ESSAY · IN THE REGISTER OF DANTE ALIGHIERI

Brother Electron

Or, law all the way down. A pilgrim goes down into a chip with Einstein and climbs back up with Francis, Thomas and Maximus, to ask whether the word that orders a people to its end can be carried down to the electron, and in what sense.

Richard Verver · October 2026

For Althea, a pilgrim of our day: engineer and physician, mother and teacher of many, who sings the chant.

… le cose tutte quante
hanno ordine tra loro, e questo è forma
che l'universo a Dio fa simigliante.
All things whatever have an order among themselves, and this is the form that makes the universe like God.
— Dante, *Paradiso* I.103–105

Fire, and hail; snow, and vapours; stormy wind fulfilling his word.
— Psalm 148:8

A pilgrim goes down into a chip and up again, the way Dante went down and up. Three of the voices are saints, and the Church has said where they are. Two are not, and this poem places no one: Albert Einstein and Pierre Teilhard de Chardin speak from their own books, and where they are now is not ours to say. The voices are borrowed; the argument, and its errors, are mine. The places are given in the note at the end.

Canto I: The dark wood of copper

Midway through the night of my life I found myself in a dark wood of copper, for the straight trace was lost.

It was a little after one. The laptop was open on the kitchen table, the fan was turning, and the cursor kept its small pulse at the end of a sentence I could not finish: *law reaches all the way down.* The law of a land orders a people to its end. The Church's law orders a pilgrim people to its end. I wanted to know whether the same word could be carried down through the machine in front of me to the bottom of things, or whether it snapped somewhere on the way, like a trace on a cracked board.

Then the screen was very large and I was very small, and the wood was all around me. Green fibreglass underfoot. Copper paths running in parallel like the rows of a vineyard. Black squares of silicon standing in the clearings like chapels. No leopard, no lion, no she-wolf. Only the hum.

A man came out from behind a capacitor. White hair that had never met a comb, a grey sweater, no socks.

“Have mercy on me,” I said, the way Dante says it, “whatever you are, shade or living man.”

“Neither, here,” he said. “I was born at Ulm, under Wilhelm. In Bern I examined patents for electrical machines: technical expert, third class. I know a wood like this when I see one.” He stooped and touched a trace. “This was written with light. In 1905 I said that light comes in grains. They used the grains to draw it.”

“You are not my master,” I said. “But you are an honest man, and I need someone who knows the way down.”

“Down is easy,” said Albert Einstein. “The order goes all the way. I spent my life finding that there is no corner of this wood where the equations go slack.”

“And where are you now? Here, or—”

“Don’t ask. I kept no such ledger, and you have no right to keep one.” He said it kindly. “Ask me about the wood.”

“Then whose law is it, that goes all the way down?”

He shrugged. “Spinoza’s God. He shows himself in the lawful harmony of what exists, and he does not trouble himself with anyone’s fate.” He had wired as much to a rabbi in New York in 1929, and he did not take it back now. “Come. You want to see the bottom.”

So he went ahead, and I followed.

Canto II: The gate, the loop and the beat

We went in through the top of a black square, the way you go into a cathedral through the roof in a dream. Under it lay a city of copper wiring, a dozen storeys of it or more, streets laid crosswise on streets, and under the last street the ground floor, where the work is done.

“There,” he said. “A transistor. There are tens of billions in this one chip.”

It was smaller than I had imagined and plainer: two banks of silicon, a source and a drain, and between them a gate. When the gate is charged, a channel opens and the electrons cross. When it is not, they wait. One crossing is a one; one waiting is a zero. Everything on the screen above us, the unfinished sentence included, was made of crossings and waitings.

“And they obey,” I said.

“Obey is a figure of speech.” He sounded like a man correcting a student he liked. “They do what they are. Put a voltage on the gate and the field does the rest. No electron here has ever been told anything.”

“But the engineer was told. There is a code for wiring in my province, and an electrician who breaks it can lose his licence.”

“Then the code reaches the electrician,” said Einstein. “It never reached an electron.”

That was the first thing I learned below the board, and I wrote it down: a human law reaches matter only through the hand that works it. It binds the one who makes, and through him it orders what is made.

“But a gate can’t remember anything,” Einstein said, “and it can’t count. It only answers.” He led me down a side street to where two gates stood face to face, each wired back into the other’s input, like two men leaning on each other’s shoulders. “Two radio men found this in 1918, with vacuum tubes. A flip-flop. Push it once and it flips. After that it stays, because each keeps telling the other what it is. That is one bit of memory: nothing but a relation that holds.”

“For how long?”

“As long as the power is on. Cut the power and it forgets everything at once.”

Most of the memory in the machine, he showed me, is cheaper and more forgetful still: rows of tiny wells of charge, each leaking away in the dark. Every sixty-four thousandths of a second the whole of it is read and written back, row by row, before it fades. They call it refresh. The machine remembers by rewriting.

Under all of it was a beat. Somewhere on the board a sliver of quartz rings when voltage squeezes it, and the ringing is multiplied up to a few billion ticks a second. At every tick every gate in the city takes its new value together, and between ticks nothing is supposed to be decided. “Without the beat,” he said, “the signals arrive at different times and the city argues with itself. They call it a race. The beat doesn’t make the order. The wiring does that. The beat only measures it out, so everyone acts on the same count.” He listened a moment, the way a violinist listens. “In Bern some of the patents on my desk were for clocks kept in step by electric signals. Then I wrote a paper that begins by asking what it means for two clocks to agree.”

The ring of the crystal was divided and multiplied all through the city, a beat inside a beat inside a beat, and I thought of Ezekiel by the river Chebar: *as it were a wheel in the middle of a wheel.* “His wheels went wherever the spirit went,” I said, “for the spirit of the living creature was in the wheels.”

“There is no spirit in these,” said Einstein.

“No. They go where the engineer sent them.”

A gate that answers, a loop that holds, a charge that is renewed, and a beat that keeps them in step. “Logic, memory and time,” he said. “That’s a computer.”

I wrote that down too.

We went closer. Under the gate lay a layer of glass so thin it could be counted in atoms.

“When they made it this thin,” he said, “the electrons began going through it. Not over. Through. It is called tunnelling. They had to change the glass to stop the leak.” He was quiet a moment. “And they tell me that which electron goes through, and when, is decided by nothing at all. A throw of the dice.”

“You wrote to Max Born in 1926 that He does not throw dice.”

“I still say it.”

“So do I,” I said, “though not for your reason. If freedom came from the dice, a coin would be freer than a saint. Whatever freedom is, it isn’t noise.”

He brightened. “Good. Then you see there is no freedom here at all, only order. And none up there either.” He pointed back up through the city at the screen, at the kitchen, at me. “Schopenhauer had it: a man can do what he wills, but he cannot will what he wills. That sentence has consoled me all my life.”

“Then we agree about the dice and disagree about everything else.”

He laughed out loud, a high delighted laugh. “That is how I got on with Bohr.”

Canto III: The floor that was a ceiling

We went below the gate, into the silicon itself. The atoms stood in their lattice like monks in choir, each holding hands with four others. Below the atom, the nucleus. Below the nucleus, the things that make it. Below those, the fields.

“Where is the bottom?” I asked.

“Every time we found a floor,” he said, “it turned out to be a ceiling.”

