

# Fugue No. 9

E Major

*Well-Tempered Clavier Book II*

Johann Sebastian Bach

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**Subject:** Fugue No. 9, *Well-Tempered Clavier*, Book II

Now the earth was formless and empty  
Darkness was over the surface of the deep;  
And God said, "Let there be light,"  
And there was light, and God saw  
that the light was good.

Genesis 1:1-2

- sea escape
- soundscape
- Let there be light!
- the Uncreated Wave

## Sea Escape

How we love the ocean! Its never-ending waves return us to a time before there was anything else. Savoring the ocean one day, with its surf racing toward me, I was amazed by a thought: of all the scenes we've come to love, this is the oldest and most pristine. Here nothing has changed from prehistory until now...always the continual coming of waves.

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In two weeks my family will make its summer migration to the coast of Oregon. We'll fly kites, soak up the sun, and of course wade the surf. In anticipation I've been thinking about how much a fugue is like the ocean, and its subject like waves.

In this analysis we'll develop that thought and come to a surprising conclusion. We'll liken the fugue to waves of all kinds, starting with the ocean, then moving to sound, light, and electromagnetic waves. We'll even delve into the physics of the atom. In all of these we'll discover designs reminding us that that the fugue, too, is a product of design.

This fugue lends itself to the analogy because its subject swells and falls, like the rolling waves at sea.<sup>2</sup> I'm rather fond of imagining how each ocean wave began, maybe weeks ago, that I might enjoy its final crest, foam, and race to shore. Who knows where the wave is that will be the first to crash upon the rocks in Yachats, two weeks from now!

Bach's subject is like that: born centuries before him. Dr. Ledbetter has observed (p. 97) that its first three pitches quote the ancient Mode 3, the *Magnificat* chant: "My soul glorifies the Lord and my spirit rejoices in God my Savior."<sup>3</sup> The quotation, however brief, identifies one source for this fugue as being the *verset* tradition, where preexisting material, often of Gregorian origin, was recycled to reveal as yet uncharted possibilities of traditional motives. Yet the white-note values of the subject indicate its primary inspiration to be that of the sober and restrained *stile antico*--again predating Bach.

In Mode 3, the subject begins with (in modern solmization) do-re-fa. But the subject is answered by sol-la-do. Notice that the final wave (m. 40) also begins with sol-la-do. While the intervals of the subject and answer are identical (normally indicating a "real" relationship between the two), it is a measure of the uniqueness of this wave that its answer is not likely to be heard as a transposition, but a continuation in the same key. This implies that it is a "tonal" relationship. In actuality this is one of those situations where you can make the box flip. So, decide how you hear it, then apply the proper term.

I'm sure that you know how waves can roll within the span of other waves. This is like a string that vibrates throughout its length, but simultaneously in halves, thirds, fourths, and ever smaller units. The ocean does this too; it has shorter waves within longer. The longest are found in the Pacific Ocean. A *Rossby wave* may be hundreds of miles long, only a few inches high, and take months to cross the Pacific--always east to west. *Kelvin waves* are similar, but move in the opposite direction.

I was amazed once to learn that the Polynesian sailors who discovered and populated the Hawaiian Islands navigated by discerning waves within waves.

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<sup>2</sup> Elias Haussmann portrayed Bach (1746) holding a triplex canon in which the subject of this fugue comprises the lead voice of canon no. 2. The same subject appears in Fux's *Gradus ad Parnassum*, an important work on 16th-century counterpoint that was translated into German, in Leipzig, while Bach lived in that city. In 1974 Olivier Alain discovered a copy of the *Goldberg Variations*, in Bach's hand, to which the composer had added an addendum of 14 canons on the first eight notes of the Goldberg ground (BWV 1087). The canon that Bach holds in the Haussmann portrait is number thirteen of the addendum.

<sup>3</sup> see Luke 1:46-55.

Understanding the directional tendencies of certain waves, they calculated vectors to determine where they were! This is a skill that few contemporary navigators have mastered.

Most listeners today would have difficulty hearing the waves-within-waves of a fugue. But one can train the ear to hear them; indeed, that's what this analysis is for. The countersubject is one of the more difficult to recognize. As the term implies it is normally heard in counterpoint with the subject (green on the timeline). Now listen to the countersubject (sounding here in the low voice and represented in aquamarine on the timeline). Notice how it begins with four rising quarter notes followed by a falling consonant skip in eighths. Those skipping eighth notes are the compass you'll need to navigate this fugal ocean. Each time you hear them, know that you are surfing the countersubject's wave. Remember, while other stepwise eighths occur, skipping eighths are always on the crest of the countersubject.

