# Library Classification in Mathematics

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The classification of mathematical subjects occurred within the larger framework of library classification, a vast project which drew sustained attention between 1870 and 1920. The two American giants in the formative period were Melvil Dewey and Charles Cutter. In 1876 Dewey published the famous Dewey decimal system of classification, while Cutter's expansive scheme of 1885 would provide the basis for the Library of Congress (LC) system. The latter was established in 1905 by James Hanson and Charles Martel, both European immigrants to the United States.

Among all of the major systems of book classification, the Library of Congress scheme was the one that achieved dominance in university and research libraries. In 1870 the US Copyright Office was by legislation placed in the Library of Congress, and the Library received copies of all publications submitted for copyright. The holdings of the Library increased and became more complete than any elsewhere, including the collections of major university libraries and large public libraries. The importance of the LC system in the world of classification was apparent in the years following its establishment. While the major university libraries with their specialized collections containing many older and foreign-language books continued to maintain a patchwork of local classification schemes, the LC's has made steady headway up to the present as the dominant and most widely used.

Unlike book classification, which was aimed at a very broad readership at various levels of engagement with the subject, the practices followed by journals reflected the outlook of advanced researchers in the field. The *Zeitschrift für Mathematik und Physik*, founded in 1856, was one of the first journals to explicitly divide its contents into subject categories. These were presented in this order: arithmetic and analysis, geometry, mechanics, optics, electricity and galvanism, and smaller and miscellaneous subjects. The grouping of analysis with arithmetic and its placement ahead of geometry reflected the prevailing view of advanced researchers, and indicated more generally the well-known "arithmetization of analysis" in mathematics in the nineteenth century.

At the turn of the century the Royal Society of London established the *International Catalogue of Scientific Literature* (1902), a major international bibliographic project that was intended to cover both periodical and book literature. Mathematics (which was also referred to as "pure mathematics") was divided into the following subject areas: fundamental concepts, algebra and number theory, analysis, and geometry. This ordering of subjects became canonical in the classification of twentieth-century mathematical literature, at least as this was followed by the LC and mathematical abstracting services.

The classification schedules for mathematical subjects in the original LC system of 1905 were compiled by J. David Thompson, chief of the science section, under the direction of Martel, head of classification for the whole of LC. Thompson was a native of England who had studied mathematics at the University of Cambridge, graduating 16th Wrangler in 1895. In the preface to the volume on science (1905, 3) he states that he has relied notably on the schedules of the *International Catalogue of Scientific Literature* (ICSL). While the overall scheme of the LC system was patterned on the Cutter system of classification, the organization of scientific subjects followed the ICSL. The 1905 edition
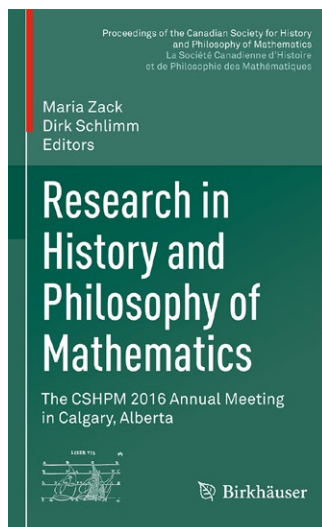
## CSHPM Proceedings

In 2014, Birkhäuser assumed publication of the papers presented by members of the Canadian Society for History and Philosophy of Mathematics at CSHPM's annual meeting. (A yearly *Proceedings* volume has been produced since 1988, but it previously was distributed only to members.) Twelve to eighteen refereed articles, covering a variety of time periods and cultures and aimed at a general mathematical audience, appear each year under the title *Research in History and Philosophy of Mathematics*.

The papers may be purchased individually or collectively; they may also be accessed at research libraries that subscribe to Springer's ebook collection. The most recent volume, from the 2016 conference in Calgary, has just appeared: **www.springer. com/us/book/9783319640921.**

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of the LC science schedules was republished in multiple later editions, each modifying and extending the original scheme.

In the LC classification system books on science are classified under Q, and those on mathematics are classified under QA. In 1905 some parts of mathematics hardly existed yet as recognized subject areas. In the ICSL under arithmetic there was a subject entry on "aggregates", what would later be called the theory of sets, but there was no entry at all for this subject in the LC. When Abraham Fraenkel's *Einleitung in die Mengenlehre* appeared in 1919 it was classified in the LC under foundations of arithmetic (QA248) in the algebra section, and that became the standard LC subject classification for books on set theory.