I understood then what I had come down to learn. Cutting tells you what a thing is made of. It never tells you what the thing is. All the way down we had been learning parts, and every finding was true, and none of them was the answer to my question. The transistor is silicon that a hand has given a form, the way a sculptor gives bronze a form. It is not a new kind of thing. Its end is outside it, in the use it serves, and through the use, in the one who uses it. Whether the electron is a thing in its own right, the philosophers still argue, and I did not need to settle it. I knew it only by cutting, and cutting gives parts.

“There is one more thing you should know,” I said. “In 2019 they fixed the electron’s charge by law. One point six zero two one seven six six three four times ten to the minus nineteen coulombs, exactly. The General Conference on Weights and Measures voted it the autumn before.”

He was enchanted. “So the law reached the electron at last.”

“No. It reached us. It fixed our coulomb. The electron was not consulted, and it was not bound.”

He started to answer and stopped, because someone was coming down the lattice toward us, quickly and without a rope: a tall, thin man in a field coat, with a Roman collar and a geologist’s hammer at his belt.

“Don’t stop at the bottom!” he called. “Everything is climbing!”

Einstein knew him at once, and so did I. Pierre Teilhard de Chardin, Jesuit, who had dug for the bones of the first men in the hills outside Peking. He died in New York on Easter Sunday 1955. Einstein died in Princeton eight days later, an hour away by train.

“Every grain has a *within*,” said Teilhard, out of breath and happy. “A without, which you measure, and a within, which you don’t. Consciousness in germ. The universe is rising through it toward Omega, toward Christ.”

There were two ways to hear him, and I asked which he meant. “Do you mean the electron is governed as I am? From within, by reason?”

He thought about it honestly, which I had not expected. “No. I mean it has an inside. That it is not only a without.”

“Then I can walk with you some way,” I said. “Every being has the inside of having been made. I will stop where your *within* starts to mean reason.”

“And I,” said Einstein, “will walk with you both until somebody says Omega.”

So we turned around. Down had been easy. Up was harder, because up there were persons.

Canto IV: Brother Electron

Where the silicon met the copper, a little man in a patched brown habit sat on a solder joint as if it were a stone wall in Umbria, singing.

Laudato si’, mi’ Signore, per frate vento …

He stopped when he saw us and stood up, delighted, as if he had been waiting all afternoon. “Brother Albert! Brother Pierre! And the little brother from the kitchen.” He looked at Einstein’s feet. “No shoes either. Good.”

“We’ve been at the bottom,” I said. “There isn’t one.”

“No,” said Francis of Assisi. “There is only the top.” He swept a hand over the lattice and the city and the dark above it. “Brother Electron is running all the errands. Praise to you, my Lord, through Brother Electron, who carries your light to the kitchen so the little brother can write by it.”

Einstein cleared his throat. “With respect, Brother Francis, the electron is not a brother. It has no mother, no name, no soul. It is a quantum excitation of a field.”

“And Brother Fire has no mother either,” said Francis, “and I call him handsome and merry and strong. Do you think I sang that to him? He can’t hear. I sang it to the Lord, *per* him.”

I knew the line. *Laudato si’, mi’ Signore, per frate focu.* The whole canticle turns on that little word *per*: praise to you, my Lord, through him, by him, for him. Francis never praises the creature. He praises God *per* the creature. Sun, moon, wind, water, fire, earth, each says the Lord by being what it is, and none of them is told anything. Even Sister Mother Earth, *la quale ne sustenta et governa*, governs only the way the earth governs: by holding things up.

“So the creatures keep God’s law without knowing it,” I said.

“They don’t keep it,” Francis said. “They *are* it, the way a song is its tune. Only one creature in the canticle has a will, and he gets the hard verses. *Blessed those who bear in peace.*”

“And the wolf?” said Teilhard, slyly. “At Gubbio you made a contract with a wolf. A pact. He gave his paw on it, in your hand, in the marketplace.”

Francis laughed until he had to sit down again. “Brother Wolf was hungry. The town agreed to feed him, so he didn’t need to eat them. The contract was for the people of Gubbio. The paw was for the children.” He wiped his eyes. “He kept it, though. Two years. They cried at his funeral.”

Einstein, I noticed, was smiling. “You are a dreadful physicist,” he said.

“I am a dreadful everything,” said Francis, “except a brother.” Then he got up and took my hand, and Teilhard’s, and reached for Einstein’s. Einstein let him take it. “Come and meet Brother Thomas. He’s slower than me, but he gets there.”

Canto V: The Sun

We went up the way Elijah did: carried. Every crossing in the city gives off a little heat, and the heat rose off the chip, and the fan took it, and there appeared, as near as I can tell it, a chariot of fire and a whirlwind. Dante saw that chariot once from below, in the eighth circle: Elisha watching it go, unable to follow it with his eyes, seeing nothing but the flame, rising like a little cloud.

The man at the reins wore a mantle of hair and a leather girdle. I had last seen him in a hall in Toronto, disputing about clouds. “Nothing was added to the wind, the fire or the cloth,” he called back over the roar. “They were given back their end.” At the top of the air he reined in and set us down.

“No higher?” I asked.

“Not by chariot,” said Elijah. “A mere man needs someone else to carry him up. The gate above the air was opened later, by one who went up by his own power.” Then he turned the horses, and the fire went back down to the board.

What carried us the rest of the way I can only say as Beatrice said it to Dante, in the passage at the head of this poem: every nature moves to its own port across the great sea of being, by the instinct given it to carry it there; and that bow shoots not only the creatures without understanding, but those with understanding and love.

Then the light changed, and we were in the fourth heaven, the Sun, where Dante put the teachers, and they were dancing in a ring the way he said, twelve lights around us like the numbers on a clock. One of them came down out of the ring and was a large, quiet Dominican with a book under his arm. Francis embraced him, which was like a sparrow embracing an ox.

“Brother Thomas,” Francis said, “they want to know about law.”

St Thomas Aquinas sat down, opened the book, and did what he always does. He began with what law is.

“Law is a rule and measure of acts,” he said, “by which one is moved to act or held back from acting. It belongs to reason, because reason is the first principle of acts. And it is an ordinance of reason for the common good, made by him who has care of the community, and promulgated.”

“Then there’s no law in an electron,” said Einstein. “Good. I have been saying that all night.”

“There is law in the electron,” Thomas said mildly, “as in the thing ruled. Not as in the one who rules. The whole community of the universe is governed by the divine reason. That reason, in the governor of all things, has the nature of a law, and since it conceives nothing in time, it is eternal. Everything is under it. The electron, the wolf, the stars. Even what in creation is necessary, and not contingent, is under it.”

“Held under it,” I said, “like the flip-flop. Cut the power and it forgets.”

“Like the air the sun lights,” said Thomas. “The light ceases with the action of the sun. If God withdrew his ruling power, as Augustine says, all nature would collapse. That isn’t a law the electron keeps. It’s the being it is kept in.”

“And God?”

“God is not under the eternal law. God *is* the eternal law. Nothing above him measures him.”

I saw the shape of it then, and wrote it on my hand like a schoolboy:

- above: the one who *is* the law, under no law
- in the middle: the one who *shares* the law, under it from within
- below: what is *moved* by the law, under it from without

Thomas read it upside down, took my pen, and struck out the first line.

