ISTL Issues in Science and Technology Librarianship

Physics Collection Development for Librarians in a Hurry: A Survey of LibGuides Resources from AAU Institutions

Amanda McCormick
Sciences Librarian
University at Buffalo
Buffalo, NY
afm33@buffalo.edu

Abstract

This study examines the library resource guides of the 65 member institutions of the Association of American Universities (AAU) to determine the resources recommended to the physics community for teaching, scholarship, and research. Data on the most frequently recommended information resources are presented. There were over 970 resources named in the library guides, including databases, journals, reference works, monographs, and professional organizations. Building off previous collection development studies and guides, this study is meant to assist librarians in developing and maintaining collections to recommend to their physics communities.

Introduction

The study of physics is the study of matter and energy, from the macroscopic to the sub-microscopic level, from the study of superfluids to high energy particles (Lerner & Newton 2014). The American Institute of Physics (AIP) states that the study of physical sciences such as physics has enabled "stunning technical achievements" that enrich "our understanding of our Universe and our place in it" (AIP 2020). The educational discipline of librarianship, in our corner of the Universe, supports such scientific endeavors by maintaining high-quality and relevant collections. Academic librarians build, manage, and assess collections meant to support university teaching, scholarship, and research, all the while balancing budgetary concerns. At the University at Buffalo (UB) Libraries, science and engineering liaison librarians develop collections in their assigned areas. Liaisons create subject guides to highlight subscription resources provided by the library, such as databases and journals, in addition to highlighting relevant open access internet resources.

As the incoming physics librarian at UB, I undertook a review of peer university library resource guides to determine which tools and resources academic librarians were recommending to their physics community. At UB, the Department of Physics faculty, graduate, and undergraduate students are actively involved in areas such as biophysics, condensed matter physics, high energy physics and cosmology, and non-linear dynamics and statistical physics. A robust and useful collection is required to support this work. Were peer libraries providing different or similar titles to their physics community?

UB is a member of the Association of American Universities (AAU), an association of 65 North American public and private "comprehensive research universities distinguished by the breadth and quality of their programs of research and graduate education" (AAU 2020), and I chose AAU institutions as the peer group for this analysis. This study seeks to determine which resources are most frequently recommended by AAU member institution libraries in physics. Like work conducted by Osorio (2014), this study is "based on the assumption that the cumulative selection made by subject librarians is a good parameter for collection building." The study will highlight the resources that are most frequently recommended to assist librarians in developing and maintaining physics collections.

Literature Review

There has been extensive research during the past couple of decades devoted to exploring collection development through content analysis surveys of resource guides. A resource guide is a page within the library website which lists and describes books, journals, databases, and other materials that may be relevant to research, teaching, and learning in an academic discipline. Researchers examine resource guides "in the hopes of articulating best practices for creating helpful, responsive guides within a particular discipline" (Furay 2018). There is not a published content analysis study of library resource guides in the discipline of physics. This research aims to fill that gap.

There are, however, several published books devoted to highlighting and explaining information resources in physics. The books are bibliographic in nature, and the recommendations are solicited from experts in the field. The books are organized by information source (e.g., books, journals, databases). The most recent is Michael Fosmire's *The Sudden Selector's Guide to Physics Resources*, which is available as both an American Library Association e-book and a Purdue e-Pub open access e-book (Fosmire 2013). The *Sudden Selector's Guide* provides an overview of information resources for physics liaison librarianship and recommendations for a robust collection. Some of the recommendations are presented by physics subdiscipline (e.g., journal titles in biophysics) to assist librarians new to the field.

Two additional, but less recent, guides have also contributed to the field of collection development in physics: *The Guide to Information Sources in Physical Sciences* (Stern 2000) and *Information Sources in Physics* (Shaw 1994). The references in the Shaw guide are dated but serve as a useful background for one interested in the evolution of physics information sources. For instance, the author declares in the introduction: "For my part, I do not count preprints as belonging to the literature of physics, and value 90 per cent of those I receive chiefly as good scribbling paper!" (Shaw 1994). This is particularly amusing given the popularity of preprints in physics today (Fosmire 2013). The Stern guide was written primarily by the author with one chapter contributed by an additional expert in the field. In his introduction, Stern describes the guide as comprehensive, but not exhaustive. He also notes that the cited information sources are primarily written in English, noteworthy because other relevant resources are not (Stern 2000).

Although physics has not been the subject of a collection development study using library resource guides, a number of other academic disciplines have been explored, including nursing, geology, geography, sociology, electrical/mechanical engineering, electrical engineering, East Asian studies, business, physician assistantship, and theatre (see Table 1). The sample size, collection method, and analysis differ by study. In choosing a sample, several studies made use of the Springshare LibGuides platform. Other studies selected a population of schools by ranking (e.g., *U.S. News and World Reports*) or by classification framework (e.g., Carnegie Classifications). Most of the authors used frequency analysis to present data but differed in the data points collected for analysis. Some of the studies examine the layout and organizational structure of the LibGuide, a topic which is not examined in this article. Table 1 describes the sample, collection, and analysis methods of these studies.

