

Blah Blah Blah and Brrr

How Complex Numbers Taught Me to Listen to the Universe

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Are mathematicians just the Sherlock Holmes of our entire universe?

Well, I think rightfully so. Archaeologists uncover things we never really understood about our past; they see cues, interpret them, and allow us folk to understand the beautiful wonders we've created through centuries of being human beings. But their job is understanding us as humans — or more precisely, understanding man-made structures. So how did mathematicians understand a world not even made by humans? Or so we think.

I mean, what would you do if someone came up to you and spoke absolute gibberish — according to you? Well, what if it *was* a language? What if there was a symmetry — maybe they said *blah blah blah* and then *brrr*, and repeated this pattern. Would you learn this art of gibberish?

We all study languages, and our minds do it so quickly when we're younger. Babies are absolute geniuses. Babies learn language by immersion, without rules, without a dictionary, just by being surrounded by it. And we *are* surrounded by math, hiding in plain sight, more than you think. The underlying harmony and tune of our universe has been uncovered, and it seems counterintuitive to us because IT IS ABSOLUTE GIBBERISH to someone who cannot understand.

I myself only found myself loving math because of its complexity — because of how I aspired to learn such an eloquent, refined language, one that also gave you a *nudge nudge* to a lot of the riches we all gawk at when we're younger. Chasing maths as if it were the only language I could understand in our world of many languages, I've learnt the essence of its beauty — of course while going down a rabbit hole at 2 a.m., the perfect hour, diving head-first into the Mandelbrot set.

The only universal truth the old natural philosophers could think of was mathematics. The mind-boggling beauty of math is sunken so deep into our reality that evolution itself has come to rediscover the world it came from. We are all just parts of crushed stars — living, breathing, talking, and exploring the exact same universe that brought us to life. Just looking at Euler's formula and the Mandelbrot set, we see that symphony rewired into a reverberating, meaningful language shared among us. We're whispering its beauty to one another — so what if we begin to scream it? This is my attempt to take math and quite literally throw it in your face, in a way that you get up — but not to yell at me — to realise its hidden beauty. Maybe math is the beast that turns into a beauty after you give it a chance.

Taking the bull by its horns: what is the derivative of e^x ? It's not a trick question. It is, in fact, e^x . In calculus, you may have skimmed past this and seen no potential. Give it another look. The derivative of something is how fast it is changing. So what this function is telling you, very quietly, is that *at every point, its value is equal to how fast it is growing*. If you're at 1, you're growing at speed 1. A moment later you're at a slightly larger number, and now you're growing *at that* speed. The bigger you get, the faster you grow. The faster you grow, the bigger you get. That is the soul of exponential growth: a function chasing itself up a ladder it keeps building.

Now here's where the universe starts whispering. Imagine the same kind of rule, but with a twist — your rate of change is no longer equal to where you are, but to i times where you are. And i has a beautiful secret: multiplying by i is the same as rotating by 90 degrees. So your motion, at every instant, is perpendicular to your position.

Stop and picture this. You're standing at the point 1 on the real line. Your velocity points straight up, because that's what $i \times 1$ means — turn 90 degrees. You start to move up. But the instant you do, your position is no longer straight right of the origin, and your new velocity rotates accordingly to stay perpendicular. It is still perpendicular. It is *always* perpendicular. And if you are forever moving perpendicular to your position, you can never drift closer to the origin, and you can never drift farther from it. You can only orbit.

Do you see what just happened? It's our beloved friend, the unit circle. Not built. Not drawn. *Summoned*. The circle is what you get when the rule for your motion says "always turn ninety degrees from where you stand." After π seconds of this, you have traced out exactly half the circle, and you land at -1 . That is Euler's identity: $e^{i\pi} = -1$. The most famous equation in mathematics is not really an equation — it's a ghost story about a particle forced to orbit by an invisible law.

And Euler's full formula, $e^{i\theta} = \cos \theta + i \sin \theta$, tells you something even more astonishing. That spinning point on the unit circle? Its horizontal shadow traces out a cosine wave. Its vertical shadow traces out a sine wave. **A sine wave is the shadow of a circle.** Every ripple in a pond, every vibrating string, every sound you have ever heard — they are all shadows of rotations happening in the complex plane. Not only does this formula give you the trigonometric identities you once forced yourself to memorise, it is the dictionary for everything that waves. The universe is full of waves, and every wave is the shadow of a hidden circle. That's what I call applied maths.