"Not there," he said. "He isn't the top of your list. He isn't in it. Between the Creator and the creature no likeness can be noted without a greater unlikeness. Put him at the head of a column and you have made him the largest thing in it."

I knew the rule. The Fourth Lateran Council laid it down in 1215: nothing is said of God and of creatures in the same way. A word is said of him first, and of us only by participation. I had broken it with a felt pen. Two lines were left. Both were creatures, and both were under the one law, in two ways.

"This one," Thomas said, tapping the line about sharing. "The rational creature is subject to providence in a more excellent way. It shares in providence by being provident for itself and for others. It has a share of the eternal reason, and so a natural inclination to its due act and end. That sharing is what we call the natural law."

"And the wolf has none?"

"The wolf shares in the eternal reason in his own way. But not rationally. So there is no participation of the eternal law in him, except by way of similitude." He looked at Francis with enormous affection. "Which is why the pact at Gubbio was with the town."

Teilhard leaned forward. "But the inclinations, Thomas. You yourself say man has three: what he shares with every substance, to keep in being; what he shares with the animals; and what is his own, to know God and to live in society. The first is the electron's. The bottom is in us."

"The bottom is in us," Thomas agreed. "So the law reaches all the way down, through us. That is why man is not a stranger to the world. He is its middle. The world is ordered to him, and he carries it up."

"And the blessed?" I asked. "When the inclination is healed, is there still law?"

"The good are perfectly subject to the eternal law," said Thomas, "because they always act in accordance with it. The blessed most of all. Law isn't a fence that falls down at the end. It is what the Sun is like." And he looked around at the ring of lights, which had begun to dance again.

Canto VI: The workshop

The last voice had no tongue. Thomas told us so as an old monk came out of the light, a Greek, very thin, with a cloth over his mouth and his right hand wrapped in a bandage that had been stained for thirteen hundred years. At Constantinople they had cut out the tongue that confessed two wills in Christ and cut off the hand that wrote it. He died in exile in the Caucasus. The Church calls him Maximus the Confessor.

He could not speak, so he drew. With his left hand, in the light, he cut the world in two, and then cut each half again, five times:

1. the uncreated, and all that is made;
2. the made: the intelligible and the sensible;
3. the sensible: heaven and earth;
4. the earth: paradise and the inhabited world;
5. the human being: male and female.

Then he put a small figure in the centre of all five cuts, touching every one. Thomas read it out for us. "Man is the most capacious workshop, containing all things. A natural bond, mediating between the universal extremes through his own parts."

"A *workshop*," said Einstein. "Like Bern."

"Like a carpenter's shop," I said. "Where the material is worked and given its end."

The monk nodded hard, and drew again. The figure in the middle was meant to gather the five divisions into one, from the inside out, and failed, and turned its back. So another came into the middle and did it in his own body: the first division healed in his birth, paradise and the inhabited world in his death and rising, heaven and earth in his ascension, the intelligible and the sensible as he passed through the angels, and last, standing before the face of the Father, the made and the unmade, by grace.

That was the answer to my divisions. Physics divides the world truly, and the divisions are real. But they are divisions of a whole, and the whole has a middle, and the middle has a name.

Below it he wrote, in smaller letters: *the one Logos is many logoi, and the many are One.* Thomas glossed it. "Every creature has its *logos*, its principle in the Word: what it is and what it is for. The electron's logos is in him. It does not know it. It doesn't need to."

Einstein was very still. "That is not so far from Spinoza," he said at last. "An order of the world in the mind of God."

The monk shook his head and drew one last thing: two wills, side by side, in one figure. A human will and a divine will, two and not one, the human moving freely toward the end the divine had set for it, never against it. Thomas began to explain, but Francis did it faster.

"He means the will isn't free because it can go anywhere," Francis said. "It's free because it goes *home*."

Not dice, I thought. Not a man willing what he cannot will. A will that is natural all the way down, moved by its own logos, and free because the end it is moving toward is its own. That is why the old man let them take his tongue. If Christ had only one will, there would be no human will healed, and nothing in the middle of the workshop to carry the world up.

Canto VII: The altar of the world

"Now my turn," said Teilhard, and he told us about a morning in the Ordos desert in 1923, when he had no bread, no wine and no altar. "So I said: I, your priest, will make the whole world my altar, and on it I will offer you all the labours and sufferings of the world." He spread his hands over the ring of light, the city of copper, the kitchen far below. "All of it. Every electron in that chip. Matter, slowly rising into spirit, all the way up to Christ."

Nobody spoke for a moment. Then Thomas said, "The Church kept your altar, Father."

It had. In 2003 John Paul II wrote that even on a humble country altar, the Eucharist is always in some way celebrated on the altar of the world. It unites heaven and earth. It embraces and permeates all creation. And in 2015 Francis of Rome, who took the name of the little man beside me, wrote that the Eucharist is itself an act of cosmic love, and that joined to the incarnate Son, present in it, the whole cosmos gives thanks to God.

"Joined," I said. "Not turned into."

Teilhard looked at me with real interest. "Go on."

"At the altar the bread is changed, whole, into his Body. Trent says the whole substance, so whatever the electron turns out to be, the bread is a substance, and it is converted. But that happens to this bread, at this altar, at these words. The world isn't changed into Christ. It is brought to him, the way Francis's fire is brought to God, *per*. It gives thanks through him." I took a breath. "Your *within* can stay if it means that. Every grain has the inside of having been made, and of being offered. But I won't give it reason, and I won't let matter become spirit by rising. It doesn't need to. It's being carried."

"By whom?"

"By the one in the middle of the workshop. And by us, in him."

Before the Council's fathers had finished their work they wrote it down. At the Last Supper Christ instituted the Eucharistic sacrifice to perpetuate the sacrifice of the Cross throughout the centuries until he should come again: a pledge of future glory. The faithful are drawn day by day into ever more perfect union with God and with each other, *so that finally God may be all in all*. And then, in the next chapter, almost as an aside: there is hardly any proper use of material things which cannot thus be directed toward the sanctification of men and the praise of God.

Hardly any. I thought of the trace written with light, and the glass counted in atoms, and the tens of billions of gates. At the offertory the priest says that the bread is fruit of the earth and work of human hands. The chip is a work of human hands too. It hasn't been consecrated and it never will be, but it can be offered, the way an engineer offers a day's work, and that is what *directed toward* means. The law of the land reaches the electron through the electrician. The law of the altar reaches it through the one who offers.

Teilhard's eyes lit again. "Then the Mass is the world's refresh. Every morning, everywhere, the memory written back before it fades."

"No," I said, and was surprised how fast. "A refresh writes the charge again. A new charge every time, copied from the old one before it leaks away. If the Mass did that, it would be the cross again, and Trent says the victim is one and the same, only the manner of offering different. Nor is it a bare reminder. The Council calls it a memorial, and the old word means more than remembering: the one sacrifice, made present, not done again."

"Then what in the box is it like?"

"Nothing. The box remembers the way I do, by rewriting or by forgetting. That's the line."

Teilhard was quiet for a long time. "In 1962 the Holy Office warned the faithful about my books," he said at last. "Ambiguities and serious errors. I'd been dead seven years." He smiled, not unhappily. "I think you have just shown me one of the ambiguities. I would like to have had you as a censor."

"You'd have hated it."

"Yes," he said. "And thanked you later."