Table 1. Collection development studies of academic disciplines using library resource guides

Academic Discipline	Sample	Collection Method	Analysis
Nursing (Stankus & Parker 2012)	50 nursing programs	Using the Springshare LibGuides searchable Community Site, the authors selected the first 25 LibGuides of unranked programs and the LibGuides of 25 programs rated in the Top 100 by *U.S. News and World Report*.	The authors reviewed the LibGuides and presented frequency data for data points such as commonly encountered databases and e-book platforms.
Geology (Dougherty 2013b)	40 geology LibGuides	Using the Springshare LibGuides searchable Community Site, the author selected the first 40 LibGuides that were retrieved after searching "geology."	The author reviewed the LibGuides and presented frequency data for data points such as tab use, e-book titles, and journals.
Geography(Dougherty 2013a)	40 geography programs	First, used 20 LibGuides of schools ranked in top tier of geography schools by Dr. Justin Holman. Then, using the Springshare LibGuides searchable community site, the author selected the first 20 LibGuides that were retrieved after searching "geography" and excluding sites on first list.	The author reviewed the LibGuides and presented frequency data for data points such as databases and e-book packages. The author also compared the frequency numbers between the two groups of data for some data points.
Sociology (Metcalf 2013)	96 sociology LibGuides	Using the Springshare LibGuides searchable Community Site, the author selected the LibGuides that were retrieved after searching "sociology" or "sociology and anthropology." Then, the author reviewed the LibGuides of 96 schools within the same Carnegie Foundation Classification as her institution.	The author reviewed the LibGuides and presented frequency data for data points such as the reference sources listed in at least 10 LibGuides.

Electrical/Mechanical Engineering (Osorio 2014)	48 electrical and 46 engineering LibGuides	Using the Springshare LibGuides searchable Community Site, the author selected the LibGuides of accredited engineering programs with at least a master's degree offering. Random samples were then taken of that population.	The author reviewed the LibGuides and presented data points such as tab and box content. The author also presented a listing of resources (but not a frequency count).
Electrical Engineering (Osorio 2015)	48 electrical engineering LibGuides	The author chose to focus on electrical engineering programs from accredited programs which offered at least a master's degree program. The initial list of 310 programs was searched in the Springshare LibGuides Community Site. A random sample produced 48 guides for the sample.	This published paper was a continuation of research initially presented during a conference. It is an annotated bibliography of the references named in the 48 LibGuides. It is a sample of the titles. Frequency numbers are not shared.
East Asian Studies (Chen & Chen 2015)	137 library resource guides	The authors visited the websites of libraries belonging to the Council of East Asian Studies.	The author reviewed the LibGuides and survey data. This article does not present frequency data for common databases, journals, etc. but reviews librarians' practices in creating the LibGuides.
Business (Kim & Wyckoff 2016)	6 library resource guides for business	The authors in this study were researching several issues, which included database funding and resources. The six institutions were a "representative" sample of top-ranked business schools, peer institutions, aspiring peer institutions.	The author reviewed the LibGuides and presented frequency data for data points such as the most common databases and Wharton Research Data Services data sets.
Physician Assistantship (PA) (Johnson & Johnson 2017)	45 PA LibGuides	Using the Springshare LibGuides searchable Community Site, the author searched first using the term "physician assistant" (570 results) and manually limited the search by removing general health sciences LibGuides (75 guides) and filter accredited programs (down to 67 guides). The 45 chosen for review were randomly selected.	The authors reviewed the LibGuides and presented frequency data for data points such as video databases and books.
Theatre (Furay 2018)	100 theatre programs	The author selected a sample of 100 institutions out of a total of 777 named in the 2017 College Board Book of Majors based on several factors. Of the 100, the author found 83 colleges/universities had theatre guides.	The authors reviewed the guides (LibGuides and course guides) and presented frequency data for data points such as multimedia content and journals.

Collection development analysis may be supplemented by a brief overview of user behaviors, particularly in those studies conducted within the sciences. Lawal (2002) explored the views of scientific researchers and scholars in colleges and universities across the U.S. and Canada. The results showed that over 50% of physics/astronomy scholars used e-prints in research. This was the highest usage among the other scientific disciplines explored in the study, which also included mathematics/computer science and engineering. Brindesi et al (2013) focused on the behavior of undergraduate physics and astronomy students in Greece. The students unsurprisingly turned to Google as a first choice for information, whether searching for a journal, data, or other resource. A similar study of the user behavior of North American undergraduate physics and astronomy students was not found.

Jamali and Nicholas (2008) investigated the information-seeking behaviors of physicists and astronomer staff and PhD students at University College London. This study reported that the most popular method of keeping up to date with research was via interpersonal communication methods (e.g., word of mouth and colleagues). Researchers also browsed e-journals and e-print archives. The authors present an apt summary of the relationship between physicists and information: “Physicists are renowned for their information prowess. They have played a significant role in scholarly communication and publishing, especially in areas such as e-print culture and electronic publishing. They are renowned for having one of the, apparently, most efficient information systems and the best organised literature in sciences. They are known as innovators in methods of scholarly communication.”

