

SOURCES

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THE MANUSCRIPTS OF PAUL CHARPIT

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1. INTRODUCTION

Paul Charpit de Ville Coer (?-1784) is one of the fascinating figures on the fringes of French mathematics in the late 18th century. Although he published nothing, his name has been preserved in mathematics in the "Lagrange-Charpit" method of solving first-order partial differential equations. But the surviving manuscripts of Charpit show that this work was only one of his interests and achievements. The purpose of this paper is to describe the current location and general content of his known extant manuscripts, and thereby to encourage deeper study of an interesting "outsider" in French mathematics.

The known manuscripts are contained in three libraries.

The *Biblioteca Medicea-Laurenziana*, Florence:

ML1: three volumes of manuscripts and letters, to Louis-François-Antoine Arbogast (1759-1803) [ms. Ashburnham App. 1838];

ML2: four volumes of manuscripts, mostly by Arbogast or Charpit [ms. Ashburnham App. 1845];

ML3: Arbogast's copy of Charpit's paper containing his method of solving partial differential equations [ms. Ashburnham App. 1841].

The *Bibliothèque Nationale*, Paris:

BN1: another volume of letters from Charpit to Arbogast [ms. f.f.n.a. 7546];

BN2: a volume of manuscripts, including still more letters from Charpit to Arbogast [ms. f.f.n.a. 3282, fols. 133-162].

The *Archives* of the *Académie des Sciences*, Paris:

AS: a *dossier personnel* on Charpit, and also a copy of the paper mentioned under ML3 above, in the hand of Sylvestre François Lacroix (1765-1843).

2. THE HISTORY OF THE CHARPIT MATERIALS

We do not know when Charpit was born, but he lived in Strasbourg until going to Paris in September 1782, apparently to study at the *Collège de France*. He presented his paper on partial differential equations to the *Académie* on June 30, 1784, but he died in Paris on December 28 of that year. The fate of his paper is outlined in Section 4; here and in the next section we describe the other manuscripts.

After Charpit's death, Arbogast tried to number the letters in chronological order, in four sequences which form the basis of the four volumes listed under ML1 and BN1 above. However, none of the numerations is exhaustive, and certain letters are broken up; some letters are undated. In addition, Charpit enclosed mathematical manuscripts with some letters, and they are not always located in the appropriate places.

Roughly, the chronological order of the letters is as follows:

ML1, Vol. 1: about 20 letters and manuscripts, written August-November 1781 (53 folios);

ML1, Vol. 2: about 30 letters and manuscripts, written December 1781-June 1782 (103 folios);

BN1: about 50 letters and manuscripts, written July 1782-October 1783 (187 folios);

BN2: about a dozen letters and manuscripts, written August-October 1783, and belonging to the latter part of BN1 (30 folios);

ML1: Vol. 4 (so numbered): about 20 letters and manuscripts written November 1783-November 1784, together with a few letters concerning his death (64 folios).

As far as can be determined, the history which led to this sorry disorder may be summarized as follows. Arbogast was a lawyer by profession, although he also taught mathematics at the *Collège* at Colmar from 1783 to 1789 and then moved to the

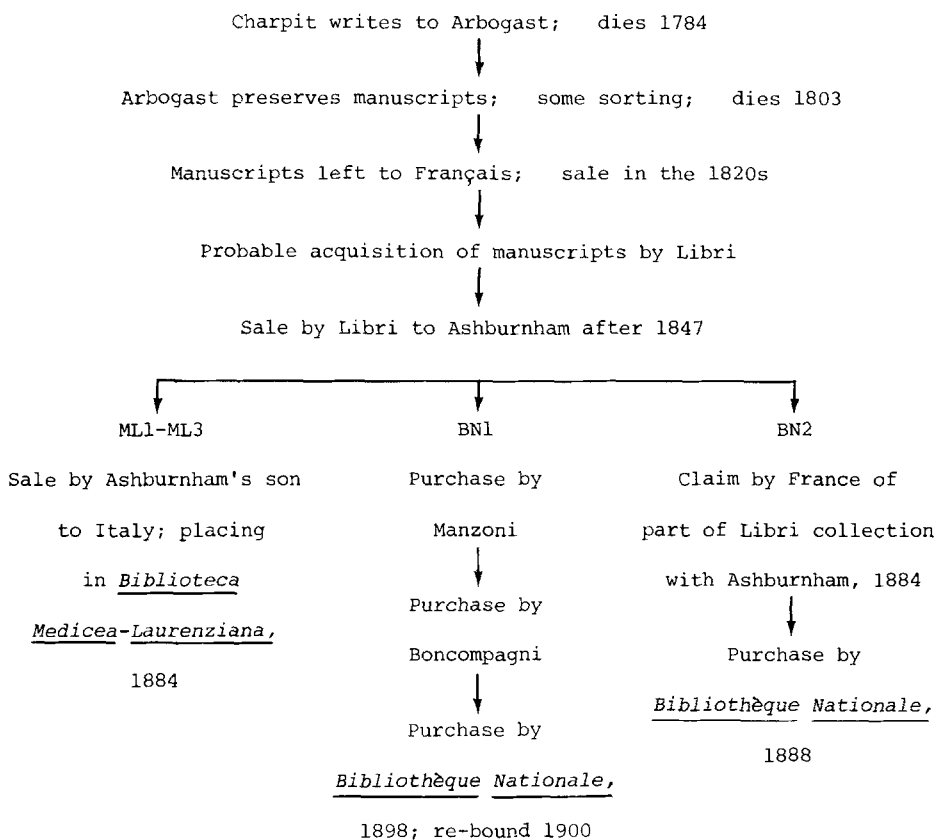
École d'Artillerie at Strasbourg [1]. After a period as a deputy in the *Convention Nationale* he was nominated "instituteur d'analyse" at the *École Polytechnique*, although he seems never to have taught there [2]. At his death in 1803 he left a large and valuable mathematical library of books and manuscripts to the care of François Joseph Français (1768-1810). In turn these materials were left to his brother Jacques Frédéric Français (1775-1833), who organized a sale 20 years later, expressing the hope that "on désirerait la vendre en bloc, ou du moins en parties assez considérables" [Français 1823, 494-495].

It therefore seems likely that the Charpit materials were sold as one lot. Unfortunately, little information is available about the sale; but a letter of September 28, 1822, from Jean-Victor Poncelet (1788-1867) to Jules-Julien Gabriel Berthevin (1769-?), a textbook writer in mathematics and then the *conservateur* at the *Imprimerie Royale*, may hold a clue. Berthevin had apparently written to Poncelet at Metz about Français' forthcoming sale there, for Poncelet mentioned that Charpit's letters to Arbogast, and Arbogast's letters to Français and his brother, were the only letters in holograph; those of Euler, Lagrange, and Bernoulli(s?) "sont presque toutes de la main de [Arbogast] qui les a copiées textuellement (d'après les lettres autographes qu'il a eu entre les mains) sans en retrancher les plus petites choses" [3]. Perhaps Berthevin bought the Charpit letters; according to the letter from Poncelet, Français was transmitting to Berthevin (by the hand of the engineer Antoine Marie Augoyat) two letters written by Arbogast to François Joseph Français. These letters were offered "comme un faible témoignage de la reconnaissance qu'il doit à votre obligeance." Such was the casual attitude toward the preservation of manuscripts at the time.

The man who elevated this attitude into a career was Guglielmo Brutus Icilius Timoleon, Count Libri-Carucci dalla Sommaja (1803-1869), the great "black hole" for manuscripts in France during the early 19th century. Born in Florence (a rather nice touch for this story) he came to Paris in 1830, was elected a *correspondant* of the geometry section of the *Académie* in 1832, and a full member the next year (when he also took French citizenship). He "built up" his library until he was accused in the late 1840s of having done so by stealing, especially manuscripts, from public collections. A scandal erupted, lasting throughout the 1850s to the early 1860s. Libri had to sell much of his collection in sales in London, whither he had moved in exile.

Libri's first sale was actually carried out in 1847, before the scandal started. He sold a substantial collection of manuscripts in secret to the collector Bertram, Lord Ashburnham (1797-1878) (see [Delisle 1888, xxv-xxvi]). Later Ashburnham acquired additional small collections of manuscripts from Libri

TABLE 1



and others, and grouped them under the heading "Ashburnham Appendices." After his death his son sold the bulk of the collection in 1884 to the Italian government, which placed it in the *Biblioteca Medicea-Laurenziana* in Libri's home town [4].

By these means the Charpit materials listed under ML1-ML3 found their way to Florence. As they are in the section "Ashburnham Appendices" it is not certain, though nevertheless very likely, that Ashburnham obtained them from Libri after 1847. It is also not known whether Libri had acquired the manuscripts by means of his carpet bag rather than his purse (at Français' or another sale, perhaps) [5].

The deal negotiated between Ashburnham's son and the Italian government, which was made long after the scandal had been settled against Libri, did not please the French, who claimed those man-

uscripts which pertained to France (see [Delisle 1888, lv]). They were purchased by the *Bibliothèque Nationale*, and included the volume containing the letters listed under BN2. The volume has an 1875 binding, which implies that it had been prepared at Ashburnham's instructions.

The principal sales of Libriana occurred in 1847, and between 1859 and 1862. None of the catalogues seems to list Charpit materials [6]; but at some time the bibliophile Giacomo Manzoni (1816-1889) bought, presumably from Libri, a volume of manuscripts containing some Charpit letters. This volume was purchased by Baldassare Boncompagni (1821-1894) and then sold to the *Bibliothèque Nationale* in a sale of Boncompagni's collections in 1898 [7]. It was uncased; later the Charpit letters were re-bound in 1900 to become the volume listed as BN1.

This history is summarized schematically in Table 1.

3. THE CHARACTER OF CHARPIT'S MANUSCRIPTS

We know little about Charpit's background and upbringing, but he seems to have belonged to a reasonably well-off family. The correspondence suggests that his supposed purpose was to receive legal training, and that his father, like Arbogast, was a lawyer. On September 24, 1782, he complained to Arbogast about his new style of life in Paris, as opposed to Strasbourg, where as "Maître absolument de ma personne dans cette dernière ville je pouvois disposer de mon temps comme il me plaisoit et l'employer a l'étude des sciences et de la philosophie. Ici [Paris] au contraire il faudra que je m'envelisse bientôt dans les replis de la chicane et de la procedure et que j'employe à cette ennuyeux occupation la grande partie de mon temps." One of his occupations was to assist in a course of Monge, who also gave him private tuition in solid geometry [8].

The content of the letters and manuscripts is wide ranging and perceptive, especially for a young man working in isolation in Strasbourg. In mathematics he was especially influenced by Lagrange, not only in the context of partial differential equations but also in the general trend of algebraization of mathematics at that time, to which Lagrange was the presiding father. There are frequent discussions of polynomial and other equations (factorization, roots and their approximation, and so on), complex numbers, power series, infinitesimals, differences, trigonometry, and of course solutions to differential equations. Otherwise geometrical problems constitute the most popular mathematical topic.

A feature of particular note in Charpit's mathematics is his attempt to convert mathematical expressions into power series. In 1800 Arbogast published a book *Du calcul des dérivations*, in

which he attempted to develop general rules for converting "any" expression into the form of a power series, and parts of his work bear some similarity to certain of Charpit's analyses. Thus, although there is no mention of Charpit in the book, and while both men were working under the influence of Lagrange, there may be some measure of influence by Charpit on Arbogast. It is a pity that as yet the location of Arbogast's letters to Charpit is not known. It would be advantageous to know, rather than infer, the views to which Charpit was responding, and thus perhaps to assess more closely his possible influence.

Charpit often discussed scientific and philosophical questions and described his current wide reading. For example, manuscripts survive among the letters on Hassenfratz' theory of winds, astronomical questions, Volta's work on electricity, Berthollet's and Lavoisier's experiments in chemistry, Lambert's *Architectonic* of 1771 ("un ouvrage d'ontologie" [9]), Boscovich's work on optics ("fondé tout entier sur la loi de continuité" [10]), and so on. From Paris he discussed his teachers, especially the lectures of Jacques Antoine Joseph Cousin (1739-1800).

Among Charpit's manuscripts in ML2, the most important is Volume 4, an incomplete treatise of 86 folios on differential equations which appears to be in Arbogast's hand but is basically a text by Charpit. Methods of solving differential equations by Fontaine, Lagrange, and Laplace are discussed. The work as a whole conveys the impression of an intelligent mind surveying and distilling a mass of methods, rather than the conscientious but laborious compilations in the published treatises of that period by writers such as Cousin. Indeed, Charpit's treatise seems to have been planned to succeed Cousin's.

Arbogast was Charpit's continual *confidant*, probably his only one. Even when occupied with new things in Paris Charpit still wrote regularly. His letters are intensive in all senses--often very long, written over several days, and always cramped in a villainous scrawl on both sides of the paper. We hope that Arbogast was more successful than we in deciphering the texts that he received. At least he had the advantage of talking with Charpit on the occasions of their meeting, which he recorded at the heads of some of the letters.

Charpit died in Paris at 10 o'clock on the evening of December 28, 1784, 6 months after submitting his paper on partial differential equations to the *Académie*. Arbogast copied out a letter written a few days later between Charpit's relations (including Laplace), who reported him as having been regarded as a phenomenon by his colleagues [11]. But after his death there was virtually silence about his work, broken only by an occasional reference to the method contained in his June paper.

4. THE FATE OF CHARPIT'S PAPER

Charpit read his "Mémoire sur l'intégration des équations aux différences partielles" to the *Académie des Sciences* on Wednesday, June 30, 1784. At this meeting the following mathematicians were present: Monge, Bossut, Condorcet, Cousin, Laplace, Vandermonde, and de Borda. At that time, Lagrange was still in Berlin, and Lacroix--who would make Charpit's results known 15 years later--was not yet a member of the *Académie*. Condorcet, in charge of keeping the *procès-verbaux*, only briefly indicated Charpit's appearance: "M. Charpi [sic] est entré et a lu un mémoire sur le même sujet." Just before Charpit, Charles Prudhomme, the Count Nieuport (1746-1827) also presented a memoir on partial differential equations. Whereas for this paper the appointment of Cousin and Condorcet as reporters is explicitly mentioned, this was not the case with Charpit's paper [12]. But, as becomes clear from one of the extant manuscripts of Charpit's paper, at some time Laplace and Condorcet were nominated as reporters [13].

We do not know why Charpit's paper was treated differently from Nieuport's; perhaps Laplace altered the usual procedure in order to check it against his own results first. At any rate, no report on it was ever mentioned in the *procès-verbaux*, nor has any such report been discovered. Presumably the original manuscript remained in the possession of Laplace, who, almost 9 years later, on June 13, 1793, passed it on to Lagrange (who was by then in Paris). In September, 1793, Lagrange sent the text to Arbogast, who prepared a copy for himself. This copy ended up in Florence as item ML3 of the list in Section 1. Arbogast sent the original manuscript on to Lacroix, who made the copy that has been preserved at the *Archives* of the *Académie des Sciences* (AS) [14].

At this point the original manuscript seems to have vanished. However, Lacroix first reported Charpit's paper in 1798, in the first edition of his *Traité du calcul différentiel et du calcul intégral* [Lacroix 1798, esp. pp. 496-497, 513-516]; then in 1802 in his contribution to J. Lalande's completion of the second edition of J. F. Montucla's *Histoire des mathématiques* [Montucla 1802, 349]; and finally in 1814 in the second edition of his *Traité* [Lacroix 1814, 548-567]. For a typical, later treatment of Charpit's method based on this "indirect" tradition, see, for example, [Forsyth 1888, 317-324].

When Carl Jacobi (1804-1851) asked in 1841 for the publication of Charpit's paper, it was reported lost for the first time [Jacobi 1841, 151]. (Lacroix had merely said that "la mort enleva ce jeune homme au moment où ses talents donnaient de grandes espérances, et son mémoire ne fut pas imprimé.") Jacobi's claim that the paper was lost has been repeated ever since (for

example, by C. R. Wallner in [Cantor 1908, 976 ff.]; more recently in [Kline 1972, 535] and [Dieudonné 1978, 46]). However, in 1928 H. Villat, while sorting documents in the *Archives* of the *Académie des Sciences*, unearthed Lacroix' copy. This was photographed and sent to N. Saltykow in Belgrade, who published an extensive description of the paper in the *Bulletin des sciences mathématiques* [Saltykow 1930, 1937]. For further information on the contents of Charpit's paper we refer the reader to these articles, which seem to have been overlooked completely.

Arbogast's and Lacroix' copies of the paper differ considerably. Arbogast's copy consists of 68 written pages, 18 × 23.5 cm in size. It seems to be the more reliable one, being written in a fine, clear hand and containing well-formed, clearly expressed sentences. By contrast, Lacroix' copy, which consists of 30 folio pages, may have been written in haste; the sentences are frequently shortened, and details which must have been considered irrelevant have been left out. Furthermore, it contains remarks and calculations which are obviously Lacroix' own. Thus Arbogast's copy appears to be a literal one, suitable for publication, whereas Lacroix' copy seems to be a version prepared for personal use.

Both copies of the paper commence with an "extrait fait par l'auteur" which precedes the main text. Presumably it was this extract that was read to the *Académie* at its meeting of June 30, 1784. The paper itself is in two parts: the first deals with first-order, and the second with higher-order, differential equations in an arbitrary finite number of variables.

During the 1930s and early 1940s efforts were twice made to publish the paper. Documents in the *dossier personnel* for Charpit in the *Académie des Sciences* show that around 1935 H. Lebesgue and E. Picard envisaged publication of the paper as a booklet (the series *Mémorial des sciences mathématiques* had been considered), and to this end F. Vasilescu prepared a transcript of Lacroix' copy. However, the plan was not completed (perhaps because of the unsatisfactory state of Lacroix' copy), although Vasilescu's transcript has been preserved in the *dossier personnel*.

In 1942 P. Montel again took up the project, but he had to abandon it because Lacroix' manuscript was kept in a deposit outside Paris, along with many other *Académie* documents. The manuscript referring to Montel's plan is marked "Affaire à reprendre après la guerre." But after the war, the matter seems to have been forgotten.

An edition of Charpit's paper is now planned by S. Engelsman, which will be based mainly on Arbogast's copy. This edition will appear in the *Revue d'histoire des sciences*.

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NOTES

1. See the brief obituary [Hachette 1807] and the biography [Fréchet 1920] of Arbogast.

2. *Ecole Polytechnique* archives, cartons numbered 1794(2) and 1808(2). A list in the 1836 carton states that Arbogast taught during the first month of the school's existence.

3. This valuable letter is kept in a miscellaneous collection at the *Bibliothèque Nationale*, mss. f.f.n.a. 2762, fol. 176. Poncelet also mentions that Arbogast had collected some rare British and German books. He wrote to Berthevin also on July 22, 1821 (Smith manuscripts, Columbia University, New York).

4. For catalogues of this collection see [Delisle 1886; Narducci 1886] and the manuscripts in the *Bibliothèque Nationale*, mss. f.f.n.a. 3260, fols. 97-188v (list of sales from Libri to Ashburnham), 3285 (list, prepared during the inquiry, of manuscripts that Libri definitely bought) and 3286 (list of manuscripts of doubtful acquisition). Ms. 3285, fol. 345, may have another clue for our story, for it contains a note that Libri bought from Isidore Didion (1798-1878), a student of Poncelet at Metz in the late 1820s, a manuscript on Arbogast-style "échelles des opérations," written by François Joseph Français. That manuscript went to Ashburnham (it is mentioned in ms. 3260, fol. 180) and then to Florence (it is listed in the 1886 catalogues noted above); but it is now lost.

5. Taton states that Libri acquired some of Arbogast's library, still unsold from a bookseller, in Metz in 1839 [Taton 1972, 111]. Perhaps Libri obtained the Charpit manuscripts, by one means or another, on this occasion.

6. See [Silvestre 1847; Sotheby 1859a, 1859b, 1861, 1862].

7. See [Narducci 1892, 385], where the ownership by Manzoni is mentioned and the letters and manuscripts now in BNL are listed. The manuscripts are not mentioned in the 1894 sale of Manzoni's collection [see Tennerone 1894]. Boncompagni's *Nachlass* is now widely scattered. Some items are in the *Bibliothèque Nationale*; for indications of others, see [Grattan-Guinness 1971, 372; Wells 1978; O'Sullivan 1979].

8. See BNL, Vol. 4, fols. 50-53; MLL, Vol. 4, fols. 13-16.

Legal matters are mentioned from time to time in the correspondence.

9. See MLL, Vol. 1, fols. 26-29. Interest in Lambert is one of the common features in Charpit's and Arbogast's mathematics. As a fellow Alsatian, Lambert would have been a sympathetic interest.

10. See MLL, Vol. 1, fols. 32-33.

11. See MLL, Vol. 4, fol. 59. Laplace' kinship with Charpit emerges from a letter of January 12, 1785, by Charpit's father, in which he transcribes a letter of December 30, 1784, from Laplace to Laplace' aunt, Charpit's mother (fols. 60-61). Laplace and Charpit are thus cousins, although Laplace refers to Charpit as his nephew. Laplace was unmarried in 1784, so there is no possibility of a more distant kinship.

12. Nieuport's paper was entitled "Mémoire sur la solution des équations aux différences partielles." The report on this paper by Cousin and Condorcet is contained in the dossier of the meeting of July 14, 1784.

13. See fol. 6v of Arbogast's copy of the paper.

14. The evidence for this line of transit is a set of notes made at the beginning of both copies. Lacroix' copy reads: "M. La Place en a été rapporteur, il a été communiqué à M. La Grange le 13 Juin 1793, à Arbogast le 9 Septembre 1793, à moi le 1 Septembre 1794." Arbogast's copy reads: "Reçu de M. de la Place le 13 juin 1793. signé Lagrange. Reçu du C.ⁿ Lagrange le 9 7^{bre} 1793. Arbogast."

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