|  |  |  |  |
| --- | --- | --- | --- |
| 53-tet / 53-edo | 79, 80, 81, 219, 221, 558 | Tone system with 53 equally spaced pitches per octave. The unit interval has the irrational ratio  and measures  cent. Since 53 Pythagorean fifths are very close to 31 octaves, 53-tet is suited to approximate the Pythagorean tone system. It also provides an excellent approximation of the syntonic tone system, because the unit interval is between the Pythagorean comma (23.46 cent) and the syntonic comma (21.51 cent). | 10001 |
| Boethius triangles | 1, 2, 3, 11, 16, 60, 62, 71, 93, 94, 95 | The number triangles given by Boethius are two dimensional discrete coordinate systems for subsets of the positive integer numbers.  For two relatively prime positive integers *a* and *b*, the numbers in the triangle have the format  with power indices . If the numbers are interpreted as points with coordinates  on a grid with equidistant meshes, equal vectors (directed line segments symbolized by arrows) correspond to equal musical intervals. For *a* = 2 and *b* = 3 the system of possible vectors defines the intervals of the Pythagorean tone system.  Likewise, the intervals of the syntonic tone system can be described as vectors in a three dimensional grid with numbers of the format . | 10002 |
| Chromatic scale | 49, 75, 76, 203, 207, 211, 215, 217, 218, 509, 510, 516, 550, 551, 552, 553 | Since the Pythagorean semitone (256:243) is only a little smaller than half a tone (9:8), it seems to be natural to describe the octave by twelve semitones, i.e., by a chromatic scale of twelve pitch classes. An early diagram guided by this idea was given by Heritius [203]. The system of the 13 tonoi of Aristoxenus as described by Galilei seems to work only in a 12-tempered chromatic scale [509]. The division of the octave into twelve equal semitones (12-tet) was an acceptable compromise for tuning lutes [552, 553, 516].  In order to approximate 12-tet on lutes, Vincenzo Galilei proposed a tuning with semitones of the ratio 18:17 [(GALV\_1581) Galilei 1581, 49]. This approach was discussed by Zarlino (1588) [550, 551].  The syntonic tone system offers various approaches to the chromatic scale, see Syntonic chromatic scale [10027]. | 10003 |
| Combinations: kappa-n | 12, 17, 29, 32, 35, 46, 48, 73, 74, 212, 501, 515 | There are  possibilities to select two out of *n* objects, if the order of the selection does not matter. These numbers, 3, 6, 10, 15, … are called triangular numbers, because they can be represented as triangular patterns of dots [6, 7]. Therefore, a list of all combinations can be given as a triangular table, an arrangement chosen by Ramon Llull [74] and Descartes [73].  If the *n* objects are represented as points, the selection of a pair can be represented as a connection of two points. A full graph of *n* nodes, with all possible connections (edges) is called kappa-*n*. Such a graph has  edges. Up to kappa-4 the nodes can be arranged in the plane so that the edges do not intersect [17]. The representation of the tetractys 6:8:9:12 by Odington with intersecting edges, highlights the equal ratios, “sequialterae” (3:2) and “sesquitertiae” (4:3).  If the nodes of kappa-*n* are arranged on a circle as in [32, 212, 515], the straight edges are clearly distinct.  If the nodes are arranged on a straight line, the use of semi-circular arcs is convenient as in [498, 501, 29, 35] by Cochlaeus, Fogliano, Glareanus and Zarlino.  The arrangement used by Salinas in [47], where many of the possible connections are labelled, is similar but confusing.  The visualisation [32] of the senario by Zarlino is distinct, because the three pairs of opposite numbers are labelled twice. Therefore the diagram has  labelled connections. | 10004 |