Methods

The study’s primary focus was to compare information resources across institutions with a similar educational and research focus as UB, that is, educational institutions offering the terminal degree in physics. Thus, the population chosen for this study was AAU institutions. In 2017, AAU member institutions awarded 59% of the doctoral degrees in the physical sciences nationally, and all 65 AAU member institutions offer doctoral programs in physics (AAU 2020). During the months of January and February 2020, I visited the library websites for each of the 65 AAU member educational institutions (see Appendix 1 for the complete list) to collect and analyze information about their physics research guides.

First, I searched the library website to determine whether a research guide for physics was present. Second, each title listed on the library resource guide was entered into a Microsoft Excel spreadsheet for further classification. This method is similar to that used in several resource guide content analysis studies (Stankus & Parker 2012; Dougherty 2013a; Johnson & Johnson 2017).

The resources on the spreadsheets were then classified according to the category scheme delineated by Fosmire (2013) and adapted to fit this analysis. The categories described in the *Sudden Selector's Guide to Physics Resources* were selected because it was recently published, as compared to Stern (2000) and Shaw (1994). Those guides, while extremely useful in describing the nature of physics information sources, do not reflect the needs of the modern research community.

Table 2. Categories of physics library resources

Category	Description
Databases	Preprint servers, abstracting and indexing databases, and publisher/vendor/government platforms for access to journals, reference works, monographs, and data
Journals	Review, letter, popular/trade magazines, conference proceedings (published in journals)
Reference Works	Dictionaries, encyclopedias, handbooks, data tables
Monographs	Textbooks, collected works, festschrifts, dissertations and theses, biographies, histories, conference proceedings (published as monographs)
Professional	Society organizations dedicated to the advancement of the profession of physics and its members; private or government workplaces in the business of scientific research
Software Platforms	Programs providing access to content produced by a publisher or company
Educational Resources	Organizations and web resources devoted to the teaching of physics to students (all levels)
Informal Communications	Blogs and/or wikis informally reviewing the physics profession
Science Librarianship	Organizations and web resources devoted to the profession of science librarianship

Results and Discussion

Information about 974 unique information resources (see Appendix 2 for a complete list) were collected from the 65 AAU member institution library resource guides. Most AAU libraries provided a physics-centered research guide to users on their library websites.[1] Approximately half of the AAU libraries combined the disciplines of astronomy and physics into one guide (n=29 or 45%). If a library had a combined physics/astronomy research guide, the entirety of the resources listed were compiled into the spreadsheet. I did not attempt to determine which resources were meant for physics and which were meant for astronomy. Only subject guides were examined in this study; course guides (a guide developed for a specific course) and topic guides (a guide focused on a non-academic discipline, such as data management) were excluded.

Categorization proved challenging, as some information resources provide access to multiple categories of information. For instance, the professional society AIP was referenced on 38 occasions in the library resource guides. In addition to this reference, the library guides also referred to AIP's paid subscription platform Scitation (journals and conference proceedings), AIP's *Physics Today* magazine (stand-alone publication), and AIP's online Center for History of Physics (grant information and online exhibits). Such resources were sorted into the category that most suited its purpose, as opposed to the publisher or society that enabled its publication or access. In this case, AIP was categorized as a professional society, AIP Scitation was categorized as a database, *Physics Today* was categorized as a journal, and AIP's Center for the History of Physics was categorized as a database.

Additionally, when categorizing the resources, I strived to not make assumptions about the name of the resource. For instance, if a resource guide named "AIP Journals" as a resource, I did not assume that the librarian who prepared the guide meant to say "AIP Scitation," a platform providing access to various AIP publications including journals. Instead, they were categorized as different resources.

Individual titles were categorized as monographs or reference works. Journals named by title were sorted into the journal category. Websites, however, provided another challenge. The websites listed in the resource guides were tested. If the resource URL address was no longer viable (i.e., a dead link), it was removed from this study. There were approximately 25 resources discarded from the data analysis because of this factor, less than 1% of the named resources. If it was evident that the resource was available at that URL address but had transitioned to a different name, the name was updated to the current name in the data collection spreadsheets (for the sake of analysis, assuming that the content of the resource had not substantially changed or had been updated). Because the URL links in the resource guides were tested, and not the name of the resource, the study does not capture resources that may have moved to an updated URL address.

The following table details the information resources that were collected from the AAU institution library resource guides. Databases were referenced the most by title (n=357 or 37%) and by frequency (n=1476 or 53%) in the library guides. Journals are the next most referenced by title (n=204 or 21%), but the frequency of named resources is similar among journals (14%), reference works (13%), and professional societies (14%). There are very few references to educational resources and software tools. Science librarianship was not mentioned on the library guides.

