://lists.ala.org/wws/info/sts-l).

American Society for Information Science and Technology, Special Interest Group on Scientific and Technical Information Systems

www.asis.org/SIG/SIGSTI/sti.html

American Society for Information Science and Technology (ASIS&T) provides a venue for those librarians more oriented toward research or technology issues. The Special Interest Group on Scientific and Technical Information Systems (SIG STI) is a smaller group than the others, but contains a mixture of researchers, practitioners, and government agency representatives, focusing on the information problem rather than the operation of libraries.

SCIENCE LIBRARIAN BLOGS

***Special Libraries Association*, PAM Division Blog**

http://pam.sla.org/

Communication mechanism for events in the division, as well as a discussion forum especially for presentations at the annual conference.

Pat Viele, *Physics Information Fluency*

http://physicsinformationfluency.blogspot.com/

This blog reflects Viele's work bridging the gap between the physics community and the physics librarian community. It contains news and resources relevant to both physicists and librarians interested in information fluency.

Debra Kolah, *Effervescent Librarian's Blog*

http://effervescentlibrarian.wordpress.com/

A physics librarian, now user-experience librarian at Rice University, Kolah shares her views on user-centered librarianship, technology, and outreach efforts.

Christina Pikas, *Christina's LIS Rant*
http://scientopia.org/blogs/christinaslisrant/

An outspoken and knowledgeable SLA PAM member, Pikas is a force of nature, and her blog provides commentary on scholarly communication, science librarianship, conference summaries, and life as a doctoral student.

CORE JOURNALS IN SCIENCE LIBRARIANSHIP

Only two major library science journals focus on science librarianship. To keep abreast of the field, it is important that you at least skim articles in those journals, to see what is relevant for your work. In addition to the journals described below, you should maintain an awareness of the major collection development journals, such as *Collection Building*, *Collection Management*, *Serials Librarian*, and *Resource Sharing and Information Networks*. The high-impact journals such as *College and Research Libraries*, *Journal of Academic Librarianship*, and *portal: Libraries and the Academy* also publish content relevant to physics librarians.

Issues in Science and Technology Librarianship
www.istl.org

Issues in Science and Technology Librarianship (*ISTL*) is an open-access, electronic-only, quarterly journal published by the Science and Technology Section of ACRL. It started out in 1991 as a hybrid newsletter-journal distributed via email, and it has grown over the years into a peer-reviewed journal, although it still publishes board-approved articles as well. It contains several sections, including webliographies of freely available web resources, book and electronic resource reviews, and tips from the experts. (NOTE: For full disclosure, the author has been a member of *ISTL* editorial board for the past decade and edits the webliography section of the journal.)

Science and Technology Libraries

Science and Technology Libraries (*S+TL*) offers another high-quality outlet for science librarianship scholarship. With the appointment of a new editor in chief and acquisition by Taylor and Francis in 2010, the focus of the journal shifted primarily from thematic issues, many of which were republished as monographs, to a more typical, article-focused research journal. *S+TL* also has columns for Profiles in Science (biographies of scientists), Reviews of Science (topical reviews), and Analysis of Nobel Prize Winners, written by and for science librarians.

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Emerging Issues in Physics Librarianship

I leave you with a discussion of a few topics of importance to physics librarians: the institutional repository (IR), e-science, and SCOAP3, a new business model for physics publishing. As traditional library services have become increasingly automated or self-service, the library community has tried to determine where the growth areas are for our services and expertise, and what expertise we need to cultivate as a profession. These topics provide a glimpse of the new roles in which libraries and librarians are engaging.

INSTITUTIONAL REPOSITORIES

Libraries have started to embrace a role as publisher, rather than just collector, of material created at their institutions. The rise of the institutional repository has enabled libraries to offer a permanent home especially for the intellectual output of their institutions, as the cost of subscribing to journal content continues to increase at an unsustainable rate.

Although institutional repositories have been around for about ten years (MIT's DSpace was released to the public in 2002), in many ways libraries are still determining what role the IR should play in the overall information landscape. Intellectual property issues often complicate the process because authors typically sign some or all of their copyrights over to a publisher. Since each publisher has its own copyright-licensing policy and authors sometimes ask for customizations of those policies, it is usually quite difficult to track down the exact copyright status of an article. (The SHERPA/RoMEO site [www.sherpa.ac.uk/romeo/] provides summaries of publisher licensing agreements, searchable by publisher or journal title). Thus, authors who are willing to contribute their work to a repository or post to their personal website often do not have the legal right to do so.