| Descartes 1635 | 305, 306, 307, 308 | By contrast with the diagrams in the Middleburg manuscript (of Beeckman), the sizes of the intervals in these diagrams from Leiden [305, 306, 307, 308] are relatively accurate: although they are by no means perfect. The same is true of the diagrams in the Groningen manuscript [309, 310, 311, 312] and in the 1650 Utrecht printing of the treatise [313, 314, 315, 316]. This perhaps means that the original, lost manuscript possessed quite accurate diagrams, but this would raise the question of how they were constructed. It is possible that a logarithmic calculation was used, although if this was done as early as the initial composition of the treatise in 1618 it would be surprising: the first printed description of logarithms appeared only in 1614, in England, and no text is known to apply logarithms to musical problems at so early a date. It is possible, alternatively, that an approximation was used based on the division of the octave into a large number of equal parts: say 53, which yields quite a good approximation to the tuning system displayed here. But this, too, would be surprising, since no such approximation is mentioned anywhere in Descartes's treatise. BeW | 10005 |
| Descartes 1640 | 309, 310, 311, 312 | These diagrams are the most accurate diagrams found in the manuscripts of the Descartes’s Compendium musicae, as the comparison with a computer program shows [🡪 animations: descartes\_diatonic\_scale1; descartes\_diatonic\_scale2]. | 10006 |
| Descartes 1650 | 313, 314, 315, 316 | Descartes wrote his Compendium musicae in 1618 but it was published posthumously in 1650. It included circular representations in which the whole circle represents an octave, while smaller intervals are shown according to a logarithmic scale: so for instance an equal-tempered semitone would occupy a twelfth of the circle.  On the whole the accuracy of the diagrams in the first Latin edition of the Compendium is no better than that of those in the Leiden and Groningen manuscripts, suggesting that no new calculation of the sizes of musical intervals was undertaken by the editor but that the manuscript diagrams – it is not certain which version or versions – were merely copied. BeW | 10007 |
| Descartes 1653 | 321, 322, 323, 324, 325, 326, 327, 328 | The four diagrams in the 1653 English translation of the Compendium [321, 322, 323, 324] are exceptional in that they use the circumference of the circle to represent not one octave of pitch (with equal intervals given equal sizes) but one half of a vibrating string (with equal intervals taking unequal sizes). This is the reason for their very different appearance compared with the diagrams in all the other versions of the treatise. The author of a preface to the English translation in fact complained of the inaccuracy of the diagrams in the Latin publication, implying that he had not understood their mathematical content: unlike the author of an appendix to the same volume, who did something to repair the error [325, 326, 327, 328]. BeW | 10008 |
| Descartes 1656 | 329, 330, 331, 332 | The diagrams in the 1656 second Latin edition of the Compendium are a close copy of those in the 1650 edition [did they in fact re-use the same blocks? I don't know] and share their reasonable accuracy and, in the case of [330] and [331] their striking symmetry. BeW  According to Buzon the same diagrams are also used in the 1661 Flemish edition of the Compendium [<BUZO\_1987> Buzon 1987, 40]. | 10009 |
| Descartes 1668 | 333, 334, 335, 336 | Although it is possible [<BUZO\_1987> Buzon 1987, 21] that the editor of the 1668 French translation had access to now-lost manuscript material relating to the Compendium, the diagrams are no more accurate than those in the Latin printings of the text, and there seems to be no reason to suppose that they are more than a diligent copy of those printed diagrams. BeW | 10010 |
| Descartes 1683 | 337, 338, 339, 340 |  | 10011 |
| Descartes 1628 | 301, 302, 303, 304 | The presence of the four diagrams in the Middleburg manuscript makes it likely (though not absolutely certain) that they were present in Descartes's lost autograph manuscript. (They are incorrectly stated to be absent by [<WARA\_2008> Wardhaugh 2008, Chap. 3]. The sizes of the pitches in these diagrams are in some cases strikingly inaccurate, and in some cases it is quite clear also that the lines bounding the intervals do not all meet at a single point as they were intended to. ([301] and [302] might be characterised as little more than quite rough sketches, indeed.) But it is not clear that this provides any sort of clue to the construction of these diagrams, since these diagrams are merely copies of the lost originals, and may have been produced by a quite ad hoc procedure such as tracing those originals. BeW | 10012 |