Table 3. Categories of information resources in AAU library resource guides

Category	**# of Titles**	**% of Total (974)**	**# of Times Referenced**	**% of Total (2768)**	**Examples From This Study**
Databases	357	37%	1476	53%	Web of Science, Springer Physics
Journals	204	21%	379	14%	*Physics World*, *Nature*
Reference Works	152	16%	348	13%	*CRC Handbook of Chemistry and Physics*, *Smithsonian Physical Tables*
Monographs	98	10%	110	4%	*The Collected Papers of Albert Einstein*, *Guide to Information Sources in the Physical Sciences*
Professional	114	12%	377	14%	U.S. Department of Energy (DOE), American Institute of Physics (AIP)
Software Tools	2	<1%	7	<1%	Browzine, Kanopy
Educational Resources	32	3%	53	2%	Eric Weisstein's World of Physics, PhysicsGirl

Informal Communications	15	1%	18	<1%	Physics Humor Collection, Theoretical Nuclear Physics Rumor Mill
Science Librarianship	0	0	0	0	(There were no titles mentioned in this study, but an example would be the Science & Technology Section of the Association of College and Research Libraries.)

The difference between databases and the other categories is striking, as the percentage of databases mentioned is equivalent to 37% of the titles and 53% of the times referenced. One possible reason for this result is that the categorical definition is too broad. Table 4 attempts to refine the category by adding in sub-classifications such as paid subscription or open access. But, aside from the definition, the reliance upon databases may be a reflection upon the prevalence in library services of large collections of information hosted on one platform. Journals and books, previously available as separate print items, are now subsumed into a database such as Springer Physics or Elsevier's ScienceDirect.

Earlier guidebooks to physics collections are not entirely helpful in this analysis. Shaw (1994) was written when paper journals were the dominant format; Stern (2000) devoted a chapter to abstracting and indexing databases that were the precursors of the modern databases. Fosmire (2013), however, recommends several databases that were also found in this study, such as INSPIRE, the Institution of Engineering and Technology's (IET) Inspec, Clarivate's Web of Science, and Elsevier's Scopus (Table 4). Alternatively, remembering that the resource guides were prepared by librarians, it may reflect the research needs of the physics community at their university, and/or it may reflect the purchasing power of their university.

Table 4 details the 50 most frequently named resources. This table sorts by resource name, not by category. The category description is further broken down into a subcategory that reflects whether the resource is available via a subscription or open-access platform. If a professional organization is named, it is subcategorized by where it is located. The number of times that a resource is named ranges from a high of 69 to a low of 10.

Unsurprisingly, many of the resources named in the top 50 are indeed databases (n=33 or 66%). Three of the most named databases are open access portals to information sources such as preprint articles, published articles, astronomical object information, data catalogs, data sets, job postings, seminars, and institutions (arXiv, SAO/NASA Astrophysics Data System (ADS), and INSPIRE). The subscription databases Web of Science and Springer Physics also placed high on the list. These platforms provide access to online materials such as books, journals, conference proceedings, patents, and technical reports and also serve as abstracting and indexing platforms. The controversial Google Scholar was mentioned on 20 occasions. Klassen (2020) summarizes the literature surrounding the use of Google Scholar in his longitudinal study of science and technology abstracting and indexing databases. He highlights literature discussing user preference for Google Scholar, despite its lack of accuracy or transparency.

Professional organizations such as the AIP, the American Physical Society (APS), and the Institute of Physics (IOP), are frequently recommended as a resource, as are the databases of those professional organizations (e.g., AIP Scitation). The professional society databases, which include journals, conference proceedings, and monographs, are a combination of open access and paid/subscription access. Professional organizations of the U.S. government are also referenced frequently in the resource guides. The U.S. Department of Energy (DOE) places four entries on the list, with references to the Office of Science and Technical Information (OSTI), the DOE Data Explorer, the Fermi National Accelerator Laboratory, and the Brookhaven National Laboratory. The National Institute of Standards and Technology (NIST) Physical Reference Data portal and National Aeronautics and Space Administration (NASA) Technical Reports Server are frequently named in resource guides. CERN, the European Organization for Nuclear Research, is included on several resource guides.[2]

Rounding out the top 50 list are references to a few individually titled journals and reference works. The most named reference work is the *CRC Handbook of Chemistry and Physics*. The AAU library resource guides also direct the physics community toward dissertations and theses, whether hosted on the university's platform or through paid subscription database ProQuest. One educational tool, Eric Weisstein's World of Physics, was referenced in the resource guides on 10 occasions.