Fortunately, most of the physics society publishers have very liberal self-archiving rules for authors, including allowing them to post the published version of a paper on an author's website. One of the rationales for this approach is that there should only be one final document of record in circulation, and publishers who care most about accuracy and integrity of research results understand the value of limiting the versions available for scientists. This means that libraries can, with the approval of the authors, post the publisher's copy directly into their institutional repository. Some libraries have even reached agreements to have publishers provide them with copies of publications authored by their faculty. This approach neatly sidesteps the copyright difficulties, as publishers unambiguously do have the right to allow downstream redistribution of the authors' work.

Why should libraries care about institutional repositories? After all, publishers publish content and libraries purchase the content and make it available to their users. Publishers have more resources than a typical library to make their content easy to find and access. Furthermore, arXiv provides open access to physics publications already. Why, of all disciplines, would physics care about institutional repositories? These are good and important questions to consider before you start advocating for your own institutional repository.

The most important factor in favor of institutional repositories, one that will only continue to grow in importance, is the fact that libraries cannot afford to purchase all the journal content they want. Implementing an IR will not solve the problem, but will ensure that your authors' papers are easily accessible to the world. Better access translates into more people reading about your authors' work, which translates into more readers and citations of the papers and increases the authors' influence.[1] Most institutional repository software, furthermore, provides better indexing and OAI-PMH compliant formatting than an author can provide by posting an article on their own personal or professional website, so Google Scholar and other document locating services can more easily find the freely available version for searchers.

Contributing to an institutional repository, then, provides a competitive advantage for your researchers.

One may still ask whether physics content could just be housed on arXiv. To some extent, the answer is yes. It is important to remember, however, that high-energy physics and astrophysics have the vast majority of published papers appearing in arXiv. Condensed-matter physics, especially, lags behind the other areas. Another consideration is that arXiv was designed to be an e-print service and not necessarily a permanent content archive. It does, in fact, act in that capacity at this time, even though it was not designed to do so. Institutional repositories provide another opportunity for preservation, and one of the rules of thumb of preservation is that having several copies provides the most protection against losing content.

Prior to the electronic age of journals and contrary to popular opinion, publishers did not see it as their role to preserve their own content. They expected libraries to accept that role, and indeed, when it came time to retrospectively digitize journal content, many publishers had to ask libraries for assistance in locating back issues. Currently, publishers take their role as preservers of content quite seriously, even though serving content to users is an expensive proposition (as witnessed by the growing trend to charge maintenance fees for journal backfiles). Responding to the perceived potential for publishers to default on their preservation commitments, libraries have spearheaded initiatives like the centralized Portico (www.portico.org) and the more distributed LOCKSS (http://lockss.stanford.edu) systems. Institutional repositories, then, are another option for preservation, albeit operating at an institutional rather than disciplinary level.

Institutional repositories can also provide more flexibility to meet local needs for documenting institutional work. For example, in addition to housing journal articles, one could create collections of undergraduate research, faculty presentations, and reports of any laboratories or centers affiliated with the department. Often, government technical reports generated by a laboratory will not have copyright restrictions. The flexibility of an institutional repository can also manifest in the presentation of the results. For example, when new papers are added, they could be piped onto the library's or an author's personal webpage via an RSS feed.

E-SCIENCE

With the National Science Foundation now requiring data management plans for all grant proposals, e-science support has also emerged as an important role for science librarians. With their institutional document repository background, libraries have a natural place in the development of data curation services for scientists, not only in finding a final home for data generated by an experiment, but also in helping scientists integrate data documentation practices as an integrated part of their workflow.

E-science can be briefly defined as the use of information and social technologies to carry out computationally intensive research projects. According to Tony and Jessie Hey, e-science is "networked, data-driven science . . .. It is important to emphasize that e-science is not a new scientific discipline in its own right: e-science is shorthand for the set of tools and technologies required to support collaborative, networked science. The entire e-science infrastructure is intended to empower scientists to do their research in faster, better and different ways."[2] E-science is coming, to the extent that it is not already here, and librarians need to figure out how they fit into the changing needs of their researchers and by doing so remain critical to the success of their institutions' missions.

