Bach's Music and Newtonian Science: A Composer in Search of the Foundations of His Art

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Bach the musical scientist

Let me quote from an article published in 1737: 'Mr ... is the most eminent of the Musicanten in ...' So begins an unsigned, controversial piece of music journalism in the new, fashionable, and deliberately progressive periodical Der Critische Musicus.¹ At the time, any informed and vigilant reader could have filled in the blanks in the first line, especially after reading what followed. The editor of the pamphlet and also the article's author, a twenty-nine year old upstart named Johann Adolph Scheibe, was fully aware of that. Moreover, he knew that the terms 'eminent' and 'Musicant' (music-maker) hardly fit together, and that combining them so ambivalently would add insult to injury rather than express any muted reverential gesture toward 'Mr Bach in Leipzig' – the implied subject.

Of the numerous critical points that reflected Scheibe's aesthetic preferences and general orientation, and constituted one of the most vitriolic yet ultimately inconsequential pieces of early music criticism, what offended Bach the most was being referred to and labelled as a Musicant – a music-maker, a mere practitioner. His frame of mind becomes evident in the published response written on Bach's behalf by Johann Abraham Birnbaum, a faculty member of Leipzig University. In defending Bach, who was undoubtedly enraged by Scheibe's assault, Birnbaum also takes issue with the utterly inappropriate application of the term Musicant. He writes:

Now, let the reasonable reader himself decide whether the praise that is due the Hon. Court Composer can be fully expressed by calling him the most eminent of the Musicanten. This is in my opinion equivalent

¹ The New Bach Reader. A Life of Johann Sebastian Bach in Letters and Documents. Edited by Hans T. David and Arthur Mendel, revised and enlarged by Christoph Wolff (New York: W.W.Norton, 1998), no. 343. This source is hereafter abbreviated as NBR.

to wishing to pay a special tribute to a thoroughly learned man by calling him the best member of the last class of schoolboys. The Hon. Court Composer is a great composer, a master of music, a virtuoso on the organ and the clavier without an equal, but in no sense a Musicant.²

In his defence, Birnbaum primarily focuses on Bach's achievements as a composer. His constant references to 'the Hon. Court Composer' seem to reflect stiff formality but are actually meant to emphasise Bach's publicly recognised stature as a composer; in 1736 he had been awarded the title of Electoral-Saxon and Royal-Polish Court Compositeur. This honour came about as the somewhat belated response to a significant gesture Bach had made three years earlier when Friedrich August II succeeded his father as elector and king. In 1733 Bach had dedicated his Missa in B minor - that is, the Kyrie and Gloria of what would become the B-minor Mass - to the electoral court in Dresden. Bach's dedication letter begins as follows: 'To your Royal Highness I submit in deepest devotion the present small work of that science which I have achieved in musique.¹³ Stripping the phrase of the conventional stiff formalities of modesty and courtly protocol reveals a central statement, namely that this work was to represent his achievements in the science of music. Besides presenting himself as a virtuoso performer, Bach the composer considered himself a musical scholar producing works of musical science.

This corresponds with the general evaluation of Bach's compositional achievements in his obituary published in 1754. That portion of the obituary was written by Johann Friedrich Agricola, a former Bach pupil and colleague of C. P. E. Bach's at the Prussian court capelle. He writes:

If ever a composer showed polyphony in its greatest strength, it was certainly our late lamented Bach. If ever a musician employed the most hidden secrets of harmony with the most skilled artistry, it was certainly our Bach. No one ever showed so many ingenious and unusual ideas as he in elaborate pieces such as ordinarily seem dry exercises in craftsmanship.⁴

More often than not, superlatives such as these provoke scepticism, but this statement – although penned in 1750 under the immediate burden of loss and pressure of time – presents a remarkably insightful summary of Bach's most important musical accomplishments. It emphasises that his music truly demonstrates the power of polyphony, the artful application of intrinsic harmonic structure and organisation, and his imaginative, uncommon, and original approach to the design of complex works. Yet it must be understood that it was written to continue fighting off the criticism to which Bach had been subjected some twelve years before, when Scheibe had written:

This great man would be the admiration of whole nations if he had more amenity, if he did not take away the natural element in his pieces

² NBR, no. 344, p. 341

³ *NBR*, no. 162, p. 158

⁴ NBR, no. 306, p. 305

by giving them a turgid and confused style, and if he did not darken their beauty by an excess of art.⁵

However, Bach's ghostwriter Birnbaum explicitly articulates the composer's views on the matter of art and nature, and rather elegantly counters Scheibe's broadside when he states:

The essential aims of true art are to imitate nature, and, where necessary, to aid it. ... Thus art lends nature a beauty it lacks, and increases the beauty it possesses. Now, the greater the art is – that is, the more industriously and painstakingly it works at the improvement of nature – the more brilliantly shines the beauty thus brought into being. Accordingly it is impossible that the greatest art should darken the beauty of a thing.⁶

To some extent Birnbaum's argument was built on a statement by Johann Joseph Fux in his 1725 counterpoint treatise, Gradus ad Parnassum. There Fux refers to 'art which imitates and perfects nature, but never destroys it'.⁷ Bach, who owned a copy of this Latin treatise, may well have directed Birnbaum to emphasise the ancient Aristotelian principle of 'ars imitatur naturam', a dictum that lay at the heart of what Bach considered 'musicalische Wissenschaft', the term used in the dedication letter of the Kyrie-Gloria Mass of 1733 - a work that was meant to represent a summary of his vocal writing, not only in its variety of styles, compositional devices, and range of sonorities, but also in its high level of The Mass offered a full panoply of the art of musical technical polish. composition, a comprehensive grasp of music history, particularly in its use of old and new styles. Not just in the Mass but in general, Bach would receive the justification for his art from its relationship with the reality of the world, nature, and its transcendental reason, God; who, according to the apocryphal Book of Wisdom, 'ordered everything by measure, number, and weight' - the prevailing motto in German musical thought of the baroque.⁸ Therefore, the concept of harmonia - in seventeenth-century (and Bach's) terminology generally pertaining to musical composition - refers to the order of nature and to its efficient divine cause.

Newtonian philosophy

There is no question that Bach was influenced, notably in Leipzig (at that time home of Germany's largest and most distinguished university), by the academic climate of intellectual inquiry and search for truth propounded by the philosophers Gottfried Wilhelm Leibniz and Christian Wolff. Both defined philosophy as 'Weltweisheit' (wisdom of the world) and – according to Bach's student Lorenz Mizler – as 'a science of all things that teaches us how and why

⁵ *NBR*, no. 343, p.388

⁶ NBR, no. 344, p.345

⁷ Translated from the annotated German translation published by Bach's student Lorenz Christoph Mizler (Leipzig, 1742), p. 196

⁸ Wisdom of Solomon 11:20

they are or can be'.⁹ Bach was exposed to much abstract theoretical discourse, especially in Leipzig, but he had no interest in contributing to it himself. He focused instead on a genuinely empirical approach that made him explore 'the most hidden secrets of harmony with the most skilled artistry', that is, push and expand the known limits of musical composition.

Bach's intricate musical art resulting from this approach figured in a brief but public literary dispute between the Berlin capellmeister Johann Friedrich Agricola, co-author of the Bach obituary mentioned earlier, and Filippo Finazzi, a Hamburg-based opera singer and critical essayist. In August 1750, just days after Bach's death, Agricola published a piece in which he recognised that Finazzi – much like Scheibe – denied Bach's music 'the effect of pleasure for the listener who would not savour such difficult harmony'. But he characteristically responded:

Not all learned people are able to understand a Newton, but those who have progressed far enough in profound science so they can understand him will find the greater gratification and real benefit in reading his work.¹⁰