Table 4. Top 50 physics titles named in the resource guides of AAU libraries

Rank	**Resource**	**# of Times Referenced**	**Category**	**Sub-Category**
1	arXiv	69	Database	Preprints
1	Web of Science	69	Database	Subscription
3	SAO/NASA Astrophysics Data System (ADS)	53	Database	Open Access
4	Springer Physics	51	Database	Subscription
5	INSPIRE HEP	48	Database	Open Access
6	*CRC Handbook of Chemistry and Physics*	42	Reference Work	Subscription or Print
7	IET Inspec[3]	39	Database	Subscription
8	AIP	38	Professional	Society
9	Elsevier Scopus	36	Database	Subscription
10	National Institute of Standards and Technology (NIST) Physical Reference Data	34	Database	Open Access
11	European Organization for Nuclear Research (CERN)	31	Professional	Europe
11	U.S. DOE OSTI	31	Database	Open Access
13	AIP Scitation	30	Database	Subscription

14	Institute of Electrical and Electronics Engineers (IEEE) Xplore Digital Library	29	Database	Subscription
14	Society of Photographic Instrumentation Engineers (SPIE) Digital Library	29	Database	Subscription
16	American Physical Society (APS)	28	Professional	Society
16	Elsevier ScienceDirect	28	Database	Subscription
18	ProQuest Dissertations and Theses	25	Database	Subscription
19	Institute of Physics (IOP)	22	Professional	Society
19	Knovel E-Books	22	Database	Subscription
19	SciFinder/SciFinder-n	22	Database	Subscription
22	IOP Journals	21	Database	Subscription
23	Google Scholar	20	Database	Open Access
23	University-hosted Dissertations and Theses Databases	20	Database	Open Access
25	National Nuclear Data Center (Brookhaven)	19	Professional	U.S.
26	Elsevier Compendex	18	Database	Subscription
26	Wiley Online Library	18	Database	Subscription
28	American Mathematical Society (AMS) MathSciNet	17	Database	Subscription
28	APS Journals	17	Database	Subscription
28	NASA Technical Reports Server (NTRS)	17	Database	Open Access
28	*Physics World*	17	Journals	Subscription
28	*Review of Particle Physics* (Particle Data Group)	17	Reference Work	Open Access
33	PhysLink.com	15	Database	Open Access
34	NIST Fundamental Physical Constants	13	Database	Open Access
34	*Oxford Dictionary of Physics*	13	Reference Work	Subscription or Print
34	Science.gov	13	Database	Subscription
37	*Encyclopedia of Applied Physics* (Trigg)	12	Reference Work	Subscription or Print

37	*Science*	12	Journals	Subscription or Print
39	EBSCO Academic Search Complete	11	Database	Subscription
39	Fermilab (Fermi National Accelerator Laboratory)	11	Professional	U.S.
39	Optical Society of America (OSA)	11	Professional	Society
39	U.S. DOE Data Explorer	11	Database	Open Access
43	*AIP Physics Desk Reference*	10	Reference Work	Subscription or Print
43	*Physics Today*	10	Journals	Subscription or Print
43	*APS Physics Subject Headings (PhySH) Guide* (previously Physics and Astronomy Classification Scheme (PACS))	10	Reference Work	Open Access
43	Elsevier Engineering Village (access to multiple databases including Compendex and Inspec)	10	Database	Subscription
43	Eric Weisstein's World of Physics	10	Educational	Open Access
43	HepData Durham High Energy Physics Database	10	Database	Open Access
43	NASA High Energy Astrophysics Science Archive Research Center (HEASARC)	10	Database	Open Access
43	WorldCat	10	Database	Open Access

There were many information sources that did not rank on the top 50 list. Indeed, 636 resources (65% of total titles) were referenced only one time each. This may be due to several factors, including the librarians' preference and/or the research, teaching, and learning needs of a particular AAU member institution. It is interesting to compare this to the results of the study of geology LibGuides, where Dougherty (2013b) found that a high percentage (83%) of the websites collected were recommended only once. Even though that study did not provide a total of resources collected, the diversity of recommendations is apparent in both studies.

Turning first to journals: Only three journal titles (*Physics World*, *Science*, and *Physics Today*) were on the list of top 50 resources. The total number of journals listed by the resource guides was 379, or 14% of the total. There were 204 different journals mentioned by individual title. Because of the sheer breadth of discretely named journals, it is difficult to make any inferences from the data, but there may be some reasons why the number appears high. The subdisciplines of physics, such as biophysics and condensed matter physics, each have journals devoted to the subdiscipline. *The Sudden Selector's Guide* recommends 5 journal titles for biophysics and 13 journal titles for condensed matter physics, together with over 20 journal titles recommended for the discipline of physics (popular journals, review journals and general physics). The Stern (2000) guide devotes over 50 pages to a discussion of physics journals for a collection, including journal titles divided by subdisciplines (pp 39-103). The number of journal titles may be linked to the number of physics subdisciplines. It is also interesting to note that the resource guides frequently recommend popular/trade journals - such as *Physics World* - to their community. Perhaps this is because of the cross-disciplinary nature of physics; these publications assist researchers with keeping up to date on trends in other areas of research. Table 5 is a listing of the five most frequently named journal titles.