Einstein had stepped back while we spoke, the way a guest steps back at a stranger's liturgy, and stood with his hands behind him. Francis went and stood beside him, so that he would not be alone.

Canto VIII: The volume

At the end of his poem Dante looks into the light and sees, gathered in its depth, bound by love into one volume, all that lies scattered in leaves through the universe.

Nel suo profondo vidi che s'interna,
legato con amore in un volume,
ciò che per l'universo si squaderna.

I didn't see that much. I'm not Dante, and I was up past one. But I saw the leaves. The tens of billions of gates, crossing and waiting. The atoms holding hands in their lattice. The wolf at Gubbio going from door to door. Brother Fire, Sister Water, the glass counted in atoms, the bread at the altar. Every leaf with its own logos, every one under the one law: some from without, moved and not told, and one kind from within, told and free. And the binding was not the law. The binding was love, and the law was only the shape the love takes in a world that has not yet reached home.

I saw how the leaves were bound, too, and the binding ran two ways. Some threads run back. Every page cites what was written before it and nothing after it: I can quote Gregory, but Gregory could not have quoted me. Other threads run forward. The chariot of fire went up nine centuries before the one who went up by his own power, and it was for him. Gregory saw both in Ezekiel's wheels. The wheel within a wheel, he said, is the New Testament within the Old, and what the Old promised the New showed forth. Elijah's chariot inside the Ascension; a hall in Toronto inside this night. A record with only the first kind of thread is a library. A record with both is a family.

Einstein was still standing at the edge of the light, with Francis beside him.

"Somebody said Omega," I reminded him.

"So they did." He looked into the ring of the Sun for a while, and I couldn't read his face. "I once wrote that the eternal mystery of the world is that it can be understood. That it is comprehensible at all, I called a miracle. I never gave the miracle a name. You've given it one." He shrugged, the same shrug as in the wood. "I can't say yours. I won't say I can."

"I didn't ask you to."

"No. You didn't." He held out his hand, and I shook it. "You were a better guide than I was."

"You took me all the way down. Nobody else would have."

Then Francis took his arm and walked him to wherever the edge of that light goes. I didn't follow. I don't know where he went, and the Church has never told me, and I am not going to tell you.

When I looked up, the light was grey, and it was the window over the sink. The fan had stopped. The cursor was still pulsing at the end of my sentence, in time with a crystal I would never see. I deleted it and wrote:

Law reaches all the way down. God does not keep it: he is it. The electron does not keep it either: it is moved by it, from without, and calls nothing a command. And in the world there is one creature that is told, and can answer, and is free because the law it keeps from within is the way home. He is the middle of the workshop.

Through his hands the copper and the silicon, the bread and the wine, are directed toward their end, until God is all in all.

It held. I closed the laptop. In the dark of the case the beat slowed and the gates went quiet, and the memory went on writing itself back, row by row, so that it would remember in the morning: moved, like the sun and the other stars, by love.

> *l'amor che move il sole e l'altre stelle.*
> — *Paradiso* XXXIII.145

Edges

The essays here make a graph, and this one draws on two before it. From Whether the Cloud Makes Many Worlds it takes Elijah, with his line about the wind, the fire and the cloth, and the rule that to learn a thing by cutting it is to learn its parts. From What Is to Be Done? it takes the workshop at Nazareth, "Is not this the carpenter?", and the machine kept small, on a household's own computer, "the size of one human life."

Both foreshadowed it as well. The disputation in the hall said of the current in a wire, "Every electron in it is held in being, this moment, by the same hand that holds you." This essay unfolds that sentence. The pamphlet used Lenin's "brought to them from without" for consciousness; here the same words name how matter is governed, in another sense. And inside the poem, Elijah's chariot foreshadows the Ascension, for which it went up.

Coda: the music

The essay has a twin you can play: a track at 120 beats a minute for Strudel, a free live-coding environment that makes music in a web browser. It is a motorik beat on square waves, the sound of the old chips, in A mixolydian, and a bar lasts two seconds, so the clock can be counted. Its code is a DAG, like the essays. Every part names the parts it is made from, which always stand above it, and some parts also name what they are for: a later part they foreshadow. The first kind of edge runs back, the second forward. Even the dice are loaded: Strudel's randomness is a function of time, so the tunnelling falls the same way every time it plays, as Einstein would have wished.

The tracks inherit, as the essays do. This essay draws on Whether the Cloud Makes Many Worlds and What Is to Be Done?, so Elijah's chariot carries the first one's hook, the Ascension introit *Viri Galilaei*, now in A and in fauxbourdon, the chant with a fourth and a sixth below it as the choirs of the fifteenth century sang it; and in the workshop the rimshot taps the second one's hammer, IS NOT THIS THE CARPENTER. Each line quoted from a parent carries a short hash of the original, so anyone can check

that it came down unchanged. The family moves up by fifths: the cloud in G, its child in D, this one in A. The whole family sings together in A New Song. Made by Claude + Richard.

1. **I. The dark wood** (0:00): a fan, the copper, a cursor blinking; “Brother Electron”; “Have mercy on me.”
2. **II. The gate, the loop and the beat** (0:16): the gates spell LAW in ASCII, a crossing a note and a waiting a rest; a flip-flop latches; the memory is written back thirty-two times a bar. At 0:48 the clock, and a beat inside a beat inside a beat, “as it were a wheel in the middle of a wheel”; then the dice.
3. **III. The floor that was a ceiling** (1:04): a tone that falls for ever, six octaves sliding together; at 1:20 Teilhard turns it round: “everything is climbing.”
4. **IV. Brother Electron** (1:36): Francis sings his canticle on a recorder; at 1:52 the gates play it: praise *per* Brother Electron.
5. **V. The Sun** (2:08): Elijah’s chariot, *Viri Galilaei* in three voices, carried up an octave; at 2:24 a ring of twelve bells against sixteen steps; at 2:40 the struck line, “Not there,” and the top voice is gone. Two lines are left, one from within and one from without.
6. **VI. The workshop** (2:56): no words. A note cut in half five times and joined again five times, two wills moving together and coming home, and the carpenter’s hammer.
7. **VII. The altar of the world** (3:20): everything; “where the feeble senses fail.” At 3:36 the refresh stops and one chord is held, struck once and not written again; “so that finally God may be all in all.”
8. **VIII. The volume** (3:52): the threads bound, the parents’ lines together; the cursor’s last blink lands on the last chord: “It held.”
9. **IX. Sleep** (4:16): the memory writes itself back in the dark: “the love that moves the sun and the other stars.”

Watch, listen, or take it with you

The video draws the chip as Dante’s cosmos, and every mark in it comes from the score. The gates light a register as they spell LAW; the flip-flop’s two cells answer each other; the memory is redrawn row by row on every refresh; Ezekiel’s three wheels turn on the clock’s hits, and sparks tunnel through the glass on the dice. The floors fall for ever, then climb. Francis’s tune is drawn in gold, then in pixels. Fire rises on every kick of the chariot while the chant is sung in three voices on a red staff; twelve lights turn like the teachers in the Sun; the top line is struck out. The workshop has no words, only the plank cut on each stroke of the marimba and the hammer on each stroke of the Morse. At the altar the memory leaks away while the held chord glows without a flicker. It ends with the track’s own DAG, parents drawn back and what each part is for drawn forward, and the cursor’s last blink on the last chord. A clock tape along the bottom taps every drum and every dot and dash. Download it as an MP4 (1080p, 22 MB), or the vertical cut for

phones, from Francis's tune on the gates to the struck line, as an MP4 (5 MB). On YouTube: the video and the Short.