| Descartes: consonance circle | 301, 305, 309, 313, 321, 329, 333, 337, 325 | These diagrams show the consonant intervals within the octave. If an interval is consonant, its complement with the octave is also consonant. The consonant intervals are precisely those that occur between the notes of a major triad: minor third (e-g), major third (c-e), fourth (g-c), fifth (c-g), minor sixth (e-c) and major sixth (g-e).  Descartes’s naming of the thirds is inconsistent: where ‘Ditonus’ seems to refer to a Pythagorean major third (81:64; two major tones), ‘Tertia minor’ (instead of ‘Semiditonus’) refers to the syntonic minor third (6:5). From the context, however, it is clear that the syntonic intervals are meant. The use of ‘Tertia major’ would have been consistent. | 10013 |
| Descartes: diatonic scale 1 | 302, 306, 310, 314, 322, 330, 334, 338, 326, 327, 328 | These diagrams show the interval sizes for a complete diatonic scale. The numbers around the edge are the lengths of string needed to produce the notes, assuming the lowest note comes from a string 540 units long. As the diagram illustrates, the use of just intonation produces some imperfections, here dealt with by having two different versions of one of the pitches, separated by a ‘schisma’ (syntonic comma). BeW  The distribution of the intervals is mirror symmetric about the vertical diameter through the middle of the syntonic comma and the middle of the minor tone 360/324. The full set of eight notes contains three major triads in the frequency proportion 4:5:6 on F, C and G, as well as three minor triads in the frequency proportion 10:12:15 on D, A and E. [🡪 animation: descartes\_diatonic\_scale1] | 10014 |
| Descartes: diatonic scale 2 | 303, 307, 311, 315, 323, 331, 335, 339 | This version of the diatonic scale contains both B (b quadratum) and Bb (b rotundum) but otherwise no ambiguous pitches. The configuration is mirror symmetric about the vertical diameter through the middle of Bb-B and the middle of E-F.  The full set of eight notes contains three major triads in the frequency proportion 4:5:6 on Bb, F and C, as well as three minor triads in the frequency proportion 10:12:15 on D, A and E. The major triad on G, however, has a fifth of the ratio 40:27, i.e., a Pythagorean fifth flattened by a syntonic comma. [🡪 animation: descartes\_diatonic\_scale2] | 10015 |
| Descartes: hexachords | 304, 308, 312, 316, 324, 332, 336, 340 | The final circular diagram of musical pitch from Descartes’s Compendium musicae. Here three different musical scales are shown together, and the diagram enables us to understand how they differ. Their starting notes are F, C and G; they use slightly different selections of pitches, but the use of just intonation also means that their versions of certain pitches – such as D – differ from one another by a ‘schisma’ (syntonic comma). BeW  The three hexachords ut-re-mi-fa-sol-la have the same symmetric interval structure tTSTt. Together they cover two major scales, on F and C with ambiguous pitches D and G. The configuration of the 10 pitches is mirror symmetric about the vertical diameter through the middle of Bb-B and the middle of E-F. [🡪 animation: descartes\_hexachords] | 10016 |
| Figurate numbers | 6, 7 |  | 10017 |
| Hexachords | 9, 15, 19, 28, 36, 42, 47, 60, 61, 80, 81, 304, 308, 312, 316, 324, 332, 336, 340 | Traditionally, a hexachord is a series of six notes within the range of a major sixth. Thereby, a semitone step s (256:243) in the middle is flanked by two whole tones T (9:8) on both sides, so that the hexachord has the internal structure TTsTT.  Seven hexachords starting at different pitches (on G, C and F) are used by Guido of Arezzo in order to describe the Pythagorean diatonic tone system. Guido also introduced the solmization of the hexachord with ut-re-mi-fa-sol-la.  The hexachords were reinterpreted by Descartes in the syntonic tone system, see Syntonic hexachords [10031].  The word “hexachord” was also used to denote the interval of sixth, “hexachordon maius” for the major and “hexachordon minus” for the minor sixth. | 10018 |