Table 5. Top five most named journal titles in the resource guides of AAU libraries

Rank	**Journal Title**	**Publisher**	**# of Times Referenced**
1	*Physics World*	IOP	17
2	*Science*	American Association for the Advancement of Science (AAAS)	12
3	*Physics Today*	AIP	10
4	*Physical Review Letters*	APS	8
4	*Nature*	Springer	8
5	*Journal of Physics A: Mathematics and General*	IOP	7

There were 152 reference work titles cited in the resource guides. Table 6 is a listing of the five most frequently named resources. All the titles referenced in this table are also in the top 50 resources. Many of the reference works are available online via subscription or in book format. Fosmire (2013) posits that the "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." As this researcher was schooled in both paper and internet research, this argument is entirely convincing. The shift to online reference for data and other information is a welcome improvement, and this is reflected in the resource guides.

The resources mentioned least frequently fell into the individual monograph category. In this category, the library resource guides most frequently referred users to dissertations and theses, whether hosted on a platform by the individual AAU member institution or accessed through ProQuest. There were 98 individual monograph titles named. The most frequently named monographs were the *Springer Lecture Notes in Physics* book series (n=4) and the *AIP Conference Proceedings* book series (n=4). The remaining monographs were referenced either once or twice. The lack of references to monographic works is not surprising, given the physics community's propensity toward communicating through journal articles, as demonstrated in the user studies of Jamali and Nicholas (2008) and Brindesi et al (2013).

Table 6. Top five most named reference work titles in the resource guides of AAU libraries

Rank	Resource	Online Access Through:	Type of Access	# of Times Referenced
1	*CRC Handbook of Chemistry and Physics*	CRC Press	Subscription or Print	42
2	*Review of Particle Physics*	Particle Data Group	Open	17
3	*Oxford Dictionary of Physics*	Oxford Reference	Subscription or Print	13
4	*Encyclopedia of Applied Physics* (Trigg)	Wiley	Subscription or Print	12
5	*AIP Physics Desk Reference*	AIP	Subscription or Print	10
5	*APS PhySH Guide*	APS	Open	10

Professional organizations are defined in this study as either (1) society organizations dedicated to the advancement of the profession of physics and its members, or (2) private or government workplaces in the business of scientific research. One-hundred and fourteen professional organizations were named by title for a total of 377 mentions, or 14% of the total. This number is slightly less than the number of journals (n=379) named in the guides. Table 7 lists the most referenced professional organizations (society) and a sample of their resources named in the guides. Table 8 lists the most referenced professional organizations (U.S. government agencies) and a sample of their resources named in the guides.

Table 7. Most frequently named professional organizations (society) in the physics resource guides of AAU libraries

Rank	Professional Organization	# of Times Referenced	Sample Resources
1	AIP	136	AIP Scitation; *AIP Physics Desk Reference*; *Physics News*; Center for the History of Physics; GradSchoolShopper; Statistics Research Center; Spectral Database for Organic Compounds
2	IOP	95	*IOP Science*; Physics to Go; Physics Education News; Bright Recruits Careers & Jobs; Physics World; University Student Community
3	APS	73	*APS Physical Review Style and Notation Guide*; Physics Central; Contributions of 20th Century Women to Physics; APS PhySH Guide
4	IEEE	44	IEEE Xplore Digital Library; IEEE Standards
5	SPIE	35	SPIE Digital Library

Table 8. Most frequently named professional organizations (U.S. government agencies) in the physics resource guides of AAU libraries

Rank	Government Agency	# of Times Referenced	Sample of Named Resources
1	NIST (U.S. Department of Commerce)	86	Physical Reference Data; Materials Database; Atomic Spectra Database; Atomic Transition Probability Bibliographic Database; Basic Reference Data for Electronic Structure Calculations; Ceramics WebBook; Chemistry WebBook; Data Gateway; Digital Library of Mathematical Functions; Elemental Data Index; Fundamental Physical Constants; Funding Opportunities; Physical Measurement Laboratory; Physics Laboratory
2	U.S. DOE	78	OSTI; Data Explorer; National Labs (Argonne National Laboratory, Brookhaven National Laboratory, Fermi National Accelerator Laboratory, Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, Los Alamos National Laboratory)
3	NASA	72	Technical Reports Server; Astronomical Virtual Observatories; Goddard Space Flight Center; High Energy Astrophysics Science Archive Research (HEASARC); Images; Jet Propulsion Laboratory; National Space Science Data Center; Open Data Portal; Planetary Data System; Planetary Defense Videos; Skyview Virtual Observatory; Space Physics Data Facility; Aura; IPAC Extragalactic Database; IPAC Infrared Science
4	U.S. Department of Health and Human Services - NIH	12	U.S. National Library of Medicine – PubMed and PubSpace
5	U.S. Department of Defense	5	Defense Technical Information Center

The role of professional organizations within the information world of physics is not addressed by Stern (2000) or Shaw (1994), aside from the mention of the professional organization as a publisher. Publishing journals is no small role, but it does not appear that the extensive data resources now provided by professional organizations was foreseen by these authors. Only Fosmire (2013) focused on the professional organizations, as he provides a descriptive list of some large society organizations. That librarians at AAU universities choose to point their physics community toward these resources is not surprising given the broad scope of available information. Likewise, the sheer amount of open access data available on U.S. governmental agencies is mind-boggling. As AAU member institutions received $25.6 billion in federal research dollars in 2018, it is expected that AAU researchers have contributed to this wealth of data (AAU 2020). It would have been difficult for Shaw (1994) to anticipate this development in government resources, but Stern (2000) devotes a chapter to online resources (notably, the NIST Physical Reference Data and NIST Fundamental Physical Constants). Fosmire (2013) also cites the NIST Physical Reference Data resource. Some of the NASA information sources may be from the library resource guides that did not separate Physics resources from Astronomy resources, as they appear to be more focused on the discipline of astronomy.