When you've learned to hear the countersubject's consonant skip, you'll recognize it even after its durations have been doubled. This is exactly what Bach has done in the 2nd half of his counterexposition.

Don't be disoriented by the word *counterexposition*; it is simply a reordering of elements in the exposition. The realigned waves let us know that we're in a different place. The animation reveals how the counterexposition implements a compression of entries, a new contrapuntal strategy, and trading of positions. Entries are compressed so that new waves begin before the prior have ended. This is called *stretto*. The new strategy enables the subject to accompany itself and the countersubject to do likewise (before this, they had only counterpointed each other). With respect to traded positions, the answer from the exposition now leads, while the subject for its part follows.

In the fugue's triple exposition the countersubject wave dissipates and we encounter two new ones. Some writers refer to these entries as countersubjects, but I'm going to take Dr. Ledbetter's lead and call them subjects. The exposition is "triple" because it has three distinct ideas. You'll recognize the 2nd subject (middle voice, pink) for its initial rising 4th followed by decorated suspensions in *stepwise* eighths. The 3rd subject (low voice, yellow) is chromatic; it rises by three half steps.

The triple exposition is indeed a new place--the high seas for sure! You might think of its new subjects as Rossby and Kelvin waves, alerting us to that fact that the fugue's ocean, here, is very deep. How deep? To plumb its depths will require us to recall that in Bach's day the formula  $3 \times 3 = 9$  equated to the Holy Trinity.

Does it strike you as odd that each new subject has been stated in only three voices? There are four voices in this fugue, and Bach would normally have "exposed" the subject to each voice. Had you noticed how the 1st and 2nd subjects span the interval of a fourth (three diatonic steps) while the 3rd subject spans three half steps? Do you think it possible that the triple exposition, with its three subjects, stated in only three voices, three times in *stretto*, and three-step spans, portrays God the Father, Son, and Holy Spirit? It is an intriguing question for which I have no answer.

It may seem odd to identify m. 23 as the beginning of the first development. Everything so far, though quite developmental, has nonetheless conformed to the conventions of exposition. Measure 23 begins an episode where the subject is developed in the minor mode. Bach has again compressed entries of the subject to produce the tightest stretto yet. The theme has been transformed by the addition of a passing note; what began as do-re-fa has become do-re-me-fa (high voice). (Do you recall Bach's earlier *thematic transformation* of the countersubject's skipping eighths to quarters?)

In the second *development*, the rolling waves of the exposition have become choppy and more frequent. These are the shortest of all! The contrapuntal techniques that Bach has used to create this little storm are *diminution* and *inversion*. Subjects identified by minus signs are in quarter notes; their durations have been cut in half. Subjects identified by curling arrows are not only diminished, but inverted; their intervals move in the opposite directions.

The third development returns us to the rolling subject, and countersubject, of the deep sea. But for its position, and function, this section might have been called another counterexposition. It is a *recapitulation*.

## Soundscape

Photographer Ray Doan has generously consented to allow his seascape, *Sunrise Panorama*, to be featured above this narrative. Clicking on it will take you to a larger image where, in addition to sea waves, you'll see waves in the sand. What the photograph does not reveal is the *soundscape*: the music of breaking surf, the wind, the fog of gulls and cormorants crying in the distance. These lovely sea sounds, too, are waves.

So far the fugue has been likened to ocean waves--a metaphorical resemblance to be sure. But, inasmuch as the fugue is made of sound, it is *literally* comprised of waves. Although it is impossible to see them, their presence can be represented on an oscillograph, where channels one and two represent the sounds produced by Dr. Korevaar's right and left hands respectively. You may toggle between the soundscape and score by clicking the radio buttons to the right.

The reason for representing the oscillograph in this analysis is to reveal what appears to be no more than a chaotic sea of sound. While one can readily deduce the presence of waves, even periodic, they appear to be *formless and empty*. By referring only to the graph, it is impossible to determine if any given segment is subject No. 1, No. 2, No. 3, the countersubject, a diminution, an inversion, or free counterpoint. They all look the same. But they do not *sound* the same! Aurally, we perceive distinct musical ideas in counterpoint with each other.

How does the composer do it? How does he splash the air in such a way as to create, not noise, not isolated tones, but sounds that are distinct from, yet connected with, each other? How does the composer conceive sounds that can be perceived as *motives* complementing each other? How does he prevent them from becoming homogenized, impossible to distinguish from each other? The

tools are few, but powerful: pitch, rhythm, dynamics, articulation, and phrasing.