| Large numbers | 27, 405 | Boethius knew that the ratio of the Pythagorean comma lies between 75:74 and 74:73 [13] and that the Pythagorean semitone lies between three and four Pythagorean commas. [(BOET\_1867) Boethius 1867, Inst. Mus. III, 14, 293–195] [<MUZZ\_2017> Muzzulini 2017]  Before the invention of decimal fractions by Simon Stevin and of logarithms by Jost Bürgi and John Napier, a direct comparison of the Pythagorean comma with the Pythagorean semitone was tried by Faber Stapulensis (1496, 1551) and by Michael Stifel (1544). Their cumbersome calculations involved numbers with up to 33 decimal digits, which were not entirely correct. | 10019 |
| Mesolabio | 552, 553, 555,  2054,  2067 | A mesolabio is a mechanical tool for constructing geometric sequences. It can be used to divide a musical interval ratio into any number of equal parts. This is equivalent with finding the *n*-th root of a number. [<BARB\_1996> Barbieri 1996>]  For any opening angle of the outer legs the instrument generates a system of similar right triangles, so that corresponding parallel line segments form geometric sequences. The illustration by Descartes [555] is instructive.  It is impossible to divide a ratio into more than two equal parts by straight edge and compasses. | 10020 |
| Microintervals | 13, 27, 30, 38, 39, 45, 46, 79, 210, 219, 221, 314, 495, 498, 500, 501, 503, 507, 508, 558 | The first micro interval that entered music theory was the Pythagorean comma (531441:524288), the difference between an octave and six tones of the ratio 9:8 [13]. An interval of about half the size of the Pythagorean comma called “schism” appears in a diagram by Johannes de Muris (1323) [495]. De syntonic comma is essential in the context of the syntonic tone system. In order to describe the syntonic tone system the octave was divided into 53 equal parts by Mercator [219, 221] and Newton [80, 81]. Newton also divided the octave into 612 equal parts in order to get an almost perfect fit [79].  The micro intervals were not introduced in order to enable microtonal music, but to create a tonal system, in which the conventional intervals can be realised in their simplest form, so that the diatonic scale can be realised in different keys. | 10021 |
| Pythagorean comma | 11, 13, 27, 30, 404, 405, 494, 495, 498, 500, 507, 508 | The Pythagorean comma is a small interval with the ratio 531’441:524,288 corresponding to 23.46 cent. There are several ways to describe this interval:  - The difference between twelve Pythagorean fifths (intervals of the ratio 3:2) and seven octaves (intervals of the ratio 2:1).  - The difference between six whole tones (9:8) and an octave.  - The difference between a whole tone (9:8) and two Pythagorean semitones (intervals of the ratio 256:243).  (The difference of two intervals corresponds to the quotient of the related ratios.)  Because of the uniqueness of the prime number decomposition a positive power of 3 is never equal to a power of 2, i.e., a multiple of Pythagorean fifths is never equal to a multiple of octaves. Therefore, a tone system that is based on Pythagorean fifths is not closed. Without any restrictions it would contain infinitely many pitch classes that fill the space of an octave more and more. | 10022 |
| Pythagorean diatonic scale | 18, 19, 28, 36, 47, 200, 201, 203, 208, 402, 497 | The diatonic scale can be constructed as a stack of fifths modulo octave F-C-G-D-A-E-B, corresponding to the white keys on a piano. In the Pythagorean diatonic scale these six fifths are Pythagorean fifths of the ratio 3:2. The Pythagorean diatonic scale consists of five tones of the ratio 9:8 and two semitones of the ratio 256:243. | 10023 |
| Senario | 32, 35, 73, 74 | The senario, the set of numbers {1, 2, 3, 4, 5, 6}, is the extension of the tetraktys from 4 to 6, The ratios of the senario are used to legitimate the syntonic consonances. The problem is that the major sixth (5:3) is part of the system, but the minor sixth (8:5) is excluded. | 10024 |