Several library and scientific organizations have created reports attempting to flesh out the requirements for e-science and e-data, and a recent international conference of science and technology libraries, IATUL, had the theme of "The Evolving World of E-Science."[3] Anna Gold provides a nice introduction and outline of what e-science is and how librarians can contribute.[4] The Association of Research Libraries' *Agenda for Developing E-Science in Research Libraries* focuses on institutional level priorities and areas for investigation and research, and Tracy Gabridge's "The Last Mile: Liaison Roles in Curating Scientific and Engineering Research Data," focuses on what roles individual librarians can take on to support e-science at their institutions and how they can acquire the skills to fulfill those roles.[5]

Fundamental to the library's role in supporting e-science and providing access to this collection is the curation of data, also called data stewardship or data management in the literature. Briefly, data curation refers to the maintenance of data sets as well as adding value to those sets. Providing a place to park data constitutes one level of curation, that of actual preservation. However, curation implies a much richer depth of service, which includes archiving (for example, selecting what data to keep), annotating, applying metadata, and generally making the data accessible and usable, even interoperable with other systems. Curation also incorporates the ideas of promotion and management of data, just as a museum exhibit is more than a collection of artifacts, but rather provides pathfinders and an organization so that a visitor leaves with an understanding greater than the sum of the individual artifacts on display. Curation also involves the development and dissemination of tools to combine, manipulate, and visualize data to facilitate the extraction of meaning from it.

Most projects will not include all aspects of the curation process, and one individual is not expected to have all the skills needed to carry out a large-scale project. Librarians, then, need to determine what skills they bring to the table that add value to research teams. While this seems daunting, as most science librarians have little if any subject expertise in their liaison field, organizing, managing, and providing access to information are skills at which librarians excel, and they should underpin libraries' evolving role in the curation process. In many cases, it is not about the science, as the scientists already know that part. It is about managing the data coming from the research program. Information technologists can write the code, but it is the librarian who can help create the connections and understanding of how different users might want to interact with the data. Information technologists may post the data, but librarians focus on making it useful and usable. For example, librarians are promoting the use of DOIs to create durable links to resources or recommending appropriate metadata standards, so that researchers in other fields can find and use the data.

The roles of e-science librarianship as outlined by Gold include acquiring, providing access to licensed data, creating metadata and documentation for data, and offering reference services around locating appropriate data from different data sources. Furthermore, librarians may provide assistance with intellectual property issues, developing standards and schemes for sharing and archiving data, and even maintaining long-term repositories of data, at least for mid-size and small data sets. For inspiration, one can look at GIS librarians and social sciences librarians who have managed access to government and Interuniversity Consortium for Political and Social Research (ICPSR) data.

The National Science Foundation data management plan requirement provides a real opportunity for librarians to collaborate with information technology (IT) and university-level research departments to develop an infrastructure and workflow to support the data management needs of researchers, especially those without a well-established disciplinary repository to which they can submit their data. MIT and the University of Minnesota have been early leaders in articulating the contents of a data management plan; Purdue University and the University of Illinois' Data Curation Profiles and the Digital Curation Center's Data Asset Framework provide questions that can start a conversation about data curation needs of a research group.[6] Several institutions are developing institutional data management plan frameworks, creating infrastructure that scientists can use in support of their grant proposals.

The National Academies Press report, *Harnessing the Power of Digital Data*, suggests that plans should include the following:

- description
- impact
- content and format
- protection
- access
- preservation
- transfer of responsibility

Data constitute the new collections librarians are being asked to manage, and it requires core library science philosophies and techniques, as well as information technologies, to provide ready and usable access to these data sets. Librarians have a vital and evolving role as e-science proliferates, but must step up before processes become standardized or other groups will.