Imagine that you and I are standing by a placid lake; its surface mirrors our faces and its shore is covered with smooth stones. What would you do? Choose a nice flat one and skip it across the water? That's what I would do. I'd revel in the rippled patterns, maybe grab a handful and skip them in different directions to see how the waves might interact. I'd run up and down the shore, hollering for you to join me in making circles on the water. But, no matter how hard we tried, we could not make our waves form the shape of a giraffe, a coconut palm, a windmill. In persisting, we would create only a choppy surface, a cacophony of waves destroying each other in dissonance and disharmony.

Suppose, by some magic, that you skipped your pebbles and were suddenly able to produce little ponds of waves consistently in the shape of this subject. What a delight that would be! Then imagine that I tossed another handful to make a 2nd subject, and a 3rd, and a countersubject, and that my waves did not fight yours. Now that would be counterpoint! And that is exactly what Bach has done in this fugue. It is incredible, really!

If such a composition is extraordinary, so is the skill of the performer who reproduced it. Each time he begins the study of a new fugue "darkness is over the face of the deep." He studies. He depresses a key and throws a pebble into the air; he says, "Let there be light." He articulates each sound so as to distinguish it from, yet complement, the others. This demands first an awareness of the fugue's structure. It requires, second, an infallible technique: purposeful articulation, thoughtful dynamics, and careful phrasing. This is Dr. Korevaar's skill, and we should be thankful that he has allowed us to enjoy this beautiful performance!

Just as you and I *caused* the waves on the placid lake, Bach caused the waves of this fugue and Dr. Korevaar the sound waves that bring it to you now. But, lest we forget, there may be oceans between us. To transcend them, Dr. Korevaar's soundscape had to be converted to another type of wave, one that could vastly outdistance sea and sound. That wave is electromagnetic. Whether you access the Internet through a phone line, fiber optic cable, or satellite, you are surfing the ocean of electromagnetism.

In the next section we'll consider electromagnetic waves in more detail. It will be a difficult discussion, but revealing. So hang on to your surfboard! When we finish riding this wave we'll make a surprising inference, so I'll make this point as simply as I can.

### **Let There Be Light!**

Light waves are of special importance to my argument. For nearly a hundred years the orthodox view has been that light is a duality of particle and wave. This theory is currently under siege. It appears that a new model will emerge; light and matter, *both*, are waves.

This revolution in our understanding of physics is of such importance that a brief history will be helpful. These paragraphs cannot but introduce this fascinating subject, which I redact from David Haddon's excellent review of

Carver Mead's *Collective Electrodynamics: Quantum Foundations of Electromagnetism* (Cambridge, Mass: MIT Press, 2000).<sup>4</sup>

The story begins in 1897 with Sir Joseph Thomson's discovery of the electron. Three years later Max Planck learned that the radiated energy of matter does not progress along a continuous curve, but in steps. Prior to Planck, scientists had thought of an atom as being like the solar system, with planets (electrons) orbiting in predictable and stable circuits around the sun (proton).

Planck discovered that electron "orbits" are not predictable; they appear instantaneously to occupy new circuits--as if the Earth were to assume the orbit of Mars without traversing the intervening space! He also learned that the increments whereby electrons changed "orbits" are constant. Planck called the smallest of these steps a *quantum of energy*. It is in this term that *quantum physics*, the study of sub-atomic particles, was born.

The story gets more interesting in 1910 when Niels Bohr discovered that whole-number multiples of the quantum map on to energy increments of the hydrogen atom. "When an electron fell to a lower energy level, the atom radiated a whole number of energy quanta as light, and when an atom absorbed a certain number of light quanta, an electron would jump to a higher level" (p. 44).

Werner Heisenberg, an associate of Bohr's, put sub-atomic physics on a statistical plane when he devised an equation that could predict the wavelengths of various atoms as they emitted light. Today's astronomers use Heisenberg's equation to calculate the proportion of various elements present in stars.

But problems remained. Bohr and Heisenberg could not predict how, when, or why, electrons made their "quantum leaps." In response to this problem Heisenberg devised another equation specifying the degree of uncertainty.

The "Uncertainty Principle" (as it came to be known) evolved from Bohr's and Heisenberg's inability to observe an electron's path. Before they could take its picture, it was gone. The instrumentation used in their experiments apparently altered the path so that one could never determine where an electron might be, only where it had been. Because they could not predict where it would be, Bohr and Heisenberg believed that they had reached the limits of atomic inquiry. In this realm of physics, they concluded, uncertainty was the only certainty.