Here, for the first time, a parallel is drawn between Bach and Isaac Newton; not by way of analogies between Bach's music and Newton's science, but by explaining that Bach's music is best appreciated by connoisseurs, just as Newton's writings are best understood by readers with a profound knowledge of science. Newton, a generation older than Bach, had earned a legendary reputation across Europe by the early eighteenth century, and by 1750 he represented the undisputed paradigm of the scientist as genius. In 1740 Lorenz Mizler called him 'the immortal Newton'. The British mathematician, physicist, and philosopher had died in 1727, but ever since the Leipzig academic periodical, *Acta eruditorum*, published one of the most important early reviews of his principal opus (*Principia*) in 1714, Leipzig University had been the centre of Newtonianism in eighteenth-century Germany.

Newton played a critical role in the foundation of modern science. The invention of calculus, the discoveries of the laws of motion, the laws of optics, and the concept of universal gravitation were perhaps his most spectacular accomplishments, but his fundamental scientific contributions covered an astounding range of fields and topics: pure and applied mathematics, theoretical and experimental physics, and astronomy; he worked on space and time, heat, the chemistry and theory of matter, and on other subjects; he formulated the basic concepts of mass and of dynamics, and invented the gravitational theory of tides; he also involved himself with the design of scientific instruments (the reflecting telescope, for instance). Beyond this, and particularly toward the end of his career, he turned to alchemy, history, chronology, Biblical exegesis, and theological issues.

Newton's theoretical and experimental works exemplified a new kind of scientific method, although without differentiating clearly between the roles

 ⁹ Mizler, De usu atque praestantia Philosophiae in theologia, Iurisprudentia, Medicina (Leipzig, 1736) (Leisinger 1994, p. 66)

¹⁰ NBR, no. 349, p. 358

played in this endeavour by reason and by observation. Moreover, Newton's understanding that his discoveries 'pointed to the operations of God' is typical of his pre-Enlightenment outlook. Unlike post-Enlightenment science, which focuses only on the knowledge of nature, Newtonian science implies that the search for truth always encompasses both natural and divine principles. Trying to understand the relationship between God and nature led Newton to explore the boundaries between them, where he ultimately saw the fusion of natural and divine principles.

Newton created a revolution in a number of areas (most notably calculus and the theory of mechanics) and he was immediately recognised for it by his contemporaries. Indeed, his work represents the pinnacle of the seventeenthcentury scientific revolution. Bach, on the other hand, created no revolution, but the stakes were completely different. In the search for scientific truth, the principle of universal gravity, for example, would eventually have been discovered by someone else. However, the search for 'artistic truth' - so to speak - in the exploration of both the natural fundaments and the limits of musical composition can only be guided by the classical true-false logic. The element of individuality plays too decisive a role in all artistic endeavours, both pre- and post-Enlightenment. Yet Bach's music, his life's work, in part subconsciously and in part consciously, was affected more than that of any other contemporary musician by the spreading culture of Newtonianism and the general spirit of discovery that prevailed following the Scientific Revolution, which no keen intellect could escape. And under the firm umbrella of seventeenth-century Lutheran theology, Bach's musical discoveries - like Newton's, whose works Bach almost certainly did not know - ultimately pointed to the operations of God.

If the eclectic natural philosophy of late seventeenth and early eighteenth century Germany defined itself as 'a science of all things that teaches us how and why they are or can be', Bach's musical philosophy might well be understood analogously – not in terms of subject matter and methodology, but in the sense of an empirical search for the foundation and boundaries of his art – as the science of all musical phenomena that teaches us not only how and why they are or can be, but also how they relate to an understanding of nature, of God's creation or, in contemporaneous scientific language, of 'the system of the world' (title of book III of Newton's Principia). Moreover, the sheer scope and breadth of Newton's intellectual endeavours, too, find their analogy in the enormous and unparalleled range of the interests, undertakings, and efforts of Bach the musician.