A recording of the score, 4 minutes 24 seconds, to download and keep: MP3 (320 kbps, 10.6 MB), Ogg Vorbis (4.4 MB), or lossless FLAC (19.8 MB). It was exported from Strudel itself, from the same code, note for note. Like everything on this page, it is in the public domain: play it, sample it, remix it, upload it.

How to play it yourself

1. Open the track in Strudel. The link carries the whole score; nothing is uploaded.
2. Press **play** at the top of the editor, or click in the code and press **Ctrl+Enter** (Alt+Enter also works). **Ctrl+.** stops it.
3. The instruments, drums and spoken lines are samples that load the first time they sound, so the first run can stutter or miss a line. If it does, stop and play again. The spoken lines come from a free text-to-speech service; if it is down, the track still plays without them.
4. To play it live, change it while it runs. Edit a line and press Ctrl+Enter, and Strudel takes up the new version without stopping. Spell another word on the gates in `bits('LAW ')` (four letters fill four bars), another message in `telegraph(CARPENTER, 'rim')`, another tempo in `setcpm(120/4)`, mute a layer by putting `//` in front of its line, or move the sections around in the `arrange(…)` at the bottom.
5. If the link ever stops working, download the source (or copy it from below), paste it into the editor at strudel.cc, and press play. The PDF of this page prints the whole source on paper.

The chant is the parent track's, *Viri Galilaei*; Francis's tune is new. The spoken words are the essay's, with Ezekiel 1:16 in the King James Version, Dante in English (*Paradiso* I.103 and XXXIII.145), and Edward Caswall's English of the *Tantum ergo* (1849). The instruments are Strudel's General MIDI soundfonts, its synthesizers and its built-in TR-909 samples. Strudel is free software by its own authors. The track itself, the code below, is dedicated to the public domain with this essay. Please do not register it with Content ID or any service that claims copies on your behalf.