| Solmization | 9, 18, 80, 81, 84, 86, 87, 89, 91, 203, 515, 208, 209, 212, | The solmization syllables ut, re, mi, fa, sol, la for the notes of a hexachord were introduced by Guido of Arezzo [9]. They highlight an interval structure with a semitone step mi-fa in the middle and form a system of relative solmization. The positions on Guido’s hand, however, indicate absolute pitch [https://en.wikipedia.org/wiki/Guidonian\_hand].  Some solmization systems do not use all six syllables and later a further syllable for the leading note (si or ci) was added to the system. Mersenne gives two different seven-notes systems of solmization [209], the second one is already used by Lippius [515]. | 10025 |
| Spiral and helix | 60, 88, 91, 96, 97 | The spiral and helix can be used to visualize the two aspects “pitch” and “chroma” of a tone. Chroma is the circular aspect, defined by pitch classes of octave replicas, whereas pitch is the linear aspect related to frequency. By taking both the circular and the linear aspect into account pitch becomes a two dimensional perceptual phenomenon. | 10026 |
| Syntonic chromatic scale | 39, 46, 48, 75, 76, 77, 78, 79, 94, 95, 211, 212, 222, 502, 505, 558, 559, 560 | The task of defining a chromatic scale in the syntonic tone systems has many different solutions. Since C# and Db are different pitches in the syntonic system, it is not a priori clear that a chromatic scale should consist of twelve pitch classes. Suggestions by Fogliano [502] and Salinas [48, 46] had 14, 15 or even 24 different pitches per octave.  Various chromatic scales with twelve notes were given by Kepler [559], Mersenne [211, 212], Newton [75, 76, 77, 78], Holder [222] and Euler [94, 95].  The problem with these scales is that most of the diatonic scales on different keys are distorted forms of the original C-major scale: they contain fewer perfect major triads (4:5:6) and perfect minor triads (10:12:15). Positively said, the different keys have specific interval structures. For example, Holder’s chromatic scale contains seven structurally different major triads [🡪 animation: syntonic-spiral].  Arthur von Oettingen (1917) proposed a syntonic tone system of 53 pitch classes [558], which contains 39 diatonic scales of the standard structure TtSTtTS, see Syntonic diatonic scale [10029]. | 10027 |
| Syntonic comma | 38, 43, 45, 48, 89, 210, 221, 314, 501, 502, 503 | The syntonic comma is an interval with the ratio 81:80 corresponding to 21.51 cent. This ratio can be described as the intervallic difference of a Pythagorean major third (Ditonus) in the ratio 81:64 and the major third of “just intonation” in the ratio 5:4.  The syntonic comma is also equal to the interval difference of a major tone (9:8) and a minor tone (10:9) because of . Since the 13th century, the thirds are viewed as imperfect consonances. The Pythagorean major third is not conformable with the paradigmatic equivalence of consonance and simple ratios. This has favoured the establishment of the syntonic tone system, where both fifths and major thirds appear in the simple ratios 3:2 and 5:4. The price is an ambiguity of pitch: The syntonic tone system contains pitch classes of the same name whose frequencies deviate by syntonic commas. | 10028 |
| Syntonic diatonic scale | 37, 41, 45, 84, 89, 90, 91, 92, 208, 209, 216, 217, 222, 314, 315, 322, 323, 502, 515 | The syntonic diatonic scale has fifths of the ratio 3:2 and major thirds of the ratio 5:4. Usually, the seven-note scale has the inner structure tTSTtTS or TtSTtTS with minor tones t (10:9), major tones T (9:8) and diatonic semitones S (16:15). Descartes suggested an ambiguous second degree of two pitches separated by a syntonic comma cs (81:80), so that the corresponding “eight-note scale” has the symmetric structure tcStSTtTS [314]. Newton gives different syntonic diatonic scales, sometimes containing a Pythagorean third TT (81:64). | 10029 |
| Syntonic grid | 93, 94, 95 | The pitch grids of Rameau and Euler, which are similar to the Boethius triangles, abstract from the octave dimension. Therefore, points represent pitch classes (“Tonigkeiten”). The two main axes of the coordinate system are fifths (3:2) modulo octave and major thirds (5:4) modulo octave. | 10030 |