Bach's Music

I have discussed all these matters in more or less abstract terms, with only a few general hints at Bach's actual work as a scholarly-minded composer. Below are five specific examples that should illuminate some of the points made previously.

1) Canon 'Trias harmonica' BWV 1072

I begin with Bach's shortest composition, a piece that is hardly ever discussed and certainly never performed: an enigmatic canon, in all likelihood originally written as an album entry for a colleague or student (the autograph source has not survived), entitled 'Trias harmonica' (the harmonic triad), and published in Friedrich Wilhelm Marpurg's 'Treatise on Fugue' (Berlin, 1753).



Example 1: Canon 'Trias harmonica' BWV 1072 in abbreviated notation

Take a look at the abbreviated notation (Example 1). Not a triad – but this is, after all, enigmatic notation. The composer hints at a solution by specifying: 'canon for eight voices and two choirs'. The composer demonstrates with this composition what his definition of the harmonic triad is: the result of a contrapuntal structure. In a way we hear Bach's musical Credo: Harmony is constituted by accumulated counterpoint. It defines both triadic chord, and contrapuntal function.



Example 2: Canon 'Trias harmonica', BWV 1072

How does the counterpoint structure work? Choir 1= four successive entries, distance of a half note; Choir 2=for successive entries, inverted form, distance of a quarter note. (Example 2) In fact, the piece represents a commentary on a canon by Werckmeister (17th C): Werckmeister uses only notes of the triad whereas Bach uses passing tones, i.e. alternating consonance and dissonance. Bach's little canon now in a sophisticated manner defines musical space (two- and threedimensional: 2-dimensional = ascending, descending, and 3-dimensional = double choir), and then musical time as the fourth dimension,

progressive/regressive time (tempus musicum = space of a breve = 4 half notes). This canon treats these natural phenomena simultaneously. Space and time and infinity. Space and time, one of the main philosophical themes of the late seventeenth/early eighteenth centuries, is a mirror of the universe, as an abstract concept and as a concrete subject, and at the same time it is the absolute musical unity, infinite (finalis artificial). The Canon 'Trias harmonica' BWV 1072 is not a primitive piece, but a scholarly and crystal clear demonstration of counterpoint generating harmony.

2) The Hexachordum naturale

This is, of course, musical theory, not real music, but it tells us a lot about Bach's mind and about the internal control factors that guide his genuinely musical composition. Let me now turn to Birnbaum who defended Bach against Scheibe in 1738:

It is certain [...] that the voices in the works of this great master of music work wonderfully in and about one another, but without the slightest confusion. They move along together in opposition, as necessary. They part company, and yet all meet again at the proper time. Each voice distinguishes itself clearly from the others [...] They now flee, now follow one another without one's noticing the slightest irregularity in their efforts [...].¹¹

The Hexachordum naturale, based on C: C major (only two other chords in the diatonic scale have the same structure: F and G, all three create tonal cadences in C major). Considering this, it is not surprising that Bach chose as his starting point the 'trias harmonica' when he defined, for the first time in the history of music, the 24 keys of the major and minor modes in Well-tempered Clavier Book I. It quickly modulates, but his point of departure is clear.

3) Fantasie in c minor, BWV 906/1

My next example introduces a different configuration of basic materials, put very effectively together in a keyboard fantasy. The triad in minor mode: c minor, both plain and arpeggiated, ascending and descending, alternating with two scale-patterns, diatonic and chromatic, again ascending and descending.



Example 3: Fantasie in c minor, BWV 906/1, bars 1 and 5

We experience here an added dimension, namely that of keyboard virtuosity. Bach with his utmost and effortless expertise, outdoes the most fashionable Italian and French examples of so-called 'piece croises'. In a way this piece, in terms of combining fundamental materials with fancy virtuosity, represents a response to both Werckmeister and Scarlatti, c. 1738. It is not a piece of empty virtuosity, but extremely tightly constructed, demonstrating what can be done by uncovering the true potential even of these rudimentary elements.