Briefly, there are number of resources that were highlighted by the library resource guides that are worthy of further mention. Guides referred the physics community to university-hosted pages addressing citation management tools, scientific writing, information literacy, and data management. Resources listed links to other substantive guides on patents, grey literature, and mathematics. This study did not collect data from these guides, as they were university-specific and directed users to university resources and programs.

There are, of course, limitations to this study. This study was limited to the resource guides of the libraries of the 65 AAU member institutions. The resources found in the AAU guides are likely to be focused on research activity because of the nature of the member institutions in the AAU. Because the methodology was frequency based, there is no accounting for the reasoning of librarians in compiling the specific resources. The results may have been skewed by the presence of resource guides which did not make a distinction between physics and astronomy. The results may also have been skewed by the research focus and subdiscipline focus areas of the AAU member institution, which may have affected the physics information sources named on the guides. Moreover, there is not a way in this study to determine whether the frequently named resources are useful to the physics community and/or are used by the physics community.

Conclusion

This study shows the resources most frequently included in the library resource guides of the 65 AAU member institutions. It provides a different view of physics information sources than that previously seen in physics collection development books/guides and adds to the literature examining library resource guides. The study also highlights challenges in conducting a survey of library resource guides in a discipline with varied subdisciplines that host their own world of information resources. Future studies could investigate which resources are most relied upon by the physics community and how much the resources vary by subdiscipline.

The frequent reference to professional organizations is a surprising finding of this study. Although the resources of these organizations are mentioned in the physics collection development works, the depth of the resources provided is not discussed. Further research could also seek to provide additional insight into the physics discipline's reliance upon information from society organizations and governmental organizations.

Although the demands of a university's physics faculty and students will have a substantial impact on the collection development practices of a science librarian, this study aims to provide an overview of information resources most frequently recommended by librarians in order to provide a robust compilation of resources to their community. The resources listed in this study, in particular, those listed in the Top 50 resources, can be a starting point for conversations with faculty when updating or purchasing new resources.

Acknowledgements

Thank you to E. Rowley and J. Hackenberg for their thoughtful suggestions during the research and writing process. Thank you as well to the anonymous reviewers for their helpful suggestions, which greatly improved the manuscript.

Notes

[1] Only one AAU library did not have a resource guide devoted to Physics and/or Astronomy. Instead, that library had a resource guide addressing the Geophysics collection. This information was compiled into the main list of named resources. In hindsight, this information should have been deleted from this study, as the discipline of geophysics is considered tangential to the discipline of physics. Because the collected information was not identified by AAU institution and is limited by a collection date of January/February 2020, it is impractical to remove the information from this study. It is hypothesized that the data will have a minimal impact on this study, as it is based upon frequency data.

[2] The U.S. is an Observer State with Special Rights and the largest user community (over 2,100 users) of CERN (https://international-relations.web.cern.ch/stakeholder-relations/states/United-States-America).

[3] IET Inspec may be subscribed to directly or through a vendor, including Clarivate Web of Science, EBSCOhost, Elsevier Engineering Village, Ovid, ProQuest Dialog, Questel Orbit, or STN International.

References

Association of American Universities [Internet]. Washington (DC); c2020 [cited 2020 Aug 18]. Available from https://www.aau.edu/.

Association of American Universities [Internet]. AAU by the numbers. Washington (DC); c2020 [cited 2020 Aug 18]. Available from https://www.aau.edu/who-we-are/aau-numbers.

American Institute of Physics [Internet]. About AIP. College Park (MD); c2020 [cited 2020 Aug 18]. Available from https://www.aip.org/aip/about-aip.

Brindesi, H., Monopoli, M. & Kapidakis, S. 2013. Information seeking and searching habits of Greek physicists and astronomers: A case study of undergraduate students. *Procedia - Social and Behavioral Sciences* 73:785-793. DOI: 10.1016/j.sbspro.2013.02.119.

Chen, Y. & Chen, X. 2015. Web-based subject guides for East Asian studies: Current status, challenges, and recommendations. *Internet Reference Services Quarterly* 20(1-2):1-17. DOI: 10.1080/10875301.2015.1018474.

Dougherty, K. 2013a. The direction of geography LibGuides. *Journal of Map & Geography Libraries* 9(3):259-275. DOI: 10.1080/15420353.2013.779355.

Dougherty, K. 2013b. Getting to the core of geology LibGuides. *Science & Technology Libraries* 32(2):145-159. DOI: 10.1080/0194262x.2013.777233.