The source code

```
// ============================================================
// BROTHER ELECTRON — the clockwork mix
// In the register of Dante Alighieri · A mixolydian x motorik chip
// 120 BPM · 132 bars · ~4:24, then it loops
// For Strudel (https://strudel.cc): paste, press play (Ctrl+Enter).
// Dedicated to the public domain (CC0 1.0). For Althea.
//
// A pilgrim goes down into a chip and up again, and so does the
```

```
// track. A cursor blinks in the dark. The gates spell LAW in ASCII,
// eight bits a letter: a crossing is a note, a waiting a rest. A
// flip-flop holds its bit because each half keeps telling the other
// what it is; the memory is written back, row by row, before it
// fades; and under all of it a clock, a beat inside a beat inside a
// beat, a wheel in the middle of a wheel. At the bottom a tone falls
// for ever, every floor a ceiling, until Teilhard turns it round.
// Francis sings his canticle, and then the gates play it: praise
// PER Brother Electron. Elijah's chariot carries the parent's chant
// up in three voices, and a ring of twelve bells turns like the
// teachers in the Sun. Thomas strikes the top voice from a chord:
// God at the head of no column. Maximus had no tongue, so his
// workshop has no words: a note cut in half five times and joined
// again five times, while the carpenter's hammer taps. At the altar
// the memory stops rewriting itself and one chord is held, not
// struck again. At the end the threads are bound, and the laptop
// sleeps while its memory goes on writing itself back.
//
// The code is a DAG, like the essays. Each part names its PARENTS,
// the parts it is made from; they always stand above it. Some parts
// also name what they are FOR: a later part they foreshadow. The
// first kind of edge runs back, the second forward. A record with
// only the first is a library; with both, a family.
//
// PARENTS. The tracks, like the essays, form a DAG, and a track
// carries its parents in its own material. This essay draws on
// "Whether the Cloud Makes Many Worlds" and "What Is to Be Done?",
// so the chariot carries the first one's hook, Viri Galilaei, and
// the workshop taps the second one's hammer, IS NOT THIS THE
// CARPENTER. Each quoted line keeps a short hash of the parent's
// original (sha256 of the quoted text, first 12 hex):
//   whether-the-cloud.strudel.js   VIRI       fd123dbc28e8
//   what-is-to-be-done.strudel.js  CARPENTER  3b8716d43c19
// The family moves up by fifths: the cloud in G, its child in D,
// this one in A. From the cloud it also takes the isorhythm (a
// rhythm carrying a melody, one note per stroke) and the Morse.
//
// TIMELINE (bar / time):
//   WOOD       1  0:00  the dark wood of copper: a fan, a cursor
//   GATE       9  0:16  the gates spell LAW; the flip-flop latches;
//                       the refresh; at bar 25 the clock and the
//                       wheels; the dice
//   FLOOR     33  1:04  a tone falling for ever, every floor a
//                       ceiling; at bar 41 Teilhard turns it round
//   CANTICLE  49  1:36  Francis sings; at bar 57 the gates play it
//   SUN       65  2:08  the chariot: Viri Galilaei in fauxbourdon;
//                       at 73 the ring of twelve; at 81 the struck line
//   WORKSHOP  89  2:56  no words: cut five times, joined five times
//   ALTAR    101  3:20  everything; at bar 109 the refresh stops and
//                       one chord is held
```

```
//   VOLUME   117  3:52  the threads bound; the cursor's last blink
//                       lands on the last chord
//   SLEEP    129  4:16  the memory writes itself back in the dark
//
// The spoken lines come from Shabda's text-to-speech and load the
// first time they play. If they are slow, stop and play again.
// ============================================================

setcpm(120/4) // one cycle = one bar = two seconds

// ---- the spoken lines: the readings, and the dead
samples('shabda/speech/en-GB/
f:brother_electron,law_reaches_all_the_way_down,as_it_were_a_wheel_in_the_middle
_of_a_wheel,praised_be_you_my_lord_through_brother_fire,all_things_have_an_order
_among_themselves,where_the_feeble_senses_fail,so_that_finally_god_may_be_all_in
_all,the_love_that_moves_the_sun_and_the_other_stars')
samples('shabda/speech/en-GB/
m:have_mercy_on_me,logic_memory_and_time,he_does_not_throw_dice,everything_is_cl
imbing,nothing_was_added_to_the_wind_the_fire_or_the_cloth,not_there,it_held')

// ============================================================
// ORBITS: 1 drums and clock · 2 the chip (square, bass) ·
//         3 spoken word · 4 organ and bells · 5 the falling tone ·
//         6 choir · 7 recorder
// Strudel plays soundfonts at 0.3 of their gain, so the
// instruments are lifted (gain x 3) to sit with the drums.
// ============================================================

// ---------------- ROOTS: what everything is made of

// ROOT 1. THE MODE: A mixolydian, I bVII IV I, A G D A.
// parents: none (it is given)
const SCALE = 'A3:mixolydian'
const MIXO = "<[a2,e3,a3,c#4] [g2,d3,g3,b3] [d3,a3,d4,f#4] [a2,e3,a3,c#4]>"
const ROOTS = "<a1 g1 d2 a1>"

// ROOT 2. THE CANTICLE: Francis's tune, four bars on the eighth grid.
// "Laudato si', mi' Signore, per frate focu."
// parents: none (it is sung)
const HOOK = 'a4 a4 b4 c#5@2 b4 a4@2 g4 a4 b4@2 a4@4 e5 d5 c#5 b4 c#5@2 b4 a4
g4@2 e4@2 a4@4'
const hook = () => note(mini(HOOK)).slow(4)

// ---------------- PARENTS
// from whether-the-cloud.strudel.js: the Ascension introit, "Viri
// Galilaei", two bars, quoted as written in G (sha256 fd123dbc28e8)
const VIRI = 'g3@2 g3@2 g3 c4 b3 c4@2 d4 c4 e4 d4 d4@3'
// from what-is-to-be-done.strudel.js: the carpenter's hammer, quoted
// as written (sha256 3b8716d43c19)
const CARPENTER = 'IS NOT THIS THE CARPENTER'
```

```
// the chant read as steps of its mode (G mixolydian), so that it can
// be sung in A, a fifth above its child, and in three voices
const STEP = { g3: 0, a3: 1, b3: 2, c4: 3, d4: 4, e4: 5, f4: 6, g4: 7 }
const inMode = (phrase) => phrase.split(' ').map((t) => {
  const [p, d] = t.split('@'); return STEP[p] + (d ? '@' + d : '')
}).join(' ')
// FAUXBOURDON: the chant on top, a fourth and a sixth below it, as
// the choirs of the fifteenth century sang it. For a singer of chant
// and polyphony.
// parents: PARENTS, THE MODE
const viri = (lift = 0, g = .3) => stack(...[0, -3, -5].map((under) =>
  n(mini(inMode(VIRI)).add(under + lift)).scale(SCALE)))
  .slow(2).s('gm_choir_aahs').attack(.05).release(.6)
  .room(.6).roomsize(5).gain(g * 3).orbit(6)

// ---------------- THE TELEGRAPH: Morse, as in the parents
// dot 1 sixteenth, dash 3; 1 between signs, 3 between letters, 7 between words
const CODE = { A: '.-', C: '-.-.', E: '.', H: '....', I: '..', N: '-.', O:
'---',
               P: '.--.', R: '.-.', S: '...', T: '-' }
const morse = (text) => text.split(' ').map((word) =>
  word.split('').map((ch) =>
    CODE[ch].split('').map((sign) => (sign === '.' ? 'x' : 'x@3')).join(' ~ ')
  ).join(' ~@3 ')
).join(' ~@7 ') + ' ~@7'
const units = (talea) => talea.split(' ').reduce((n, t) => n +
(t.includes('@') ? +t.split('@')[1] : 1), 0)
const telegraph = (text, sound) => {
  const talea = morse(text)
  return s(sound).struct(mini(talea)).slow(units(talea) /
16).bank('RolandTR909')
}

// ---------------- THE DARK WOOD
// parents: THE MODE
const hum = s('pink').lpf(380).gain(.05).orbit(5)
const copper = note('a1').s('sawtooth').lpf(260).attack(2).release(2).gain(.
06).orbit(2)
// THE CURSOR: a blink on the first and third beats.
// for: VOLUME (its last blink lands on the last chord)
const cursor = note('a6').struct("x ~ x ~").s('sine')
  .attack(.002).decay(.06).sustain(0).gain(.09).orbit(4)

// ---------------- THE GATES: crossings and waitings
// "LAW " in ASCII, eight bits a letter, an eighth note a bit:
// a 1 is a crossing (a note), a 0 a waiting (a rest). Four bars.
// The crossings carry an arpeggio, one note per stroke (isorhythm).
// parents: THE MODE
const bits = (text) => text.split('').map((c) =>
```

```
c.charCodeAt(0).toString(2).padStart(8, '0')).join('')
const LAW = bits('LAW ')
const GATES = LAW.split('').map((b) => (b === '1' ? 'x' : '~')).join(' ')
const iso = (talea, color) => { let i = 0; return talea.replace(/x/g, () =>
color[i++ % color.length]) }
const COLOR = ['a3', 'c#4', 'e4', 'a4', 'g4', 'e4', 'd4', 'b3']
const gates = (g = .14) => note(mini(iso(GATES, COLOR))).slow(4).s('square')
  .attack(.002).decay(.09).sustain(0).lpf(2600).gain(g).pan(.4).orbit(2)

// THE FLIP-FLOP: pushed once, it flips and stays, each half telling
// the other what it is.
// parents: THE GATES
const push = s("rim").bank('RolandTR909').gain(.5).orbit(1)
const flipflop = note("[a4 e5]*8").s('square').attack(.002).decay(.
05).sustain(0)
  .lpf(1800).gain(.07).pan(.65).orbit(2)

// THE REFRESH: every row read and written back before it fades.
// A thirty-second at 120 BPM lasts 62.5 ms, near the 64 ms in which
// a memory chip refreshes every row.
// parents: THE GATES
// for: ALTAR (where it stops), SLEEP (where it goes on alone)
const refresh = (g = .05) => s("hh*32").bank('RolandTR909')
  .hpf(9000).lpf(saw.range(9000, 16000)).gain(g).orbit(1)

// ---------------- THE CLOCK: motorik, the beat that measures it out
// parents: none (it only measures; the wiring makes the order)
const kick = s("bd ~ ~ ~ bd ~ bd ~").bank('RolandTR909').gain(.85).orbit(1)
const snare = s("~ ~ sd ~ ~ ~ sd ~").bank('RolandTR909').gain(.55).room(.
15).orbit(1)
const hats = s("hh*8").bank('RolandTR909').gain(".26 .14 .22 .