As an artist at heart, I was drawn to the curious nature of laying multiple squares down — and with one unexpected line, I got up like any person would upon hearing news of their one and only being outside the door: "*find a way to make all four squares share borders.*"

Take a pause — but not too long — and try this. I challenge you. Take four coloured squares. Lay them down on a table. Now arrange them so that every square touches every other square along an edge. If we first try the easier version and work up, you'll find it is easy with three. But with four, you're fighting: every time you make two of them touch, the other two drift apart. That night, I was pulling my hair out just to prove my YouTuber of choice wrong. You'll

spend so many hours thinking, *if I put a colour here to make these two share an edge, then those two over there stop touching*, and all of this frustration.

It is really hard — for squares.

But the Mandelbrot set does something stranger. It makes infinitely many regions all touch each other — not at corners, not along single edges, but along a boundary so intricate that every colour meets every other colour at every scale, forever.

This illustrates an idea we cannot quite compute, or understand *why* it is so. How could anything hold such complexity — something we cannot wrap our minds around, or something we choose not to understand?

Skydiving into complex numbers, all because someone decided to write $z \rightarrow z^2 + c$ and pressed enter. How absurd is that?

Pick any complex number c — any point on the plane. Now let's play a simple game. Start with $z = 0$. Square it, and add c . You get a new number. Square that, and add c again. Keep going. You are walking a path through the complex plane, and the rule is the same at every step: square, add c , repeat. Just like the gibberish-speaking person from earlier, isn't it? *Blah blah blah and brrr and repeat.*

Two things can happen. Either your path stays close to home forever, no matter how many steps you take — or it eventually breaks free and runs off to infinity, never to return. The Mandelbrot set is the collection of every starting point c whose path stays home. That's it. It's simple, wasn't it?

Although my eyes were tired, I could not mistake the essence of the fractal from its very name. A snowflake — it looked exactly like what we would fold up many times and cut into a snowflake. Something that passes by every time of the year, but my heart knew this adventure would last until my last breaths.

Here is what I was looking at. The Mandelbrot set has a big heart-shaped body called the cardioid, and attached to it on the left is a perfect round bulb. Attached around the edge of the cardioid are smaller bulbs, and around *those* are even smaller bulbs, and so on, forever. Each bulb corresponds to a different rhythm — the cardioid is the region where the game settles into a single number, the big left bulb is where it bounces between two numbers, and there are bulbs for every rhythm you can think of: three, four, five, a hundred, a million. If you colour each bulb by its rhythm, then zoom into any tiny patch along the boundary of the cardioid, you will find bulbs of every single rhythm crammed in there, all kissing each other, all kissing the cardioid. Zoom in again, and the same impossible kissing is happening at the smaller scale. Zoom in again, and again, and again. You never reach the bottom. The boundary is a coastline with infinite length and zero area — a shape that cannot be drawn by any hand, only revealed.

The one-line rule produced a picture no human designed, but something that has been etched into reality long before we came to realise it. All of them touch each other in a way I can't

comprehend, but a way that is tangible. Nobody drew this. Mandelbrot just wrote $z \rightarrow z^2 + c$ on a page, pressed enter, and *it was already there*. It had been waiting for us since the beginning of multiplication.

Now that I myself have come full circle, becoming the Enola Holmes of our universe, I still browse the internet on a 2 a.m. spur — but now I gossip about our universe's secrets wholeheartedly, with the comfort of understanding them. Maybe now I've encouraged you to take this sword of courage into battle against the demon lord, math. But don't jump straight into complex analysis. Its nature is beautiful, but to understand it with more climax, you should know the beauty of everything leading up to it. Euler didn't just discover $e^{i\theta}$ out of nowhere — centuries of minds led us up to that formula, and sharing it with one another accelerates our process tenfold.

Somewhere out there in the unknown, we may see the dust and speck of *blah blah blah* and *brrr*, but fail to realise how it is screaming at us in plain sight. If only you had a Google Translate that worked for that — wouldn't you?