Unable to predict electron behavior, Bohr and Heisenberg theorized that, "at the atomic level, matter doesn't have a definite existence as either a wave or a particle, but only an Aristotelian potential existence" (p. 44). They posited that the atom was both particle and wave, therefore neither particle nor wave, calling this seeming contradiction the "Principle of Complementarity."

In their *Principle of Complementarity* Bohr and Heisenberg abandoned an historic assumption: that nature is rational and predictable. Karl Popper writes that the principle was tantamount to "a renunciation of the attempt to interpret atomic theory as a description of anything" (*Conjectures and Refutations: The Growth of Scientific Knowledge*, as in Haddon p. 47).

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<sup>4</sup> *Touchstone*, Sept. 2003. Unless otherwise noted, all page numbers of this narrative refer to Haddon.

Unfortunately the "Principle of Complementarity" was hailed by some, for its very contradiction, as the vindication of metaphysical presuppositions that a thing is what it's not, and not what it is. In Bohr's conception: "A great truth is a truth of which the contrary is also a truth." In this famous statement Bohr questioned not only the rationality of science, but of rationality itself, and certainly of religion. He once pronounced: "'There is a God' [is] a statement of great wisdom and truth, and the converse 'There is no God' [is] also a statement of great wisdom and truth."<sup>5</sup> Such thinking has permeated postmodern philosophy and even crept into the scientific community with books like *The Tao of Physics*, by Fritjoff Capra.

At its inception, the contradiction of Bohr's and Heisenberg's Principle of Complementarity was, for many, beyond the pale. Wave-particle duality was challenged by Einstein who objected that it contradicted the law of noncontradiction; as he put it, "The Lord is subtle, but not malicious." Einstein engaged Bohr twice in public debate, both times unsuccessfully.

Because Heisenberg's theorems could predict some atomic events, physicists have maintained their model for nearly a century. During the interim we've been stuck in what Haddon calls a "mathematical-statistical limbo," where physics has had "no intelligible concept of fundamental physical reality" (p. 45).

To hold that the physical world is neither particle nor wave, therefore it is both particle and wave, would be like maintaining that since this fugue is comprised of both countersubject and subject it follows that the fugue is neither subject nor countersubject. The analogy is flawed, of course, but still useful. It is predicated upon a false assumption that subjects and countersubjects are mutually exclusive (which they are not), and that the presence of one contra-indicates the other (which it does not). But if one can, for the moment, pretend, one can appreciate the irrationality of Bohr's and Heisenberg's Principle of Complementarity.

A solution to the supposed non-reality of matter was foreseen in 1994 by theologian R. C. Sproul (*Not a Chance*) who reasoned that "a quantum leap is an illusion" (p. 47). Sproul argued that Bohr and Heisenberg had made a mistake in jettisoning the principle of rationality and the law of noncontradiction. He predicted that physicists would eventually find a better explanation.

Six years later Carver Mead published *Collective Electrodynamics*, where he proclaimed that future generations will call the last seven decades "the dark ages of theoretical physics." Both light and matter are in fact waves. Mead offers ten examples of pure wave phenomena that have been discovered since 1933. These include lasers, superconducting electrical currents, and the Bose-Einstein condensate of atoms (p. 46).

Mead's stated purpose is not to discredit quantum mechanics, only its Zen-like halo. He seeks to reconcile quantum physics with wave theory by challenging irrationalism: specifically the notion of *discontinuity*--that an electron moves from here to there without occupying the space between. Instead he demonstrates, mathematically, the probability of *continuous* trajectories, crediting Janes, Cramer, Zeh and others with having paved the way for what he describes as "a

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<sup>5</sup> As quoted in Paul Dirac, *Niels Bohr: His Life and Work as Seen by His Friends and Colleagues*, 309.

resounding victory for Einstein" (p. 127). It is a victory where everything--matter, energy, light, radiation of all kinds (and we might add fugues), are waves.

### **The Uncreated Wave**

I need to confess that the idea of comparing a Bach fugue with subatomic particles didn't come from me, but Einstein. The problem, as he saw it, was one of causality. In 1931 he replied to a question from Planck:

We are like a juvenile learner at the piano, just relating one note to that which immediately precedes or follows. To an extent this may be very well when one is dealing with very simple and primitive compositions; but it will not do for the interpretation of a Bach Fugue. Quantum physics has presented us with very complex processes, and to meet them we must further enlarge and refine our concept of causality.