A part of mathematics that was very well established in 1905 was analysis, and books on this subject received call numbers in the range from QA300 to QA400. The theory of functions was designated QA331 and was made up of books we would regard today as belonging to complex analysis. The theory of functions of a real variable came to be designated QA331.5, being regarded as a branch or offshoot of the theory of functions. The classification scheme is evident in the following two books on analysis from the early years of the century:

> QA331 Heinrich Burkhard, *Theory of Functions of a Complex Variable* (1913)
> QA331.5 James Pierpont, *Lectures on the Theory of Functions of Real Variables* (1905–12)

When Lars Ahlfors's *Complex Analysis* was published in 1953 it was given the LC subject designation QA331. In the 1960s "complex analysis" replaced "the theory of functions" as the standard subject name for the theory of functions of a complex variable. One also began to see the publication of books with the term "real analysis" in the title. H.L. Royden's *Real Analysis* appeared in 1963 and was given the subject designation QA331.5. Thus real analysis was envisaged in this classification scheme as an offshoot of complex analysis. The earlier subject classifications QA331 (theory of functions, implicitly functions of a complex variable) and QA331.5 (theory of functions of a real variable) mapped onto the new subject names "complex analysis" (QA331) and "real analysis" (QA331.5).

In the LC books on analysis with the classification QA300 are devoted to the more general parts of analysis and the foundations of the subject. A widely used primer on analysis for senior undergraduate and graduate students from the 1950s and 1960s was Walter Rudin's *Principles of Analysis* (1953 and later editions). Rudin's book was classified under QA300. We have the classification sequence:

> Q *Science*
> QA *Mathematics*
> QA300 *Rudin Principles of Analysis*
> QA331 *Ahlfors Complex Analysis*
> QA331.5 *Royden Real Analysis*

By the 1970s some books on real analysis were assigned the designation QA300, and thus were understood to belong to more general parts of analysis, prior in the classification scheme to complex analysis. Other books on real analysis continued to receive the traditional designation QA331.5. There was an overhaul of LC mathematical analysis subject designations in the 1980s, a change that was completed by around 1990. Here is how the breakdown for subjects in analysis is now given:

> QA300 *Analysis*
> QA300 *General works, treatises, and textbooks*
> QA331 *Theory of functions*
> QA331 *General works, treatises, and advanced textbooks*
> QA331.3 *Elementary textbooks*
> QA331.5 *Functions of real variables*
> QA331.7 *Functions of complex variables; Riemann surfaces including multiform, uniform functions*

Evidently the QA331 section dealing with the theory of functions has been reorganized to reflect the standard order of subject presentation: first general works, followed by elementary presentations, and then, according to some presumably natural principle, an ordered list of the subject areas that fall under the theory of functions. An old principle of book classification followed by the LC that is very useful to the historian is that books are not reclassified when a revision, either major or minor, of the classification system takes place. This seems to be partly for practical reasons—it would be difficult for libraries to be continually reclassifying the materials in their collections. But it should be noted that although the *classification* of a book is not changed, in the LC a later edition of a given book may have a different *call number*. For example, Stanley G. Krantz's *Function Theory of Several Complex Variables* was classified as QA331 when it appeared in 1982, a designation that remains unchanged to this day, while the second edition of this book in 1992 received the call number QA331.7.

For more information on the subject of the present essay see Fraser (2018).

## References

[1] Bliss, Henry E. (1935) *A System of Bibliographic Classification*. New York: The H.W. Wilson Company.

[2] Cutter, Charles A. (1891–93) *Expansive Classification Part I: The First Six Classifications*. Boston.

[3] Dewey, Melvil. (1976) *A Classification and Subject Index for Cataloguing and Arranging the Books and Pamphlets of a Library*. Amherst, Mass.: Case, Lockwood & Brainard Company.

[4] Fraser, Craig. (2018) Mathematics in Library Subject Classification Systems. In Maria Zack and Dirk Schlimm (eds), *Research in History and Philosophy of Mathematics: The CSHPM 2016 Annual Meeting in Calgary, Alberta*. Basel: Birkhäuser.

[5] Library of Congress. (1905) *Library of Congress Classification Class Q Science*. Washington, D.C.: Government Printing Office.

[6] Royal Society of London. (1902) *International Catalogue of Scientific Literature. A, Mathematics*. Royal Society of London.

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