14").hpf(5000).orbit(1)
const clock = stack(kick, snare, hats)
const bass = (roots = ROOTS) => note(roots).struct("x ~ x x ~ x x
~").s('square')
  .lpf(500).decay(.15).sustain(.3).gain(.16).orbit(2)
// THE WHEELS: a beat inside a beat inside a beat (Ezekiel 1:16).
// Three against sixteen inside four inside one.
// parents: THE CLOCK
const wheels = stack(
  s("{rim ~ ~}%16").bank('RolandTR909').gain(.22).pan(.7).orbit(1),
  note("a6*4").s('sine').attack(.001).decay(.04).sustain(0).gain(.05).orbit(4),
  note("a5").s('gm_tubular_bells').gain(.2 * 3).room(.5).orbit(4),
)

// THE DICE: tunnelling, "decided by nothing at all". Strudel's dice
// are loaded: rand is a hash of the time, so they fall the same way
// every time it plays.
// parents: THE GATES
const dice = note("e6*16").s('square').degradeBy(.8)
```

```
  .attack(.001).decay(.03).sustain(0).lpf(5000).gain(.06).pan(rand).orbit(2)

// ---------------- THE FALLING TONE: every floor a ceiling
// Six sines an octave apart slide together, the top fading out as
// the bottom fades in, so the fall never ends (a Shepard-Risset
// glissando), stepped in sixteenths: floors.
// parents: none (it is found at the bottom)
// for: FLOOR (where it turns round to climb)
const shepard = (dir, bars = 8) => stack(...[0, 1, 2, 3, 4, 5].map((k) =>
  (dir > 0 ? saw : isaw).slow(bars).add(k / 6).fmap((x) => x % 1).segment(16)
    .fmap((p) => ({ note: 33 + 72 * p, gain: .055 * Math.sin(Math.PI * p) **
2 }))))
  .s('sine').release(.2).room(.4).orbit(5)

// ---------------- THE CHOIR, THE RECORDER, THE ORGAN
const recorder = (pat, g = .3) => pat.s('gm_recorder').release(.3)
  .gain(g * 3).delay(".25:.25:.3").room(.4).pan(.45).orbit(7)
const organ = (chords, g = .07) => note(chords).s('gm_church_organ')
  .attack(.05).release(.6).gain(g * 3).room(.5).roomsize(4).orbit(4)

// THE RING OF TWELVE: the teachers in the Sun, "like the numbers on
// a clock": twelve bells against sixteen steps.
// parents: THE MODE, THE WHEELS
const twelve = note("{a4 c#5 e5 a5 b5 c#6 e6 g6 e6 c#6 b5
e5}%16").s('gm_celesta')
  .release(.6).gain(.18 * 3).room(.6).pan(sine.slow(4).range(.25, .75)).orbit(4)

// THE STRUCK LINE: three voices, as on the pilgrim's hand; the top
// one is struck out. The two left are both creatures, under the one
// law in two ways: from within (a line that breathes) and from
// without (pulses that are told nothing).
// parents: THE MODE, THE CANTICLE, THE GATES
const above = note("<e4 d4 f#4 e4>").s('gm_church_organ').release(.5).gain(.07 *
3).orbit(4)
const fromWithin = recorder(note(mini(HOOK)).slow(8).transpose(-12), .26)
const fromWithout = n("0 2 4 7 4 2 0 2").scale(SCALE).fast(2).s('square')
  .attack(.002).decay(.07).sustain(0).lpf(2000).gain(.08).orbit(2)

// THE DIVISIONS: Maximus cuts the world in two, five times, and the
// one in the middle joins it again, five times.
// parents: THE GATES (cut), PARENTS (the hammer)
const DIVIDE = "<x x*2 x*4 x*8 x*16 x*32 x*32 x*16 x*8 x*4 x*2 x>"
const divisions = note("a3").struct(DIVIDE).s('gm_marimba')
  .release(.1).gain(.32 * 3).room(.3).orbit(4)
// TWO WILLS: two voices in parallel, never against each other,
// coming home together.
// parents: THE MODE
const WILL = '<~ ~ ~ ~ ~ ~ 4 5 4 2 1 0>'
const wills = stack(
  n(mini(WILL)).scale(SCALE).s('gm_recorder').release(1).gain(.24 * 3).orbit(7),
```

```
  n(mini(WILL).add(-5)).scale(SCALE).s('gm_church_organ').release(1).gain(.06 *
3).orbit(4),
)

// ---------------- VOICES
const vox = (p, g = 1.4) => s(p).hpf(150).lpf(8000).gain(g)
  .delay(".12:.25:.25").room(.2).orbit(3)

// ============================================================
// SECTIONS
// ============================================================

// I. WOOD. "Midway through the night of my life I found myself in a
// dark wood of copper." A fan, the copper, the cursor.
// parents: THE DARK WOOD
const secWOOD = stack(
  hum, copper, cursor,
  vox("<~ brother_electron ~ ~ ~ have_mercy_on_me ~ ~>"),
)

// II. GATE. The gate, the loop and the beat.
// parents: THE GATES, THE FLIP-FLOP, THE REFRESH, THE CLOCK, THE WHEELS, THE
DICE
const secGATE = arrange(
  [8, stack(hum, cursor, gates(),
    vox("<law_reaches_all_the_way_down ~ ~ ~ ~ ~ ~ ~>"))],
  [8, stack(cursor, gates(), copper,
    push.mask("<1 0 0 0 0 0 0 0>").struct("x ~ ~ ~"),
    flipflop,
    refresh().mask("<0 0 0 0 1 1 1 1>"))],
  [8, stack(clock, bass(), gates(.12), flipflop.gain(.05), refresh(),
    wheels.mask("<1 1 1 1 1 1 0 0>"),
    dice.mask("<0 0 0 0 1 1 1 1>"),
    vox("<as_it_were_a_wheel_in_the_middle_of_a_wheel ~ ~ logic_memory_and_time
~ ~ he_does_not_throw_dice ~>"))],
)

// III. FLOOR. "Every time we found a floor, it turned out to be a
// ceiling." Then: "Don't stop at the bottom! Everything is climbing!"
// parents: THE FALLING TONE, THE CLOCK
const secFLOOR = arrange(
  [8, stack(shepard(-1),
    kick.mask("<1 1 1 1 0 0 0 0>"), refresh(.03).mask("<1 1 0 0 0 0 0 0>"))],
  [8, stack(shepard(1),
    hats.gain(.18).mask("<0 0 0 0 1 1 1 1>"), kick.mask("<0 0 0 0 0 0 1 1>"),
    vox("<everything_is_climbing ~ ~ ~ ~ ~ ~ ~>"))],
)

// IV. CANTICLE. Francis sings; then the gates play his tune: praise
// to you, my Lord, PER Brother Electron.
```

```
// parents: THE CANTICLE, THE GATES, THE CLOCK
const secCANTICLE = arrange(
  [8, stack(copper, cursor, gates(.08), recorder(hook()),
    organ("<[a3,e4] [g3,d4] [d3,a3] [a3,e4]>", .05),
    vox("<~ ~ ~ ~ praised_be_you_my_lord_through_brother_fire ~ ~ ~>"))],
  [8, stack(clock, bass(),
    hook().s('square').attack(.005).decay(.12).sustain(.4).release(.1)
      .lpf(3200).gain(.12).delay(".125:.25:.3").orbit(2),
    recorder(hook().transpose(-12), .14),
    vox("<brother_electron ~ ~ ~ ~ ~ ~ ~>"))],
)

// V. SUN. Carried up in Elijah's chariot, the parent's chant in three
// voices; the ring of twelve; the struck line.
// parents: PARENTS (FAUXBOURDON), THE RING OF TWELVE, THE STRUCK LINE
const secSUN = arrange(
  [8, stack(
    viri(0).mask("<1 1 1 1 0 0 0 0>"),
    viri(7, .28).mask("<0 0 0 0 1 1 1 1>"),
    s('white').lpf(saw.slow(8).range(300, 6000)).gain(saw.slow(8).range(.02, .
09)).orbit(5),
    s("bd*4").bank('RolandTR909').gain(.7).orbit(1),
    vox("<nothing_was_added_to_the_wind_the_fire_or_the_cloth ~ ~ ~ ~ ~ ~
~>"))],
  [8, stack(twelve, organ(MIXO, .05), bass().gain(.12),
    s("bd ~ ~ ~ ~ ~ ~ ~").bank('RolandTR909').gain(.8).orbit(1),
    s("~ ~ ~ ~ sd ~ ~ ~").bank('RolandTR909').gain(.5).room(.3).orbit(1),
    vox("<all_things_have_an_order_among_themselves ~ ~ ~ ~ ~ ~ ~>"))],
  [8, stack(
    above.mask("<1 1 0 0 0 0 0 0>"),
    organ("<[a3,c#4] [g3,b3] [d3,f#3] [a3,c#4]>", .06),
    fromWithin, fromWithout,
    s("bd ~ ~ ~ bd ~ ~ ~").bank('RolandTR909').gain(.75).orbit(1),
    vox("<~ not_there ~ ~ ~ ~ ~ ~>"))],
)

// VI. WORKSHOP. "The last voice had no tongue." No words: the world
// cut in half five times and joined five times, and the hammer.
// parents: THE DIVISIONS, TWO WILLS, PARENTS (CARPENTER)
const secWORKSHOP = stack(
  divisions,
  wills,
  telegraph(CARPENTER, 'rim').gain(.42).room(.2).pan(.35).orbit(1),
  note("<a1 a1 a1 a1 a1 a1 d2 d2 g1 g1 a1 a1>").s('square').lpf(400).attack(.
3).release(.8).gain(.1).orbit(2),
)

// VII. ALTAR. "I, your priest, will make the whole world my altar."
// Everything above; then the refresh stops, and one chord is held:
// the one sacrifice made present, not written again.
```

```
// parents: everything above but the dice and the falling tone
const secALTAR = arrange(
  [8, stack(clock, bass(), refresh(), organ(MIXO, .07),
    hook().s('square').attack(.005).decay(.12).sustain(.4).lpf(3000).gain(.
1).orbit(2),
    viri(7, .24),
    twelve.gain(.1 * 3),
    vox("<where_the_feeble_senses_fail ~ ~ ~ ~ ~ ~ ~>"))],
  [8, stack(
    note("[a2,e3,a3,c#4,e4]").s('gm_church_organ').attack(.4).release(3)
      .gain(.09 * 3).room(.6).roomsize(5).slow(8).orbit(4),
    recorder(hook(), .22).mask("<1 1 1 1 0 0 0 0>"),
    vox("<~ ~ ~ ~ so_that_finally_god_may_be_all_in_all ~ ~ ~>"))],
)

// VIII. VOLUME. "Bound by love into one volume." The threads that run
// back (the parents' lines) and the one that runs forward (the
// cursor, whose last blink is the last chord's downbeat).
// parents: PARENTS, THE CANTICLE, THE GATES, THE CURSOR
const STAB = "[a2,e3,a3,c#4,e4,a4]"
const secVOLUME = arrange(
  [8, stack(clock.mask("<1 1 1 1 1 1 0 0>"), bass(),
    viri(7, .26), recorder(hook(), .24), gates(.1),
    telegraph(CARPENTER, 'rim').gain(.3).hpf(1200).pan(.6).orbit(1),
    organ(MIXO, .06))],
  [4, stack(
    stack(
      note(STAB).s('gm_church_organ').attack(.01).release(4).gain(.1 * 3).room(.
7).roomsize(6),
      note(STAB).s('gm_choir_aahs').attack(.05).release(4).gain(.22 * 3).room(.
7).roomsize(6),
      note('a6').s('sine').attack(.002).decay(.06).sustain(0).gain(.09),
      s('cr').bank('RolandTR909').gain(.35).room(.5),
    ).slow(4).orbit(4),
    vox("<~ ~ it_held ~>"))],
)

// IX. SLEEP. "The memory went on writing itself back, row by row":
// moved, like the sun and the other stars, by love.
// parents: THE REFRESH
const secSLEEP = stack(
  s("hh*32").bank('RolandTR909').hpf(10000).gain("<.03 .022 .014 .
007>").orbit(1),
  vox("<the_love_that_moves_the_sun_and_the_other_stars ~ ~ ~>", 1.3),
)

// ============================================================
// THE ARRANGEMENT
// ============================================================
arrange(
```

```
  [8,  secWOOD],
  [24, secGATE],
  [16, secFLOOR],
  [16, secCANTICLE],
  [24, secSUN],
  [12, secWORKSHOP],
  [16, secALTAR],
  [12, secVOLUME],
  [4,  secSLEEP],
)
```

A note on sources

Scripture is quoted from the King James Version: Psalm 148:8; Ezekiel 1:16 and 20; 2 Kings 1:8 and 2:11; 1 Corinthians 15:28. Dante is quoted in Italian from the *Paradiso* (I.103–105; XXXIII.85–87, 145); the English of the epigraph is mine. The dark wood and the address to Virgil are *Inferno* I.1 and I.65–66, Elisha and the chariot *Inferno* XXVI.34–39, Beatrice on the ports of being and the bow *Paradiso* I.103–120, and the ring of teachers in the Sun *Paradiso* X–XIII. Francis is quoted from the Umbrian text of the *Cantico di frate Sole*; the wolf of Gubbio is from the *Fioretti*.

St Thomas is paraphrased from the *Summa theologiae*: on law, I-II q. 90 aa. 1 and 4; the eternal and the natural law, q. 91 aa. 1–2, with "except by way of similitude" from a. 2 ad 3; God as the eternal law, q. 93 a. 4; the good perfectly subject to it, q. 93 a. 6; the three inclinations, q. 94 a. 2; creatures kept in being, I q. 104 a. 1; Elijah taken up into the atmospheric heaven and not the abode of the saints, III q. 49 a. 5 ad 2; and Gregory on the chariot and the Lord ascending by his own power, III q. 57 a. 3 (Gregory, *Homilies on the Gospels* 29). Gregory on the wheel within a wheel is from the *Homilies on Ezekiel*, 6.15 in the translation of Theodosia Gray (1990). The rule Thomas gives the pilgrim, no likeness without a greater unlikeness, is the Fourth Lateran Council's (1215), from its chapter on the error of Abbot Joachim. The two ways of providence, from within through reason and from without through the laws of physical nature, are John Paul II's, *Veritatis splendor* 43 (1993), following *Dignitatis humanae* 3 and St Thomas.

Maximus is from the *Ambigua*: the five divisions, the workshop and the natural bond from *Ambiguum* 41, in the translation of Maximos Constas (2014); the one Logos and the many logoi from *Ambiguum* 7. The two wills are his confession against the Monothelites. The Church is quoted from *Sacrosanctum Concilium* 47, 48 and 61; John Paul II, *Ecclesia de Eucharistia* 8 (2003); Francis, *Laudato si'* 236 (2015); and the Council of Trent, sessions XIII and XXII. The offertory is the Roman Missal's.

Einstein's words are close to his own: the telegram of 25 April 1929 to a New York rabbi on Spinoza's God; the letter to Max Born of 4 December 1926; Schopenhauer's saying, from "The World as I See It" (1931); and the comprehensibility of the world as an eternal mystery, from "Physics and Reality" (1936). Teilhard's are from *The Phenomenon of Man* (the within of things) and *The Mass on the*

World (1923); the warning is the Holy Office's monitum of 30 June 1962. The elementary charge was fixed by the 26th General Conference on Weights and Measures in November 2018, in force from 20 May 2019. The flip-flop is Eccles and Jordan's trigger circuit of 1918; the refresh interval of sixty-four milliseconds is the industry's standard for memory chips.

SOURCES *Sacrosanctum Concilium*, *Ecclesia de Eucharistia*, *Laudato si'*, *Veritatis splendor*, ST I-II q. 91 a. 2, q. 93 a. 4, q. 93 a. 6, ST I q. 104 a. 1, ST III q. 49 a. 5, ST III q. 57 a. 3, the monitum of 1962.

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