

**Quantum Sensibility:
From Macroscopic Myopia to Cosmic Humility**

**SIX L.
MFADT THESIS
MAY 2023**

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ABSTRACT

Behind the mechanics of quantum technology is fundamental physics counterintuitive to how we perceive the world. This Thesis posits that our incessant need to know, beyond our capacity to know, has resulted in myopia that limits our understanding of ourselves and the world we live in. Therefore, it is essential for us to suspend what we think we know, how we can know, and who can know, and to embrace an air of cosmic humility to understand that the Universe works how it does regardless of our comprehension of it.

This Thesis is an introduction to the concepts behind quantum mechanics, for people without scientific backgrounds, as a stepping stone to learning about quantum technology before it becomes widely accessible. It is not, however, about quantum technology. Instead, through the medium of a chair, this Thesis aims to take interactors and readers from a place of knowing toward a curious uncertainty and a quantum sensibility. Everyone has experienced a chair, and by deconstructing what people think they know about chairs, I aim to guide them toward understanding what quantum mechanics reveals about our world.

IMPETUS

We are just now starting to harness the power of quantum technology on a scale that is projected to soon become ubiquitous. Quantum technology is unlike any other technology in that it is based on counterintuitive principles such as uncertainty, slipperiness, and instability. These principles are fundamental to quantum mechanics and emblematic of what the quantum revolution will bring with it. Any new and groundbreaking technology affects the people who use it (and those who don't) in unforeseen ways. Whether in our daily lives or the shifting of the human condition, ubiquitous technology

brings a world of change. The Quantum (technology, computing, systems) era we are on the precipice of will necessarily bring a quantum ontology embedded in the technology.

To understand the quantum ontology of technology, we must first think through a quantum epistemology. This piece of writing aims to open the door to understanding Quantum through your own embodied experience. I hope to extend to you, dearest reader, a gateway into the wealth of knowledge that you have within through the vehicle of quantum sensibility.

INTRODUCTION

I stand at about 5'4", 125 pounds, with 20/20 vision, sound hearing, ostensibly reliable olfactory and somatosensory systems, and audio-visual synesthesia. Looking out my window, I see buildings, trees, people, pets, lights, clouds, and countless other things. I see some buildings as rectangular prisms with colors and textures; some are so obscured they appear as just faint shapes in the distance. I can see individual leaves on the trees nearest to me, but most of the trees I see are green and brown amorphous shapes that I, as someone somewhat familiar with trees, assume are also trees. The further I look, the harder it is to see. I assume that there are more trees and buildings beyond the trees and the buildings I can see. But my body and its limitations do not allow me to receive or process the information to know that.

I know that a tree is a living thing that grows from a seed, bears fruit and flowers, and is usually on a brown-green spectrum of colors. But if, in the distance, there was a tree sculpture made of clay or some other convincing material, I would not know the difference. From my point of view, things that look like trees are trees until they are not. In this

experience of zooming in, I hit an upper limit that makes the constraints of my faculties clear.

What we sense and our interpretations of them form our perception. The relationship between our perception of the world and the world itself forms our umwelt (the German word for the environment); the world and our interpretation of it are inseparable. This concept hints at something I will get to later, the idea that our perception and the mind forming it is part of the environment that forms our environment. But before we get lost in this proverbial black hole, let's break down how sensation and perception work.

Perception starts with sensation. The popular computer game, pipe mania, pipe dream, or water pipes is an example of how our senses work. In the game, there is a valve dispensing liquid through a series of pipes, and the objective is to configure the direction of the pipes so that the liquid flows to the end of the pipes out into receptacles. Imagine the input or the liquid is the information: color, texture, scent, shape, etc. The pipes are your senses processing the information in whichever configuration leads to perception or the output or receptacle. Notice in this example that there isn't a direct, prescribed, or accurate path, but your senses are guided toward making information perceivable. Our ways of perceiving are why people with impairments in one sense are said to have another sense become stronger.¹ Our brain processes information however it can to paint a picture that is useful to us. If one output valve is blocked, the brain makes different configurations to process as much information as possible²

¹ Donovan Tokuyama, "Supersensors: How the loss of one sense impacts the others," Wu Tsai Neurosciences Institute, May 9, 2017,

<https://neuroscience.stanford.edu/news/supersensors-how-loss-one-sense-impacts-others>.

² Richard E. Cytowic, *Synesthesia* (Cambridge, MA: MIT Press, 2003), 98-101.

Another important part of the process of sensation and perception is reinforcement. Someone who is visually impaired from birth with hearing ability has more opportunities to engage with hearing and build a stronger hearing "muscle." Everyone experiences this to a certain extent. It has been proven that our vision faculties are only activated once we need them.³ Instead, we assume what we see based on what we have seen before, *then* measure this against what we see. Think of when you get up at night. At first, everything is dark, and then your eyes adjust to let in more light. Then, for a second, you see a figure in the corner. Knowing (hoping) that can't be right and looking a little longer, you realize it's just your coat hung up. Your brain assumes, then checks. Our visual perception working like this is a result of evolution.

In the waking up in the night example, we see the figure of a person because we are attuned to recognize people to identify them as friends or foes. This tendency is also why we see faces in everyday objects. We assume before we check to save brain power. Our brains are energy guzzlers, and it takes shortcuts to conserve that energy for when we might need it (like when we have to face the coat intruder in the corner).

Because our brains are configured toward the evolutionary goal of getting our genes into the next generation, they are fallible. Our interpretation of the world around us is not formed by a mechanism that cares for reality but instead by a blind designer with the goal of persisting at any cost.⁴ Beyond our internal mechanisms being fallible, it creates an unstable relationship with the world around us; our *umwelt*, too, is unreliable. We often interpret our environment as an objective observer standing outside of it. But this view reaches limitations in all directions. The thing that forms our

³ Charles D. Gilbert and Wu Li, "Top-down influences on visual processing," *Nature Reviews Neuroscience* 14 (2013): 350-363, doi:10.1038/nrn3476.

⁴ Cytowic, *Synesthesia*, 101.

perception of our environment is inextricably part of that environment. This results in a paradox.

This paradox has been at the center of many existential philosophical viewpoints. The question of how can I know I exist if "I" am the thing both doing and interpreting the existing. Rene Descartes famously said, "I think, therefore I am." The infamous brain in a vat thought experiment is another take on explaining the construction of reality. It hypothesizes that we are simply a brain in a vat that creates a world that we perceive or are controlled by someone else.

A version of this exists in Plato's Allegory of the Cave. In this, a group of people dwell in a cave, and their reality is formed by shadows cast on the cave wall. One day, one of them exits the cave and realizes there is a source to the images created on the wall, which are a true reality. Plato used this allegory to speak to the pursuit of knowledge, education, and what constitutes reality. As far as the dwellers were concerned, what they perceived (the shadows) was reality. The answers to how we can know reality have taken many forms over centuries, but under all of them, there is an assumption that an objective reality exists.

From my point of view and for the purposes of my existence, things that look like trees are trees until they are not. For the cave dwellers, shadows are reality until they are not. That means that reality is not an objective endpoint but a moving target created at the point of measurement. Reality is a relationship between observer and observed, creating a framing of information useful for evolutionary purposes.

Philosophical views on scientific inquiry until the 20th century dealt with issues that arose from the observer and the observed being regarded as separate. But placing the observer

outside the observed and operating from a macroscopic view creates inevitable myopia.

Newton was the forefather of classical physics, who described what happens to large bodies on a physical scale with his laws of physics. He was not wrong, but he did not get the full picture, only that macroscopic one we could garner from observation through our own lenses. Newton recognized this, writing, "Gravity must be caused by an agent acting constantly according to certain laws; but whether this agent be material or immaterial, I have left open to the consideration of my readers." ⁵ Physicists went on to discover gravitational fields and quantum mechanics and theorized about the relationship between the two. But what was realized at this point is that on the smallest scale, physical events behave counterintuitively without regard to whether we can observe them.

On a physical level, things that are too small for us to see behave differently than those that are big enough to see. For centuries, our macroscopic myopic view limited our ability to realize that. In the West, we have held on to, and continue to hold on to, a view that we are God and must be capable of knowing all. But, as Niels Bohr replied to Einstein's declaration that "God does not play dice," "stop telling God what to do." ⁶

⁵ Jeffrey Edwards, Martin Schoenfeld, Eric Watkins, and Andrew Janiak, "Newton's Philosophy (Stanford Encyclopedia of Philosophy)," Stanford Encyclopedia of Philosophy, accessed May 15, 2023, <https://plato.stanford.edu/entries/newton-philosophy>.

⁶ Carlo Rovelli, *Helgoland: Making Sense of the Quantum Revolution* (Chicago: University of Chicago Press, 2021), 56-70.

THESIS

I am now going to talk about quantum physics, which is often met with a sense of defeat when I bring it up in conversation. The idea of quantum physics is so counterintuitive and vast that people believe that they are not capable of understanding it and that it is not for them to understand. This is erroneous and dangerous thinking. Moreover, it relegates knowledge to a certain kind of person, which historically has largely been white, cis, wealthy, and male.

We can all understand quantum because it is all around us. It is us. In writing this, I hope to instill in you the confidence to begin understanding Quantum through embodiment, not physics. Through a position I am defining as Quantum sensibility, where belief is suspended, and we may let the quantum enter us.

Now, dear reader. If you are reading this with a critical eye, perhaps you've noticed a slight contradiction. Here I am, presenting myself as a source of knowledge, garnering these insights from my observations but claiming that they are illusory. If you are already questioning me as a source of knowledge, great. If not, I implore you to do so. Don't consider me a passive disseminator of knowledge; use this to create your understanding with me. Let us take this journey together. Believe me, don't believe me, but ultimately believe yourself.

Before we begin, let me tell you a little more about the quantum journey I have been on, and how it has led me to guide you toward it. In the first semester of my MFA program, I was tasked with writing a design manifesto titled *The Future Is*

Quantum: A Quantum Design Manifesto. During the semester, I found myself reading about mindfulness, love, and quantum physics, among other things. At the time, I was just starting to grasp the concepts of quantum physics at a basic level. I used my understanding of these concepts as metaphors for my design values, with section titles: "Superpositioning as Mindfulness," "Quantization as Transferability of Disciplines," "The Uncertainty principle as soft-ignorance and Childlike Curiosity," and "Entanglement as Love." This manifesto used scientific concepts to make sense of elusive personal values contextualized around design. At the time, my thinking was to reveal the similar within the dissimilar, forging a connection through metaphor. ⁷

Until this point, I had learned about quantum physics through the lens of physics. Not being a physicist, there was a limitation to my understanding through this mode. Knowing there was something important, I needed to grasp this Quantum stuff, and wanting to learn more, I thought, how could I understand quantum physics through what I already know? Then, as if the Universe heard me, I was given the opportunity to take part in the class "Quantum Commonsense," taught by speculative designers Anthony Dunne and Fiona Raby. As I took this class, we learned about artists, designers, philosophers, musicians, political scientists, and people using their understanding of quantum physics to make sense of the world through a different lens. I was also reading works from some of my tutelaries, who share radical ways of understanding the world, from James Baldwin to Janelle Monáe. It was the perfect recipe for an epiphany; that everything is Quantum. Therefore, I am quantum, and I can understand quantum through understanding me.

⁷ Cytowic, *Synesthesia*, 28.

QUANTUM

We know that as things become smaller, the edges of our world become increasingly obvious. The Quantum Revolution has proven this to us in ways vastly beyond our imagination. Quantum mechanics describes the world at an atomic and subatomic level, the point where the infinite becomes discrete and finite, where things are no longer divisible. At that scale, things begin to behave strangely, according to what we experience as intuitive.

Quantum mechanics reveals three great things about the Universe; indeterminacy, granularity, and relationality. Relationality is Rovelli's interpretation and the one I consider most useful to understanding our place in the world and achieving a quantum sensibility.⁸ Other interpretations of what to make of this indeterminacy and granularity include the Many-Worldian, Qbism, and the Hidden Variables theory.⁹

Quanta, the smallest unit of a physical entity, contains discrete packets of energy that can only exist at certain values. This discovery debunked the commonly held belief that particles and energy were infinite and continuous. Einstein proved this to be true by studying the photoelectric effect and what would come to be known as photons. His realization that light was, in fact, made up of particles was heavily contested because it had recently been found that light was made of waves. The two seemingly contradictory functions of light were resolved through wave-particle duality. This states that light, and all energy, in fact, behaves like a particle and a wave. What is particularly interesting in this discovery is observation's role in this duality.

⁸Carlo Rovelli, *Reality Is Not What It Seems: The Journey to Quantum Gravity* (New York: Riverhead Books, 2017), 136

⁹ Rovelli, *Helgoland*, 56-70.

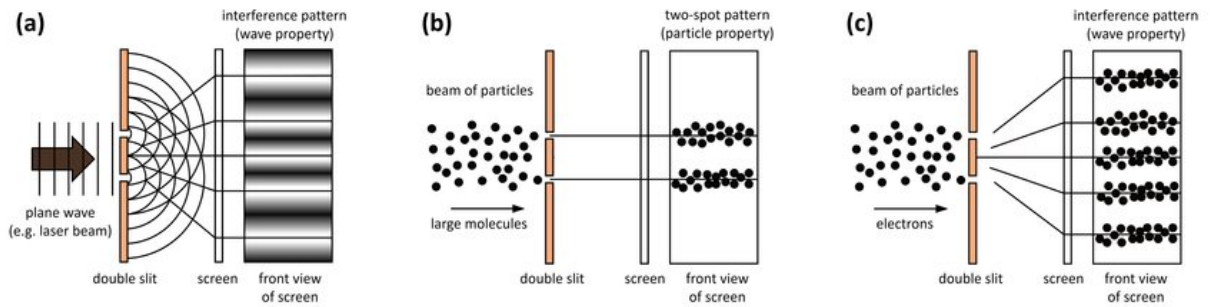


Figure 1: Double-slit experiment with (a) photons, (b) very large particles, (c) electrons. Aydin, Alhun *Quantum Shape Effects*, 2021.

In the simplest terms, a particle behaves like a particle when we look at it and like a wave when we are not. When not observed, a particle is in a state of superposition. That means it is in all possible places that it can be, at once, as a wave. When measured, it collapses to one point, resulting in wave function collapse. It cannot be known where the particle will appear with exact accuracy, as it can with classical physics and Newton's laws of motion. Instead, there is a probabilistic indeterminate prediction of how it may appear based on all the possibilities.

Within the field of Quantum mechanics are inherent contradictions to our eyes. But the math and science behind it make it today's most proven physical theory. Newtonian physics, or classical mechanics, deals with the predictable and calculable nature on a large scale. While Newtonian physics is constrained by what is observable, quantum mechanics functions in a way contradictory to what we can perceive. When the observer is at a disadvantaged viewpoint and can too be observed, all that remains is relations. The observer and the observed are part of the same quantum system, interrelated, and only the event of measurement of an interaction can be found. "What quantum theory describes, then, is the way in which one

part of nature manifests itself to any other single part of nature." ¹⁰

CHAIRS

Now, back to our journey. Let's take another version of zooming in. Take a mundane object, like a chair, the one you may be sitting on. Ask yourself what makes it a chair. Is it the parts: the legs, the arms, the back? Zoom in. Is it the material: wood, plastic, metal, cloth? Zoom in some more. Is it the connections that bring it together: the hardware or the joinery? Keep zooming in. Is it the details of the materials themselves: the grain direction, wood knots, the finish? Zoom in again. Is it the sensations you feel from the chair: the texture, the smell, the taste, the anti-gravity, the look? For me, beyond this I cannot see the makeup of a chair. On a quantum level, the chair ceases to exist. All there is, is an arrangement of particles chair-wise. But we still need to sit on them, so what do we make of this?

Plato wrote of his theory of forms, an ideal unattainable form that exists outside the realm of space and time. ¹¹ He would argue that the chair you are sitting on is an utterance of and an attempt at this idyllic form, which exists outside of the utterance. This would mean that if all the chairs in the world were to evaporate into thin air, chairs would still exist in this form, and a chair utterance could be created once more. Aristotle contested this, essentially expressing that the forms are indeed inextricable from their utterances, and there is no abstract realm in which they exist. While on a physical level, Aristotle may have been closer to the truth, Plato's theory does have useful relevance in our relation to things.

¹⁰ Rovelli, *Helgoland: Making Sense of the Quantum Revolution*, 74-75.

¹¹ Richard Kraut, "Plato (Stanford Encyclopedia of Philosophy)," Stanford Encyclopedia of Philosophy, February 12, 2022, <https://plato.stanford.edu/entries/plato/>.

It cannot be proven that chairs exist on a physical level, so where do they exist? And how are we sitting on them? Plato's theory is also known as the theory of ideas, which is a more interesting and apt framing. What underlies this theory is not an explanation of physics but that of ideas and abstractions and the relationships and arrangements born out of them. Moreover, it represents one of humankind's most important and sustaining inventions, language.

A famous assemblage, *One and Three Chairs*, by Joseph Kosuth, grapples with this idea.¹² The physical iteration of this thesis project is a response to this piece, a palimpsest approach with the added layer of quantum sensibility. In his piece is a wooden chair, a picture of a wooden chair, and the printed definition of the word chair. The piece asks its audience, "Which of these is the real chair? Which of these chairs embodies chairness the most?"

The wooden chair in three dimensions is an arrangement of particles from wood in a shape with four vertically positioned rectangular prisms (legs), joined with a wooden a shorter cube horizontally atop them (seat); perpendicular to one end of this cube is another rectangular prism (back). Even within this description of the chair, we are confronted with three elements that the other versions of the chair reconcile: language, abstraction, and dimensionality. Within these representations of the chairs are the triangulation of these elements, held in a particular arrangement by the artist and observer. The image of a chair framed on the wall lacks dimensionality; it is a flattened abstraction of the chair into two dimensions. As I write about this piece, I refer to a picture of it, having never seen it in person. There is an added, invisible abstraction of dimensionality between this picture of the piece, where I can

¹² Thomas Folland, "Joseph Kosuth, *One and Three Chairs* – Smarthistory," Smarthistory, December 21, 2017, <https://smarthistory.org/kosuth-one-and-three-chairs/>.

perceive and deduce that the chair in the picture exists in three dimensions. However, the picture of the picture exists in two while looking at a two-dimensional arrangement of hundreds of pixels on a screen. My role as perceiver is a necessary part of the interpretation of a chair. Rovelli writes, "We are nothing but images of images. Reality, including ourselves, is nothing but a thin and fragile veil, beyond which ... there is nothing." ¹³

The last instance of a chair in this piece is the definition:

chair (char), n. [OF. chaire (F. chaire), < L. cathedra: see cathedra.] A seat with a back, and often arms, usually for one person; a seat of office or authority, or the office itself; the person occupying the seat or office, esp. the chairman of a meeting; a sedan-chair; a chaiset; a metal block or clutch to support and secure a rail in a railroad.

This version holds the idea of a chair through the abstraction of a mental image or meaning of the word through language, specifically semiotics. The arrangement of shapes known as letters of the English alphabet, "c, h, a, i, r," in consecutive order, holds no inherent meaning. This arrangement came from a written version of a sound that symbolized the arrangement of physical stuff encountered in a three-dimensional space and was reinforced by people who made the same sound to refer to this idea. I argue that none of these versions of the chair is more accurate or more "chair" than the other, and none exist more than another, but that the chair only arises out of a relationship between them.

Imagine this; you come across five pieces of hollow cylinders of metal arranged in a pentagon. What would you call

¹³ Rovelli, *Helgoland: Making Sense of the Quantum Revolution*, 158.

that thing? As I know, there is no particular word in the English language to describe that specific thing. Let's say you decide to call it a pontith. If you encounter another English speaker and ask them what a pontith is, they will have no idea. For now, there is your abstraction of a mental image derived from an encounter with the physical world. You explain what a pontith is to this person, and they go on to explain to another person, and so forth. And now, a pontith exists as a word that describes an abstraction of a collective idea triggered by an event in space and time. This is an oversimplified version of how language works through semiotics, but what it shows for the purpose of this conversation is that there is a necessary process where abstraction creates a reality.

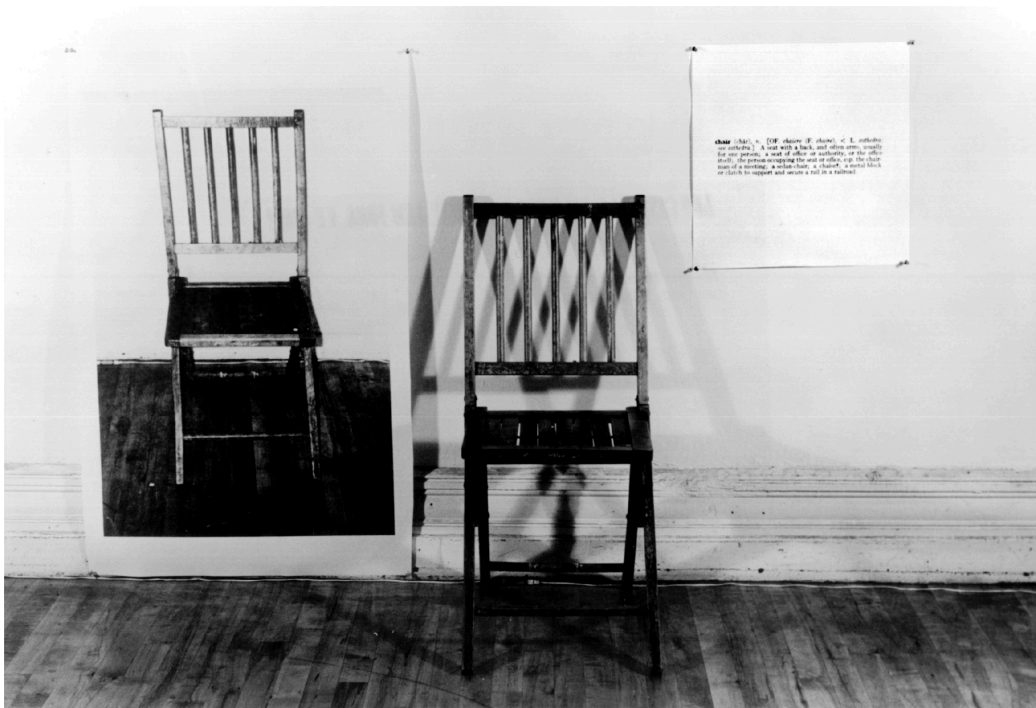


Figure 2. Joseph Kosuth, One and Three Chairs, 1965. Wood folding chair, mounted photograph of a chair, and mounted photographic enlargement of the dictionary definition of "chair" (MoMA).

A chair, like any other object, is an abstraction of a collective idea held in the substrate of language, measured against physical arrangements. Chairs exist in our minds, are

reinforced by our behavior, and are held together conceptually by language. Their constitution is only what we make of it. Chairs do not exist as physical entities, nor does anything else.

"In Language, There Are Only Differences," writes linguist Saussure.¹⁴Complex language is a uniquely human trait, as far as we know, in that it allows us to think of and describe things that don't exist, relate to one another, and create things from the ideas of our minds. We use language through differentiating; to say this thing is like this other thing, not like that thing. As humans, in the race of evolution, we find differentiation a useful skill. It has helped to recognize what is friend or foe, food or enemy. But, as mentioned before, our evolutionary mechanisms have motives outside of describing reality. We are regularly confronted with the limitations of our minds and bodies, but our cognition is adept at making up the rest for our evolution.

Knowing our cognitive biases and abilities are limited is one step to realizing we are not authorities in the Universe. We need not be defiant or feel defeated by this limitation, but we can recognize and expand within our bounds. Once we realize we are no more special than any other thing in the Universe and are just one small part of it, we gain the perspective of cosmic humility. This humility allows for an expansive experience and understanding of the world, not one shrouded by our inabilities. Evolution's myopic design ultimately leads to our downfall. Only trying to get our genes into the next pool creates selfishness, shortsightedness, and lack of love and care for others which can only result in our demise.

Another unique human quality is behind our evolutionary propensities and trajectory. That is the self-awareness and

¹⁴ Ferdinand de Saussure, *Course in General Linguistics* (Open Court Publishing, 1986), 120.

capability to conceive of oneself as an abstraction. This rouses an anxiety, a thirst for understanding that has undergirded the desire to understand our place in the world and the world itself. The driving force between reality and scientific inquiry (as well as philosophy) is the pursuit of knowledge. Knowledge is much like reality, an invention of the mind. Knowledge begins with information. According to information theory information is just the number of options possible. For example, the results of a coin flip contain less information than that of a draw from a card deck. Knowledge is derived from a measurement of information in a particular arrangement. If I flip a coin and it heads on tails, I know (or presume) that the other side is heads. If I draw an ace of spades from a card deck, I know there is no longer an ace of spades, but there are 51 other pieces of information I cannot derive knowledge from. Neither information nor knowledge is static things that we are after and one day have all of but are extractions of relationships. Knowledge is an ever-moving target and a tool that serves a self-serving function. Knowledge begets knowledge.

The scientific pursuit is pushing against this wall of what we know (for now) and what is out there to be discovered. For example, two scientific theories have been proven separately, but there is no solid theory of how they work together; quantum mechanics and the general theory of relativity. This problem of quantum gravity has a solution yet to be discovered, almost 100 years after the discoveries made by the first theories. Reality, as it is held, informs reality. It was the reality that the Universe was geocentric up until the 17th century. Knowledge changed that reality and reality changed that knowledge. Knowledge and reality are two sides of the same unattainable coin. The Model-dependent realism view coined by Stephen Hawking and Leonard Mlodinow accounts for this view of reality,

where an objective, independent reality cannot be found, and any model of reality is just a frame to put a picture in.¹⁵

Reality and knowledge being both unattainable do not render them useless. What recognizing their unattainability can do is uncover where we as humans lie within the Universe. Reality and knowledge are merely a means to an end, that end being the survival and proliferation of our species. Reality exists outside of our interpretation of it, but that reality is not something we can know. Knowledge is our attempt at understanding reality, but because of our place in the Universe, we cannot know what we don't know. But we will and do try anyway.

Descartes went through a series of meditations to locate where existence lies and how he can know he exists. His conclusion was by the very act of questioning and doubting his existence; he must exist. There are many critiques of this thinking, a significant one being that the notion of "I" is assumed.¹⁶ This is another example of myopia revealed through our tendency to distinguish between the observer and the observed. There is no view of ourselves outside of ourselves.

The closest we can get to a view of ourselves outside of ourselves is still keenly aware of the notion of self as part of the observation. If we suppose a view from nowhere, an objective outside view, it would be a view much like a God's or the Universe's (which for me are the same). Surely, the Universe could not "care" about one individual, me, Six, or you, dear reader's gene pool proliferating to the next generation. We are of the Universe, and the Universe is us, irrespective of these seemingly independent flesh vessels that contain us. What we can learn from the Universe is that there is no "I," only the Universe experiencing itself through our eyes.

¹⁵Stephen Hawking and Leonard Mlodinow, *The Grand Design* (Random House, 2011).

¹⁶Lex Newman, "Descartes' Epistemology (Stanford Encyclopedia of Philosophy)," *Stanford Encyclopedia of Philosophy*, February 15, 2019, <https://plato.stanford.edu/entries/descartes-epistemology/>.

CONCLUSION

When you zoom in, whether into a tree, a chair, or an atom, there reaches a point where new information ceases to be found. So when we start at the point of no physical reality, where do we go from there?

Metaphors are one of those great inventions that language provides to us. So, to summarize this journey, I will provide you with a metaphor. A metaphor of a picture, a picture of a metaphor.

Before we paint the picture, let's start with a frame. This frame tells us what we can paint. The size, the material, and the shape of the frame determine what can be seen in the picture we are to paint. Here are some things we can consider frames; science, knowledge, you, me, past, present, future, and language. These are containers for substances to be held in and moved through. We paint certain pictures, tell stories, make theories, and arrange materials within these frames. Here we can see; the picture of a chair, the world is geocentric, you and I are different. Lastly, there is the third, invisible thing that I hope I have made more visible to you. The moment of measurement creates the relationship between you, the picture, and the frame. These relationships are between you and me, dear reader, you and a chair, knowledge, understanding, past, present, and future.

Once a picture is in a frame, it does not change on its own. To change the picture, one must alter the frame. Perhaps

simply putting a new picture in the same frame. But what happens when we change the frame to paint a different picture? New worlds of possibility, imagining, and dreaming open up. When Copernicus discovered a heliocentric model of our Universe, he sparked a scientific revolution. The sun being at the center of the Universe changed the frame so that people could paint entirely new pictures. I hope to use and give you the frame of Quantum sensibility so that we can both paint new pictures of the world.

I, too, want to leave you with a picture I have created through Quantum sensibility. Knowing that reality is a lens that both neuroscience and physics have proved to be illusory, that knowledge is a means of holding information in a certain perspective, and that there is no reality that we can attain irrespective of our individual inaccurate perceptions.

Ultimately you and I don't exist. So what do we do now? I implore us to do three things.

1. Embrace a quantum sensibility.
2. Pursue knowledge fervently, knowing it will never be attained.
3. Love.

To embrace a quantum sensibility is to recognize that things are not what they seem because of our relationship to the physical world. We must reconsider our relationship to reality, the world, and the Universe through the assumed position of the inability to know. For centuries we could not get closer to knowing how our world works, running up against a wall by assuming it was for us to know. It wasn't until we began to understand that maybe there are things beyond our comprehension that we truly began to comprehend.

Pursuing knowledge fervently, knowing it will never be attained, is the delight of curiosity. One of the magical things

to me about this human experience is the ability to learn and create. Imagine if one day everything had been figured out. What fun would that be? The chase toward the unknown allows us to expand and truly proliferate as a species.

Along with pursuing knowledge fervently, identifying oneself as a source of knowledge is a powerful imperative. Knowledge is born out of an embodiment of information in space and time. That means we all have the ability and unique perspective to create knowledge. As knowledge is a moving target with no end in sight, knowledge begets knowledge. This means that arriving at one point in knowledge opens a world of further knowledge.

Lastly, and above all else, love. "We do not love in order to live: we live because we love," wrote Rovelli. His writing was a big inspiration for this project, and for making my way to Quantum sensibility. We are on the precipice of a technological revolution unlike before, with the potential to further alienate, destroy, and corrupt. One that will include the ubiquity of quantum computing. We are also experiencing a recession in love.¹⁷ A Quantum understanding of the world is inherently incompatible with a lack of love. Understanding how the Universe works is understanding that we are just part of that Universe and are all one.

POSTSCRIPT

This Thesis is a culmination of my life and learning from the past few years - it is synthesis. As a lover of language, I refer to etymology. Thesis comes from the Greek - *tithenai* 'to place' - coming to mean a 'placing, a proposition.' Synthesis *suntithenai*, to 'place together.' The knowledge I have garnered, bound to change, does not exist outside of me, my experiences,

¹⁷ Byung-Chul Han, *The Agony of Eros* (MIT Press, 2017).

and my relationship with others. What I have encountered, placed within me, comes together so that I can place it outside myself and give it to you. This is a love letter to those who have inspired me, changed me, and guided me.

Coming out of one of the greatest calamities in human history, a pandemic that changed the world, into getting a degree in Design + Technology from one of the world's most renowned art and design schools. An institution that had to reckon with its birth, growth, and place in the world in Fall 2022. This degree and the past two years have taught me more about myself, my place in the world, and my understanding of the world, than "design and technology."

I've learned through my experience that knowledge is not something objective to be bestowed upon you. It is instead created through experience and embodiment and is most valuable when recognized as such. This is my quantum understanding of the world, created from within, guided by the connections in this Universe. I hope you, dear reader, can, too, begin a journey of understanding through quantum sensibility.

APPENDIX A

This thesis paper is a companion to a lecture recorded in four parts and played as part of my physical iteration. The contents of the lecture are as follows:

I am going to give a lecture in four parts, one about Chairs, one about Quantum, one about knowing, and one about experiencing. All of these are lectures about Quantum. All of them are lectures about chairs. None of them are to be believed to be true.

CHANNEL 1. CHAIRS

I will begin this lecture with a series of questions about the chair you are seated on. I implore you to reflect on these questions on your own. To ask me, what makes this a chair? To come along this journey of searching for the reality of the chair.

1. What is a chair?
2. What isn't a chair?
3. Would chairs still exist if people didn't sit?
4. Are chairs art?
5. Is a chair with no legs a chair?
6. Is a chair with no back a chair?
7. Is it a chair if it cannot be sat on?
8. Is it a chair if it can be sat on?
9. Is it a chair if it is missing parts?
10. Is it a chair if it was once a chair?
11. Is it a chair if there is more space than chair?
12. Is it a chair if no one sits on it?
13. Is it a chair if no one can sit on it?
14. Is it a chair if it has three legs?
15. Is it a chair if it has two legs?
16. Is it a chair if it has one leg?
17. Is it a chair if it moves?
18. Is it a chair if it's broken?
19. Is it a chair if it changes shape?
20. Is it a chair if it looks like a chair?
21. Is it a chair when you are not sitting on it?
22. Is it a chair if it's not "human" shaped?
23. Is a chair too large for one person a chair?
24. Is a chair too small for one person a chair?
25. Is a chair close to the ground a chair?
26. Is a chair you have to climb a chair?

27. Is a chair made out of materials not conducive to sitting a chair?
28. Is an uneven chair still a chair?
29. Is a person a chair?
30. Do other species have "chairs"?
31. Is a foldable chair a chair when it's folded?
32. Is a chair at an obtuse angle a chair?
33. Is a chair rearranged still a chair?
34. Are the parts of a chair yet to be assembled, a chair?
35. If it is not human-made, is it a chair?
36. Is it a chair if it wasn't intended to be sat on?
37. Is it a chair if it has multiple seats?
38. Is it a chair if it has multiple orientations?
39. Is a chair you can't move, a chair?
40. Is a chair that is used for things other than sitting a chair?
41. Is a pile of materials that could make a chair a chair?
42. Is something recycled from a chair still a chair?
43. Is a chair missing a leg still a chair?
44. How close must a chair's parts be to be considered a chair?
45. Is a chair that would injure you to sit on a chair?
46. Which piece of the chair is most essential?
47. What if a chair was defined as a verb instead of a noun?
48. Do chairs refer to the same thing in different languages?
49. If a chair is primarily another object, is it still a chair?
50. Is a chair that has never been sat on, a chair?
51. Were there chairs before people?
52. Is a chair when people are not around still a chair?
53. What came first, the "chair" or the sitting ?
54. Are chairs just things that hold us in a particular position?
55. Is a chair not raised from the floor a chair?
56. Is a chair with no seat a chair?
57. What is the difference between a seat and a chair?
58. Is an unstable chair still a chair?
59. Is a chair with no arms a chair?
60. Is a chair with one arm a chair?
61. Is a chair that cannot stand upright a chair?
62. How long must you be able to sit in a chair for it to be a chair?
63. Is a suspended chair, a chair?
64. Is a couch a chair?
65. Is a table a chair?
66. Is a stool a chair?
67. Is a swing a chair?
68. Is a "throne" a chair?

69. Is a car a chair?
70. Is the air under you if you squat in a chair position still a chair?
71. Is a bean bag chair a chair?
72. Is a soft chair a chair?
73. Is a block a chair?
74. Is a bench a chair?
75. Is a room a chair?
76. Is a window sill a chair?
77. Is a chair with more than four legs a chair?
78. Is a chair with a seat that isn't flat still a chair?
79. Is a chair with a triangular seat a chair?
80. Is a swivel chair a chair?
81. Is a chair with a circular seat a chair?
82. Is a chair made of legos a chair?
83. Is a bike a chair?
84. Is a skateboard a chair?
85. Are kneeling chairs, chairs?
86. Is a hammock a chair?
87. Are the materials a chair is made from, a chair?
88. Is a stack of materials a chair?
89. Will chairs evolve to fit humans?
90. If humans go extinct, will there still be chairs?
91. Did chairs exist before we named them?
92. Must chairs exist?
93. What is the minimal angle of the seat and back for a chair to be a chair?
94. How narrow can a chair be?
95. How big can a chair be?
96. What are chairs "made of"?
97. What makes a chair a chair?
98. Do chairs exist outside of our minds?
99. Do chairs exist?

CHANNEL 2. THE QUANTUM

On a physical level, chairs do not exist. There is no singular physical entity that we can point to and say, "This is a chair." Instead, when we examine chairs on a micro level, we find an arrangement of matter that we identify as a chair. It is the arrangement of materials that constitutes what we refer to as a chair.

Consider the chair you are currently sitting on. It is composed of various pieces, with holes filled with more chairs. But which chair is the chair? And what about the holes or the absence of a chair within the larger chair? Holes are ontologically parasitic— they are dependent on the existence of another thing to be able to exist. There are large noticeable holes in the chair, but there is also an abundance of space that we cannot see. So the whole chair is dependent on the existence of something else to exist. So I ask again, does this chair exist?

The world is strange but simple, says theoretical physicist Carlo Rovelli. Quantum mechanics revealed these three fundamental things to us about the way the world works that we cannot see because of our macroscopic view: indeterminacy, granularity, and the relational nature of the universe.

Let me take you through a brief history of the discovery of the way the universe has always worked and how we came to know what we know of it. It is hard to know exactly when the first ideas of Quantum came into being, but a relevant point to begin this story is with the person that it would come to defy, Sir Isaac Newton.

Newton gave the world three laws of motion and the equation $F = ma$ to describe how bodies will move according to these laws of motion.

These three laws proved to be useful to the extent that these tenets of classical physics describe observable phenomena and get us one step closer to what lies beyond. But, these three laws are missing something fundamental to how the universe works, whether we observe it or not.

Newton himself recognized this, writing, "Gravity must be caused by an agent acting constantly according to certain laws; but whether this agent be material or immaterial, I have left open to the consideration of my readers."

Michael Faraday and James Clerk Maxwell happen to be the readers who would consider what Newton could not figure out. Faraday, a natural philosopher turned physicist, dreamt up forces independent of the physical variables they act upon; Maxwell, a physicist and mathematician, came up with the equations that prove them – developing what we now know of as electromagnetic fields. Maxwell would also discover that light was a form of an electromagnetic wave.

Max Planck, a German Physicist, discovered that energy moved to and from a physical body with an ideal electromagnetic absorption or a blackbody moves in discrete packets, known as quanta. Quanta are the smallest physical entities.

By incorporating Planck's theory, and the constant that went along with it, physicist Niels Bohr became the first person to model the atom. He discovered that the discrete packets Planck postulated move at fixed points within the atom, leading to what we now know as the quantum leap and quantization.

Einstein developed the photoelectric effect using Planck's theory, explaining that light was composed of discrete packets of quanta that would come to be called photons. At this point, the wave function and the particulate quanta were two incompatible and opposing theories.

Louis de Broglie hypothesized that light and all matter exhibited both wave-like behavior and particle-like behavior, which is known as wave-particle duality. Clinton Davisson and Lester Germer found evidence of this through their double-slit

experiment. This experiment also documented the observer effect, where the act of measurement or observation alters the state of what is measured.

Erwin Schrödinger provided the equation, Schrödinger's equation, which described the probabilistic function of a wave. This is the quantum response to Newton's classical formulas. Werner Heisenberg developed the uncertainty principle in response to this, realizing that it is impossible to measure both the position of a particle and the speed of a wave with complete accuracy.

Einstein was not convinced by the probabilistic and unknowable nature of the universe, famously saying, "God does not play dice," to which Niels Bohr responded, "Stop telling God what to do."

This is the story of Old Quantum mechanics, marked by uncertainty, doubt, contest, and in response to classical mechanics.

From this point on, the study of quantum mechanics grew throughout the world, but its fundamental postulations were generally established. Quantum mechanics has been used and rigorously tested and still stands strong, but as one of the people who used quantum mechanics to develop the atomic bomb said, "Nobody understands quantum mechanics."

So far, we have covered the indeterminacy and granularity of quantum mechanics, but what to make of this relational nature? And what does this have to do with chairs? This chair is made of pieces of wood that are made of particles, which are made of atoms that function through quantum systems. Atoms are not fixed in space but are probabilistic in how they appear and when. Chairs are quantum. Everything is quantum. So again, there is no physical thing we can identify as a chair.

But, there is a relationship between you as an observer and this arrangement of particulate matter as you experience it.

Physically none of these chairs is more of a chair than the next, but against your idea of a chair, maybe one is. Language is a way of abstracting ideas to hold them conceptually as something we can communicate with other people. Chair is a word we use in English to describe something that we measure against a mental frame of previous encounters of similar arrangements of particles. A relationship between us and the physical world, and us and each other. There is no physical chair but an arrangement, an event, an interaction, and a relationship. All there is, are relationships.

This chair represents the many relationships between us and our world. The relationship between us and gravity, us and language, us and objects, us and each other. It does not exist as an entity but instead holds within it these relationships that we place within and upon it. It does not exist on a physical level but is a measurement of physical events against our collective concepts. We are not relegated to not knowing because there is infinite information, but there is a finite granularity that we cannot see.

Quantum is everywhere; we just can't see it.

As Feynman put it, "The 'paradox' is only a conflict between reality and your feeling of what reality 'ought to be.'"

CHANNEL 3. EPISTEMOLOGY + THINKING

If nothing exists, if nothing is real. What do we do now? How do we know anything?

Knowledge itself is a self-serving construct. When we recognize it as such, we can open ourselves up to alternative

ways of knowing that are expansive, allowing our realities to be limitless.

The history of Quantum Physics is part of a much larger story; the story of physics as a scientific study, the story of science, and the story of the pursuit of knowledge. There are two kinds of people in the West who have historically been at the helm of the pursuit of knowledge – philosophers, and scientists.

The idea of knowledge as a pursuit holds within it a misconception that there is a final point that we are chasing and will one day arrive at. Knowledge is created and ever-changing. The story that lies within these stories is the story of epistemology, of what we know, what we can know, and how we know.

Let's begin this story with Plato, the proverbial son of the father of western Philosophy, Socrates. Plato developed a theory of form and matter known as the "eternal forms." What this theory posits is an essence, an ideal unattainable embodiment of physical things that existed outside of their material manifestation, that each object is an iteration towards. Plato favored the realm of ideas over that of material reality, which is ever-changing. While Plato was misguided in disregarding physical phenomena as a basis for reality, he was uncovering something important about how we make sense of the world through language, thoughts, and ideas.

His student Aristotle did not wholly reject the physical but instead found that the material and the form come together to make things that the two parts were inseparable. In his work, *Physics*, he attempted to explain the workings of nature, addressing gravity, speed, atoms, and the order of the universe.

Much of what he wrote turned out to be wrong, but his approach allowed him to be considered by many the father of science. While his teacher Plato relied on a priori principles, Aristotle used observation to deduce a posteriori evidence.

There is the story of the lesser-known characters of the pre-socratic era, who have had much more to contribute to the physics we know today. Among them are Anaximander, Democritus, Pythagoras, and Thales of Miletus. These were among the first people in recorded history who tried to explain the workings of the universe without mythology, spirits, and gods, but instead observation and reason.

Democritus, millennia before Niels Bohr would come to first model it, dreamt up the atom. His atomic hypothesis was that everything was made of what he called atoms, which were physically, but not geometrically, indivisible; that between atoms, there lies empty space; that atoms are indestructible and have always been and always will be in motion; that there is an infinite number of atoms and of kinds of atoms, which differ in shape and size. Democritus's work did not survive, and the fragments we have of it were given to us by the writing of later philosophers, including Aristotle.

But Aristotle did not agree with the existence of these atoms and instead posited that the most basic elements that make up the world were the observable Fire, Water, Earth, and Air. This view was more intuitive and was regarded to be true in the West for centuries to come. It wasn't until more than a thousand years later, in the 17th century, that Galileo Galilei suggested that there is more to nature than the eye can see and opened a line of scientific inquiry about what the world is made of. Later that century, Isaac Newton would claim that it is probable that there is a smallest piece of indivisible matter, which all

other matter consists of, picking up where Democritus had left off.

Here we can end this story and begin the one of quantum mechanics.

A view of the world that rendered us unimportant consequences of the universe has been incompatible with the way that we are blinded by our sense of self-importance as a species.

For a long time, holding humans as critical observers made it difficult for us to understand things beyond ourselves. Science is a system invented for gaining knowledge, which is another invention. Ways of knowing that are confined and prescribed, we can see, ultimately hinder what we can know. How we know is crucial to what we know.

I have been talking about Western philosophy and science, whose participants were overwhelmingly white males. The authority that these people held over knowledge and continue to hold is part of the way that knowledge is restricted. Knowledge is not this objective endpoint given to people who have the time, resources, or status to attain it. Knowledge is what we make of it. It is everywhere.

Knowledge could and should be expansive. There is not a singular way of knowing. We all move through the world differently and are thus loci of individual knowledge. None more valuable than the next. The first step to knowing is dreaming, which we all have the power to do.

CHANNEL 4. PHENOMENOLOGY + EXPERIENCING

Quantum sensibility is what I regard as the position of the universe, where things are not what they seem because of our relationship to the physical world. And must reconsider our

relationship to reality, the world, and the universe through an assumed position of the inability to know.

Through this position and necessitated by it comes cosmic humility, an understanding of our place in the universe—we are authorities on nothing but ourselves. Cosmic humility shows us that understanding our limitations allows us to expand. It allows us to be closer to ourselves, to others, and to the world and universe around us. It allows us to be limitless. This thesis project is a culmination of my life and learning from the past few years - it is synthesis. As a lover of language, I refer to etymology. Thesis comes from the Greek - *tithenai* 'to place' - coming to mean a 'placing, a proposition.' Synthesis *suntithenai*, to 'place together.'

The knowledge I have garnered, which is bound to change, does not exist outside of me, my experiences, and my relationship with others. What I have encountered, placed within me, comes together so that I can place it outside of myself and give it to you. This is a love letter to those who have inspired me, changed me, and guided me.

Coming out of one of the greatest calamities in human history, a pandemic that changed the world to get a degree in Design + Technology from one of the most renowned art and design schools in the world. An institution that had to reckon with its own birth, growth, and place in the world in Fall 2022. This degree and the past two years have taught me more about myself, my place in the world, and my understanding of the world, than quote-unquote design and technology.

I've learned that knowledge is not something objective to be bestowed upon you, but it is created through experience and embodiment and is most valuable when recognized as such. This is

my quantum understanding of the world, created from within, guided by the connections shared in this universe.

I have an English degree, and many of my professors from undergrad were sad to hear that I was abandoning the world of language and literature for design. I could never. Design is a language that people don't know they speak, and everything that makes humans human is a result of language. Literature is my life's source. Everything I know comes to me through the gift of language. One of the most impactful professors I've had in my life, James Crowley, instilled a love for Shakespeare, the word alchemist, in me. The last lines in Shakespeare's last play, "The Tempest," the lines "We are such things as dreams are made on; and our little life is rounded with a sleep," have always stuck with me, inspiring me to be the dreamer and the dream, to dream into my reality. To hold dreaming as the ultimate form of being and knowing as merely a means toward that goal. I will finish this lecture with a series of words that have guided me throughout this journey to what I know and thank these muses for their knowledge.

"I don't know what I'm looking for." if I knew, I wouldn't be able to look for them.

- Douglas Adams

If you want to know your own mind, there is only one way: to observe and recognize everything about it.

- Thich Nhat Hanh

Reading is that fruitful miracle of a communication in the midst of solitude.

- Marcel Proust

Create no images of God.

Accept the images

that God has provided.

They are everywhere,
in everything.
God is Change-
Seed to tree,
tree to forest:
Rain to river,
river to sea;
Grubs to bees,
bees to swarm.
From one, many;
from many, one;
Forever uniting, growing, dissolving-
forever Changing.
The universe is God's self-portrait.
- Octavia Butler

If the concept of God has any validity or any use, it can only be to make us larger, freer, and more loving. If God cannot do this, then it is time we got rid of Him.
- James Baldwin

Life can bring; whatever it brings must be borne.
- James Baldwin

You can't know where you are going until you know where you are. I won't always know where I'm going but I can always know whether I'm going in the right direction.
- Bill Burnett and Dave Evans

One can, then, perhaps see the Self idea as fulfilling a role akin to a rocket which boosts a payload into space, against the force of gravity. It provides the force to drive the mind out of the gravity field of attachment to the personality factors [the

aggregates]. Having done so, it then 'falls away and is burnt up; as itself a baseless concept.

- Robert Wright

A thinking mind is not swallowed up by what it comes to know. It reaches out to grasp something related to itself and to its present knowledge (and so knowable in some degree) but also separate from itself and from its present knowledge (not identical with these). In any act of thinking, the mind must reach across this space between known and unknown, linking one to the other but also keeping, visible their difference. It is an erotic space.

- Anne Carson

The power of self-mythologizing is to imagine a future that reflects your own experience.

- