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Jean-Philippe Rameau's Demonstration du Principe de L'Harmonie (1750) and Pierre Esteve's Nouvelle Decouverte du Principe de L'Harmonie (1752): A Translation

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JEAN-PHILIPPE RAMEAU'S <u>DEMONSTRATION DU PRINCIPE DE L'HARMONIE</u> (1750) AND PIERRE ESTEVE'S <u>NOUVELLE DECOUVERTE DU PRINCIPE DE L'HARMONIE</u> (1752): A TRANSLATION

by

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Arsen Ralph Papakhian

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INTRODUCTION

While the theoretical writings of Jean-Philippe Rameau (1683-1764) have been the subject of much recent analysis, research and scholarship, only two of his major works, *Traité de l'Harmonie* (1722) and *Génération Harmonique* (1737), have been translated completely into English.[1] My purpose, then, in the preparation of this translation has been to provide a readable English version of his *Démonstration du Principe de l'Harmonie* (1750). Though Rameau's ideas and the development of his thought can only be understood by exhaustive studies from a variety of perspectives, it has been assumed here that the complete translation of a single work can offer both the translator and the reader a continuity of thought and an intimacy otherwise unobtainable. To the *Démonstration*, I have appended a translation of Pierre Esteve's *Nouvelle Découverte du Principe de l'Harmonie* (1752) which, though a minor work, is directly related to the *Démonstration*. The remainder of this introduction will briefly consider these two works with respect to their bibliographic histories, their relationship, and major ideas.

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[1] *Treatise on Harmony*, trans. with an intro. and notes by Philip Gossett (New York: Dover, 1971). Deborah Hayes, "Rameau's Theory of Harmonic Generation: An Annotated Translation and Commentary of *Génération Harmonique* by Jean-Philippe Rameau" (Unpublished Doctor's dissertation, Stanford University, March 1968).

Rameau

The major body of Rameau's theoretical writings were analyzed in terms of their validity and with respect to the development of music theory by Shirlaw[1] in the early part of the century. More recently, Sister Michaela Keane's published dissertation[2] traces Rameau's works chronologically in considerable detail, while Pischner[3] attempts to evaluate Rameau's contributions in more general terms and especially with regard to eighteenth-century musical thought. Rameau's relationship with the philosophical thought of the Enlightenment has been the subject of Charles Paul's studies.[4] The major biography of Rameau and the most comprehensive study of his musical works is Cuthbert Girdlestone's Jean-Philippe

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[1] The Theory of Harmony: An Inquiry into the Natural Principles of Harmony, with an Examination of the Chief Systems of Harmony from Rameau to the Present Day (London: Novello & Co., 1917; rpt. Dekalb, Ill.: Dr. Birchard Coar, 1955).

[2] The Theoretical Writings of Jean-Philippe Rameau (Washington, D.C.: The Catholic University of America Press, 1961).

[3] Die Harmonielehre Jean-Philippe Rameaus: Ein Beitrag zur Geschichte des musikalischen Denkens (Leipzig: Veb Breitkopf & Härtel Musikverlag, 1963).

[4] "Rameau's Musical Theories in the Age of Reason" (Unpublished Doctor's dissertation, University of California, Berkeley, 1966). Paul's dissertation is the basis of his article "Jean-Philippe Rameau (1683-1764), the Musician as Philosophe," Proceedings of the American Philosophical Society, CXIV (April 1970), 140-154.

Rameau: His Life and Work.[1] Rameau's works have been reproduced in facsimile with excellent commentary in Erwin R. Jacobi's monumental edition of The Complete Theoretical Writings of Jean-Philippe Rameau.[2]

By the late 1740's Rameau had achieved the highpoint of his career as operatic composer. He had, at last, overcome "Lullisme" and the famous Bouffons' Quarrel was still a few years off. At the same time, while he had gained considerable reputation as a theorist, he sought more official entry into the distinguished community of French Enlightenment philosophers and scientists. Association with and recognition by such figures as d'Alembert and Diderot, let alone his immense personal motivation, must have encouraged Rameau in his inquiries into the principles of music.

In 1749 Rameau submitted to the Royal Academy of Sciences a Mémoire ou l'on expose les fondemens du Système de musique théorique et pratique de M. Rameau. The Academy responded with the composition of a Rapport (attributed to d'Alembert) on the memoire. These two documents (now found in the archives of the Academy), with

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[1]Jean-Philippe Rameau: His Life and Work, rev. ed. (New York: Dover, 1969). This work contains the most comprehensive bibliography on Rameau.

[2]The Complete Theoretical Writings of Jean-Philippe Rameau (American Institute of Musicology, 1967-72).

certain alterations and corrections, were published in early 1750 as the Démonstration. The corrections in the report, according to Jacobi, "were not made for linguistic or stylistic reasons, but were done a few days after the completion and the signing of the report with the clear intentions, in the event of publication, of reducing the responsibility of the Académie and increasing that of Rameau."[1] The major change made by Rameau was to alter the title of Mémoire to Démonstration (and, of course, to mention the approval of the Academy on the title page). Later, as Rameau began making certain claims for his "principle" that were unacceptable to d'Alembert, d'Alembert made a point of explaining that the Academy's approval was not for a "demonstration" but for something substantially less.[2]

Since the Démonstration has generally been regarded as the most lucid example of Rameau's prose, it has been asserted that Diderot may have had a hand in its composition. The assertion is based on a few comments made by Raynal in the Correspondance litteraire concerning Diderot and Rameau.[3] Since the proof is not

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[1]Rameau, The Complete Theoretical Writings, III, XLIII. All of the bibliographic information above is from this preface to vol. III by Jacobi. The differences between the Mémoire (1749) and the published Démonstration (1750) are given in vol. VI, 191-193.

[2]See Jean Le Rond d'Alembert, Elémens de Musique Théorique et Pratique Suivant les Principes de M. Rameau...Nouvelle Edition (Lyon: Jean-Marie Bruyset, 1762), p. xvi. The passage referred to here is from the "Discours Preliminaire," relevant parts of which are given in Pischner, pp. 319-327.

[3]These comments are quoted by Jacobi in Rameau, The Complete Theoretical Writings, III, XL-XLI.

definitive, Leeds has evaluated the relationship as follows:

> The friendship between the two men is indisputable, but more doubtful is the possibility that Diderot and Rameau collaborated on some works dealing with musical theory. . . . We may never know definitely Diderot's role in the writing of the works of Rameau, but we firmly believe that our philosopher's genius was capable of such an erudite task.[1]

Rameau's name as a music theorist is most often associated with his first and largest published work, the Traité of 1722. This work is perhaps the most 'practical' of all his writings, and it contains important theoretical formulations that would subsequently be developed and extended. It is of interest that the principle of music in the Traité is the division of the monochord and mathematical manipulation. The Génération Harmonique (1737) and the Démonstration (1750), however, are based on the acoustical discoveries of Sauveur and Mairan relative to the harmonic series contained in the resonance of a sonorous body.[2] These works attempt to refine and rationalize (never fully satisfactorily) Rameau's earlier ideas in order that they might conform to the "natural principle" of music. In his later works, Rameau adds relatively

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[1]Frederick M. Leeds, "Diderot: The Philosopher as Musician" (Unpublished Doctor's dissertation, Pennsylvania State University, December 1971), pp. 55-56.

[2]The discovery and use of the harmonic series by Sauveur, Mairan and Rameau are considered by Burdette Lamar Green, "The Harmonic Series from Mersenne to Rameau: An Historical Study of Circumstances Leading to Its Recognition and Application to Music" (Unpublished Doctor's dissertation, Ohio State University, 1969), pp. 376-484.

little to his theory of music, but he does begin to view his natural principle of music as a universal principle of knowledge and art.

Rameau, himself, considered the Démonstration to be a major work, as evidenced by his title page, his use of the dedication, the value he placed on the approval of the Academy,[1] and his presentation of copies to distinguished European scholars (e.g., John II Bernoulli). It has retained significance in several respects. Rameau reveals in many instances his thought processes, certain personality characteristics, and clues to his eventual use of the "sonorous body," his first principe, as the source of all science and art. With respect to music theory and practice, Rameau introduces in the Démonstration a new theory of the origin of the minor mode and its relationship to the major, while retaining the so-called "arithmetic proportion" to explain the sub-dominant and to derive the "triple proportion." Other significant topics dealt with are the identity of octaves, the application and effects of chromatic genera, and temperament. Within two years after publication of the Démonstration, Rameau's fortunes took a turn for the worse. The Buffons' Quarrel ushered in French operatic reform, and Rameau's relationship with the Encyclopedists began to seriously

[1]Roger Hahn points out that "to be an academician, or to have one's views discussed favorably by the Academy, was in fact to receive the supreme accolade of that loosely knit community known as the 'Republic of Science.'" The Anatomy of a Scientific Institution: The Paris Academy of Sciences, 1666-1803 (Berkeley: University of California Press, 1971), p. 35.

deteriorate, calling into question his stature as a philosophe.[1]

Estève

Little is known of Pierre Estève. He was born in Montpellier in 1720 and apparently was active in the Montpellier Royal Academy of Sciences in the 1740's. Though a minor academician, his wide ranging interests were not atypical of the time. He published on such subjects as mathematics, astronomy, physics, acoustics, music, diction, literature, philosophy and art. From about 1750 to the end of his life[2] he lived in Paris.

In general Estève is regarded as a mediocre scholar whose works were forgotten during his own lifetime. But he did have some friendly associations with the Encyclopedists (though he supported French music in the Bouffons' Quarrel), and was given recognition in the publications of the Royal Academy of Sciences of Paris.[3] Aram Vartanian has also noted that Estève's Origine de

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[1]See Alfred Richard Oliver, The Encyclopedists as Critics of Music (New York: Columbia University Press, 1947), pp. 101-112.

[2]The main sources are Junius Castelnau, Mémoire Historique et Biographique sur l'Ancienne Société Royale des Sciences de Montpellier...(Montpellier: Boehm, 1858), pp. 179-180, and the entries on Esteve in Dictionnaire de Biographie Francaise, sous la direction de J. Balteau...(Paris: Letouzey et Ane, 1933-), XIII, fasc. LXXIII, cols. 89-90 and Die Musik in Geschichte und Gegenwart, hrsg. von Friedrich Blume (Kassel: Barenreiter Verlag, 1949-68), III, cols. 1575-1576.

[3]He published three articles in Vol. II (1755) of the Academy's Mémoires de Mathématique et de Physique Présentés a

l'univers explique par un principe de la matiere (Berlin, 1748) was a "good example of the application, within the framework of Cartesian cosmogonical science, of Newton's law of gravitation."[1]

Of Estève's six or seven works concerning music,[2] the most significant are L'Esprit des Beaux Arts (1753) and the Nouvelle Découverte du Principe de l'Harmonie (1752). With regard to L'Esprit des Beaux Arts, its "seconde partie" deals with "des expressions sonores."[3] Some of the topics considered are Greek music and theory, melody, "modern music," French opera and recitative. In Chapter VII, "De la Gamme des modernes,"[4] Estève refers to and discusses the Nouvelle Découverte and Rameau.

According to Jacobi, the Nouvelle Découverte must have been completed in 1750, and apparently it was published in a rare first

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l'Académie Royale des Sciences, par Divers Scavans, et Lus dans Ses Assemblées (Paris, 1750-1786). See Hahn, p. 62 and Louis Dulieu, "La Contribution Montpellieraine aux Recueils de l'Academie Royale des Sciences," Revue d'Histoire des Sciences, XI (1958), 260-261.

[1] Diderot and Descartes: A Study of Scientific Naturalism in the Enlightenment (Princeton: Princeton University Press, 1953), p. 94n.

[2] See the bibliography in MGG, III, col. 1576. The article entitled "Recherche sur le meilleur systeme de musique..." which is listed under "Literatur" is actually by Estève and is the article referred to in the Nouvelle Découverte.

[3] L'Esprit des Beaux Arts(Paris: C. J. Baptiste Bauche Fils, 1753; rpt. Geneve: Slatkine Reprints, 1970), I, 127-252, II, 1-36.

[4] Ibid., I, 198-209.

edition in 1751 by "Huart et Moreau fils, Durand."[1] The edition more often referred to (and the one used here) was a second edition of 1752 with the same pagination. The publication of the Nouvelle Découverte did arouse some attention. It was reviewed in the Mémoires pour l'Histoire des Sciences et des Beaux Arts (Journal de Trévoux) and discussed in relation to Rameau's Démonstration and Nouvelle Réflexions de M. Rameau sur sa "Démonstration du Principe de l'Harmonie" (1752).[2] Esteve had also presented his Nouvelle Découverte to the Royal Academy, and it was reported in the Histoire de l'Académie Royale des Sciences (Annee 1750, pp. 165-167) immediately following a report on Rameau's Démonstration (pp. 160-165).

Esteve raises serious criticisms of Rameau's Démonstration but does not reveal a profound understanding of Rameau's work in general. He approaches harmony more as a scientist than as a musician trying to rationalize current harmonic practice. Specific arguments are made against Rameau's methods as not being demonstrable proofs but assertions based only on analogy (for example, Esteve's comments on the "multiples"). The principle of octave identity in the harmonics of fundamentals is challenged as well as Rameau's manipulation of the harmonic series to derive the perfect

[1]Rameau, The Complete Theoretical Writings, III, XLVIIIn.

[2]For specific citations and a discussion of these and other reviews see Keane, pp. 152-157 and Rameau, The Complete Theoretical Writings, vol. III, XLVII-XLIX, LIX, and vol. V, XXIII ff.

chord. Estève goes on to establish a theory of consonance based on a "mechanical principle" of the transmission of sound, which has been compared to Helmholtz's theory of consonance.[1]

Though the Nouvelle Découverte cannot be regarded as having major importance, it has some significance in that it was one of the first writings criticizing details of Rameau's theories.[2] It can certainly be viewed as a contribution to the intellectual attack on Rameau's claim to have demonstrated a "scientific" theory of music.

Remarks on the Translation

The translation of the Démonstration was made from the facsimile reproduced in volume III of the Complete Theoretical Writings and a microfilm copy available at the University of Michigan. A microcard copy of the Nouvelle Découverte (1752 edition) is available from the University of Rochester. The Privilege du Roy has not been included here in either case. The Démonstration was published under a privilege granted to the Academy and dated 12 November, 1734. The Errata at the conclusion of the Démonstration have been incorporated without comment. Estève's Nouvelle Découverte has a privilege dated 25 January, 1751 and an approbation signed

[1] Estève's theories are briefly discussed in Shirlaw, pp. 283-285 and Pischner, pp. 140-141.

[2] Pischner, p. 140.

by Clairau dated 4 January, 1751.

My intent has been to translate as literally as possible. However, I have taken certain liberties in the interest of clarity. These liberties mostly consist of breaking up lengthy sentences and the consequent omission of connectives. Technical terms have been translated with cognates whenever possible. This has led in some instances to the use of words that must be understood in an eighteenth-century context. For example, Rameau's word mode could be translated as key in several passages. Since Rameau also had available to him the word ton (also meaning key) and since he apparently made some distinction in usage, it seems appropriate to translate with the cognate so as to avoid connotations Rameau may not have implied.[1] Some terms and phrases have no English equivalents (such as double emploi) and in these cases the French was used directly. In other cases, the French terms are given following the English (in brackets and underlined) whenever this would aid understanding. Also, the few additions I have made to the text are always given in brackets. Rameau's musical symbols are always in reference to a fixed ut (do) and should cause no difficulty.

The order of the parts of the Démonstration are different in various bindings (some giving the Extract first). I followed

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[1]Hayes, pp. vi-ix, discusses some of the basic terms and meanings used by Rameau in the Harmonic Generation. See also her translation of Rameau's "Alphabetic Table of Terms" contained in that same work, pp. 5-10.

the order found in the facsimile mentioned above. This leads to four paging sequences in the original (the Preface, the Demonstration, the Extract, and the Tables). The original page numbers are given in the right-hand margins. Internal notes always refer to my pagination with the original pagination given in parenthesis ("R" will refer to the Preface and the Demonstration, "Extract" will refer to the Extract, and "Esteve" will refer to the *Nouvelle Découverte*). Numbered footnotes are editorial additions. Original notes are indicated by asterisks.

DEMONSTRATION

OF THE PRINCIPLE OF

HARMONY,

Serving as the Basis for the Complete Art

of Theoretical and Practical Music.

Approved by Gentlemen of the Royal Academy of Sciences, and dedicated to His Lordship the Comte d'Argenson, Minister & Secretary of State,

by Mister Rameau

Paris,

Durand, rue Saint Jacques, au Grisson

Pissot, Quay des Augustins, a la Sagesse

M. DCC. L.

With Approbation and Privilege of the King

To Your Lordship

THE COMTE D'ARGENSON[1]

Minister and Secretary of State, of War, etc., etc.

Your Lordship,

I could not have dared to flatter myself that in the overwhelming multiplicity of your labors, you would glance upon the work I have the honor of presenting to you. But you have viewed it with a philosophic eye. You have comprehended all of its relationships. And you have honored it with your approbation. Your Lordship, deign to continue for me this protection. It will be the dearest recompense for my lucubrations and will bring to the remainder of my life a calm and refinement that I have not as yet been permitted to enjoy.

I am, with the most profound respect,

Your Lordship,

Your very humble and very obedient servant, RAMEAU.

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[1]Marc-Pierre de Voyer de Paulmy, Comte d'Argenson (1696-1764), distinguished statesman, was an academician and former president of the Royal Academy of Sciences. The historic _Encyclopédie_ was also dedicated to him.

PREFACE

The work I am presenting today is the result of my medi- (v)
tations on the scientific part of an art in which I have been en-
gaged for my whole life. Fortunately, I have not been deterred
in my research, and I have finally succeeded in demonstrating this
fundamental principle of music which others before me had vainly
attempted to discover.* I sensed it as far back as my Treatise on
Harmony. It lacked only this final touch in order to justify all (vi)
I advanced in my Harmonic Generation.

It is in music that nature seems to point out to us the
physical principle of those primary, purely mathematical notions
upon which all sciences depend. I mean the harmonic, arithmetic,
and geometric proportions from which progressions of the same genus
follow. These proportions are manifested in the first moment in (vii)
which the sonorous body resonates; either in its third and fifth,
which resonate along with it, and which are made to vibrate in
other sonorous bodies tuned at the unison with this third and fifth;
or in its triple and quintuple, which are likewise made to vibrate
in other sonorous bodies tuned at the unison with this triple and

*Brossard, in his Dictionnaire de Musique [(Paris, 1703; 2nd ed., 1705)], cites more than 800 authors who have written on music, among which Pythagoras, Plato, and several other ancients as famous are not forgotten. As for the moderns, Zarlino, Kircher, and Mersenne have contributed immense works. Descartes wrote a brief treatise as did Wallis, Huyghens, etc.

quintuple (not to speak of the sonorous body's octaves, which are only replicates [répliques]).*

Taken singly, the sonorous body as a whole is always perceived as containing within itself the same harmony it resonates. It is the generator of that harmony, and that is why I consistently call it generator. If there are several sonorous bodies, I label each of them, indistinctly, fundamental sound. The primary sonorous body, the one from which all the others originate, is always indicated by the number '1,' unless, in order to avoid fractions, it must be raised to a composite number. With that once established, one immediately sees the origin of the harmonic proportion (1:1/3:1/5) of the sonorous body to its third and fifth, from which the most perfect harmony is formed. One then sees the origin of the arithmetic proportion (1:3:5) by comparing the sonorous body to its triple and quintuple, from which a harmony nearly as perfect is formed. Next, the geometric proportion originates from the comparison of the sonorous body with its octaves (1:1/2:1/4 or 1:2:4). This does not result in harmony, since the octave is only a replicate. (viii) (ix)

Thus, with harmony restricted to the first two proportions, one has only to give it a succession. That is accomplished by making the fundamental sounds (the choice of which is prescribed by nature; the limits, by the product that results from them) follow (x)

*See Chap. 8 of my Harmonic Generation.

each other in a geometric proportion between the generator and the two corresponding terms of each of the first two proportions: 3:1:1/3 on the one hand, 5:1:1/5 on the other. In order to avoid fractions, 3:1:1/3 is expressed as 1:3:9, and 5:1:1/5 as 1:5:25 (xi)
where the generator is seen between its triple and its third, as well as between its quintuple and fifth. No one should be troubled by the position that the multiples and sub-multiples occupy in these proportions, because that depends only on the object to which one applies them—either to the lengths, or to the vibrations.

Each term of the geometric proportion is always the generator of one of the two first proportions (that is, of the harmonic or arithmetic proportions), from which nothing can be deduced. Be- (xii)
cause, although one is free to sound only one part, one cannot prevent the others from being implied. These other parts are regarded as the product of the generator, where the octave is always included. Based on the order which the products of each term of this geometric proportion maintain between themselves, one recognizes that the triple (1:3:9) must have preference over the quintuple (1:5:25).

All that is most perfect in music originates in the triple proportion: the modes, and the smallest natural degrees of the (xiii)
voice (ut, re, mi, fa, etc.) under the designation of diatonic genus. The less perfect genera (by which the modes differ amongst themselves and intermingle) originate from the quintuple proportion, under the designations of chromatic and enharmonic. Thus, all

theoretical and practical music follows from these three proportions (the harmonic, arithmetic, and geometric) without any exceptions for reason or the ear. (xiv)

In music the limits of these proportions are determined (for judgment and for the ear) by the dissonance introduced through a fourth term. It is necessary to introduce this fourth term to the triple proportion in order to have the complete diatonic octave [i.e., the scale ut to ut] from the generator of the mode. (See tables C and F at the back of the book, to which capital letters refer.) With the introduction of this fourth term, however, one encroaches upon another mode. It is only after many and quite curious consequences, which are very difficult to discover, that (xv)
one can, in this case, preserve the impression of the same mode throughout the complete range of this diatonic octave.

That which I call <u>fundamental bass</u> is nothing but the succession of the terms of one of the two geometric proportions—a succession from which one draws new results so that the succession can be varied even more than these two proportions would allow. The representation of a generator by each of the sounds of this bass forces a recognition (simultaneously, and for the immediate purpose (xvi)
of all musical effects) that its product is merely accessory to it. Some relationships in the succession of the products cannot even be practical, because they are inappreciable to the ear. However, their effect is felt by means of the fundamental bass as if one really heard them. This merits attention, especially with the

music of the ancients, who established upon these same products the powerful musical effects they have described. (xvii)

All musical systems presented up until my Treatise on Harmony have been based only on these same products, while the ratios of these products constantly introduce altered consonances. Some of these systems pretended not to notice these altered consonances, and others contented themselves by citing them without drawing the least consequence.

This last remark adds a great deal to the principle, for, despite the alteration between the products that I just mentioned, (xviii) they always accord perfectly with their base or fundamental bass: all the proportions are regularly observed here.

After having provided justification for these facts (as well as for the modes, their proportions, their intermingling, and for dissonance), I go on to temperament, the necessity of which I demonstrate. I prove rather clearly that the temperament I proposed in my Harmonic Generation[1] is the only one derived from nature. (xix)

If writers find assistance in books and conversations, I have found only obstacles. If one examines all ancient and modern systems and the innumerable calculations that flow from them, and if one compares them to the simplicity to which I have reduced them (so much of truth is in simplicity), one will see how these systems

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[1]Chapter VII (pp. 75-104) of the Harmonic Generation is entitled "Origin of temperament, its theory and practice."

had to lead me astray rather than direct me aright.

I now have reason to believe that a theory, disencumbered of all these calculations and reduced to clear and simple truths, (xx) will no longer repel the practical musician. And by this method, the fortunate genius, supported by a little experience, will find himself in a position to make his capabilities known in a brief time. Among others, a man of letters,[1] who is in no way initiated in geometry or musical art, so perfectly understood my Demonstration at the first reading, that in order to convince me of his understanding he gave me some proofs worthy of admiration in all regards, (xxi) as one will be able to determine if, some day, he presents them to the public.

Moreover, the principle in question, applied to its first object, is not limited merely to the composition of music. One can draw from it assistance for the manufacture of instruments, and even for the invention of new instruments. But, more essentially, it made me discover the means to give the voice the most beautiful sound it is capable of in its entire range, to augment (xxii) the range beyond the point previously believed to be its limit, to render the voice flexible (as much for the tremblemens—called cadences—as for the roulemens), to form the ear, and especially

[1]This individual has been identified as Jean-Francois Marmontel (1723-1799). See Rameau, Complete Theoretical Writings, vol. III, XLVI-XLVII. The "proofs worthy of admiration" were published as a poem, "Epitre a Rameau," extracts of which are published in vol. VI, 213-215.

to reform bad habits which can put obstacles before all these perfections, and which pass, with many people of the art, as natural and irreparable faults. I had this method nearly complete, but my poor health forced me to abandon it some years ago. For the same (xxiii)
reason, and nearly at the same time, it was necessary for me to abandon a method of composition already in progress, but I have entrusted it to a very capable person[1] to advance it for his own benefit and that of the public.

The End of the Preface

[1]Jacobi suggests convincingly that this person might be d'Alembert on the basis of a manuscript found among d'Alembert's papers in the Institut de France. See Rameau, The Complete Theoretical Writings, vol. VI, XLV-XLVI ("Epilogue to the Complete Edition").

DEMONSTRATION (1)

OF THE PRINCIPLE OF

HARMONY,

Serving as the Basis for the Complete Art

of Theoretical and Practical Music.

Melody and harmony constitute the complete science of musical sounds. Melody is the art of making sounds succeed each other in a manner agreeable to the ear. Harmony is the art of pleasing the ear by uniting those sounds.

I do not challenge the ancients' renown for having excelled in the first of these aspects of music. I would agree, if (2)
one wishes, that they were familiar with harmony, although this fact is still contested. But what I maintain is that they ignored the true fundamentals of both these aspects: *the true fundamentals of melody* (since they were scarcely in a position to rationalize why this or that scale or succession of sounds was composed of some particular sounds rather than of others; why, consequently, a given sound could or could not succeed another; what was but one mode and what the relationships among the modes were), and *the true fundamentals of harmony* (since it is not conceivable that musicians who were not in a position to rationalize the succession of one sound (3)
to another would be more enlightened concerning the consonance of two or several sounds; also, their harmony was reduced, according to all appearances, to the octave, the fifth, and the fourth,

since they had always treated the third and sixth as dissonances). If they made some astonishing progress with respect to melody, if they advanced in their methods with some assurances, it was because they were secretly guided by nature. The blind believed they could walk by themselves with nature guiding, but the lack of principles necessarily rendered many roads impracticable or entirely closed. It would be a miracle greater than any of those (4)
attributed to their compositions if the ancients had encountered no insurmountable difficulty in their use of sounds, since they were not enlightened on the nature of the succession of the sounds that composed their scales.

To discover through experience the rules dictated by nature is a long and thorny path. It is a method which yields results only very slowly (and all the results of which are by no means sure of attainment), which enlightens but one particular usage at a time, and whose indications one can hardly generalize without chancing much and exposing himself to errors. This experience, I contend, was the ancients' resource. (5)

Conditions for the moderns have not been better. The experiments of the ancients have been lost for us along with the works that contained them.

Our predecessors have been obliged to work at the perfection of an art as if it were totally new. The miracles which ancient music effected have been, in truth, transmitted to us; but not a single rule observed by the authors concerning the execution

of these miracles has reached us.

What was done in order to restore this loss? Our predecessors searched in nature for some fixed and invariable point from which they could assuredly start, and which could serve as (6) the foundation of melody and harmony. Was there no result? They set about making experiments, groping, compiling facts, multiplying signs. They had, after much time and trouble, a collection of a certain quantity of phenomena without connection and order, and they were content with that. However, the knowledge of these phenomena was hardly extended: the use of them was so arbitrary that whoever possessed the best of them was hardly more informed.

Such was the state of things, when, astonished at the difficulties I, myself, had had in learning what I know, I considered a means to abridge these phenomena for others, and to provide a (7) more certain and less lengthy study of composition. I also realized that I could hardly obtain one of these benefits without advancing the other, and that progress in the science of sounds would surely be less lengthy when its principles were more certain.

I understood, at first, that it was necessary in my research to follow the order maintained by these phenomena themselves. And since, according to all appearances, melody had occurred before harmony, I wondered how one succeeded in obtaining melody.

Enlightened by Descartes' Method,[1] which I had fortunately

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[1]The reference is, of course, to Descartes' Discours de la

read, and by which I had been impressed, I began by descending into myself: I attempted some melodies almost as an infant who was practicing singing, and I examined what occurred in my mind and in my voice. It always seemed that there was nothing at all which forced me, after I intoned a sound, to succeed it by intoning one rather than another of the multitude of sounds available to me. There were, in truth, certain sounds for which my voice and ear seemed to have a predilection; that was my first impression. But this predilection seemed merely a matter of habit. (8)

I imagined that in a system of music other than my own, (9) one with a different habit of singing, the predilection of the voice and judgment would have been for another sound; and I concluded that since I did not find in myself a single good reason for justifying this predilection and regarding it as natural, I could neither take it as the basis of my research nor even suppose it in someone else who would not have the same habit of singing or hearing a melody. I began, however, to calculate and to examine what the proportions were between the sounds I had intoned and those which the ear and voice had immediately suggested to me. I found (10) that this proportion was rather simple. It was, in truth, neither

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Methode (1637). Concerning Rameau's use of the Cartesian method, Girdlestone, p. 523, quotes Charles Lalo, Esquisse d'une Esthétique Musicale Scientifique (Paris, 1908), p. 86, note 2, as follows: "It is all there; the methodical and even hyperbolic doubt; the revelation of a *cogito* which is here an *audio*. Only this allegedly Cartesian method leads Rameau, contrary to Descartes, to *experience* and to a principle of certitude whose value lies entirely in that it exists *outside him*."

the unison, as 1 to 1, nor the octave, as 1 to 2. It was one of the proportions which followed almost directly in the order of simplicity; I mean, the proportion between a sound and its fifth, as 2 to 3, or its third, as 4 to 5. But had this simplicity of proportion been even larger, it would have produced at most only a species of the harmonies of sounds such as those to which I succeeded directly by predilection; this simplicity had neither explained this predilection nor provided the fixed point I was searching for. I saw
then that I could not encounter the principle within myself, and I (11)
abandoned those harmonies despite the authority and force they possessed in matters of taste, fearing that they would entrench me in some system which would be my own, perhaps, but not nature's.

I then placed myself, as far as was possible, in the position of a man who had neither sung nor heard a melody. Indeed, I assured myself recourse to different experiences every time I suspected being, against my will, in the habit of a state contrary to the one assumed.

That done, I began to look about myself, and to search in (12)
nature for that which I could not draw from my own background as clearly or as certainly as I desired. My search was not long. The first sound that struck my ear was like a flash of light. I realized in a moment that the sound was not indivisible [<u>un</u>], but gave the impression of being composite. There, I said to myself on the spot, is the difference between noise and sound.* Each event that pro-

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*I had already reported this difference in my <u>Harmonic</u>

duced on my ear a composite impression caused me to hear sound. I labelled the original sound or generator fundamental sound, and (13) its concomitants, harmonic sounds. I had (independent of and very noticeably different to my ear) three very different things in nature: noise, fundamental sounds, and harmonic sounds.

Before investigating the relationship of the harmonic sounds or concomitants to the fundamental sound (or the position they would occupy in our diatonic scale), I realized that these harmonic sounds were very high and fleeting, and that, consequently, it would by necessary to have an ear that would grasp them more distinctly than an ear that perceived but two harmonics or one which (14) was affected by only a single harmonic, or perhaps even one that received no impression at all. I said directly, that that is one of the sources of the difference in sensibility to music one notices amongst people. There are people for whom music will only be noise. There are those who will be affected only by the fundamental sound, for whom all the harmonics are lost. There are, I added, noises that are more or less high; there are scales of noises as well as scales of sounds, intervals of noises like intervals of sounds. Those, if any that unfortunate exist, who would take the scale of (15) sounds for the scale of noises would be totally alien to the pleasure of music.

I passed from that to the consideration of the fundamental

Generation, pp. 29-30, printed in 1737.

sound and its harmonics. I found that the harmonics were the twelfth and the seventeenth, that is to say, the octave of the fifth and the double-octave of the third (instead of being what I had previously demonstrated to myself: I had succeeded the fundamental with its fifth and third, in preference to all other sounds).[1]

I considered the reason for this difference and soon saw
that the untrained ear would not be able to discern sounds as distant (16)
as its concomitants the first time the fundamental was heard. More-
over, I knew by experience that the octave is only a replicate,
that there is an identity between sounds and their replicates, and
that it is easy to take one for the other (since these sounds, when
they are heard together, are ever confusing the ear). I then con-
cluded (with my ear and imagination deprived of practice and ex-
perience, and disposed to nothing else) that I was forced to lower
the sounds to their smallest degrees. That is to say, my attention
had to be fixed on the third and the fifth of the fundamental sound,
and not on their replicates. This fact is common to us all: either (17)
because of the indolence or weakness of the ear, or because of the
small range of the voice, we are all inclined to reduce the in-
tervals to their smallest degrees. For example, if we desire to
intone ut and re, it is always by the interval of a whole step or
of a second, as 8 to 9, even though 8 is the triple octave of the
fundamental sound, 1, which first produced ut and from which ori-

[1] The distinction between the third and seventeenth, and fifth and twelfth is being carefully maintained here.

ginates the feeling for re. Thus we naturally confuse all replicates in order to aid ourselves according to our own needs.

Moreover, the octave serves as a limit to intervals and consequently to harmony, since all that exceeds the octave's range (18)
is only a replicate of that which the octave contains between its two terms.

The octave multiplies intervals, because when one believes he is hearing only a third, like ut to mi, he also hears a sixth between the same mi and the octave above this ut.

In thus multiplying intervals, the octave indicates the possible inversion of intervals. For if one omits the lower ut of the preceding third, the sixth mi-ut will remain. A possible inversion in harmony(which provides to the composer the means of varying a bass at his pleasure and of rendering it more melodious (19)
than that which I call fundamental bass) likewise originates from this use of the octave.

With all that established, I proceed to substance. As I have the honor of speaking to mathematicians and so that they will have nothing to question, I am going to borrow their language as much as my limited learning will allow.*

The sonorous body, which I call (with an appropriate label)

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*The sign # signifies a sharp, which raises the sound a minor half-step, and the sign b signifies a flat, which lowers the sound as much; the # joined to the name of an interval, or to the number that represents it, takes the place of the word <u>major</u>, and the b takes the place of the word <u>minor</u>.

fundamental sound, this unique source, generator and regulator of the whole of music, this direct cause of all of music's effects, the sonorous body, I say, does not resound but rather it engenders (20)
all the continued proportions [proportions continues][1] simultaneously (proportions from which originate harmony, melody, the genera, and even the most specific rules necessary to practice).

The sonorous body's resonance causes three different sounds to be heard, whose proportions are

Fifth above the octave, called double fifth, or twelfth.		Sixth # [i.e., major sixth]
1	1/3	1/5
ut	sol	mi
	Third # above the double octave called triple third, or seventeenth #.	

These proportions, reduced to their smallest degrees by means of the octaves (which are not included for reasons already described), result in (21)

	Fifth	
1/4	1/5	1/6
ut	mi	sol
Third #		Third b [i.e., minor third]

If one tunes other sonorous bodies so that they are in the same ratios to the fundamental sound as the sounds it causes

[1]These are not continued proportions in the modern sense.

to be heard (so that they are tuned not only with its third and fifth but also with its triple and quintuple), then the fundamental sound will cause them all to vibrate, with the difference that those tuned to the third and fifth will vibrate in their totality while those tuned to the triple and quintuple will vibrate in segments that are in unison with the fundamental. Thus, the fundamental sound has the same power on the multiples as on the submultiples.[1] These experiments are equally perceptible to the ear, to the eye, and to the touch. (22)

The following ratios originate from the forementioned power of the source on its multiples:

Seventeenth #

5 la b   3 fa   1 ut .

Sixth #   Twelfth

These ratios, reduced to their smallest degrees and applied to the lengths of the strings, result in

Fifth

6 fa   5 la b   4 ut .

Third #   Third b

The harmonic proportion is recognized in 1:1/3:1/5, or

Fifth

1/4   1/5   1/6 .

Third #   Third b

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[1]The power, as Rameau has indicated in the previous sentence, is not the same.

And the arithmetic proportion is recognized in 5:3:1, or

Fifth

6 5 4 . (23)

Third b Third #

Although the fifth and the third would be, originally, a double fifth and a triple third, I shall always give them the names <u>fifth</u> and <u>third</u>, for the reason that we naturally reduce all intervals to their smallest degrees, as has already been said.

The difference between these two proportions consists in a transposition of the order of the two thirds, whose succession forms a fifth in each case. From that, it is evident that only the fifth constitutes harmony and that the thirds vary it. (24)

This variety of thirds is distinguished by two genera: the one, major (when the major third is the lowest, that is to say, the first, as in the harmonic proportion reduced to its smallest degrees), the other, minor (when the minor third is lowest, as in the arithmetic proportion similarly reduced). Thus, the ear, nearly equally predisposed in favor of these thirds, seizes one or the other after a given first sound (though it does feel more of a penchant for the major as the single, truly natural third).

A geometric proportion, whose necessity will soon be discovered, is naturally formed from these two proportions, either in this order, 3: 1: 1/3 (fa ut sol), or in this, 5: 1: 1/5 (la b ut mi). (25)

The difficulty of reducing the multiples and sub-multiples under the same denomination has forced me, above all, to employ

whole numbers, which apply to the vibrations of strings. These whole numbers, nevertheless, will always represent fractions. The denominators of these fractions will be the above whole numbers, and the numerators will be the number 1.[1] Thus, I say $\underset{fa}{1}:\underset{ut}{3}:\underset{sol}{9}$ in place of $\underset{fa}{3}:\underset{ut}{1}:\underset{sol}{1/3}$, and $\underset{la}{1}:\flat\underset{ut}{5}:\underset{mi}{25}$ in place of $\underset{la}{5}:\flat\underset{ut}{1}:\underset{mi}{1/5}$, where the source, which in each case is the middle term, equally arranges the proportion. This is useful to take note of, because in this case, with the source no longer designated as the number 1, it makes no difference which number it is, provided that all the numbers agree with the order of the indicated proportions. For example, in $\underset{si}{9}:\flat\underset{fa}{3}:\overset{\text{generator}}{\underset{ut}{1}:}\quad\underset{sol}{1/3}:\underset{re}{1/9}$, one finds the same order and the same ratios as in $\underset{si}{1}:\flat\underset{fa}{3}:\overset{\text{generator}}{\underset{ut}{9}:}\quad\underset{sol}{27}:\underset{re}{81}$. In the latter series (27)
9 is taken as the generator and the fraction is assumed—1/9 is the ninth of 1. In the first series, where 1 is taken as the generator, 1 is the ninth of 9. If, on the contrary, one does not assume any fraction in the second series, one can then apply the series to the vibrations. It will be seen that 9 gives nine vibrations, while 1 gives only one. Thus, in whatever manner considered, it all amounts to the same thing.

From these two last proportions (the triple and quintuple) progressions are formed, from which all the possible intervals in

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[1] For a clearer explanation of the conversions described here see below, pp. 74-75 (Extract, pp. x-xi).

music are obtained, by adding the double, which is that of the octaves, and which serves to bring together one term with another (28) according to need. See A in the tables.

Each term of these progressions is always observed to have its harmonic proportion; its fifth is found immediately below and its major third is at the side in the adjacent column.[1] Thus one sees the origin and the genus (in a word, all the properties) of each interval.

The harmonic proportion yields the most perfect harmony that one might hear. Its effect is admirable when one knows how to arrange it in the order indicated by nature. But the difficulty is in knowing how to distribute the voices and the instruments— (29) this is a technique that the composer cannot always master, since he does not control the choice of the subjects needed. However, after having used the perfect harmony without success, I had the good fortune of coming upon nearly all that was necessary in the chorus of _l'Acte de Pigmalion_ (which I presented in the autumn of 1748) where Pigmalion sings the _Amour triomphe_ with the chorus, and in the closing of the overture of the same act where only a few more instruments are needed for certain sections.

Although in practice the name _perfect_ is given to the chord that results from the harmonic proportion as well as to that which (30) results from the arithmetic proportion, the latter is indeed de-

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[1]This is referring to table A.

ficient. (However, it is as affective as the former.) And if the latter has its own particular ornaments, they occur in situations that display the subordination of its genus [i.e., minor], as will be seen when the modes are considered.

THE PRODUCT OF THE FIFTH OR OF THE TRIPLE PROPORTION

Now that harmony is known, there is only the matter of giving it a succession, a succession that can be imagined only among the sounds that constitute this harmony, since no other sounds are known. Moreover, each of the sounds of this succession, con- (31)
sidered as a particular sonorous body, will be, just as the first sonorous body, the source of its harmony.

Since the sonorous body causes only its fifth and third to resonate, it can be succeeded only by one of these two consonances. (I would first choose the fifth, which alone gives the most perfect order, as will be seen.) And as the source causes two fifths to vibrate simultaneously (one above, the other below, which I name elsewhere the dominant and the sub-dominant), these fifths, then, together with the source, form the triple proportion:[1] (32)
1: 3: 9, or 3: 9: 27, or even 9: 27: 81—all of which are the same, representing

Fifth below or sub-dominant		Fifth above, or dominant
3	9	27
fa	ut	sol
	Generator, or principal sound, or even, tonic note	

[1]This is one of the "geometric proportions" referred to on p. 32 (R, p. 25).

Next, please see table A, which has to do with the same subject in the triple progression. One will notice there that the fourth term is no longer tuned perfectly with the first, because they form together a minor third diminished by a comma: from which it is demonstrated that beyond these first three terms, 1: 3: 9, there is nothing else which is absolutely perfect.*

The following (which I am going to explain originate from this triple proportion: the natural mode called major, its adjuncts or relative modes, the diatonic genre (that is, the smallest natural degrees of the voice), nearly all of melody, the pauses or cadences, the liason, the double emploi, and several other natural and necessary occurrences. (33)

Mode, in music, is nothing but the order of sounds (together as well as in particular, that is to say, in harmony as well as in melody) prescribed by the triple proportion, as seen in table B. (34)

The order is extended further in table C than in table B, but by proceeding to 81 in table C one exceeds, in that case, the limits of the given proportion and consequently the limits of the mode. Thus in table C, one encroaches upon another mode, and this

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*In order to determine the ratio between the first and the fourth terms of the triple progression, merely double 1 as far as 32, then, by comparing 27 to 32, and by tripling them (which gives 81: 96), one will see that they differ by 1/81 from the ratio of 5 to 6, which gives the minor third in the harmonic and arithmetic proportions. For, in multiplying 5 and 6 by 16, one will have 80:96, so that the difference between the two ratios (81:96 and 80:96) consists of 80:81, which gives the ratio approximating the tenth part of a whole-step, called a comma.

is what I wanted to have understood by the word <u>adjunct</u>, of which the following shall instruct in greater depth.

The diatonic genus consists of the direct succession of whole-steps and half-steps, distributed throughout all of the scales. With respect to the smallest degrees, it is the only na- (35)
tural genus.

The possible succession among the harmonic and fundamental sounds, joined to the diatonic, produces nearly all of melody, since it lacks only the product of the quintuple proportion, which consists of a single half-step, called <u>chromatic</u>, and which is much less natural than that of the scales, as the following shall inform us.

All the fundamental progressions of the fifth form pauses or cadences as well. The first of the two sounds of this fifth announces the pause, the second terminates it. But the effect of the pause is not very perceptible except when it terminates on the generator of the mode. The diatonic order, which is a product (36)
of the progression of fifths, consequently follows the same law, so that there can always be a pause from one sound to another.

The most perfect pause, after which nothing is desired, is that in which the fifth descends to the generator, as from 27 to 9 (that is, from sol to ut in tables B and C). It is called the <u>absolute pause</u> or <u>perfect cadence</u>. In this case, it is the fifth engendered by the resonance of the sonorous body, source and generator of the mode, which returns to this same generator. Where-

as, in ascending from the fifth below, the product that passes to the generator could not strike the ear at its source (since it vibrates simply, it is 3 that passes to 9, it is fa that passes to (37)
ut). Thus, the ear, which is guided only by the resonance of the sonorous body, would never take this progression for that of a generator passing to its product (as from 9 to 27, from ut to sol) unless it was already preoccupied with this generator. Therefore, in practice, the pause which is thus formed is named *imperfect cadence*.

There is more yet concerning the absolute pause. The major half-step (produced by the complete fundamental progression of the fifth) has such a control over the ear, that if one hears only the first of the two sounds that form the interval by ascending (as the major third of that fifth which is 27 with respect to the ge- (38)
nerator, 9—that is, as the third, named si, of the dominant sol), then, either one intones the second sound himself or at least desires it. This second sound is, as a matter of fact, the generator or its octave, ut. Thus the first sound of the ascending major half-step, in such cases, is given the appellation *leading tone* [*note sensible*].

That one can ascend diatonically to the generator of a mode only through its leading tone is a law dictated by nature itself. This is a product of the first step taken by the generator in passing to its fifth. If one ascended to the generator by a whole-step, then the effect of the pause would no longer occur. (39)

The note ascended to would then no longer be the generator of the mode, and the mode would change.

It follows from the above that three consecutive whole-steps cannot be intoned naturally, not only because the ratio between the first and the last of these three whole-steps is not consonant (a ratio which should always naturally form the fourth), but also because, with the mode changing at least at the third whole-step, the impression received of the mode that existed until that point suggests to the ear that only a half-step should follow the first two whole-steps. In a word, these three consecutive
whole-steps cannot be products of the fundamental sounds of the (40)
mode producing the diatonic order. This proves sufficiently that their immediate succession is not natural. The matter will be considered again in a moment.

Here is the first case in which the great power of the fundamental bass begins to be discovered—at the occurrence of the effects which it uniquely causes, and where its product (to which it communicates this power) has force only so far as the fundamental bass can be implied with it.

For example, if one terminates a diatonic melody in this manner—re, re, ut, ut (making a <u>tremblement</u> called <u>cadence</u>)—
then, on the second re, one will feel the effect of an absolute (41)
pause whether or not it is accompanied by its fundamental bass, sol-ut, since it is always understood without further thought. But if one gives the melody another bass, such as sol-la (called

deceptive cadence [<u>cadence</u> <u>rompue</u>]), the effect of the pause vanishes and one desires a continuation of the melody, although it remains unchanged.

If a little musical experience is necessary in order to evaluate this fact, judgment alone will be sufficient to convince one of other facts that will soon be presented.

The <u>liason</u> consists of there being at least one tone common to the successive harmonies of two fundamental sounds. For example, (42)
sol, which exists in its own harmony also exists in the harmony of ut, with which it forms a fifth.

If one extends the given proportion by one progression, as, for example, 1:.3: 9: 27: 81, then one shall find in these five terms the elements from which can be formed three modes similar to that which I have just presented, thus:

1:	b3:	9		3:	9:	27		9:	27:	81
si	fa	ut		fa	ut	sol		ut	sol	re

. All of the difference between these modes consists in the fact that the extreme modes are at the fifth below or above the middle. Thus, the two fundamental sounds common to each of the extremes and the middle link the modes in such a way (43)
that they can intermingle without distracting much from the predilection that one could have for one or the other mode. In effect, after 3 and 9 have been employed, 1 as well as 27 can complete the proportion. Similarly, after 9 and 27 have been employed, 81 as well as 3 can complete the proportion. Doubtlessly, the generator 9 in the tables passes sometimes to 27 and sometimes to 3 (which are the extremes of its own proportion, that is, its two fifths)

in order to preserve this predilection. Although the deficiency of the ratio between 3 and 27 offends the ear and gives it an even greater partiality for the generator, the generator accords perfectly with both 3 and 27. This will be verified. (44)

3 and 27 cannot be resonated together without having 81 implied, since it resonates naturally with 27. Thus, 3 to 81 is as 1 to 27, which are the first and fourth terms of the triple progression and which together form the minor third diminished by a comma (the comma has already been discussed).[1] This clearly proves the deficiency of the ratio between 3 and 27, since 81 resonates with 27.

The liason, of which I have just spoken, is indeed the source (45)
of the correlation of the modes [rapport des modes]. These are the same modes given by the extremes I call adjuncts, because 3 and 27, which are the extremes of the first generator 9 and exist only because of it, can in turn become generators in order to be susceptible to all of the varieties that the first generator is capable of. There should be no doubt that after 9 has passed to 27, 27 can pass to 81, which resonates with it. Similarly, when 9 has passed to 3, 3 can pass to 1, since 3, by means of its resonance, causes 1 to vibrate. We notice, nevertheless, that the ear always favors the sub-multiples whose resonance, caused by that of the so- (46)
norous body, overwhelms the simple vibrations of the multiples.

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[1] The explanation of the comma was given above on p. 36 (R, p. 32).

As we see in table C, the generator 9 borrows 81 from its submultiple 27, in order to obtain a diatonic order in its complete octave.

With respect to the deficiency of the ratio between the extremes of the triple proportion, I decided, in order to give it a very distinct formulation, to divide the diatonic scale as did the Greeks into two conjunct tetrachords at B, which are the only natural ones, and into two disjunct tetrachords at C, where one always finds, in both tetrachords, an alteration between the thirds formed by the product of each extreme. (47)

Moreover, this alteration has nothing that should surprise us: 1, because it takes place in the product of a succession that is not direct, as one can see by the altered thirds in tables B and C; 2, because the ear, occupied solely with the fundamental succession and the perfection of its harmony, is forced to submit to the fundamental succession in all its products.

One should expect a similar alteration in the complete sequence of modes that are a fifth apart, as would be those that give these two proportions: 1: 3: 9, 3: 9: 27, where the alteration (48) is well marked. This proves a change of mode, even from one tetrachord to another, and from one extreme to another, because 27 resonates with 9 in the proportion 1: 3: 9, as 81 resonates with 27 in the proportion 3: 9: 27.

This alteration of a comma in the product of the extremes is a very definite directive to us not to have them succeed each

other directly. This is all the more so, for since they do not have any common terms in their harmony, they are in no way linked by this harmony. It is from the above that, without knowing it
and only through the aid of experience, two successive perfect (49)
chords (even two successive major thirds) in a diatonic bass have been forbidden, as for example in the succession of the two extremes fa and sol, drawn from the proportion $\underset{\text{fa}}{3} : \underset{\text{ut}}{9} : \underset{\text{sol}}{27}$.

We should not be surprised, therefore, if the source (in its first order of generation and as the only thing that is truly perfect) refuses the diatonic succession of la to si, because they are harmonics of these extremes, $\underset{\text{fa}}{3}$ and $\underset{\text{sol}}{27}$, as is seen in table B. Besides, the succession of la to si would have introduced, in the diatonic order from fa to si, three successive whole-steps which are not intoned naturally (see H in table C), and which have
been the subject of several questions that have never been resolved. (50)
But it should now be seen, outside of the reasons already given, that the mode changes in such cases. Not that one could not maintain there the feeling of the first mode in the complete range of the octave of its generator, since the diatonic sounds contained within the octave are found to be the harmonics of the fundamentals; however, it is necessary at least to imply there a pause by means of which, while forgetting what proceeded, we can easily surrender ourselves to what follows as a completely new entity. This is what the Greeks felt (even though they did not know it) by indicating
this pause, or at least the place where one should use it with a (51)

parenthesis between the two sounds that form the first whole-step in the disjunct tetrachords composing the diatonic order of the octave. See H in table C, where the first order of nature (established in table B) suffers a well marked alteration at I by means of a major third which is too large by a comma. This alteration suggests a new origin of la with respect to fa, since in this case it is no longer a harmonic of fa. It can no longer really be a harmonic of fa, because when one wants la to ascend to si the two extremes, fa and sol, would succeed each other directly. Also, it is no longer the same la in that it exceeds the other by a comma. (52)
But we will see in a moment that this difference is, at bottom, of no consequence at all; it even introduces one of the most beautiful variations to which harmony is susceptible. I mean by that the double emploi, which was unknown until my Harmonic Generation, where I gave a rather exact accounting of it,[1] especially with respect to the mode carried through the octave in a diatonic order. That is why, in the following, I shall say only what will be necessary to give the reader some insights into the double emploi.

Returning to the three successive whole-steps, one sees in (53)
table C that after the pause assumed from 3 to 9, a new tetrachord begins on the first tone that follows after fa-sol. It is similar in its ratios to the first tetrachord, and the two whole-steps contained are intoned with the same facility as whole-steps that

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[1]Chapter IX (pp. 107-119) of the Harmonic Generation is entitled "Origin of dissonance and of its double emploi."

have not been preceded by others. For the ear, it is a new harmonic phrase whose relationship to what preceded is no longer of concern. In effect, the mode changes in this new phrase. It is enough to see this change in the forced passage of 27 to 81, in order to be able to draw from the harmony of 81 a la that can ascend diatonically to si.

81, which resonates with 27, can naturally succeed it. (54)
If the absolute pause formed by the return of 81 to 27 does not have its full effect, it is because 3 (which previously had followed and preceded 9) destroyed the agreement between them, since 3 and 81 (81 being a product of 27) are not in accord. Thus each extreme, in counterbalancing naturally the effect of the other, supports our predilection for the generator, as should have been realized from what I have already said.

There are other means (such as the direct minor third and dissonance) of predisposing the ear in favor of the generator. This will be verified in the following.

We find here the solution of a question all the more curious (55)
as it upsets all musical systems that have appeared previously: namely, why do diatonic intervals designated by the same names have different ratios in tables B, C, and F, and why are consonances on the one hand just, on the other altered?

In order to resolve the question, it suffices to consider what must be our guide—is it the fundamental bass, which comprises harmony, or the diatonic intervals, which are merely the product

of the fundamental bass?

The tones are products that lead, in truth, to consonances, but to which consonances? Doubtlessly to those required by the (56) fundamental bass. In some instances these products, although under the same names, belong to certain fundamentals; in other instances they belong to other fundamentals (as seen at I in tables B and C, and at G in tables B and D). Sometimes the same mode subsists in the same tetrachord (as at I of table B); sometimes it changes in passing from one tetrachord to another (as at I in table C). But everywhere, the consonances attached to the fundamental bass are just; and in the case of different ratios between the degrees that result, it is of little concern to the ear, since the ear is insensible to them. That this alteration exists would not even (57) be known if one executes (either with the voice or on an instrument) a major whole-step in place of a minor. The altered consonance that can result is of no concern to the ear. Always directed by the fundamental bass, it is on the basis of the ratio of the consonances belonging to this fundamental bass that the ear determines the ratio of the degrees that result. Moreover, this alteration of consonances will seem forced (and contrary to the order of nature) whenever there are fifths drawn from a progression other than the triple as well as thirds drawn from this same progression. (58)

If our authors in theory dared to fathom this question, those who would judge the ratios of consonances only by means of a comparison between the products would soon see all of their

edifices collapse, since it is impossible to establish any diatonic system in the range of an octave without encountering altered consonances. But they closed their eyes to that. If some cited the ratios of these altered consonances, it was without dwelling upon them or without drawing from them the slightest consequence.

Now, on the basis of this account, we must judge of the possibility of the double emploi (cited but a moment ago), since it is of little importance to the ear whether la (which is the point in (59) question) belongs to fa (3) as a third, or to re (81) as a fifth. It is also unimportant to the ear whether la is the same in one case or the other, because it forms, in each case, a just consonance with its fundamental bass.

How many principles emanated from only one! Gentlemen, is it necessary to recall them for you? Merely from the resonance of the sonorous body, you have just seen the origin of the following: harmony; the fundamental bass; mode (and its correlations [rapports] in its adjuncts); the order or the diatonic genus from which the smallest degrees natural to the voice are formed; the major and minor genera; nearly all of melody; the double emploi (fecund (60) source of one of the most beautiful variations in harmony); the pauses or cadences; the liason (which alone can guide an infinity of relationships and successions); even the necessity of a temperament (which is not yet under consideration because all that must lead to it is not yet established, but of which one should already have some suspicions on the basis of the occurrence—of no conse-

quence itself, all things considered—of the altered consonances). And we have not yet spoken of the minor mode, or of dissonance (which always emanates from the same source), or of the product of the quintuple proportion (which will be the subject of the following sections). (61)

On the other hand, the proportions originate with harmony, the progressions with melody, so that these primary mathematical principles find their physical source in nature.

Thus, this constant order (which we recognized as such only in consequence of an infinity of operations and combinations) precedes here all combination and human operation, and is presented at the sonorous body's first resonance, just as nature requires. Thus, what was but an indication becomes a principle, and the ear, without the assistance of the mind, verifies here what the mind discovered without the intervention of the ear. As a phenomenon (62)
in which nature justifies and fully establishes abstract principles, this must be, in my opinion, a discovery agreeable to scholars who are guided by metaphysical illuminations.

The mode as a whole partakes of the genus of the third with respect to the generator. That is why the one mode is called <u>major</u> and the other, of which I am going to speak, will be called <u>minor</u>.

ON THE MINOR MODE

The source ut, in the pure and simple operation of nature, produces the major mode directly. Simultaneously, it indicates to (63)

the art of music the means of forming a minor mode.

This difference between nature's own product and that which it is content to suggest is very distinctive in that the resonance of the major genus is in the sonorous body ut, whereas other bodies capable of producing the minor mode vibrate simply by the effect of the sonorous body's power upon them (as seen in the manner in which the arithmetic proportion is formed).

But with this indication once given, nature recovers its rights. We cannot do other than what nature desires—to have art adopt (in the new product that nature allows art to construct) all (64)
that which nature has already created. It desires that the generator, as founder of all harmony and succession, should similarly provide the law in this new structure. Also, the new structure should accept all that the generator has produced, and the generator's products should be usable in the same manner in which it had first regulated them.

Moreover, in order to form a perfect chord when the minor genus occurs, it is necessary to suppose that the multiples resonate and that they resonate in their totality. According to the experiment that I reported, they in fact vibrate simply, and are divided, while vibrating, into segments that constitute the unison of the (65)
sonorous body that set them in motion. So that if, in this state of division, one supposed that the multiples happened to resonate, one would hear only this unison.

We can therefore assume the resonance of the multiples in

their totality in order to form a complete harmoniousness, only by deviating from the primary laws of nature. Though, on the one hand, nature indicates the possibility of this complete harmoniousness by the proportion naturally formed between the sonorous body and its multiples considered in their totality; on the other hand, nature proves that this is not its primary intention, since it forces these multiples to be divided in such a manner that their
resonance, in the actual disposition, can only render unisons, as (66)
I have just said. But does it not suffice to find in this proportion the indication of the perfect chord that can be formed? Nature offers nothing uselessly, and we most often see it content in giving art simple indications, putting it on the proper course. Let us not go on to imagine that these multiples can present the law in their totality. Let us be content with the indications that can be drawn from nature. Far from wanting to overstep the limits, let us, on the contrary, approach the principle that guides us.
And let us see what nature means by this forced division of the mul- (67)
tiples.

What does nature require? It demands that the source, once established, should present the law everywhere, that all should rely on this source, all should submit to it, all should be subordinated to it: harmony, melody, order, mode, genus, effect, in short, everything. Because, by these unisons of the multiples, one can conclude nothing but the fact that the source, by forcing the multiples to reunite with itself, still maintains the right, as it

were, of regulating, in what it has already produced, the variety provided by the new genus indicated by the multiples.

The mode is given. Everyone in theory (until Zarlino and his followers) had known only one mode, because the varieties that they indicate in the mode are only a matter of appearance and not at all of effect. With them, the difference of the thirds never occurs in the mode, unless by chance, since modulation directed them in their first designated mode. One sees here fifths and fourths (which are in all respects the same) as models. There is, in modulating to the fifth, fourth and octave, only a variation in the extent of the same modulation, but no fundamental variation. (68)

The mode is given. Then it is no longer in our power to change anything in it. We see it rather by the already exhausted (69) product of the fundamental succession of fifths. If it is, however, possible to vary it by the new genus in question, doubtlessly it will be without changing anything further in what is established. Otherwise all our research would be in vain.

This variety will become the cause of the different effects among the modes that will be susceptible to it. It exists in the third with respect to the generator. This generator has already determined the genus of its mode through the major third that it resonated. Similarly, it will determine the genus of a new mode by becoming, itself, a direct minor third without ceasing to be (70) the source. I say 'without ceasing to be the source' because, in this case, the product, or that which is perceived as such, is

the unique cause of the effect. The proof of this is certain.

The single direct major third resonates with the fundamental sound. The fundamental sound is consequently the cause of its effect. Consequently again, it cannot be the cause of a direct minor third which we have assumed for it. But there will necessarily be some such minor third from which the difference of the effect between itself and the major third originates.

Thus the ear indicates clearly the operation of the source
generator ut in this circumstance. The generator itself selects (71)
a fundamental sound which becomes subordinated (as is proper) and to which the generator distributes all that the new fundamental sound needs in order to appear as a generator.

By becoming the minor third of this new fundamental sound (which is correctly and necessarily determined to be the sound la), the source ut even gives its own third as a fifth to the new fundamental. The fifth, as we now know, constitutes harmony and determines the proportion around which the complete fundamental succession of the mode must turn. Thus, this new generator, which can now
be regarded as the generator of its mode, is a generator only through (72)
subordination. It is forced to follow, in every detail, the law of the first generator, which cedes to it only its position in this second creation in order to occupy there the most important position.

From that there follows a large community of sounds among the harmonies of the fundamentals of these two modes. For, as soon as the generator of the major and its third form the third and the

fifth of the generator of the minor, it must be the same among the adjuncts, as is easy to verify. From this community of sounds, there follows a similar diatonic order in the range of the octave
from one to the other mode, at least in descending, except that each (73)
generator begins and ends its order. And if the order varies in this ascending tetrachord of table E, it is in order to conform, in every particular, to the laws of the source in all of the absolute pauses, the indispensable necessity of which must have been recognized by what I have said about them and especially about that which regards the leading tone. With this second tetrachord being in the same ratios as those of table C, there follows a law for the fifth above every generator: namely, that the fifth's third must always be major when it passes to its generator, while in all other cases, the fifth receives the third that conforms to
the genus of the mode to which it belongs. (74)

Moreover, it can be noted that the greater part of the diatonic progression of pitches in both modes belongs equally to the fundamental sounds of each mode. See tables B and D, from si to fa, for further proof that the cause of the different effects necessarily encountered in these two modes arises directly from their fundamental bass. One could go further and see that a segment of these same diatonic progressions of pitches belongs also to other modes taken as the adjuncts of the former.

Furthermore, these two modes, in their first and only na- (75)
tural form (that is, as in B and D), are equally perfect once the

direct minor third is admitted, and when the necessity of providing a major third to the fifth above the generator in the case prescribed is recognized. But when it is a matter of the diatonic octave, the minor will be more susceptible to much greater variety than the major. I say variety and not imperfection because all depends, more or less, on the number of different modes that can concur there.

For example, if we descend in the minor mode through la, sol, fa, etc., after la, we first enter into the major mode from (76) which this minor derived, because all of the diatonic difference between these two modes consists in the natural or sharp sol. (In practice we would have the art of preserving the impression of the minor mode with a natural sol through the aid of a dissonance that cannot be avoided[1] and by means of a pause which occurs directly afterward.) In another case, if one descends by la, sol, fa-sharp, this fa-sharp after sol yields a new mode. And in another case yet, if one descends by sol-sharp and fa-sharp, the major mode is indicated, since this tetrachord is similar to the second tetrachord of table C, except that here fa-sharp would be for the style of the (77) melody [*le goût du chant*]. There is, then, only a single way of preserving the impression of the minor mode while descending:[2]

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[1]See Shirlaw, pp. 226, 228 for an explanation of this dissonance.

[2]This assertion is, of course, qualified by Rameau's comment concerning "the art of preserving the impression of the minor mode with a natural sol" above (R, p. 76).

namely, by excluding sol [natural] from the harmony and using it simply for the style of the melody [le goût du chant] however that may be. And, in that case, all is submitted to the obligatory succession of the three fundamental sounds of the mode. In order to determine that, it suffices to take table D in retrograde, where, to begin this scale, one should add la above fa, with another la in the fundamental bass. The rest will progress in the order found there.

Besides, the succession of fa to sol-sharp is not at all (78)
diatonic, although it would be, with respect to the smallest degrees, the only natural succession for the voice. Thus, in order to procure the succession for the voice in this case, and to contribute simultaneously to the beauty of the melody, it would be necessary either to add the sharp to fa (as in table E) or to remove it from sol; but this would be only a simple matter of melody [une affaire de simple melodie]. The harmony does not suffer at all, and the variety of the modes that can arise from this is a sure way of pleasing when one knows how to profit by it. Doubtlessly, from the above there comes to us a feeling for the chromatic before becoming familiar with it, and a feeling for the dissonance between sol-sharp and fa, which one would never have sus-
pected possible if he continued to maintain the rules of our first (79)
masters.

Let us return to the origin of the minor mode directly engendered by the major, and let us conclude from that not only the

close correlation [l'étroite liason] that must exist between them, but also the addition that the former must make to the range of the latter's most intimate adjuncts. Thus, with both the minor and the major having two adjuncts, that makes six modes in place of one—three major and three minor.[1]

Although the minor mode, in its origin, is subordinated to the major, in practice this subordination is felt to be reciprocal. Thus, with each mode being treated as the first in its (80) genus, all the others mutually lend it assistance, while preserving their right of preference established on their greater or lesser degree of correlation [rapport], their greater or lesser degree of liason. From this follows a law for the length of the phrases of each mode: the less correlation they have to the first given mode, the more their phrases must be short.

I did not believe it necessary to pass in silence over the minor mode (as all other writers in music theory have done), not only because of the great variety that it introduces to this art, but also because it serves to mollify the harshness of certain genera that will soon be considered. The minor mode also helps a single mode perpetuate its diatonic order for a greater time, (81) since at present one can give the minor third to the fundamental sound re (which is found in table C at 81) in order to maintain

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[1]The "modes" referred to are those of the generator ut, its dominant sol and sub-dominant fa, and the minor mode derived from ut, that is, la, and its dominant mi and sub-dominant re.

the impression of the mode of ut, but under the condition of a dissonance that will be the subject of the following section. Moreover, it was very important to recognize everywhere the principle as the immediate cause of the effects, as one must conclude on the basis of what has appeared up to now.

Here the fundamental succession of minor thirds takes its source.

In order to evaluate the effect of these two modes, it suf- (82)
fices to be familiar with their origin.

The major mode, this first issue of nature, has a force, a brilliancy, if I may dare to say, a virility that prevails over the minor, and that causes it to be recognized as the master of harmony.

The minor, on the contrary, existing less as a result of pure and simple nature, receives from art (by which it is partly formed) a frailty that characterizes its emanation and its subordination. Thus, good taste is naturally directed in the use of these two modes toward the characters of expression that correspond to them.

The generation of these two modes (where the major con- (83)
stitutes the genus of the minor), their analogy (which I can regard as an affiliation in their adjuncts), and the mutual aid they lend each other seem to present certain ideas of comparison from which one might, perhaps, draw several inductions in order to explain other natural phenomena.

However that may be, the single triple proportion regulated up to now all of the successions, and the single harmonic proportion formed all of the products, because the arithmetic proportion here adds nothing new except its genus. These three proportions originate directly from the resonance of the sonorous body, source and generator—ut. (84)

That is not all. We have yet to see the origin of all dissonance from this same triple proportion.

ON THE SEVENTH WHICH CONTAINS, IN ITSELF ALONE, ALL DISSONANCE

Would the source (ut, 9) make its two fifths (fa and sol, 3 and 27) vibrate only to associate them in its progression and to form new generators from them? Would it not be more to engage them in reuniting in a single harmony which would force them, in that case, to return to the source? Everything combines for the adoption of this idea. On the one hand, there is the natural reduction of intervals to their smallest degrees, where the third is the (85)
smallest harmonic degree. On the other hand, there is the gap which is found between the fifth and the octave of sol, where a new third can be inserted in this order—sol, si, re, fa—and where, precisely, the fifth [below ut], fa, engendered silently, is united to the harmony of the fifth [above ut], sol, engendered perceptibly. In addition, experience tolerates as dissonance only a union similar to that of these two fifths, forming an interval of the seventh in a chord composed of three thirds, which is moreover the great va-

riety introduced by such dissonance. And the addition of such dissonance destroys the arbitrariness among the fundamental sounds, by (86)
forcing the extremes, 3 and 27, to return to their generator, 9. These are the many reasons in favor of the dissonance. But, as the dissonance does not touch the source, and, as without it as with it, harmony always progresses the same, I can do without saying more about it, except that its introduction in the harmony becomes common to the fundamental bass. It is this which serves to carry the variety to its final period.

Concerning this chord of the seventh, we have formed from it every species as far as the fundamental succession and the liason would allow—principles that sentiment and taste have always dic- (87)
tated. Inversion, suspension and supposition (which I am going to explain) have also furnished means of varying this same chord, in which was previously believed an infinity of dissonances. All of the rules that concern the dissonances are drawn from the fundamental and diatonic successions, from the liason and from the complement of the harmony, with the result that this novelty introduces only the variety, with nothing changing fundamentally.

I have already said what the inversion consists of.[1] As for the suspension, it is but a consequence of the liason. With regard to supposition, where it is a matter only of adding a third (88)
or a fifth below the fundamental bass, it seems indicated by the

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[1]Rameau discussed inversion above, p. 29 (R, p. 18).

sonorous body itself, which causes its third and fifth below to vibrate while its harmony resonates.

There is yet the deceptive cadence [cadence rompue], which only consists of changing the fundamental bass from an absolute pause to another that ascends a second, or descends a seventh, without changing the product. This destroys the effect of the pause, as we have already been able to judge from the experiment proposed on this subject. One sees sufficiently that this deceptive cadence draws its origin from the dissonance itself, since it consists of a fundamental progression of an ascending second, (89) which is the same thing as a descending seventh.

Here, the dissonance added to the harmony of re, 81 of table C, and the minor third cited in the preceding section,[1] concludes the presentation of this question. It is used as much for preserving the impression of the first given mode as for the double emploi, of which I have already spoken. We find there re, fa, la, ut, where re receives the chord of fa, and where this fa can receive, from its position, the same re in its harmony, thus—fa, la, ut, re. For when the chord is justifiable from the one side, it must be so from the other by means of inversion.

PRODUCT OF THE MAJOR THIRD OR OF THE QUINTUPLE PROPORTION, (90)
FROM WHICH THE CHROMATIC AND ENHARMONIC GENERA ORIGINATE.

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[1]The reference is to p. 56 (R, p. 81).

When the quintuple proportion enters into progression, it yields in its product a minor half-step between 24 and 25 (see K), which is not nearly as natural as the major half-step drawn from the triple proportion. In order to evaluate it, it suffices to intone, consecutively, ut, re, mi, fa, fa #, where the minor half-step from fa to fa # embarrasses those who do not have well-rounded experience. In a word, one will not intone the minor half-step with the same facility (without concentrating or without shifting) as the half-step from mi to fa. (91)

This minor half-step is called <u>chromatic</u>, as the major is called <u>diatonic</u>. It is always designated by a sharp or a flat joined to a note that does not change its name; it occurs only in order to change the mode; and it is precisely that which prevents persons of little experience to have a feeling for it present in the ear. It originates from the difference of the major third to the minor, which is often used in the harmony of the same generator in order to change its mode from major to minor, or from minor to major.

If one passes from one extreme to the other in the quintuple proportion, their product will yield the quarter-tone, 125: (92)
128, called enharmonic, and which equals the difference between a major half-step and a minor. See L.

Since the quarter-tone does not occur at all in our instruments because the ear cannot distinguish it, it can be employed by means of the chord of the seventh composed entirely of minor

thirds (the chord I cited on page 78, between sol # and fa) and through the borrowing of a fundamental bass that progresses by the minor third, which renders it tolerable. The explication of the above would be too long. However, permit me only to cite, concerning this subject, the first monologue of the fourth act of my opera *Dardanus*, where this enharmonic genus is employed with some (93)
success, although the quarter-tone does not occur at all.

The alternating succession of a fifth and a third, where the triple proportion is intermingled with the quintuple (see M), gives a composite genus that is called *diatonic enharmonic*, especially because the half-steps which are products of the diatonic enharmonic genus are always major, and because two major half-steps form a whole-step too large by a quarter-tone. Therefore the half-steps (always diatonic) necessarily cause the enharmonic in the whole-step that is formed from them. This renders their use difficult for the voice, but not impossible. (94)

Concerning this subject, I regret having been forced to abandon plans for theatrical performances of the *Trio des Parques* of my opera *Hippolyte et Aricie*, whose [trial] performance by skillful and dedicated musicians was successful, and whose result surpassed anyone's expectations, considering the situation. Thus, art, as long as it lacks competent performers [*protecteurs accrédités*], will always remain within narrow limits.[1]

If one passes alternatively by a descending minor third to an ascending major third while each fundamental sound carries suc-

[1]The circumstances alluded to here are explained more fully

cessively the minor third and the major third, there will result a composite genus called chromatic enharmonic, precisely because (95) the product will give two successive minor half-steps, which form a whole-step too small by a quarter-tone. See N.

I do not know if this genus is suitable to the voice. One can prove it to be so at least for instruments in a proper situation, as I wanted to show in an earthquake scene in my ballet of the *Indes Gallantes*; but that passage was so badly received and so badly favored, that it was necessary for me to change it into more common music.

All of these new genera originate, as we see, from the primary fundamental successions established on the triple and quin- (96) tuple proportions, but the product of these successions has no power of expression.

As the source strays from its primary paths, it loses its claims on the ear. And when the ear can no longer understand the source in its product, all harmonic feeling is prohibited to it: the diatonic recalls to the ear the triple proportion, the chromatic recalls the quintuple proportion, and as the latter is already less simple that the triple, the ear does not grasp its product with the same facility. As for the enharmonic, it recalls nothing. The enharmonic is the product of two extremes (very dissonant with re- (97) spect to each other) to which even nature, at first, refused im-

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by Girdlestone, p. 149.

mediate succession. Therefore it is not surprising that the ear cannot distinguish it.

In the monologue "Tristes apprets" of my opera Castor et Pollux, the enharmonic is found at every instance of the change in mode, where one feels the effect of the chromatic, and where, however, the minor half-step which is the product of the enharmonic never occurs. With regard to the enharmonic there is never any question of its product; one cannot perceive it even on our instruments.

With the product existing only through its generator, then
the cause of the effect is in this generator, as I have already (98)
intimated on the subject of the absolute pause. If this product, where it is perceivable, can add force, it maintains force always with the same generator. Thus, when the fundamental succession leads from one mode to another, the effect of the difference between the modes comes from this succession (and not from some other cause), by comprising the difference of the major and minor genera, which are always part of the harmony of this same succession.

The more or less perceptible impressions originate from
the greater or lesser degree of correlation in the successive modes.
And it is only through these means that grand effects are produced. (99)
The diatonic has, as its share, an agreeable effect; the chromatic varies that, and in the minor mode it possesses tenderness and even greater sadness; the enharmonic routs the ear, carries the

effect to excess in all of the passions (fright, terror), and especially causes disorder when one knows how to compose it in relation to the diatonic and the chromatic and how to maintain it by a rhythm suitable to expression.

I cite here the products in place of their generators, which only required mention because they are the unique cause of the effects that we experience equally in these products as with the generators.

Although the quarter-tone is unperceivable, its expression (100)
(if it were possible) would rout the ear rather than aid it. Since the quarter-tone is excluded from keyboard instruments, one cannot even consider expressing it on keyless instruments where, however, that would be possible by sliding the finger. With the same key, the same sound expresses particularly the two different sounds given, for example, at $\overset{125}{\text{la}}$ # and $\overset{128}{\text{si}}$. Therefore it is indeed evident that if we experience the effect of a quarter-tone, when either $\overset{125}{\text{la}}$ # or $\overset{128}{\text{si}}$ occurs consistently, this effect has no other cause than the change of mode occasioned by the fundamental succession, whose harmony requires a similar product. (101)

Now, what should be thought of the ancients who derived these different genera only in the products, when the effects that they relate concerning these products do not depend on the products; when, even, these products (I mean the quarter-tone) are inappreciable to the ear?

Can one doubt, after what has just appeared, that the cause

of the effects resides uniquely in the greater or lesser degree of correlation between the modes that are always regulated by the fundamental bass? Concerning this, need more be said than what I have already noted on the subject of the absolute pause, more than (102) what must now be recognized in the chromatic, and especially in the enharmonic, whose product does not exist at all?

All of that, combined with the generation of the genera, the modes (and what flows from them—pauses, liasons, etc.), uniquely dependent on a triple proportion, to which is added, finally, the quintuple proportion; all that, I say, proves well the existence of the principle in a single sound, which engendered all of this by means of its resonance.

Behold music presented by nature in a manner so complete: on the one hand, these qualities, these powers that we can no longer fail to recognize in the sonorous bodies; on the other, the conformation of our ears, which are disposed to receive the effects (103) of these sonorous bodies and to make us enjoy them. Though reduced to pure ornament in appearance, might we not believe that such an art is destined by nature to be for us of a value better proportioned to its purposes? Gentlemen, pardon this reflection, which I admit to be much more in your jurisdiction than mine, and all of whose consequences only you are capable of perceiving.

Furthermore, gentlemen, you see sufficiently how easy it is to draw from my principle clear and precise methods, either for finding all the possible melodic lines for a given fundamental

bass, or for finding a fundamental bass for any melodic line. That (104) is a detail that is all the more useless to pursue since it can be found, in part, in works that I have published, and since it adds nothing to the present concern.

I shall add only a word on the necessity of temperament: it is one of the things suggested by nature.

ON TEMPERAMENT

All of the difference that consists in the inappreciables is consequently unperceivable. One would not perceive at all the difference of the quarter-tone between the major and minor half-step, if it were not for the difficulty of intoning the minor when (105) it immediately follows the major. Also it is on the basis of this observation that keyboard instruments, in which the half-steps are equal or nearly so, are manufactured. One perceives even less the difference of the comma between the major and minor whole-step; it is not perceived even in the consonances given by the products that serve to lead to the just consonances required by the fundamental bass. Thus (with the whole being well considered), one sees how it is of little importance to the ear that these whole-steps, quarter-tones and half-steps are in their just proportion. One might remain doubtful concerning this, but the reason for that doubt would be unknown if one were not by now convinced that such products (106) have impact in a melody only as long as they are arranged in the order required by the harmony. And how important can the ratios

of these products be to the ear when the whole effect experienced by the ear originates directly from the fundamental bass, from the perfection of its harmony, from the difference between the major and minor genera in this harmony, and from the greater or lesser degree of correlation between the successive modes?

The uselessness of correcting inappreciable differences has already been clarified. These differences, therefore, must be considered unperceivable. But since twelve fifths, and consequently, twelve half-steps (diatonic as well as chromatic) are (107)
needed in order to arrive at the octave (see the progression A), and since the sounds of each of these half-steps are capable of becoming in their turn generators of a mode, altered consonances will occur in the harmony itself. It will be necessary, for example, that the same re form the major third of si ^{b}, and the fifth of sol (being 5 on the one hand, 81 on the other). Would not nature have remedied that by its concern with keeping us predisposed in favor of the fundamental sounds (the single and unique causes of these effects) whose harmony (always implied in the perfection required by the <u>liason</u> and the correlation of the successive modes) (108)
adjusts for the ear some small alterations that occur only in momentary products but are foreign to the sonorous bodies represented by these fundamental sounds? It is very necessary that such should be the case, especially if one recalls what is expressly indicated in my <u>Harmonic Generation</u> on the subject of organs (pp. 13-14) and on the subject of voices accompanied by different instruments whose

temperament is different (fifth proposition, p. 87).* These indications themselves carry an undeniable conviction in favor of the fundamental bass, whose perfect harmony, always present, forces (109)
us to tolerate small alterations foreign to it.

Thus, with the necessity of a temperament once recognized, and with the triple proportion (which must be extended now in a progression of fifths in order to reach the octave of the first term) containing in itself alone all the diatonic and chromatic intervals and thus necessarily becoming our guide here (as it had been in the generation of the modes), it is only a matter of knowing how to set about constructing the temperament. I do not believe that there is a better means than what I proposed in my Harmonic (110)
Generation. It is the only means indicated by nature. Moreover, experience subscribes to it, and if it has not been put into use, only inherited customs that are difficult to depart from must be blamed. But, as long ago as my most tender youth, and led by a mathematical instinct in the study of an art for which I was destined and which had singularly occupied my whole life, I wanted to learn the true principle of that art as the only thing capable of guiding me with certainty and without regard for customs or inherited rules.

I shall not speak at all of my practice, although it is considerable enough to form a sufficient test for the application of (111)

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*These experiments are explained in the report made at the Royal Academy of Sciences, which is found following this work. [P. 88 below (Extract, p. xlii).]

my rules. I appreciate the complete insufficiency of such proof when it is a matter of philosophic truths, and especially for intelligences such as yours which can and must be convinced only by demonstrations, demonstrations I hope to have accomplished. I would only say, gentlemen, with regard to practice, to which I committed myself while working in the theatre, if I was stirred by the pleasure of producing, as an artist, many portrayals whose idea I had conceived (something that infinitely flatters good taste and imagination), I was even more stirred by the pleasure of noting, as a philosopher, the interaction of these phenomena, whose principle was no longer unknown to me, and by giving rise to the pro-
duction of an infinity of effects, the causes of which I put myself (112)
in a position to know.

Gratified by the favors of the public through the success of my musical compositions, sufficiently satisfied and content myself, I dare to say, with my discoveries in theory, I desire only to obtain, from the most respectable tribunal of European scholarship, the seal of its approbation on that part of my art in which I have always been most ambitious to succeed.

The End.

EXTRACT FROM THE REGISTERS OF THE (i)

ROYAL ACADEMY OF SCIENCES.

10 DECEMBER, 1749.

We, commissioners appointed by the academy, have examined a memoir[1] in which Mr. Rameau presents the fundamentals of his system of theoretical and practical music.

The entire system is based on the two following experiments:

1. If one resonates a sonorous body, which we will call ut in order to designate it more easily, one hears, besides the principal sound, two other very high sounds, of which, one is the twelfth above the principal sound (that is, the octave of its fifth above), (ii)
and the other, the major seventeenth above this same sound (that is, the double octave of its major third above).

2. If one tunes with the body ut four other bodies of which the first is at its twelfth above, the second at its major seventeenth above, the third at its twelfth below, and the fourth at its major seventeenth below, then by making the body ut resonate, one will see the first and second of these four bodies vibrate in their totality. As for the third and the fourth, they too will vibrate; but in vibrating, they will be divided by a kind of wave, the one in three, the other in five equal segments (a circumstance essential for what we have to say in the following, and which we (iii)

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[1]This memoir was the manuscript version of what would be published as the Demonstration. See pp. 3-4 above.

have witnessed). Moreover, these two experiments have been well known.*

With that established, if one calls the string that produces the sound ut 1, then one knows that the string that produces the twelfth above would be 1/3 of the string 1; and that the string that produces the seventeenth above would be 1/5 of it.

One can therefore designate the principal sound and the two other harmonic sounds that accompany it by these numbers: 1: 1/3: 1/5, which form a proportion that has been named, as a matter of fact, harmonic. (iv)

It is not necessary to be a musician to perceive the resemblance that exists between any sound and its octave, with these two sounds becoming almost entirely identical when they are heard together. From this fact, Mr. Rameau concludes that, for any sound, one can always substitute, indifferently, its simple, double or triple octave, ascending or descending. It is known, moreover, that two strings an octave apart, are between themselves as 1 to 2: thus, with the three sounds, 1: 1/3: 1/5, being put as near together as possible, by means of their octaves, the author forms (v)
the new harmonic proportion 1/4: 1/5: 1/6, which he substitutes for the first. In this proportion, 1/4: 1/5: 1/6, the first two terms, 1/4: 1/5, form a major third, or what amounts to the same. This proportion represents the melody ut, mi, sol, to which if one

*See Mersenne and Wallis. [See the citation to Green's dissertation on this subject on p. 5 above.]

adds the octave ut above, one will have the melody ut, mi, sol, ut, which can be regarded as being given directly by nature itself. In effect, we intone the third in place of the seventeenth, and the fifth in place of the twelfth; we incline naturally to reduce all intervals to their smallest degrees because of the small range of our voice and the ease with which we confuse sounds with their (vi)
octaves.

The chord formed with the twelfth and the major seventeenth united with the fundamental sound is for this same reason extremely agreeable, especially when the composer can balance the voices and instruments in such a manner as to give this chord its complete effect, which does not always occur. Mr. Rameau has accomplished this successfully in his very well known chorus from _l'Acte de Pigmalion_.

The author uses again the first of the two experiments in order to establish the difference between noise and sound, and the reason for the varying degrees of sensibility to musical pleasure that occur among people. All noise is indivisible [_un_]; all sound, (vii)
on the contrary, is necessarily composite, always being accompanied by its harmonics; and musical pleasure, says the author, will be more or less great according to whether the ear is more or less affected by these sounds. This manner of explaining the feeling for harmony had already been presented by Mr. de Mairan, in the _Mem. Acad._ 1737.[1]

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[1] _Mémoires de l'Academie Royale des Sciences_ (Paris, 1737).

Mr. Rameau passes next to the second experiment. He observes, at the outset, that with the fundamental sound being 1, its twelfth and major seventeenth below are represented by 3 and 5.

Thus the vibrations of this twelfth and seventeenth, pro- (viii)
duced by the principal sound, give to Mr. Rameau the arithmetic proportion 1: 3: 5. These three terms, being brought together as closely as possible by means of their octaves, result in the new arithmetic proportion 6: 5: 4. That corresponds to the melody fa, la ^{b}, ut, where the minor third, 6: 5, is found first and the major third, 5: 4, second. This is the opposite of the proportion 1/4: 1/5: 1/6 that had been given by the first experiment, and in which the major third is found first and the minor third second. The difference in this arrangement of the thirds constitutes the total difference between the two genera or modes, modes which have been (ix)
named major and minor. We shall return to that as we proceed in this extract. But it is necessary to consider first, according to Mr. Rameau, that which is deduced from the two proportions (given directly by the two experiments): 1: 1/3: 1/5 and 5: 3: 1; the one harmonic, the other arithmetic.

These two proportions combined between themselves furnish the author two new proportions that are geometric: namely, 3: 1: 1/3 and 5: 1: 1/5. The first, as one sees, contains the two twelfths of the fundamental sound (the one above, the other below), between which the fundamental sound itself is found. The second is formed (x)

out of the fundamental sound and its two major seventeenths. Mr. Rameau begins by considering the first geometric proportion.

He observes that the terms 3, 1/3, although representing the twelfths of the sound 1, can be regarded as its fifths, since the twelfth is but the octave of the fifth. Thus he represents 3: 1: 1/3 for fa, ut, sol, although fa, ut, sol, to be exact, would be 3/2: 1: 2/3. Moreover, in order to avoid the inconvenience of fractions, he substitutes 3: 1: 1/3 with the whole numbers 9: 3: 1, which are in the same ratio, so that the sonorous body is no longer indicated by 1 but by 3. This makes no difference, the (xi)
order of the proportion being otherwise preserved.

It is known, moreover, that the number of vibrations produced during the same duration of time by strings of the same thickness, the same material and the same tension, is in inverse proportion to the length of the strings. Thus the numbers of vibrations that the strings 9: 3: 1 produce in a given time, will be represented by 1: 3: 9. One can, says Mr. Rameau, use the latter three numbers to designate the sounds fa, ut, sol. By this reasoning, 9: 3: 1 designate only the lengths of the strings that produce these sounds, while the numbers 1: 3: 9, representing the number (xii)
of vibrations, seem to him more appropriate in designating the sound.

Thus the author expresses fa, ut, sol by the numbers 1: 3: 9, and the proportion that they form is that which Mr. Rameau calls <u>fundamental bass of ut in triple proportion</u>, or simply, <u>fundamental bass</u>. The three sounds that form this bass and the harmonics of

each of these three sounds constitute what is called the <u>major mode of ut</u>.

If one substitutes the three terms 1: 3: 9 by 3: 9: 27 (which are in the same proportion), such that the generator or fundamental sound is represented by 9, and such that the proportion (xiii)
is extended in a progression of this type— $\genfrac{}{}{0pt}{}{1:}{\text{si}^{b},}$ $\genfrac{}{}{0pt}{}{3:}{\text{fa},}$ $\genfrac{}{}{0pt}{}{9:}{\text{ut},}$ $\genfrac{}{}{0pt}{}{27:}{\text{sol},}$ $\genfrac{}{}{0pt}{}{\text{81, etc.}}{\text{re, etc.}}$ —Mr. Rameau notes, first, that the two terms $\genfrac{}{}{0pt}{}{1:}{\text{si}^{b},}$ $\genfrac{}{}{0pt}{}{27}{\text{sol}}$ as well as the terms $\genfrac{}{}{0pt}{}{3:}{\text{fa},}$ $\genfrac{}{}{0pt}{}{81}{\text{re}}$ when brought together as near as possible by means of their octaves, produce the minor third 32/27, or, what is the same thing, 192/162. Now, this minor third is smaller than the harmonic minor third, 6/5, by a comma,* because 32/27 is to 6/5 as 80 to 81. From this the author concludes: 1. (xiv)
that if in the progression 1: 3: 9: 27, etc., one takes more than three terms, there is, as of the fourth term, an alteration among the thirds; 2. that one would not know how to make the terms $\genfrac{}{}{0pt}{}{\text{fa}}{3}$ and $\genfrac{}{}{0pt}{}{\text{re}}{81}$ (any more than the terms $\genfrac{}{}{0pt}{}{\text{si}^{b}}{1}$ and $\genfrac{}{}{0pt}{}{\text{sol}}{27}$) succeed each other directly in harmony, since the sounds that these numbers represent cannot be harmonics of each other; 3. that neither would one know how to make the terms 3 and 27 succeed each other, because with $\genfrac{}{}{0pt}{}{\text{re}}{81}$ being the fifth above $\genfrac{}{}{0pt}{}{\text{sol}}{27}$, it follows from the first experiment that (xv)
the sound $\genfrac{}{}{0pt}{}{\text{sol}}{27}$ necessarily carries within itself the sound $\genfrac{}{}{0pt}{}{\text{re}}{81}$, and

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*The difference between a major whole-step and a minor whole-step is called a comma. It is known that the major whole-step (for example, from ut to re) is 8/9, and the minor whole-step (for example, re to mi) is 9/10. The two fractions are to each other as 80 to 81. Thus the ratio 80 to 81 designates what is called the comma.

therefore the direct succession of $\frac{\text{fa}}{3}$ and $\frac{\text{sol}}{27}$ would carry that of $\frac{\text{fa}}{3}$ and $\frac{\text{re}}{81}$, which has just been rejected.

Mr. Rameau deduces this consequence from the above: in whatever manner one arranges the sounds of the progression $\overset{1:}{\text{si}}\ \overset{}{\text{b}},\ \overset{3:}{\text{fa}},\ \overset{9:}{\text{ut}},\ \overset{27:}{\text{sol}},\ \overset{81,\ \text{etc.}}{\text{re}}$ it is necessary for any two adjacent sounds taken from this progression to succeed each other directly. With this principle established, he conceives, to start with, a fundamental bass of ut by disposing the sounds fa, ut, sol, in this manner: $\underset{27:}{\text{sol}},\ \underset{9:}{\text{ut}},\ \underset{27:}{\text{sol}},\ \underset{9:}{\text{ut}},\ \underset{3:}{\text{fa}},\ \underset{9:}{\text{ut}},\ \underset{3}{\text{fa}}$. One can see there that the prescribed condition is observed. He puts above each of those sounds (xvi)
that constitute this bass one of their harmonic sounds—namely, either the unison or the octave, or the major third, or the fifth. And he chooses these harmonic sounds in such a manner that they will be separated, one from the other, by the smallest possible intervals. That is, they will ascend by the smallest natural degrees. From this process he deduces the scale: si, ut, re, mi, fa, sol, la,* which contains precisely the same sounds as the ordinary scale and in which it is easy to find by calculation the ratio of any two sounds taken at random, since each sound in the scale is a harmonic of ut or a harmonic of one of the fifths of ut. (xvii)

The following is what the author observes in this scale: 1. the scale is composed of two conjunct and perfectly equal tetrachords (si, ut, re, mi, fa, sol, la), and these two tetrachords are

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*See table B.

precisely those of the ancient Greeks. 2. The minor third from re to fa is altered by a comma for the reason we have said. Now, since re is found in the first tetrachord and fa in the second, Mr. Rameau concludes that there is in the range of the scale an alteration from one tetrachord to the other, and therefore there is in this scale, although formed from the single mode of ut, a necessary imperfection. 3. It is easy to explain through this the author's (xviii)
principles why the scale si, ut, re, mi, fa, sol, la does not ascend to the si above, since this new si could only be the product of sol and would require a sol below it in the fundamental bass. And, as the last term of this bass is fa, one would have the two sounds fa and sol in succession in the fundamental bass, which the author rejects for the reasons we have said. These are the same reasons, adds Mr. Rameau, which render two successive perfect chords (such as that of fa to sol) and even two successive major thirds in diatonic order disagreeable. Finally he explains again by the same (xix)
principles why one would not be able to intone naturally three successive whole steps (fa, sol, la, si), at least while remaining in the compass of a single mode. For it is seen that with the bass being composed only of the sounds fa, ut, sol, the scale (which is a product of the bass) cannot ascend to the si above.

Mr. Rameau, after having observed that one can pass indifferently from one term to the other in the proportion 3: 9: 27, provided that the two adjacent terms directly succeed each other, concludes that one will be able, similarly, in the progression

1: 3: 9: 27: 81, to pass from one term to the other under the same condition. But in this progression, it is necessary to distinguish (xx) three modes: that of ut, 3: 9: 27 which is the mode of the primary generator and which, for this reason, is called principal mode; and two other modes that are the adjuncts of the former—namely, the mode of sol, 9: 27: 81, and that of fa, 1: 3: 9. The ear is almost indifferent, continues the author, to the passing of the principal mode to one or the other of these adjuncts. It should, however, have a little more predilection for the mode of sol; because sol resonates with ut, and fa is merely made to vibrate [sympathetically]. Thus the ear, affected by the mode of ut, is a little more predisposed to the mode of sol. This is in effect what experience (xxi) teaches us, nothing being more natural and more ordinary than to pass from the mode of ut to the mode of sol. One can similarly pass from the mode of sol to the mode of re, 27: 81: 243, as from the mode of fa to the mode of si ^{b}, 1/3: 1: 3; but the author remarks that phrases in these modes should be shorter as they proceed farther away from the principal mode to which the ear always hastens to return.

Mr. Rameau conceives, now, a new fundamental bass composed of the mode of ut and of the mode of sol in this manner: ut, sol, ut, fa, ut, sol, re, sol, ut.* He then puts above each of these (xxii) sounds one of their harmonic sounds, in such a manner that the new

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*See table C.

sounds ascend by the smallest natural degrees. This produces the scale ut, re, mi, fa, sol, sol, la, si, ut, which is nothing but the ordinary scale, with the single difference that the sound sol appears there twice in succession, the first as the fifth of the sound ut of the fundamental bass, the second as the octave of the sound sol which directly follows ut in the fundamental bass; but these two consecutive sol's are, moreover, perfectly at the unison.

The author now observes in this new scale the alteration of the minor third from re to fa, as in the first scale and for the (xxiii) same reasons. He shows, further, that the whole-step or the interval from sol to la, which was minor in the first scale, is here major. In the first scale la was the third of fa of the fundamental bass, and here, it is the fifth of re of the new bass. Thus the difference of la in the two scales results only from the difference of the fundamental basses. Mr. Rameau deduces from this observation what he calls the double emploi, explained in greater detail in his Harmonic Generation.

The passage of the fundamental bass in the mode of sol (xxiv) produces the altered thirds, fa-la and la-ut, in the new scale; but the different sounds that constitute the altered thirds in this scale and in the first scale form perfectly just consonances with the sounds that correspond to them in the fundamental bass. Also, the author observes, the ear, being attentive principally to the fundamental bass (which is the origin of the diatonic scale) and concerned only with adjusting itself to this bass, remains completely

unaffected by the alterations that originate from this pitch relationship in the ordinary scale.

The mode of sol, introduced in the new bass, has the three (xxv) whole-steps fa, sol, la, si directly succeed each other in the second scale, a succession that would not have occurred in the first scale. But this direct succession requires the sound sol to be regarded as belonging to two modes simultaneously, while separating, so to speak, the two tetrachords ut, re, mi, fa; sol, la, si, ut. The best method of indicating here the passage into a new mode would be, doubtless, to repeat twice the sound sol: this is what the Greeks had well perceived, according to Mr. Rameau, since they had indicated a disjunction or pause between the two sol's. In the practice of singing one is content with a single sol, but in this case, there is always, either after the sound fa or after the sound (xxvi) sol, a pause expressed or implied. One can perceive this by intoning the scale for himself.

All fundamental progressions by fifths also form pauses that have been named cadences, so that there is always a pause from one sound to another in the fundamental bass and, consequently, also in the scales that are produced by it. When one sound of the fundamental bass passes to its fifth above, the cadence is called imperfect. The reason for this denomination given by Mr. Rameau is that since any sound includes within itself its fifth above, the progression of a sound ascending to its fifth is always taken by (xxvii) the ear for that of a generator passing to its product, that is,

to one of its harmonics. However, when one descends a fifth, it is the product that returns to the generator. Thus this last cadence is named perfect cadence or absolute pause. Mr. Rameau has proved to the Academy by a very simple experiment that a melody which seems finished when it is alone or accompanied by its fundamental bass no longer seems finished when a different bass is given to it; from which he concludes that the effect of pause is uniquely expressed or implied in the fundamental bass. The most perfect (xxviii)
of all pauses is that where one descends a fifth to the principal sound: thus, although there would be an absolute pause from re to sol in the fundamental bass of the second scale, the ear, already preoccupied with the mode of ut by the multiple impression of the sounds $\overset{9}{ut}$ which had preceded, desires to return to ut.* This is what obtains in the new absolute pause sol, ut. This absolute pause, sol, ut, produces in the two scales the major half-step si, ut; and with that, the author explains why, when one desires to ascend deatonically to the generator of a mode, one can do it only by means of a half-step whose first sound is a product of the fifth of the (xxix)
generator. So that, after having intoned the first note, si, of this half-step, one naturally intones the second, which is this very generator. Therefore, because it indicates the generator and prepares the most perfect of all pauses, the note si has been named leading tone [note sensible].

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*See table C.

We have seen, according to Mr. Rameau, that nature directly yields the major genus or mode by means of the resonance of the sonorous body. This sonorous body, he adds, by making its multiples vibrate, indicates the minor mode: it is up to art to perfect the (xxx)
product, but always by diverging as little as possible from the paths that nature has shown it. Now, the author observes that these paths are indicated by the manner in which we have seen the multiples vibrate; because, in vibrating, they divide into unisons of the principal sound, so that, if they had just resonated, they would have produced only this unison. Mr. Rameau concludes that this is how nature directs us, as far as possible, to the fundamental sound in forming the minor genus or mode. In truth, this sound will not be able to be the fundamental in the new genus, since it resonates only its major third. But in place of this position as fundamental Mr. Rameau gives it what is, in a way, the principal position, in that it characterizes the minor genus and pro- (xxxi)
duces the difference between the minor mode and the major mode. The principal sound, ut, thus becomes the minor third of the fundamental sound which will be, consequently, la. Moreover, the generator, ut, gives its major third, mi, to the fundamental sound la as a fifth. And it is the fifth, as we said according to the author, that is the rule in all of harmony and in the fundamental succession; from this Mr. Rameau concludes that the source, ut, has the greatest possible role in the formation of the new genus. He notices, furthermore, that between the two modes ut, mi, sol and la, ut, mi (the former

major, the latter minor) there are two common sounds—namely, ut and mi. The same thing is observed between the adjuncts of these two modes. Because the adjuncts of ut, namely, fa and sol, produce fa, la, ut and sol, si, re, and the adjuncts of la, namely, re and mi, produce re, fa, la and mi, sol, si, this makes six modes for a single one—namely, three major and three minor. (xxxii)

It has been seen above how the fundamental bass fa, ut, sol has produced for Mr. Rameau the diatonic scale si, ut, re, mi, fa, sol and la.* If one disposed in a similar order the sounds of the fundamental bass re, la, mi (thus: mi, la, mi, la, re, la, re), one will deduce from that, according to the author, sol #, la, si, ut, (xxxiii) re, mi, fa, in which scale he has observed that the two thirds la-ut and re-fa, which correspond to the sounds la and re in the fundamental bass, have been made minor; and that the third mi-sol # is major. For this reason the fundamental sound la must always be preceded by the leading tone sol #, as we have already noted according to him.

The author then forms by means of the two modes re, la, mi and la, mi, si a new fundamental bass of the minor mode similar to the fundamental bass of the second diatonic scale—namely, la, mi, la, mi, si, mi, la. This gives to him the new diatonic scale of (xxxiv) the minor mode: la, si, ut, re, mi, fa #, sol #, la,** where it

*See table B.

**See table E.

is seen that the fa that was natural in the first scale of the minor mode is here sharp, because it is the fifth of si which corresponds to it in the fundamental bass; with respect to sol, it is sharp for the same reason as in the first scale. The minor mode, concludes Mr. Rameau, is thus more susceptible to variation than the major; but the major, given more directly by nature, has received from nature, in recompense, a force that the minor does not have.

The author returns then to the geometric progression $\overset{\text{fa,}}{3:}\ \overset{\text{ut,}}{9:}\ \overset{\text{sol}}{27}$
and notes that of the three sounds that constitute the mode of ut, (xxxv)
there are two that are common to the mode of sol—namely, ut, sol—and two that are common to the mode of fa—namely, fa, ut—from which he concludes that when, in the fundamental bass, one passes from ut to sol, or to fa, it cannot as yet be known in which mode one is. Therefore, in order to determine the mode, one adds to the harmony of sol the sound fa by the smallest harmonic intervals in this manner: sol, si, re, fa, this being called the dissonance of the chord of the seventh; and to the harmony of fa, one adds the sound re drawn from the harmony of sol, in this way: re, fa, la, ut, or fa, la, ut, re,
this being named the chord of the large sixth [accord de grande (xxxvi)
sixte]. By that one sees that if the source ut passes to sol, it passes simultaneously to fa; and that if it passes to fa, it passes simultaneously to one of the harmonics of sol. Thus the mode of ut is, by these means, absolutely determined. Such is, in the principles of Mr. Rameau, the origin of dissonance and of the rules to which dissonance is subjected.

After having exhausted the product of the triple proportion, the author comes to that of the quintuple proportion, that is, of the major thirds (a proportion that furnished new fundamental basses). He takes, at the outset, the first terms of this progression, si^{b}, re;[*] and above each he puts one of its harmonic sounds, so that the (xxxvii) new sounds are as near as possible. There results the half-step fa-fa$^{\#}$ which is called minor, because the two sounds that form it are in the ratio of 24 to 25, while the major half-step drawn from the triple proportion yields the ratio of 15 to 16 between the two sounds that form it. A new genus called chromatic originated from the quintuple proportion. If one continues the progression through three terms si^{b}, re, fa$^{\#}$,[**] the two extremes si^{b} and fa$^{\#}$ will yield the two sounds si^{b}, la$^{\#}$ in the ratio of 128 to 125. These two sounds form a quarter of the enharmonic whole-step, which is the difference between the major half-step and the minor half-step. (xxxviii) No one, as far as we know, had as yet found its origin in the quintuple proportion.

If one, with Mr. Rameau, forms a new fundamental bass from the combination of the triple proportion with the quintuple, one will have a new genus called diatonic enharmonic, in which all the half-steps are major.[***] Finally, if one forms a fundamental bass that

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[*]See K.

[**]See L.

[***]See M.

descends a minor third and ascends, then, a major third, one will
have a new genus called chromatic enharmonic, in which all of the
half-steps are minor.* Mr. Rameau concludes from the above that (xxxix)
the effect of all these different genera of music is due only to the fundamental bass. For one would not otherwise know how to arrive at the difference between major and minor half-steps, since this, says the author, is in itself inappreciable to the ear. Mr. Rameau cites in his memoir some examples of these different genera drawn from a few very well-known segments of his operas.

The property displayed by small intervals of being inappre-
ciable, or at least of being appreciable only with difficulty, is
the basis of Mr. Rameau's reflections on temperament. We have (xl)
already noted, following the author, that the fourth term 27 of the triple progression formed, with the first term 1, a minor third altered by a comma. It was the same with the major third formed by the first and fifth terms—namely, si ^{b} and re, reduced by means of their octaves. Finally, if one extends the triple proportion through thirteen terms in this manner—si ^{b}, fa, ut, sol, re, la, mi, si, fa $^{\#}$, ut $^{\#}$, sol $^{\#}$, re $^{\#}$, la $^{\#}$,** with the last of these terms, namely la $^{\#}$ or 531441, being brought as near as possible to the first, 1 or si ^{b}, by means of the octaves—one will have the num-
bers 524288, 531441, which differ by a comma called the pythagorean (xli)

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*See N.

**See table A.

comma; although, in keyboard instruments especially, the si ^{b} and the la # are indistinguishable. From that one sees the absolute necessity of altering a bit the intervals of the fifths in keyboard instruments in order to have the two terms of the octave, which must be perfectly just, coincide together. It is principally in regard to this matter that Mr. Rameau deems temperament to be necessary, and the rule that he prescribes to achieve temperament consists in making all half-steps as equal as possible, and through this all the fifths would also be equally altered. Furthermore this rule would alter each fifth only slightly, much like the fifths (xlii)
of non-keyboard instruments (an advantage that has not occurred in ordinary temperament). Moreover, these alterations will make little or no difference to the ear, which, singularly concerned with the fundamental harmony, tolerates them without difficulty, or rather pays them no attention. Mr. Rameau strengthens this thought by an experiment reported in his Harmonic Generation.[1] Depress the three keys of the organ mi, sol, si and you will hear only the perfect chord, although the ear will be simultaneously affected by the sounds mi sol # si, sol si re, si re # fa #. The sounds (xliii)
sol #, re; re #, fa # would produce, says Mr. Rameau, an unsupportable cacophony, if the ear were to distinguish them. But since the ear hears only the perfect chord, it follows that it does not distinguish them. It is the same with a vocal melody accompanied

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[1]See the reference in the Demonstration, p. 68 above (R, p. 108).

by several instruments whose temperaments are different, since the alteration that this difference produces in the harmony is not at all perceived by the ear. Finally, independently of these reasons, Mr. Rameau assures us that experience is not contrary to the temperament that he proposes, and in this respect he has acquired the right to be taken at his word.

Such is Mr. Rameau's system, which, up to now, we have been (xliv)
content to present as clearly as possible. We believe we may conclude that the fundamental bass discovered by the author and drawn from nature itself is the source of harmony and melody; that Mr. Rameau explains with success, by means of this principle, the different facts of which we have spoken; and that no one before him had reduced the following into a system so interconnected and so extensive: the two tetrachords of the Greeks; the formation of the diatonic scale; the difference in value that the same sound can have in that scale; the alterations that are noted in this scale, (xlv)
and the total insensibility of the ear to this alteration; the rules of the major mode; the difficulty of intoning three consecutive whole-steps; the reason for which two major thirds or two successive perfect chords are proscribed in a diatonic order; the origin of the minor mode; its subordination to the major and its varieties; the use of dissonance; the cause of the effects produced by the different genera of music (diatonic, chromatic, enharmonic); and the principle and the laws of temperament. Thus, harmony, commonly subjected to rather arbitrary laws or suggested

by blind experience, has become, through the work of Mr. Rameau, (xlvi) a more geometric science and a science to which mathematical principles can be applied with a utility more real and more sensible than before. This last judgment is nearly the same as the one the Academy has already stated in 1737 concerning the author's <u>Harmonic Generation</u>.[1] The principles established in this last work are fortified in this memoir which we have reviewed by new proofs, new observations, and especially by presentations of much order and clarity. This is why Mr. Rameau, after having acquired a great reputation for his musical compositions, further merits, for his re- (xlvii) search and discoveries in the theory of his art, the approbation and commendation of philosophers.

Paris, this 10 December, 1749.

Signed, Dortous de Mairan, Nicole, d'Alembert[2]

I certify that the present extract conforms to the original and to the judgment of the Academy. Paris, this 22 December, 1749.

Grandjean de Fouchy[3]

Perpetual Secretary of the Royal Academy of Sciences

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[1]This is the "Extrait des Registres de l'Academie Roiale des Sciences" published with the <u>Harmonic Generation</u> and translated in Hayes, pp. 11-12.

[2]Jean-Jacques Dortous de Mairan (1678-1771), Francois Nicole (1683-1758), Jean Le Rond d'Alembert (1717-1783).

[3]Jean-Paul Grandjean de Fouchy (1701-1788).

A

Triple and Quintuple Progressions

B

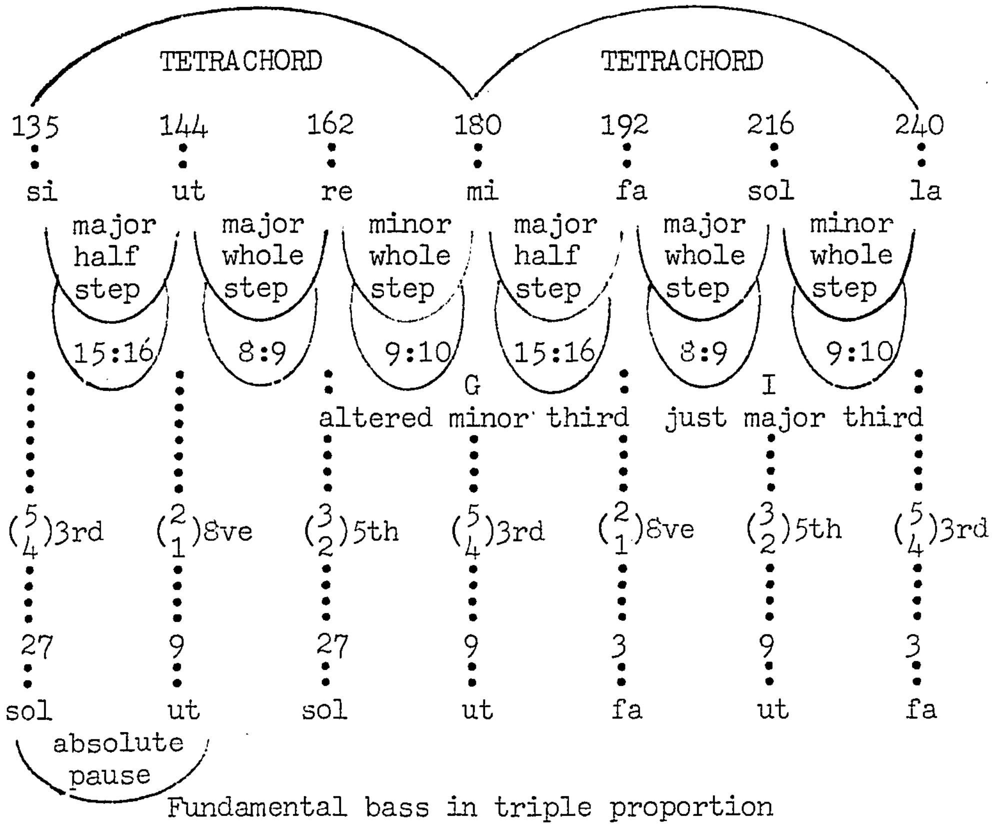
A

si b 1	re 5	fa # 25	la # . . . 125
fa 3	la . . . 15	ut # 75	
ut 9	mi . . . 45	sol # . . . 225	
sol 27	si . . . 135	re # . . . 675	
re 81	fa # . . 405	la # . . . 2025	
la 243	ut # . . 1215		
mi 729	sol # . . 3645		
si 2187	re # . . 10935		
fa # . . . 6561	la # . . 32805		
ut # . . . 19683			
sol # . . 59049			
re # . . 177147			
la # . . 531441			

The triple progression, which is vertical, presents the fifths, and the quintuple, which is horizontal, presents the major thirds.

B

Diatonic Scale of the Natural Mode Called Major



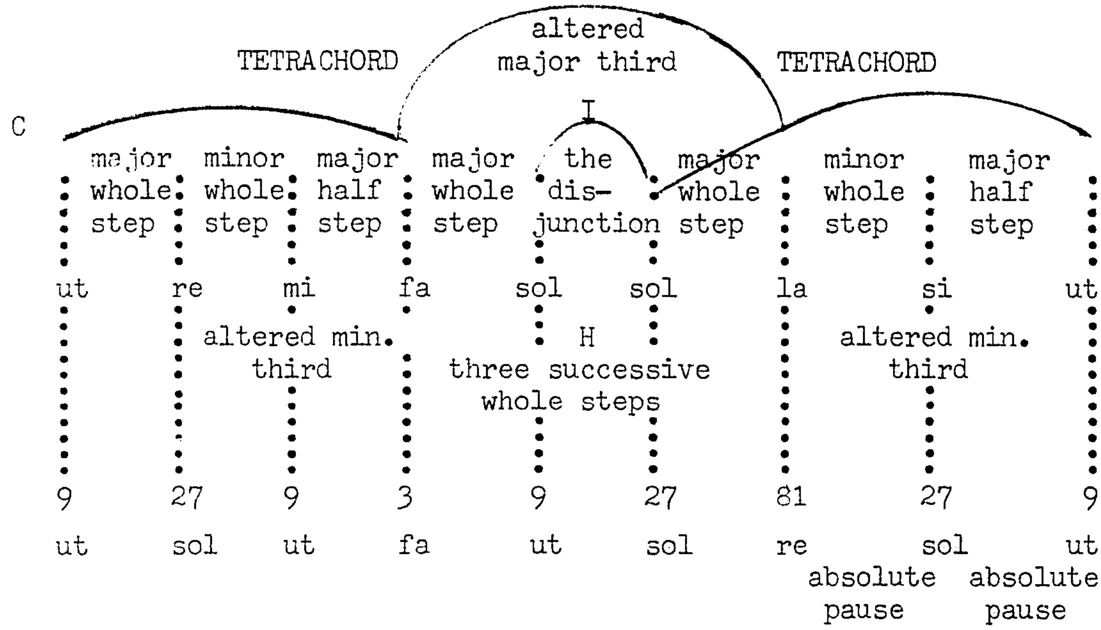
The figures above the names of the notes of the diatonic scale indicate their ratios to the fundamental bass, as given by the resonance of the sonorous body.

The name and ratio of the interval from note to note is written in the semi-circles below the names of these notes.

The figures on top of each other and enclosed by two parentheses indicate the direct ratio of the consonance formed by a sound of the diatonic scale and the corresponding sound in the fundamental bass. The names of the direct intervals, given as figures, are found to the right of the parentheses.

C

The Scale of the Diatonic Octave of the Preceding Mode

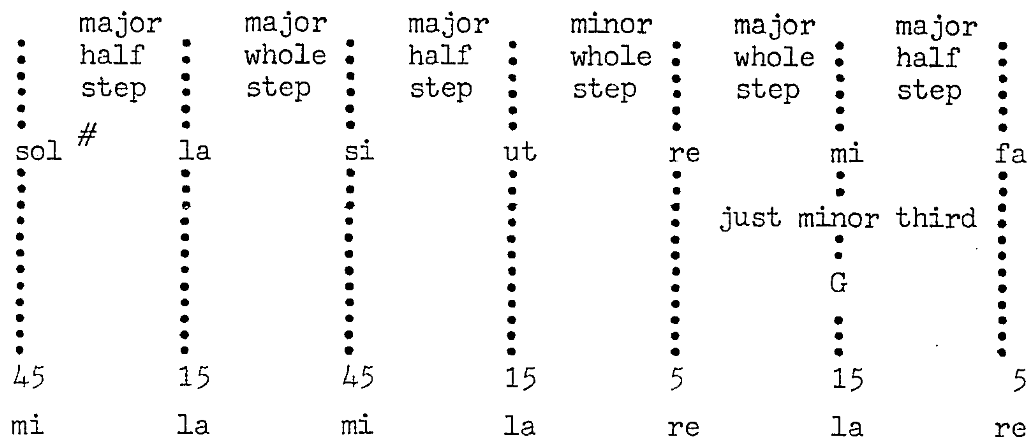


Fundamental bass in triple proportion

Since the ratios of the diatonic sounds to the fundamental bass are the same as before (except where the mode changes, as I will explain), I have only written the names of the intervals that occur from one of these sounds to the other.

D

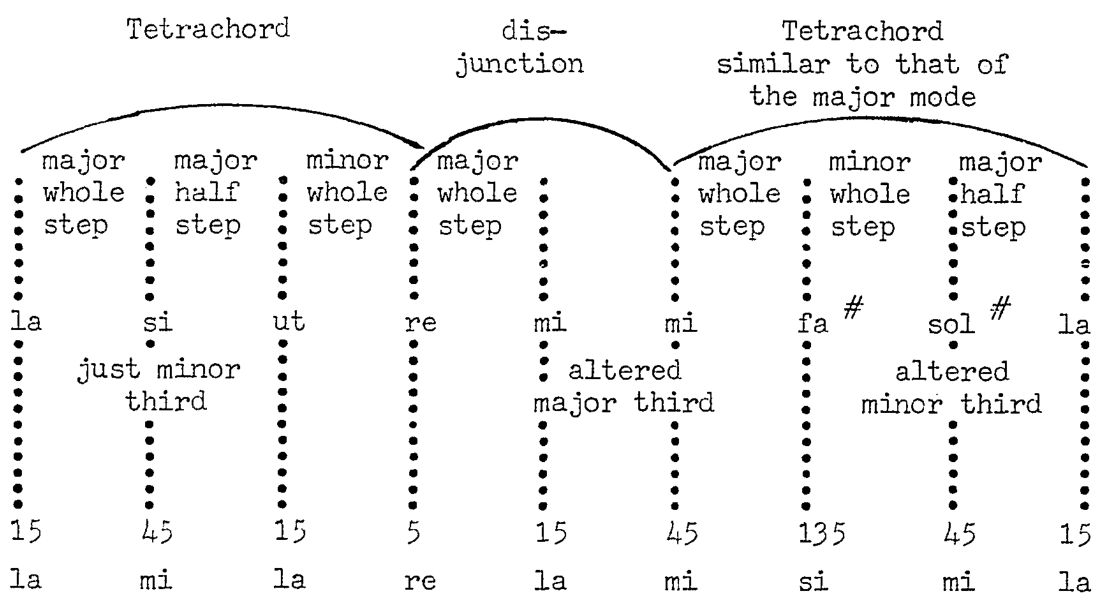
Diatonic Scale of the Minor Mode



Fundamental bass in triple proportion

E or F

The Scale of the Diatonic Octave of the Minor Mode



Fundamental bass in triple proportion

(5)

Quintuple Proportion

minor half-step

24 fa — fifth — 1 si b

25 fa # — major third — 5 re

K

quarter-tone

128 si b — octave — 1 si b

125 la # — major third — 25 fa #

L

Fundamental bass

Diatonic Enharmonic Product

M

major half-step

si b — octave — 1 si b

la — major third — 3 fa

fifth

major third

major half-step

la — octave — 15 la

sol # — major third — 15 mi

fifth

Fundamental bass in alternative succession of one of the terms from the triple proportion and from the quintuple

Chromatic Enharmonic Product

N

minor half step

mi b — minor third — ut

mi — major third — ut

min. third

unisons

mi — fifth — la

maj. third

minor half step

mi — minor third — ut #

mi # — major third — ut #

Fundamental bass which descends by a minor third and then ascends by a major third

NEW DISCOVERY

OF THE PRINCIPLE OF

HARMONY,

With an Examination of That Which

Mr. Rameau Has Published Under the Title of

Démonstration of This Principle.

By Mr. Estève of the Royal Society
of Sciences of Montpellier.

Paris,

Sebastien Jorry, Imprimeur-Libraire,

Quai des Augustins, pres le Pont S. Michel,

aux Cigognes.

M. DCC. LII.

With Approbation and Privilege of the King

INTRODUCTION

If in our time the fortunate discovery of the calculation of auditory sensations were made, what admiration would not be given to this branch of fertile geometry? Although Pythagoras lived a very long time before us, there was the same interest in what he invented. To apply rule and measure to the tumult of sentiment, to find the relation of numerical truths to the movements of the soul, to submit passions and pleasures to proportions and calculation would doubtlessly be, in our century, epochal discoveries.

Before Pythagoras we find no means of transmitting the division of the octave, nor any science of music. In the succession (iv) of sounds, one perceived the sentiment expressed by the sounds only at the same instant the soul was moved by them. The soul knew neither how to foresee nor follow the movements which must have affected its sensibility. The soul did not have the illumination that could direct it in an examination of sentiment. Music was, as yet, but a shapeless art. A philosopher was needed to make it a science.

The Greek philosopher heard the peal created by hammers that struck successively. The sounds were agreeable, their union harmonious. And as genius nearly always views objects in their correct perspective, Pythagoras decided that in order to measure the sounds, it was necessary to weigh the hammers.

The above experiment was executed and repeated. They had hammers of different weights, the figures were varied, and finally it was learned that there were constant proportions between the weights and the sound produced by their fall. What had first been done to the weights was then applied to sonorous strings. Strings (v)
of equal length, upon being agitated, rendered sounds that were in the proportion of the weights that stretched them. Strings stretched by equal weights expressed sounds that were always in a constant relation to the lengths of these same strings. These weights and fixed lengths were the measure of sentiment; the movements of the soul were expressed by numbers. They learned that what was called the octave was a sound doubling the fundamental; what was called the fifth was a sound completing three vibrations during the same interval of time in which the fundamental completed two. Thus, one had the measure of all intervals.

It was the same in music theory as in all the sciences. The inventor applied himself to the subject; he had followers and critics. Gradually the discovery was accepted. The objections disappeared. And it was no longer permissible to doubt that to cal- (vi)
culate certain numbers was to calculate sentiments. But what is peculiar to this delicate use of numbers is that it is not enough to follow mechanically and spiritlessly the result of some principles that are given as truths. It is still necessary to know how to invent for each new application. It is necessary to turn the soul back in on itself, and make it penetrate the secret of its movements.

This science cannot be perfected by the mere habit of practice, and that is why it is still so near its beginning.

Another reason for the scant progress in music theory
has been the evident desire to go, perhaps too quickly, from theory
to practice. Before commencing applications, one should at least
fathom, better than has been done, the relation of numbers to the
sentiments that they express. Then, all false applications would
be prevented, and science would be given its full scope. But in (vii)
knowing the numerical expression of sounds without fathoming this
relation, what could be discovered by wanting to determine imme-
diately a musical system, a temperament?—possibly some systems,
some temperaments that might have some advantages over those that
were worse. Whereas if one had invented according to Pythagoras,
if one had not debased himself by detailing that for which he cannot
give the most rigorous proofs, if one had developed the essence of
the fundamental principle (and that is what we believe to have
accomplished), then one would have seen this principle in its true
light. One would have seen it produce, effortlessly, the best system,
the best temperament, the most perfect harmony, and the most agreeable
melody.

The universality of Descartes' genius led him to elucidate
all. Perhaps he had also seen that in order to advance music theory
it was necessary to forget what had been accomplished since Pytha- (viii)
goras, and to start again at the beginning. However that may be,
Descartes researched why certain intervals satisfied the soul and

were agreeable to it, while other intervals fatigued the soul and produced sensations that it rejected. The reason he gives is ingenious but not fundamental.

Descartes said that the soul easily judges simple ratios, and that they must be agreeable to it. Consonances are produced by simple ratios, thus they must be good intervals. Completely to the contrary, the terms of ratios that express dissonances are difficult to compare, the soul is not pleased and it therefore has a disagreeable sentiment.[1] Thus, Descartes has taken an operation of the mind for the source of sentiment in harmony. He reduced this sentiment to a comparative judgment.

The comparative judgment that decides the sentiment is in (ix)
several affections of the soul which, however, seem neither less vivid nor less immediate than a sensation. In order to decide the just and the unjust, it is doubtless necessary that the soul make several comparisons, and it nearly always happens that the soul makes its decision as if by sudden instinct. It has therefore not been retarded. It has not perceived the operations that have made the decision. Thus, the emotion produced by a sound, although appearing instantaneous, could be regulated, in part, by an operation of the mind.

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[1]Descartes' contribution to music theory was his *Compendium Musicae* (1618, first published in 1650). Rameau was familiar with Pere Nicolas Joseph Poisson's French translation of the *Compendium* published as *l'Abrégé de Musique* (Paris, 1668). There is a modern English translation entitled *Compendium of Music*, trans. Walter Robert, intro. and notes by Charles Kent (American Institute of Musicology, 1961).

Without contradiction, several sentiments are products of the operation of hearing. The love that we have for the good, horror for the bad, moral virtues and vices, the affections and antipathies that are their products, all of that is decided by a comparative judgment which precedes and determines the sentiment. But the sensations, transmitted by the organs in their effect upon the soul, have, in addition to this judgment, movements which carry them and (x) the most fixed characters, and which command to the soul the sentiment that must affect it by means of inalterable combinations.

In the order of discoveries in music theory, here is that which was most interesting, and which will be seen detailed in the work that follows: it is the mechanical principle that establishes essential differences between the agreeable intervals and those that are not so. It is, finally, this essential relation of numbers to sounds that had to be found, which alone could add to what Pythagoras had accomplished. There is no sound that is indivisible [seul] and isolated. What seems to be the most simple always has an accompaniment formed in its passage through the air. And the sound of a voice, string, or instrument, whatever it might be, arrives at the ear accompanied by small sounds that are called its harmonics. An interval is composed of two sounds, each of which has its own (xi) harmonics. I have calculated the reciprocal actions of these harmonics in all intervals, from which I have discovered that in consonances, that is in agreeable intervals, these harmonics mutually fortify each other, while in dissonances, that is in disagreeable

intervals, the harmonics oppose and destroy each other [se combatent & se détruisent].

From this calculation one concludes the principle that justifies the judgments of the soul in the sentiments that it has from sounds. For, since in a consonance the harmonics of the sounds that compose it preserve each other, consonant harmony leaves nothing to be desired. But dissonances, having no harmonics, cannot move the soul with pleasure: the soul refuses itself to a dry and truncated movement which cannot be in the order of nature, and their impression is disagreeable.

In the following work we will see the details of the calcu- (xii)
lation that decides these different affections of the soul, and the demonstration of the sentiment produced by sonorous impressions. All the laws for the progression and use of intervals will be seen to follow from this first principle. However, I have reserved these useful applications, which cannot add to the inalterable truth of the new discovery, for the Memoirs of the Royal Academy of Sciences.

I believe I must state that in the first [actually second] volume of the Academy to appear there will be two memoirs that are a continuation of what I publish today.[1] The one concerns the best

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[1]These memoirs were published as "Recherches Sur le Meilleur Système de Musique Harmonique, & Sur Son Meilleur Tempérament," Mémoires de Mathématique et de Physique Présentés a l'Académie Royale des Sciences, par Divers Scavans, et Lus dans Ses Assemblées (Paris, 1755), II, 113-136. This series published by the Royal Academy is occasionally cited as Mémoires des Savants etrangers or Recueils des savants etrangers.

system of harmonic music, and the other concerns the best musical temperament. In the first, it is a question of researching which is the best of possible scales and which scales of those of the Greeks, Chinese, etc., were superior. In the second there will be several very curious problems of temperament, as, for example, the (xiii) impossibility of finding a temperament that alters all intervals in the ratio of their consonances.

One might wish that what I have done for sound could extend to all the other sense organs, and that what we have accomplished for the sensations of hearing would be done for all the sensations. Then we could follow the mechanism of movements into the very being they affect. But I do not dare to speak of all the benefits that could be drawn from this knowledge, for it would be able to give us laws for all the affections of sensibility, to expose to us their origin, and to allow us to understand man.

But how many fortuitous ideas would be necessary to achieve such a useful science? The mechanism of sounds is not that of light, that of light is not that of taste, touch, smell—all of which act on different principles. It is not a combination of spiritual qualities that is required: these are mechanical movements in the soul (xiv) that can be submitted to calculation. What are required, at least, are explorations into all of man's sense organs. Considering, with regret, the great number of centuries during which geometry was applied to music without seeing any part of the mechanical principle of the auditory sense, I fear that an inimical destiny will yet

hide for a long time the universal law of the affections of the soul.

However, the above is important for us to know. I will not cease to repeat: what good is it to calculate eternally the movements of the heavenly bodies, why would one occupy his entire life in order to be able to predict what would have happened if there had been more planets, if they had been larger, if the law of attraction were different, etc.? Would it not be wiser to understand oneself, to apply the supreme science of calculation to the (xv)
elucidation of the soul with respect to its tastes and pleasures, and, finally, to make the soul find joy in itself?

It is known what would have been the orbit of the fifth satellite of Saturn if the sun had been smaller than it is. It is not known why all edifices must have a pyramidal form, nor why the soul is pleased in considering a column that is in exact proportion. I propose these two problems after having resolved them with several others of the same type. One should not think that I seek explanations based on analogies such as those with which architects are content. The mechanical action that decides the sentiment of the soul is required. By examining the other senses after that of sight, one would connect the sensations to each other by means of the order of truth. One would lead the mind with lucidity from the grandest ideas to the sentiments.

I have added to this work an examination of that which Mr. (xvi)
Rameau has published under the title of Demonstration of the

Principle of Harmony. Do not imagine that I pretend to judge this very skillful musician. Very far from this presumption, I have compared what he has seen with the mechanical and primitive principle for which he has not searched. To desire to deprecate him would be to lack sensibility; to have no sensibility would be to acknowledge oneself incapable of judging him.

NEW DISCOVERY (1)

OF THE PRINCIPLE OF

HARMONY,

With an Examination of That Which

Mr. Rameau Has Published Under the Title of

Demonstration of This Principle.

It is known that when a single string vibrates or when a single pipe resonates, the principal sound causes other sounds to arise in the passage it makes in the air in order to reach our ears. This sound that was believed to be alone [*unique*] is heard to be accompanied constantly by its twelfth and seventeenth, that (2)
is to say, by sounds that are called the harmonics of the fundamental. This is an experimental truth that is easily proved. In a quiet place, during the silence of the night, pluck a harpsichord string, or resonate an organ pipe. Be attentive to the conclusion of the sound. You will hear distinctly some high sounds that are united to the fundamental, and that do not have enough force to be distinguishable in their origins. These high and harmonic sounds are the octave of the fifth and the double octave of the major third of the principal sound. A single sound constantly produces two others.

The harmonics have been known for a very long time. Aristotle spoke of them, since he wondered why sounds become higher

while finishing. Messrs. Sauveur and Mairan[1] have also distinguished the harmonics from the principal sound, and this has provided them with explanations for several phenomena. Finally, Mr. Rameau says that he finds in the harmonics the principle of harmony, which is the object of our research. (3)

This learned musician searched for the most natural intervals of sounds. After having produced a sound, one can choose, among an infinity of others, another which is desired to succeed the first. But among this infinity there are doubtlessly some that are found in the course of good music. Therefore it was a matter of knowing which sounds must be given preference. Mr. Rameau consulted his ears. He attempted some melodies [nuances] and found certain passages that seemed to him the most natural. But beyond the fact that they are not so, this manner of deciding the question is faulty. Education shapes our ears. It makes them (4) take one form, and habituates us to certain sentiments that must seem the most essential to our being, but which are so only by chance.[2]

It is a question, however, of finding a fixed, invariable and necessary rule. Mr. Rameau wishes to penetrate the first principles of his art. He listens to a sound, hears its harmonics. Immediately he goes on to say that the twelfth and the seventeenth

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[1] See the citation to Green's dissertation on p. 5 above.

[2] These are Rameau's arguments for abandoning the procedure mentioned.

must be the most perfect intervals. Moreover, these three sounds form a primitive chord from which all the rules of musical art must follow—those of melody, of accompaniment, all must conform to this origin. All must be reduced to it. That is the thrust of his demonstration. He wants to find all the sentiments subject (5)
to music in the combinations of the harmonics of a single sound.

Since Mr. Rameau wants to find all the precepts of composition in the chord formed by the harmonics, it is necessary, before studying this chord in its combinations, to research its formation and essence. What is the cause of these feeble sounds that always accompany the principal sound? Are not these sounds products of our imagination? Is not there a trap that disguises the essential source? In wanting to employ the term demonstration, why hasn't Mr. Rameau raised these doubts?

Air is composed of segments of different springiness [different ressort].[1] Thus, it is demonstrated that whatever might be the violence of a blow which puts a spring of air [un ressort] in motion, it has explosions of equal duration (i.e., this spring (6)
compresses and expands in an equal time). The single difference is that when the blow is stronger, the spring is consequently more

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[1]The quality of air, ressort, can be translated as springiness or elasticity. (The OED cites Robert Boyle's use of the phrase "spring of the air.") But Estève also writes of un ressort of air with a meaning very close to that of Rameau's particules of air mentioned in the Harmonic Generation (pp. 3-4). Since other terms were available to Estève, I am assuming he wished to emphasize a certain quality. Therefore, I have translated ressort as spring with the understanding that particle is implied.

agitated though the time for opening and closing remains the same. Thus air is composed of segments which when struck by whatever kind of blow will tighten and relax their springs in a time interval that nothing can change. It is futile to augment or diminish the force of the blow—one could not change the time that each spring must employ in opening and closing.

Now when a spring is vibrating, when blows are repeating themselves in the air at a determined interval, there will be in the air some segments that will have finished their vibrations at (7)
the same time as the string; there will be, I say, some springs that will always be aided in their movements, and there will be some that will continuously be stopped [empêchés]. These last, not being found in the order of the concurring movements, will be agitated but feebly. They will not carry any sound, unlike the others, which, continuously struck appropriately, will have a continuous, uniform movement. The latter movements will be communicated to similar segments, which, in their turn, will be able to transmit them to others. In this manner these sounds will disperse in the air.

These segments of air that are always aided in their movements are, at first, the unison or springs whose vibrations are precisely of the same duration as that of the string. Next comes (8)
the octave or springs of which two vibrations correspond to one of the string. Then comes the twelfth, the octave of the fifth of the fundamental, which makes three precise vibrations while the

fundamental makes one. There is yet the double octave of the fundamental, that is, the springs that make four vibrations while the fundamental makes one. There is also the major third of the double octave, which makes five vibrations while the fundamental makes one. And finally there is the double octave of the fifth, which makes six vibrations in the same interval of time that the fundamental makes one. The harmonic that comes after that no longer falls in the intervals of our scale, and it is probably necessary to stop there.

The harmonics are, therefore, the octave, the octave of (9)
the fifth, the double octave of the major third, the double octave of the fifth. Or, taking ut as the fundamental, the order of the harmonics will be, in ascending order, the octave ut, sol, ut, mi, sol. That is the expression of all the springs which, in moving more quickly than the principal sound, are always aided in their movements. They finish their vibrations precisely in the same instant they receive new impressions. These harmonics are above the principal sound. One can easily be convinced that they are not below it, because each of the springs that moves more slowly than the vibrations of the string cannot correspond with these vibrations. These same vibrations come to strike the slow and sluggish springs with a second blow while the slow springs still continue their first (10)
oscillation. In the middle of their movement in one direction, they are diverted by a direction that carries them to another side. Thus, through opposed directions, the forces are destroyed [<u>détournés</u>].

But, the springs that make precisely two, three, four, five and six vibrations in the same interval of time that the string makes one, are always struck at the instant that they are going to recommence their oscillation. For these springs the new impression is entirely efficacious; it aids and renews appropriately the power that would soon be enfeebled. These are the only springs that vibrate continually and give the sounds that accompany the fundamental.

However, it should not be said that the sound which makes
seven vibrations in the same interval of time that the fundamental (11)
makes one must also be ranked among the harmonics: I repeat, this sound does not fall in the intervals of our scale. Yet it is still necessary to attend to the fact that while the sound is produced only by an equal and uniform movement, the springs, which by means of a first impression must make a large number of vibrations before receiving a second blow, these springs, I say, will have no uniform equality in their movements. These springs will be nearly at rest when they will again be struck, too late in their behalf, by the fundamental. The new blow will not serve to aid the continuous movement, but will return to motion that which was weakened by the time of the pause. These springs will not carry any sounds.

The harmonic sounds thus have their origin in the movements (12)
of the segments of the air, and besides the two known to Mr. Rameau, there are still three others that the ear knows how to distinguish.[1]

[1]Rameau, of course, knew of all the harmonics.

This makes a total of five harmonics that are necessarily found in the mechanical action of all sound. Whether or not one is attentive, whether or not one distinguishes the harmonics in a sound, none escapes us and all are carried to the ear and refine [adoucissent] the principal impression by means of gradations. When one believes he is hearing a single sound, he is deceived. It is above all a mixture of sounds placed harmonically—a natural harmony.

Mr. Rameau, who has not gone back to the cause of harmonics and who is content with hearing them, correctly believes them to be essential to all sound. For it is evident that any (13)
movement will not be able to be transmitted to our ear without passing through the air, and since the passage of the principal sound in the air produces harmonics, all sound will have harmonics. Thus Mr. Rameau has said, "each event that produced on my ear a composite impression caused me to hear sound." I do not see with the same clarity why he says in the preceding lines, "each event that produced on my ear an indivisible and simple impression caused me to hear noise."[1] Because if all sound by its nature is never indivisible, if the accompaniments are essential to it, why would noise, which is a principal sound, be deprived of accompaniment? Have not the harmonics been produced for movement, for the sonorous property? This movement, this sonorous property, exists in noise.

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[1]Cf. pp. 26-27 above (R, p. 12).

Thus the harmonics must be found there. If the author [Rameau] (14)
demonstrates that the principal sound called noise can continuously suppress the harmonics that must always accompany it, then he would be able to conclude that "each event that produces on my ear an indivisible and simple impression causes me to hear noise."

The harmonic sounds are distinguished only with great attention and in a principal sound that is alone. In a succession of several sounds, in a continuous melody, the most delicate ear does not distinguish them better than the most unperceptive one. But although these harmonics are not heard distinctly, they nevertheless do not escape sentiment. They are found in the mechanical and necessary action of sounds; they enter the ear, excite its
nerves and produce in each impression this gradation of feebler and (15)
higher sounds that is distinguished only by the refinement and melody of the sonorous movements. Thus, one must not say as Mr. Rameau has said, "I realized that these harmonic sounds were very high and fleeting, and that, consequently, it would be necessary to have an ear that would grasp them more distinctly than an ear that perceived but two harmonics, or one which was affected by only a single harmonic, or perhaps even one that received no impression at all."[1] In the practice of music an ear distinguishes no harmonics—all are fleeting to the mind. But the sentiment loses nothing; it obeys the movements that develop it. It must no longer

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[1]P. 27 above (R, pp. 13-14).

be said that "that is one of the sources of the difference in sensibility to music one notices amongst people. There are people (16) for whom music will only be noise. There are those who will be affected only by the fundamental sound, for whom all the harmonics are lost."[1] People, such as those conceived by the author [Rameau], necessarily would have no nerves that could be excited by the action of the harmonics, since there is only a resistance to the higher movements in the action of the harmonics that could prevent the harmonics' effect. From which one must conclude that in order to demonstrate that the lack of sensibility comes in part from not distinguishing the harmonics, it would be necessary to establish that the force of inertia of the ear is always proportional to this lack of sensibility, and that the people for whom music is only noise have an insensitive ear that does not permit them to distinguish the feeble sounds. This is not so.

Until now, only the harmonics and their origin in the air (17) have been known. It is a relationship of correspondence [convenance] and of isochronism [isochronisme] that has produced them. Does this relation suffice to make them the most perfect? This is what Mr. Rameau has not wanted to fathom. He is content to say, 'nature shows me a chord that nature itself has formed; that is the primary principle to which all must be traced.' He has not dared to ask of this nature: the reason for the chord that it indicated to him,

[1]P. 27 above (R, p. 14).

when it bagan to give rise to the chord, or what laws it followed in the chord's formation. He has not asked whether he heard the chord as it was, if his imagination had not changed it, and finally if it had not been an illusion. In deciding by means of an indication, Mr. Rameau only imagined to draw from the combinations of the harmonics the precepts of musical art. Let us agree, for
an instant, with all that he says. He will never be able to con- (18)
clude that he had given a demonstration. He established only that his system furnished several just consequences.

Having gone back to the cause of the harmonics, we found at least five of them, and it would seem that once some of them are taken as the source, there would be an identical reason for taking them all. But Mr. Rameau, who knew of only two of them, did not speak of the other three. It is true that that will not be an objection for him, because he will not fail to say that of the three harmonics of which I have spoken, two are octaves of the fundamental and the last is the octave of the twelfth. Thus [according to Rameau], any sound is the same as its octave. There-
fore, these three forgotten harmonics are only repetitions of what (19)
is in the expression of the first two; they will not provide for new combinations. Is it not thus that he has argued about the two harmonics that he knew? These harmonics did not furnish useful combinations, and he lowered them to the octaves below in order to find what he was looking for, while the harmonics that he had forgotten are the octaves above.

This law by which Mr. Rameau has doubtlessly authorized himself to overlook the harmonics of which he has not spoken, this law that he has used in rendering the principle indicated by nature more fecund, this law, I say, that any sound is the same as its octave, had been observed in the practice of musical art.
Thus the mixture of the principal sounds and their harmonics pro- (20)
duces this same law. Before applying the law to the harmonics considered alone, we must be assured, by means of theoretical reasons, not only that octaves are always replicates in the principal sounds [i.e., as experienced in practice], but also that they would be so in the harmonics considered alone.

As I seek only to justify this great man, whom perhaps it might have been thought I wanted to oppose, I am going to consider the action of all the movements that are found in the interval of the octave. Perhaps we will find that Mr. Rameau has correctly applied to the harmonics the law that he has observed in their combination.

The interval of the octave is formed by two sounds. Each
of these sounds has its harmonics in the same ratio to the principal (21)
sound. The lowest sound has its first harmonic at the unison of the highest principal sound. This high principal sound, which forms the interval of the octave, reinforces the first harmonic of the lowest principal sound, and could be regarded merely as better developing [mieux developer] this first harmonic. With the second harmonic of the lowest principal sound making three vibrations

while the highest [principal] sound is making two, the fundamental sounds combat each other in this harmonic. The movement that the one produces is destroyed by the other. This second harmonic has no continuous uniformity of movement; before having quite finished its vibrations it is interrupted. Thus it will not be carried to the ear and will be destroyed. The third harmonic of the lowest sound joins with the first harmonic of the highest sound. Both (22)
make the same number of vibrations in the same interval of time. In continuing these considerations one finds that the fourth harmonic of the lowest sound is destroyed by the highest principal sound. The fifth harmonic of the lowest sound joins with the second harmonic of the highest sound. The third, fourth and fifth harmonics of the highest sound are also preserved.[1] In the interval of the octave, the first, the third and the fifth harmonics of the lowest sound are aided by the highest principal sound. This second sound [i.e., the octave] preserves all of its harmonics.

Since in the interval of the octave the highest principal (23)
sound preserves all its harmonics, and since it can be regarded as better developing by means of its unison the first harmonic of the lowest principal sound, this interval of the octave has the same degree of harmony as the melodic octave [la mélodie]. The sound that is added in order to form this interval is placed upon

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[1]The third, fourth and fifth harmonics of the highest sound are preserved, apparently, because Estève has totally disregarded the harmonics above the fifth harmonic of the lower principal sound.

[i.e., in unison with] the first harmonic of the fundamental. It preserves all its harmonics as the fundamental did when it was alone. Thus the second principal sound must not communicate movements different from the first. They must both arouse nearly the same idea, and that is why this interval is but a repetition. Of the two [principal] sounds that compose it one can be taken indifferently for the other.

The conflict of the harmonics can reveal this law in the principal sounds: every fundamental is the same as its octave. (24)
It is true that if this law were essential to every sonorous movement it would be found even more strongly in the principal sounds accompanied by their harmonics than in the harmonics considered alone. But why assign to every unique sound this property of being the same as its octave? The only possible reason is that it is observed in the practice of music. But in the practice of music one has only the combination of the principal sounds with the harmonics [and never the harmonics alone]. With the conflict of the harmonics capable of producing this law without any [harmonics] individually having it, I do not see that one must admit that every unique sound [i.e., either principal or harmonic] is the same as its octave.[1]

Therefore Mr. Rameau has in no way proved that the harmonics (25)

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[1]Estève seems to be accepting the principle of the identity of octaves with respect only to fundamental sounds, and not to harmonic sounds.

should be confused with their octaves [which are also harmonics]. Moreover, since this principle is not only supposed but also lacks probability, he [Rameau] could say, in speaking of the fundamentals, "thus we confuse all octaves in order to aid ourselves according to our own needs."[1] But he had to be careful in applying to the harmonics the property that their combination produced and that each in particular did not have. One must not lower these harmonic sounds to their octaves below, and conclude that he was always with the principle of nature. To say the interval of the major third and of the fifth can be taken for that of the twelfth and the seventeenth is to depart from nature. These new intervals cannot represent the harmonics. They are false images of that which nature has merely indicated. (26)

It has already been proven that the harmonics are only above the fundamental. If the movements of the strings are followed exactly, then it would be recalled that the sound is produced not by the string's vibration or transfer but by the vibration of imperceptible segments. The sonorous movement does not begin when one applies the movement of vibration, but when this vibration returns upon itself. If one combines these laws, one will always find that harmonics are above the principal sound and never below. Mr. Rameau even seems to agree with this when he says that after

[1]The original, on p. 29 above (R, p. 17), is as follows: Ainsi neus confondons naturellement toutes les répliques pour nous en aider selon nos besoins. (Thus we naturally confuse all replicates in order to aid ourselves according to our own needs.)

tuning two strings below the fundamental, the one to its twelfth and the other to its seventeenth, they are both divided in order to repeat the unison of the fundamental.[1] The entire sound of (27)
these strings was not heard—it was the sound of the third of one, and the fifth of the other. What Mr. Rameau observed of two strings is even observable of several others of different length, as Mr. Sauveur observed and demonstrated in the <u>Memoirs of the Royal Academy of Sciences</u>.[2] The sonorous bodies tuned below the fundamental are constantly divided in order to render the unison of this same fundamental, but only when they can do it exactly. I repeat, these sonorous bodies tuned below the fundamental cannot vibrate in their entirety. They must be divided in order to render the unison of this same fundamental, which, consequently, does not have any harmonics below.

The dividing characteristic of strings is not peculiar to (28)
those that are tuned to the twelfth and the seventeenth below the principal sound. Also, the latter do not vibrate in their entirety because they only repeat the unison. Mr. Rameau has concluded, however, that the sounds that these strings can produce in their entirety (or the twelfth and the seventeenth below the fundamental) are harmonics indicated by nature as being the demonstrated principle of harmony. He implies that this experiment gives to him

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[1] See pp. 30-31 above (R, p. 21).

[2] Green, in the dissertation mentioned on p. 5 above, gives specific citations to Sauveur's works.

the same intervals below the fundamental that he had heard above it. But besides the fact these intervals are not unique in this manner, they still have no relationship to what has been concluded.