4) Nach dir, Herr, verlange ich, BWV 150/4

The next example introduces a vocal piece, in fact the earliest extant cantata of Bach's, composed in Arnstadt, c. 1705. The format of this cantata depends clearly on late seventeenth-century models. It consists of small sections in the manner of a sacred concerto. The fourth (and smallest) section is a setting of a single Biblical line, psalm verse: 'Leite mich nach deiner Wahrheit' (Lead me in thy truth – Ps. 25). The key words, 'lead' and 'truth,' make the young Bach turn to a musical idea he himself did not invent, an element he considered given by nature, by God: the scale (Example 4). But the way he treats the scale as the centre piece, the musical axis of the setting, is quite extraordinary. The axis moves straight across the score, penetrates and affects all voices.



Example 4: Cantata 'Nach dir, Herr, verlange ich', BWV 150/4

The musical and theological message is: truth and divine guidance are inseparable from one another; hold on to a firm railing: bass, tenor, alto, soprano, violins through three octaves, i.e. all voices share in the scale as firm, structural backbone, b minor tonality.

5) Fantasia in g minor, BWV 542/1

Example 4 introduces yet another solution of dealing with fundamental material in a highly innovative manner. In his organ fantasia in g minor BWV 542, Bach researches the possibilities of harmonising the descending scale, approaching with uncompromising logic and resolution a pivot point, a diminished chord, a dramatic fermata. Then things turn around and, instead of a simple resolution, the harmonic structure gets involved with extreme chromaticism. This composition shows the composer of the WC, c. 1720, who breaks through the limits of the conventional tonal system. By the way, Bach also knows how the illusion of an endless scale can acoustically be created on an organ, the pedal of which extends over two octaves.



Example 5: Fantasie in g minor, BWV 542/1, bars 31-35

6) Et incarnatus est, from B Minor Mass, BWV 232/16

Finally, an example that in all likelihood represents one of Bach's last compositions, if not the last: the 'Et incarnatus est' from the B minor Mass, an afterthought added in when revising the work in late 1749, about half a year before his death. An example more appropriate to the mystery of the incarnation ('and was incarnate by the Holy Ghost of the Virgin Mary, and was made man'), a text portion of the Mass that also historically always drew special musical attention.

How does Bach deal with it? He designs a rather simple structure: an extended triad over a pedal point, a modest and steady instrumental obbligato (unison violins), outlining figuration as well (accented by emphatic appoggiaturas). This structural outline enables crystal clear declamation by the five-part choral setting (crucial importance of the text portion, previously buried in an aria segment). Close triadic imitation, with a gradual alienation effect that step by step transforms the simple triadic pattern, and finally even forces an alteration of the pedal point from b to b-sharp (cadential ending with augmented six-five chord). This is a rational musical setting of utterly irrational non-musical

content, resulting in a movement with an extremely strong interpretive and expressive message.



Example 6: Triadic imitation in 'Et incarnatus est'

To look quickly at the end of the piece ('et homo factus est'): the triadic material now appears in its inversion (ascending) and the obbligato unison accompaniment now unfolds into a three-part canonic structure: vocal texture and instrumental accompaniment merge contrapuntally and conclude this most unusual piece of intense musical language that lets one completely forget its extremely complex construction.