| Syntonic hexachords | 80, 81, 304, 308, 312, 316, 324, 332, 336, 340 | In the syntonic hexachords given by Descartes [316] the semitone S (16:15) is symmetrically flanked by two major tones T (9:8) and two minor tones t (10:9), so that the hexachord has the internal structure tTSTt, see Descartes: hexachords [10016]. | 10031 |
| Temperament | 38, 43, 551 | A tuning system that slightly compromises the pure intervals of just intonation to meet other requirements [https://en.wikipedia.org/wiki/Musical\_temperament]. Zarlino discussed two systems which distribute the syntonic comma either over seven [38] or over four Pythagorean fifths [43]. Both tunings are generated by chains of slightly diminished fifths. The latter generates perfect major thirds (5:4). Like the Pythagorean tone system, they generate an infinite set of pitch classes.  Also 12-tet and 53-tet can be viewed as temperaments generated by modified fifths of the ratios  and . However, the related tone systems are finite, see 53-tet / 53-edo [10001].  Furthermore, the tuning of the lute according to Vincenzo Galilei (1581) is a temperament, generated by semitones of the ratio 18:17 [551, 560]. | 10032 |
| Tetrachords | 28, 36, 47, 204, 205, 206, 401, 499 | A tetrachord is a series of four notes within the range of the interval of a fourth. According to their intervallic structure the Greek music theory knows three types of tetrachords, diatonic, chromatic and enharmonic tetrachords.  The diatonic scale is defined by two diatonic tetrachords, B-C-D-E and E-F-G-A with a semitone step at the bottom.  The chromatic tetrachords B-C-Db-E and E-F-Gb-A have two consecutive semitone steps and an augmented second. The Greek chromatic genus should not be confused with modern chromatic scales of twelve pitches per octave.  The enharmonic tetrachord begins with two small intervals “quarter tones”) followed by a major third. | 10033 |
| Tetraktys | 4, 5, 7, 12, 17, 21, 22, 23, 34, 40, 53, 54, 59, 403 | The number 10 is a triangular number (10 = 1 + 2 + 3 + 4) [6, 7, 21]. The configuration of 10 points in triangular form is called tetraktys.  The ratios of the underlying numbers 1, 2, 3, 4 define the Pythagorean consonances: fourth (4:3), fifth (3:2), octave (2:1 = 4:2), octave plus fifth (3:1) and double octave (4:1).  The four-element proportion 6:8:9:12 (defining the frame of the Greek tone system) is also called tetraktys. A detail in Raffael’s “School of Athens” shows both kinds of tetraktys [21]. | 10034 |
| Triads | 213, 313, 512, 554, 557 | Major and minor triads, consonant chords of three notes, became the building bricks of western classical music at about 1600 and of the related music theory since Jean-Philippe Rameau [557]. | 10035 |
| Descartes’ circular pitch diagrams | 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340 | The ‘Compendium Musicae’ by René Descartes contains four circular diagrams. There are three manuscript copies with the diagrams and six printed editions (Latin, English, Flemish, French) in the 17th century. The original manuscript written in 1618 is lost. It was a gift for Isaac Beeckman. Later on Beeckman had to give it back to Descartes.  36 diagrams are shown here. We have not yet consulted the Flemish edition “Kort Begryp der Zangkunst” (Amsterdam 1661).  The diagrams are of interest because they represent pitch classes logarithmically on the circle. The earliest diagram using the full circle for the octave is by Johannes Lippius (1612) [515].  There are diagrams by Domingo Marcos Durán (1492), Vincenzo Galilei (1581) and Robert Fludd (1618/1624), which close the circle with three octaves [603, 407, 516]. | 10036 |
| Robert Fludd: Utriusque cosmi historia (1617-1624) |  | Fludd, Robert (1624). Utriusque cosmi historia, Vol I, Tract II, 1624 (first edition 1618) | 10037 |
| Vincenzo Galilei (1581) |  | Galilei, Vincenzo (1581). Dialogo di Vincentio Galilei … della musica antica, et della moderna, Firenze 1581 | 10038 |
| Sound - Colour |  |  | 10039 |