The logic of Einstein's reply is this: while there are many things we don't understand about the atom, we can infer (from what we know of a Bach fugue, for example), that it must behave with reason, and not without cause. It is with the principle of *causality* that I conclude.

In this study we've considered waves of all kinds. If you get nothing else from it, you should remember that every wave was caused by another. But this raises a baffling question...what caused the first? I often wonder about this, as I'm certain that you wonder too. Would not whatever caused the first wave, itself have been eternal--the Uncreated Wave? Is not that which exists, but never had beginning, the only thing that requires no cause? And if no beginning, does it not follow that it has no end?

In his famous debates with Bohr, Einstein quipped, "He doesn't roll dice." This apparent reference to God should not be interpreted theologically, but in response to Bohr's rejection of causality (p. 46). Bohr's *indeterminism* required him to abandon *causality*, which forced him to embrace irrationality and contradiction. This was a conclusion that Einstein could not bring himself to make. Why?

Do you remember when you and I were skipping rocks across the lake? We were *causing* waves. We delighted in causing them. We saw that the lake, and the skipping rocks, and the waves were good. What a terrifying lake it would have been if ripples had begun to form fugal subjects and countersubjects, diminutions and inversions, without cause: no earthquake, underground spring, raindrops, or trout feeding on mayflies dipping their tails into the glassy surface...just a spontaneous formation of waves. Would we have considered such a thing to be good?

The sand and sea in Mr. Doan's photograph have been formed into waves. What caused them? Wind (more waves). But what caused the wind? Light (more waves). But what caused the light? Fusion (more waves). If Mead is correct, then *everything*, from silicone in the sand to salt in the sea, is made of

waves caused by other waves!

And what of this marvelous performance. What caused it? Your computer played sounds (waves). Where did it get them? The Internet (waves). Where did the Internet get them? Dr. Korevaar depressed the ivories on his piano to make sound waves. Why did he do that? He had an idea (brain waves) to become a world-class pianist and perform the *Well-Tempered Clavier*. How did he perform it? By studying the score and making intelligent choices about dynamics, articulation, and phrasing (more brain waves). Can you imagine what a performance it would have been had he made these decisions by the toss of a coin?

The fugue too is made of waves: sound waves with a perceivable structure. What caused its structure? In causing it, did Bach not make countless choices; should the subject go up, or down, by what interval and for how long? Shall this note be combined with that, this motive with that, this cadence in this key or that? Here shall I move to the minor mode or resume the major? Shall this stretto be with two beats of separation or three, or one? Shall I combine the subject with itself or its countersubject, or perhaps itself with its diminution and diminished inversion?

In making these decisions was Bach not like an architect, a choreographer, an engineer, a poet? Did he not make intelligent choices? One thing is for certain, he did not toss coins; he did not play eenie meenie miney moe. His choices were based upon aesthetic and musical criteria expressive of what he conceived to be a universal good.

In all of their waves--sunrise, seascape, fugue, performance--we perceive intelligence, thoughtfulness, structure, and design. Contemplation, thought, and idea must be attributes of the Uncreated Wave, the fugue's primal cause.

Since it is impossible for science to identify the Uncreated Wave we are left with presuppositions, of which there are two possible.<sup>6</sup> First possibility: there is no such thing as an uncreated wave; everything has a natural cause and explanation. This is the *naturalistic* position. It begs the question of first causes by projecting them ever further into the past. The naturalistic position cannot explain, nor will it ever, why there is something instead of nothing.

The second possibility--the Theistic one--is that everything came from an Uncreated Wave. Such a wave must have had no cause, for causality began with it. It is the primal cause, the creator of causality itself. Were we to take a lesson from the fugue, we might surmise that the stupendous variety and beauty of forms that the Uncreated Wave produced would have required, as the fugue requires, a creative process involving intelligence and design--and not (paraphrasing Einstein) "the rolling of dice."

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<sup>6</sup> Because it proceeds from an assumption that everything is open to falsification, science cannot prove metaphysical reality. It is impossible. No theory, regardless of how "sacred," can transcend this principle. Were science to "identify" the first wave, this would be cause for more investigation hypothesizing that it had not. Ontological problems are not for the scientist, but the philosopher and theologian.

In the beginning was the Word,  
and the Word was with God,  
and the Word was God.  
He was with God in the beginning.  
Through him all things were made;  
without him nothing was made  
that has been made.  
In him was life,  
and the life was the light of men.  
The light shines in the darkness,  
but the darkness has not understood it.

John 1:1-3