Bach's Music and Newtonian Science

We recognise, both in these examples and in general, Bach's remarkable ability to integrate and synthesise the various parameters and components of his musical science and his highly developed sense for the creation of unified structures. Although he realised the significance of theoretical discourse and apparently encouraged his students to engage in it, he himself made no contribution to it. Instead, he focused on 'practical elaborations' for the instruction and delight of 'those who have a concept of what is possible in art and who desire original thought and its special, unusual elaboration' - as Carl Philipp Emanuel Bach put it in advertising the first edition of The Art of Fugue in the year following his father's death. Not just among composers of his time, but among composers in general, Bach was one of the most active, dedicated, and prolific teachers the world has seen. Many of his students disseminated his music and teachings, and quite a number became influential authors of theoretical treatises. Soon after 1750, German music theory – and half a century later European theory as well – reoriented itself almost solely because of the prevailing influence of 'the Bach School'. If Bach ever created a 'revolution' it was in his teaching of composition by fully integrating the principles of bass, harmony, and counterpoint, elements that had previously been treated separately. Two works were the primary models for this method: first, The Well-Tempered Clavier, which defined the principles of free and strict composition (manuscript copies circulated widely until 1801 when three editions appeared independently in Leipzig, Bonn, and Zurich); and secondly the collection of 370-plus four-part chorales that charted

the course for tonal harmony (two posthumous editions were published, one in the late 1760s and the other in the mid-1780s).

The impact of Bach's music and teachings was such that, even at a time when the focus of the music world had clearly shifted to the Vienna of Haydn and Mozart, the musician and critic Christian Schubart wrote on Bach's significance, referring to him – in an oblique yet obvious juxtaposition to Handel, the 'Orpheus Britannicus' – as 'the Orpheus of the Germans!' In the same essay, he calls Bach 'a genius of the highest order' and puts him on a par with the paradigmatic scientist-genius when he states, 'What Newton was as a philosopher, Bach was as a musician'. In other words, as Newton brought about fundamental changes and established new principles in the world of science, Bach did the same in the world of music, both in composition and in performance.



Example 7: Kollmann's 'sun of composers'

At the turn of the nineteenth century, Schubart's appraisal was echoed in the *Allgemeine musikalische Zeitung*, the leading music periodical of the day, to which Beethoven and others subscribed. We read in 1801 the following assessment:

The name of Johann Sebastian Bach radiates supremely and sublimely above those of all German composers in the first half of the past century. He embraced with Newton's spirit everything that has hitherto been thought about harmony [composition] and that has been presented as examples thereof, and he penetrated its depths so completely and felicitously that he must be justly regarded as the lawmaker of genuine harmony, which is valid up to the present day.¹²

Curiously, at a time when Bach's works were still circulating primarily in manuscript, a first complete edition of his keyboard works was only in its early stages, and long before the majority of the vocal works became available, the relevance and permanence of the foundations laid by Bach 'the lawmaker of genuine composition' were clearly recognised. After all, these foundations provided the basis for the romantic concept of 'pure music' (i.e. reine Tonkunst) – a concept not independent of Kant's notion of 'pure reason' and contributing significantly to the emerging idea of 'absolute music.'

Two years earlier, in 1799, the same periodical had published a diagram in the form of a 'sun of composers', designed by the German-English musician and theorist Augustus Christopher Kollmann (see Example 7). There, at the centre, appears the name of Johann Sebastian Bach, surrounded in various layers by the names of other composers, the first layer comprising George Frideric Handel, Carl Heinrich Graun, and Franz Joseph Haydn. The latter, whose reputation as Europe's premier composer was by that time beyond question, is said to have been 'not unfavourably impressed by it, nor minded the proximity to Handel and Graun, nor considered it at all wrong that Joh. Seb. Bach was the centre of the sun and hence the man from whom all true musical wisdom proceeded.'

Let me conclude. The 'progenitor of harmony', as Beethoven put it, has not lost his attraction today. Even though we cannot and must not see Bach's music exclusively from the perspectives of his eighteenth and early nineteenth century enthusiasts and interpreters, our understanding of his musical philosophy benefits directly from placing it in the intellectual milieu of the Newtonian spirit of discovery. But Bach's art of penetrating, exhausting, expanding, and transcending all conceivable possibilities of harmony – that is, of musical composition – is by no means only to be understood as a theoretical exercise. It is a spirit of musical discovery that reaches beyond pure intellect by speaking directly to the heart.