Fosmire, M. 2013. *The sudden selectors guide to physics resources*. Available from: https://docs.lib.purdue.edu/lib_fsdocs/57/.

Furay, J. 2018. Performance review: Online research guides for theatre students. *Reference Services Review* 46(1):91-109. DOI: 10.1108/RSR-09-2017-0037.

Jamali, H. R. & Nicholas, D. 2008. Information-seeking behaviour of physicists and astronomers. *Aslib Proceedings* 60(5):444-462. DOI: 10.1108/00012530810908184.

Johnson, C. V. & Johnson, S. Y. 2017. An analysis of physician assistant LibGuides: A tool for collection development. *Medical Reference Services Quarterly* 36(4):323-333. DOI: 10.1080/02763869.2017.1369241.

Kim, K. & Wyckoff, T. 2016. What's in your list?: A survey of business database holdings and funding sources at top academic institutions. *Journal of Business & Finance Librarianship* 21(2):135-151. DOI: 10.1080/08963568.2016.1140548.

Klassen, T. 2020. Science A&I database holdings at ARL and Oberlin Group libraries, 2011-2016: A longitudinal study. *College & Research Libraries* 81(2):215-234. DOI: 10.5860/crl.81.2.215.

Lawal, I. 2002. Scholarly communication: The use and non-use of e-print archives for the dissemination of scientific information. *Issues in Science and Technology Librarianship*. 2. DOI: 10.5062/F4057CWP.

Lerner, K. L. & Newton, D. E. 2014. Physics. In: Lerner, K.L. et al., editors. *Gale Encyclopedia of Science*. 5th ed. Detroit (MI): Gale. p. 3078-3081.

Metcalf, S. 2013. Good stewards in trying times: Benchmarking peer collections of sociology reference sources using LibGuides. *Reference Librarian* 54(2):134-142. DOI: 10.1080/02763877.2013.755423.

Osorio, N.L. Content analysis of engineering LibGuides. *121st ASEE Annual Conference and Exposition*, 2014 June 15-18; Indianapolis. Available from https://peer.asee.org/content-analysis-of-engineering-libguides.

Osorio, N. L. 2015. Electrical engineering reference resources: A survey from LibGuides. *Collection Building* 34(1):6-12. DOI: 10.1108/cb-07-2014-0035.

Shaw, D. F. 1994. *Information Sources in Physics* (3rd ed.). London, England: Bowker Saur.

Stankus, T. & Parker, M. A. 2012. The anatomy of nursing LibGuides. *Science & Technology Libraries* 31(2):242-255. DOI: 10.1080/0194262x.2012.678222.

Stern, D. 2000. *Guide to Information Sources in the Physical Sciences*. Englewood (CO): Libraries Unlimited, Inc.

Appendix 1

AAU Member Educational Institutions (year of entry)

(https://www.aau.edu/who-we-are/our-members)

Public

Georgia Institute of Technology (2010)
Indiana University (1909)
Iowa State University (1958)
Michigan State University (1964)
The Ohio State University (1916)
The Pennsylvania State University (1958)
Purdue University (1958)
Rutgers University – New Brunswick (1989)
Stony Brook University – The State University of New York (2001)
Texas A&M University (2001)
University at Buffalo – The State University of New York (1989)
The University of Arizona (1985)
University of California, Davis (1996)
University of California, Berkeley (1900)
University of California, Irvine (1996)
University of California, Los Angeles (1974)
University of California, San Diego (1982)
University of California, Santa Barbara (1995)
University of California, Santa Cruz (2019)
University of Colorado, Boulder (1966)
University of Florida (1985)
University of Illinois at Urbana-Champaign (1908)
The University of Iowa (1909)
The University of Kansas (1909)
University of Maryland at College Park (1969)
University of Michigan (1900)
University of Minnesota, Twin Cities (1908)
University of Missouri, Columbia (1908)
The University of North Carolina at Chapel Hill (1922)
University of Oregon (1969)
University of Pittsburgh (1974)
The University of Texas at Austin (1929)
The University of Utah (2019)
University of Virginia (1904)
University of Washington (1950)
The University of Wisconsin – Madison (1900)

Private
Boston University (2012)
Brandeis University (1985)
Brown University (1933)
California Institute of Technology (1934)
Carnegie Mellon University (1982)
Case Western Reserve University (1969)
Columbia University (1900)
Cornell University (1900)
Dartmouth College (2019)
Duke University (1938)
Emory University (1995)
Harvard University (1900)
The Johns Hopkins University (1900)
Massachusetts Institute of Technology (1934)
New York University (1950)
Northwestern University (1917)
Princeton University (1900)
Rice University (1985)
Stanford University (1900)
Tulane University (1958)
The University of Chicago (1900)
University of Pennsylvania (1900)
University of Rochester (1941)
University of Southern California (1969)
Vanderbilt University (1950)
Washington University in St. Louis (1923)
Yale University (1900)

Canadian
McGill University (1926)
University of Toronto (1926)