SCOAP^3

Open-access publishing, long an interest in the physics community, now has the entire publishing industry watching the Sponsoring Consortium for Open Access Publishing in Particle Physics initiative (SCOAP^3), as it could completely change the industry's core business model.[7] The SCOAP^3 initiative attempts to invert the journal publishing business model, asserting the leverage of the authors as content providers over the publisher as packaging, dissemination, and quality-control providers. Basically, SCOAP^3 separates the different functions of the publishing industry: review, editing, distribution, and preservation and pays only for those functions that are needed by the community. The goal of the initiative is to contract out the review and editing process to publishers, in exchange for those publishers making the articles openly accessible. In this way, the consortium can send out a tender in which they will specify the rate at which they will pay for the review and editing service. One of the complaints of librarians is that they may pay up to ten times as much per unit of work from one publisher compared to another. SCOAP^3 changes the business model from a subscription service, where every institution who wants access has to pay for it individually, to a contract for services, where a consortium of institutions say they will pay for the editorial services provided by the publishers and the content will be made freely available to everyone in the world. The publisher is guaranteed a revenue stream for its services and the libraries and other supporting institutions (national labs, for example) have the collective power to strike a good deal for those services. Publishers can still brand their articles and attempt to increase market share for the good articles (as providing the best service for authors results in more publishing volume for those journals), but libraries will pay roughly the same amount per article for whoever publishes the work.

Publishers do not have to participate in the SCOAP^3 program. However, it is anticipated that any non-SCOAP^3 journal would be at a significant disadvantage in recruiting material from the cohesive community of high-energy physics (HEP) authors. If a journal loses too much of its content, journal cancellations likely will follow, perhaps leading to its demise. Librarians also could justify canceling non-SCOAP^3 journals, since authors have the choice (and potentially community peer pressure) to publish in SCOAP^3-compliant journals. Since the vast majority of the HEP literature is already available on arXiv, the journals are needed mainly for certification, editing, and review functions (not for delivering content), exactly the functions for which SCOAP^3 will pay. The HEP community, through the High-Energy Physics Advisory Panel (HEPAP), came out early in favor of the principle of SCOAP^3.[8]

The SCOAP^3 consortium first rallied libraries and national labs to make a nonbinding commitment of support to show publishers the good faith resolve to support the new business model. Having achieved a sufficient level of commitment from institutions worldwide, the consortium turned to the publishing community to gauge the interest. Finally, in September 2012, the SCOAP^3 consortium announced that all the major HEP publishers (APS, Elsevier, Springer, among others), which publish more than 90 percent of all the HEP literature, agreed to the initial tender offer that varies by publisher but is typically a bit less than $2,000 per article.[9] Now, the consortium has to collect the money from the organizations that indicated their support, an activity that continues at the time of this printing.

In some ways, the reason that this initiative has worked so far is because the reader community does not really need the publishers for access to the underlying content as they do in many other fields (including other subdisciplines in physics). However, if and when this model is fully implemented, it will be a valuable test case for libraries and the publishing industry, and the principles might be applied to other disciplines.

This initiative is still a work in progress, although it is perhaps in the final stretch. It is important to be informed on this issue because you might be asked, as I was by my supervisor, “should we support this SCOAP^3 thing?” It is important that you make a good decision for your institution. One of the biggest concerns with this system is that of the free-riders, that is, those who benefit from the open access to materials without paying a share of the costs of production. Indeed, some of my colleagues have said that they would not be allowed by their state law or institutional policy to pay for something that is freely available. If you do support the $SCOAP^3$ program, read the materials on the $SCOAP^3$ website and other literature and decide for yourself. You may need to reframe the discussion as subsidizing scholarly publishing initiatives rather than as a subscription to $SCOAP^3$. Libraries have a history of using collections money to participate in SPARC, Portico, and other initiatives that are not traditional subscription-based transactions, so the argument may have some weight with your colleagues.

Whatever you and your institution decide with respect to $SCOAP^3$, it promises to be a high-profile experiment in scholarly publishing that bears watching by everyone in the publishing and academic communities.

CONCLUSION

In summary, these examples show how science librarianship and the science information ecology continue to evolve, and the need for librarians to keep learning and adapting to their information environments. Librarians are no longer, if they ever were, defined by their ability to locate printed materials on shelves. Rather, they are becoming partners and collaborators in research and publishing, providing services for the user as creator as well as the user of scholarly content. It is always interesting being a science librarian!

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