| Timbre space |  | „Die Eigenschaften, welche man unter dem Begriff und Namen der Klangfarbe zusammenfasst, bilden eine so bunte Menge, dass man beim Überblick schier verzweifeln muss, sie wirklich unter Einen Begriff zu bringen. Wir finden als solche erwähnt: angenehm und unangenehm im Allgemeinen; dann mild, süss, weich, schmelzend gegenüber scharf, hart, rauh; dann voll, breit, pastos gegenüber leer, spitz, dünn, näselnd; dann hell, glänzend metallisch, silbern gegenüber dunkel, dumpf, trüb, verschleiert, hölzern; dann kräftig, schmetternd, dröhnend, edel, prächtig, feurig, majestätisch, romantisch gegenüber sanft, trocken, gemein, düster, melancholisch, elegisch, idyllisch u.s.w.“ [<STUM\_1890> Stumpf 1890, 514]  “The timbre of a complex sound has usually been defined as the subjective quality that depends upon the complexity or overtone structure of the physical sound. We have seen, however, that both the loudness and the pitch of a complex tone are influenced to some extent by its overtone structure. We must, therefore, fall back upon the ill-defined notion that timbre has to do with the distribution or pattern of pitch and loudness in the total sensation. Until careful scientific work has been done on the subject, it can hardly be possible to say more about timbre than that it is a ‘multidimensional’ dimension.” [<LICK\_1951> Licklider 1951, 1019]  The notion “timbre space” is one possible interpretation of the triad “sound colour space”. Timbre is usually considered a qualitative aspect of aural sensations. At the same time it is frequently associated with spatiality. It can be asked whether qualities in general can be reduced to multidimensional features. Are qualities more than just multidimensional quantities, so that quality and quantity are not really antagonists? | 10040 |
| Pulse patterns |  | "Non oportet existimare sonum quem percipiunt aures nostras, unum et individuum esse, quia pausa inter sonum et sonum non est perceptibilis: componitur enim sonus quem audimus ex tot sonis, quot sunt reditûs chordarum ad locum suum." [(BEEC\_1604) Beeckman 1604–1634, Vol. I, 53 (1614)] – One should not believe that a sound perceived by our ears is one and indivisible, because the rest between two consecutive sounds is not perceivable: a sound is composed of as many sounds as there are returns of the string to its place.  "Sonus in pluribus ictûs divisibilis." [(BEEC\_1604) Beeckman 1604–1634, Vol. I, 53 (1628 ?)]. – A sound is divisible into several “ictûs” (pulses/beats).  The idea of sound as periodic sequence of pulses supports the identification of frequency (pulses per time unit) with pitch.  If the time periods of two such sounds are in a small integer ratio and if the two sounds are presented in phase, the combined pulse pattern has coinciding peaks at the lowest common multiple of the two time periods. In the “coincidence theory” this property is made responsible for the consonance of sounds of simple frequency ratios.  This theory does not take into account that the phase relationship of sounds from different sources depends on the position of the listener. This objection against the coincidence theory of consonance was raised by Isaac Newton in a letter to John North, a brother of Francis North, in 1677 [<KASS\_2004> Kassler 2004, 177]. | 10041 |
| Vibration patterns |  |  | 10042 |
| Synthesizer |  |  | 10043 |
| Johannes Cotto: De musica |  | Cotto, Johannes (c. 1200). De musica, D-Mu 8° Cod. Ms. 375 (Cim 13), fol. 8v-27r, 35r-37v | 10044 |
| Guido of Arezzo: Micrologus |  | Guido of Arezzo (c. 1200). Micrologus, D-Mu 8° Cod. Ms. 375 (Cim 13), fol. 43-53 | 10045 |
| D-Mu 8° Cod. Ms. 375 (Cim 13) |  | https://epub.ub.uni-muenchen.de/10929/1/Cim.\_13.pdf | 10046 |
| Zarlino (1562) |  | Zarlino, Gioseffo (1562). Le istitutioni harmoniche, Venetia 1562 (first edition 1558) | 10047 |
| Zarlino (1571) |  | Zarlino, Gioseffo (1571). Dimostrationi harmoniche. Venetia 1571 | 10048 |
| Francisco Salinas (1577) |  | Salinas, Francisco (1577). De musica libri septem. Mathias Gastius, Salamanca, 1577, Reprint M.S. Kastner (ed.), Documenta Musicologica I no. 13, Bärenreiter, Kassel, 1958 | 10049 |
| Gaspard Schott (1657) |  | Schott, Gaspar (1657). Magiae universalis naturae et artis, Pars II. Acustica, in VII. Libros Digesta, [Francofurti] : Schönwetterus, 1657 | 10050 |
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