After having admitted these new harmonics, Mr. Rameau (29)
brought them nearer the fundamental by raising them to their octaves. He took from them representations, false images, just as he demonstrated at the occasion of the harmonics heard above the fundamental, which the author [Rameau] had lowered to their octaves. And since it has been concluded that to lower the true harmonics to their octaves is to depart from the principle of nature, how true is this consequence when the false harmonics are raised. All the same, Mr. Rameau would like to maintain, through the authority acquired by his genius and taste, that one can change the octaves of the harmonics without ceasing to follow the principle of harmony. If he reflected upon it, he would never say that the intervals
below the fundamental are indicated by nature and discovered through (30)
experiment. Let us grant him the intervals of the major third and the fifth as the first consequence of those of the seventeenth and the twelfth; but it would be unfair to him to want to excuse similar intervals that he places below the fundamental. A supposition is necessary in order to advance the former; to maintain the latter would require the admission of a previously demonstrated falsehood. Because, finally, if there is an infinity of sonorous bodies that repeat the unison of the fundamental in their segments, must I choose some of these bodies as the representation of the sound that

they can but do not render? Would that be rational? Would that be a demonstration?

In combining the intervals of the major third and the fifth above the fundamental with similar ones below, Mr. Rameau deduced several rules of composition and practice. These consequences conclude his work. (31)

But when, in spite of the obscurity of the combinations, one would agree that Mr. Rameau has followed a series of truths with lucidity and rigor, this gratuitous supposition would be able to justify his system; however, whatever scope the author gives his system, we would never know how to establish the demonstration of the principle of harmony. This same supposition is found in the art of applying the principle and of drawing consequences. In its greatest extent it would be used to draw just consequences from a principle that is neither demonstrated nor could be taken as an axiom.

None of the following are demonstrated and must be admitted only as ingeniously found hypotheses: the harmonics that Mr. Rameau said are not found in noise; the harmonics that he said are not heard by those who do not have a sensibility for music; the two harmonics that he had heard and lowered to their octaves; similar harmonics below the fundamental; and finally the combinations of the two latter suppositions. Mr. Rameau's work, or rather his opinion, is that the chord called perfect is the most agreeable of all the chords, and that the chord, being placed above or below (32)

the same sound, furnishes by its combinations several rules of practice and composition—that is all.

The author [Rameau] will acknowledge that in wanting to go further he gives only indications in place of proofs. And how important to him are the harmonics that accompany the principal (33)
sound, if he takes them where they exist and where they do not, and if he employs only their false representations? These principles are given by nature only in a remote fashion. One could have the analogy observed without rendering it necessary and immediate. There is no demonstration here.

If Mr. Rameau wanted to find the true principle of harmony, he should have gone further and searched for why certain sounds are united and produce agreeable sensations, and why others conflict and are disagreeable. This is what must be regarded as the elements of the theory of the sonorous sentiment. Is it not more fitting to decide in this manner than to say: I have heard fixed (34)
and invariable intervals, they must therefore be the principles of harmony? Not searching for the cause, the essence of these intervals, combining their terms, taking each combination as precept, justifying the principle by the truth of these precepts—these are not in the nature of demonstration.

Descartes has said, the soul easily judges the simple ratios, and they must be agreeable to it. The consonances are produced by simple ratios, thus they will be good intervals. Completely to the contrary, the terms of the ratios that express the

dissonances are difficult to compare; the soul is not pleased with them, it has a disagreeable sentiment. Thus it is an operation of the mind that Descartes has taken as the principle of the sentiment of harmony. He has reduced this sentiment to a com- (35) parative judgment. I would even be able to oppose this opinion here, but I am anxious to establish the truth.

An interval is formed of several sounds; each of these sounds carries its harmonics, and, at the first instant, there is a totality of impression that must be measured. This conflict of the harmonics has already been considered in the interval of the octave. We have seen that in this interval, the first, the third, and the fifth harmonics of the lowest sound are aided by the highest principal sound, and that this second sound preserves all of its harmonics. I consider all the consonances similarly, and I have calculated thereby a table in which their harmonics are found. By a simple inspection of this table, one will be able to know those (36) harmonics that are preserved or destroyed. The lowest principal sound ut is expressed in the table by the number one, or rather this sound makes one vibration while the harmonics UT, SOL, etc. make 2, 3, etc. vibrations.

TABLE OF THE HARMONICS OF THE CONSONANCES

Fundamental	ut	UT	SOL	UT	MI	SOL	7	UT	RE	MI	11	SOL
Octave	UT	UT		UT		SOL		UT		MI		SOL
Fifth	SOL		SOL	[r	e]	SOL	[s	i]	RE			
Fourth	FA	[f	a]	UT	[f	a] [l	a]	UT				
Maj. Third	MI	[m	i] [s	i]	MI	[6	$^{1}/4$][s	i]				
Min Sixth	$1^{3}/5$		[3	$^{1}/5$][4	$^{4}/5$]	[6	$^{2}/5$]	UT	[9	$^{3}/5$]		
Min. Third	$1^{1}/5$	[2	$^{2}/5$][3	$^{3}/5$][4	$^{4}/5$]	SOL	[7	$^{1}/5$]				
Maj. Sixth	LA		[l	a]	MI	[l	a]	[8	$^{1}/3$]	MI		

The first vertical column of this table contains the name of the consonant intervals. In the second column these intervals are expressed by the names of notes that represent them. When some interval, always in relation to ut, has not fallen into the just diatonic, it has been expressed by the number of its vibrations. Thus the minor sixth found in the table between sol and la is expressed by (1 $^3/5$), because that is the number of vibrations that the highest sound of this interval makes while the lowest ut makes one vibration. (38)

In the first horizontal column opposite the fundamental ut I have placed in order all the harmonics, and each of these is at the head of a horizontal [i.e., vertical] column. The harmonics of all the consonant intervals are found placed in order in these columns. When the harmonics of the sounds that form consonant intervals with ut correspond with the harmonics of this same ut, I have written them in large characters and in the column where the same harmonic of the fundamental is found. If these harmonics fell in the just diatonic, without being the same as those of the fundamental, I have written them off to the side and with the names of notes that express them [in small characters]. But if these harmonics fell neither upon the harmonics of the lowest principal sound nor in the just diatonic, I have written them as the number of their vibrations.[1] (39)

[1]It should be noted that the fundamental of the second

With this table thus constructed, one sees in an instant the harmonics in the different consonances, that are either preserved [se conservent] or destroyed [se détruisent]. In the octave, the highest principal sound preserves all its harmonics. (40)
In the fifth, its second and its fourth harmonics are destroyed. In the fourth, its first, third and fourth harmonics are destroyed. Those are the perfect consonances. In the imperfect consonances, there remains preserved but one harmonic for each, except for the major sixth which has two.

By means of this table one sees that the interval of the octave preserves nearly all of its harmonics; that of the fifth carries but three; that of the fourth only two; that of the imperfect consonances carries only one. But that of the major sixth preserves two, MI and the octave of MI, while the fourth carries UT and its octave. By means of the following table, one can be convinced that the dissonances do not preserve any harmonics;
that only the major seventh preserves its fourth harmonic, which (41)
is the RE of the third octave, inferior to all the harmonics of the consonances.

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horizontal column (the octave) is repeated in the third vertical column. All the other fundamentals are in the second vertical column, and all of the correspondences are with respect to the first fundamental ut.

TABLE OF THE HARMONICS OF THE DISSONANCES

Fundamental	ut	UT	SOL	UT	MI	SOL	7	UT	RE	MI	11	SOL
Maj. Second	re	[r	e] [3	3/8] [r	e] [5	5/8] [6	6/8]					
Min. Seventh	1 4/5		[3	3/5]	[5	2/5]	[7	1/5]	RE	[10	4/5]	
Maj. Second	1 1/9	[2	2/9] [3	1/3] [4	4/9] [5	5/9] [6	2/3]					
Min. Seventh	1 7/9		[3	5/9]	[5	1/3]	[7	1/9] [8	8/9]	[10	2/3]	
Min. Second	1 1/15	[2	2/:-5] [3	1/5] [4	4/15] [5	1/3] [6	2/5]					
Maj. Seventh	Si		[3	3/4]	[5	5/8]	[7	1/2]	[9	3/8]	[11	1/4]
Tritone	1 13/32	[2	13/16]	[4	7/32] [5	5/8]	[7	1/32][8	7/16]			
False Fifth	1 19/45	[2	38/45]	[4	12/45][5	31/45]	[7	1/9] [8	24/45]			

We have already seen that the impression which seems simplest is multiplied in its harmonics, and that although one does not at first distinguish a composite sound in a single sound this is but an apparent simplicity. The simplest sentiment is therefore composed of impressions of different force which refine [adoucissent] the principal impression by means of gradations. This is otherwise in the different intervals; all the sounds do not carry their harmonics, some are destroyed mutually. But what is constant is that the most perfect consonances preserve the most harmonics and that the dissonances lose all of them. (43)

The primary blow, the instantaneous impression forced by the different intervals, is not always the same. When one hears
a consonance, at the same instant one also hears harmonics in pro- (44)
portion to the perfection of this same consonance. But when we are made to hear intervals called dissonant, there are no longer any harmonics. Only the fundamental sounds denuded of their natural accompaniments remain. That is, therefore, an essential and distinctive character in the instantaneous and mechanical action of the intervals. There only remains to be seen if this difference can give the difference of the degree of harmony of the intervals.

Since every sound carries with itself its harmonics, or rather its accompaniment, this same accompaniment is in the order of our ears. There is in the simplest sound a gradation of sounds—sounds that are feebler and higher, which refine by means of nuances
the principal sound, and make the principal sound lose the highest (45)

sound most quickly. That is what a sound is; the accompaniment is essential to it and makes it sweet [douceur] and melodious. Thus every time that this refinement [adoucissement], this accompaniment, or rather the harmonics are reinforced and better developed, the sounds will be more melodious, the nuances better sustained. It is a perfection, and the soul must be sensitive to it. That is why the consonant intervals are agreeable. The more the harmonics are destroyed, the less the soul will be satisfied with these intervals; these are the imperfect consonances. Finally, when no harmonic is preserved, the sounds will be deprived of their refinement and their melodiousness; they will be harsh as if emaciated. The soul will refuse them; it will search for the refine-
ment that it had always found in the [consonant] sounds; and above (46)
all, by seeing only a sustained harshness, it will feel a sentiment of inquietude, disagreeability. That is how one is not pleased by the dissonant intervals.

Without waiting for the judgment of the soul, the mechanical action of the intervals causes their sensation to be varied. That is what must have been sought before having recourse to the reflective sentiment. It was necessary to calculate the movements and the forces that can occasion and establish with precision their constant differences. Therefore, one would have known that a consonance always preserves some harmonics; that the consonant harmony resembles melody; that it is merely a species of melody
whose harmonics are reinforced; that the two melodious parts of (47)

this consonant harmony are of the same species in their particularity and in their reunion. All is in its place; nothing is surprising: the new sound added in order to form the interval does not cause the structure of the first sound to be lost, it develops it further.

Completely to the contrary, the dissonances have lost their harmonics. These isolated sounds are not at all of the same genus as melody. It is like a contradiction between the melody and the new sound that was added in forming the dissonant harmony. The impressions from such dissonance cannot move the soul with pleasure. The soul refuses itself to a dry and truncated movement which does not seem to be in the order of nature, and the dissonances are disagreeable.

Not only is the conflict of the harmonics the true prin- (48)
ciple of harmony, but it is even appropriate that this is so. Because, if, as Descartes had thought, the sentiment of harmony had been regulated by the mind, then a judgment of the mind would have been necessary to decide what was agreeable and what was not. The sentiment would have been regulated by that which is foreign to it and which only tends to destroy it, because these two faculties of the soul, mind and sentiment, can almost never mutually agree and assist each other. The sentiment that is regulated by the mind does not have vivacity. If the mind is regulated by sentiment, it does not have precision. Thus the mind must not be placed where sentiment should be. It would have arrested and suspended the

vivacity of sentiment. I repeat, sentiment has vivacity only because the mind cannot govern it, and it must not have the responsibility of augmenting sentiment. Sentiment must be regulated (49)
only by sentiment. Very far from having the mind hear, distinguish, measure and compare the movements of the sounds, it is necessary to forget, to hide the movements from the mind, and even to fatigue the mind in case it wanted to place itself where one did not want it.

Independently of these primary reasons, there are yet experiences that are all objections to Descartes' opinion. Because if the soul distinguishes dissonance from consonance only when it is attentive to comparing the sounds, I would readily ask why the soul is not aware of itself in this operation? And, if it is not familiar with the operation, why do you attribute the operation to it? Has it not often happened to you that with the mind occupied in considering some object, you have been distracted by the dis- (50)
agreeable sentiment of a dissonant interval? Do not say that the mind compared these vibrations at the time. It was not following the sounds. But if one was reduced to saying that the soul must wait a longer time for judging the ratio of the sounds that form dissonances than of those that form consonances, one would still be in error, since the minor third, the minor sixth and the minor seventh have vibrations that conjoin at an equal interval of time. These three intervals, very different in degree of harmony, would be equal by this principle, which, therefore, is proven false.

That is doubtlessly enough to conclude that it is not through a reflective sentiment that there are consonant and dissonant intervals. The principle of harmony is mechanical, and, doubtlessly, the impossibility of this [principle] would have to be demonstrated (51) before having recourse to the [other] principles that have been generally accepted.

Mr. Sauveur had imagined another principle of harmony. Here are his words according to Mr. Fontenelle: "In following this idea, one finds that the intervals whose beats [battemens] are not heard are exactly those that musicians consider consonances, and that those whose beats are heard are the dissonances; and that when an interval is dissonant in a certain octave and consonant in another, it is that it beats in the one, and does not beat in the other." In order to understand these beats, here is what the same author says later: "When one hears the tuning of the organs, and when two pipes that approach the unison sound together, there are certain instances when the common sound that they render is very (52) strong, and these instances seem to return in equal intervals." These beats [battemens] are caused by the conjunction of the vibrations. There, where the vibrations reunite and join in striking the ear with the same blow, one must hear a stronger sound. This is what is demonstrated. This is what Mr. Sauveur had thought. But the consequence that he drew does not seem to me to have the same degree of certitude.

The octave and the fifth have their beats at every two

vibrations of the fundamental. The fourth and the major sixth have their beats at every three vibrations of the fundamental. The minor third, the minor sixth and the minor seventh have equal undulations, that is to say, in an equal interval of time. The swellings of sounds, the sonorous undulations are found, therefore, at the same (53) distances in intervals that are very different in degree of harmony, as also in good and bad intervals. They are not therefore the source of the difference of these same intervals.

I do not say that the beats are completely foreign to the sentiment of harmony. They are found in the intervals, but are not their primary source. Without contradiction, their action, which is mechanical, can establish a difference and augment the variety that we have already discovered. It will be the same with the judgment of the soul, when the soul is attentive to comparing the sounds. But it always remains constant that the essential and fundamental difference of the intervals is neither the combinations given by Mr. Rameau, nor a sympathy, nor a judgment of the soul, (54) nor a reflective sentiment, nor the variety of beats. This difference is established by the mechanical action of the harmonics preserved in the consonances and destroyed in the dissonances.

The End.

SELECTED BIBLIOGRAPHY

This bibliography includes only those works cited above and, from among those consulted, a selection of titles found to be especially relevant. More comprehensive bibliographies on Rameau can be found in Girdlestone's biography and in Jacobi's commentary to The Complete Theoretical Writings of Jean-Philippe Rameau.

Ahnell, Emil Gustave. "The Concept of Tonality in the Operas of Jean-Philippe Rameau." Unpublished Doctor's dissertation, University of Illinois, 1957. Pp. xii + 269.

Alembert, Jean Le Rond d'. Elémens de Musique Théorique et Pratique Suivant les Principes de M. Rameau... Nouvelle Edition. Lyon: Jean-Marie Bruyset, 1762. Pp. xxxvi + 236.

________. Preliminary Discourse to the Encyclopedia of Diderot. Trans. Richard N. Schwab with the collaboration of Walter E. Rex. Indianapolis: Bobbs-Merrill, 1963. Pp. lvi + 170.

Castelnau, Junius. Mémoire Historique et Biographique sur l'Ancienne Société Royale des Sciences de Montpellier... Montpellier: Boehm, 1858. Pp. xxiv + 308.

Cotte, Roger. "Estève, Pierre." Die Musik in Geschichte und Gegenwart. Hrsg. Friedrich Blume. Kassel: Barenreiter Verlag, 1949-68, III, cols. 1575-76.

Descartes, René. Compendium of Music. Trans. Walter Robert with an introduction and notes by Charles Kent. American Institute of Musicology, 1961. Pp. 55.

Dulieu, Louis. "La Contribution Montpelliéraine aux Recueils de l'Académie Royale des Sciences." Revue d'Histoire des Sciences, XI (1958), 250-62.

________. "Le Mouvement Scientifique Montpelliéraine au XVIIIe Siécle." Revue d'Histoire des Sciences, XI (1958), 227-49.

Estève, Pierre. L'Esprit des Beaux Arts. Paris: C. J. Baptiste Bauche Files, 1753; rpt. Geneve: Slatkine Reprints, 1970. 2 vols.

________. Nouvelle Découverte du Principe de l'Harmonie, Avec un Examen de ce que M. Rameau a Publié Sous le Titre de Démonstration de ce Principe. Paris: Sebastien Jorry, 1752. Pp. xvi + 54.

________. "Recherches Sur le Meilleur Système de Musique Harmonique, & Sur Son Meilleur Tempérament." Mémoires de Mathématique et de Physique Présentés a L'Académie des Sciences, par Divers Scavans, et Lus dans Ses Assemblées, II (1755), 113-36.

Ferris, Joan. "The Evolution of Rameau's Harmonic Theories." Journal of Music Theory, III (1959), 231-56.

Girdlestone, Cuthbert. Jean-Philippe Rameau: His Life and Work. Rev. ed. New York: Dover, 1969. Pp. x + 631.

Green, Burdette Lamar. "The Harmonic Series from Mersenne to Rameau: An Historical Study of Circumstances Leading to Its Recognition and Application to Music." Unpublished Doctor's dissertation, Ohio State University, 1969. Pp. xi + 507.

Hahn, Roger. The Anatomy of a Scientific Institution: The Paris Academy of Sciences, 1666-1803. Berkeley: University of California Press, 1971. Pp. xiv + 433.

Hayes, Deborah. "Rameau's Theory of Harmonic Generation: An Annotated Translation and Commentary of Génération Harmonique by Jean-Philippe Rameau." Unpublished Doctor's dissertation, Stanford University, March 1968. Pp. ix + 362.

Index Biographique des Membres et Correspondants de l'Académie des Sciences du 22 Decembre 1666 au 15 Decembre 1967. Paris: Gauthier-Villars, 1968. Pp. xiv + 574.

Keane, Sister Michaela Maria. The Theoretical Writings of Jean-Philippe Rameau. Washington, D. C.: The Catholic University of America Press, 1961. Pp. xiii + 265.

Leeds, Frederick M. "Diderot: The Philosopher as Musician." Unpublished Doctor's dissertation, Pennsylvania State University, December 1971. Pp. v + 142.

Oliver, Alfred Richard. The Encyclopedists as Critics of Music.

New York: Columbia University Press, 1947. Pp. viii + 227.

Paladilhe, J. "Estève (Pierre)." Dictionnaire de Biographie Francaise, sous la direction de J. Balteau... Paris: Letouzey et Ane, 1933- , XIII, fasc. LXXIII, cols. 89-90.

Paul, Charles Bennett. "Jean-Philippe Rameau (1683-1764), the Musician as Philosophe." Proceedings of the American Philosophical Society, CXIV (April 1970), 140-54.

________. "Rameau's Musical Theories in the Age of Reason." Unpublished Doctor's dissertion, University of California, Berkeley, 1966. Pp. vii + 189.

Pischner, Hans. Die Harmonielehre Jean-Philippe Rameaus: Ein Beitrag zur Geschichte des musikalischen Denkens. Leipzig: Veb Breitkopf & Härtel Musikverlag, 1963. Pp. 364.

Rameau, Jean-Philippe. The Complete Theoretical Writings of Jean-Philippe Rameau. Ed. Erwin R. Jacobi. American Institute of Musicology, 1967-72. 6 vols.

________. Démonstration du Principe de l'Harmonie, Servant de Base à Tout l'Art Musical Théorique et Pratique. Paris: Durand, Pissot, 1750. Pp. xxiii + 112 + xlvii + 5.

________. Treatise on Harmony. Trans. with an introduction and notes by Philip Gossett. New York: Dover, 1971. Pp. lv + 444.

Shirlaw, Matthew. The Theory of Harmony: An Inquiry into the Natural Principles of Harmony, with an Examination of the Chief Systems of Harmony from Rameau to the Present Day. London: Novello & Co., 1917; rpt. Dekalb, Ill.: Dr. Birchard Coar, 1955. Pp. xvi + 484.

Vartanian, Aram. Diderot and Descartes: A Study of Scientific Naturalism in the Enlightment. Princeton: Princeton University Press, 1953. Pp. vi + 336.

Verba, E. Cynthia. "The Development of Rameau's Thoughts on Modulation and Chromatics." Journal of the American Musicological Society, XXVI (Spring 1973), 69-91.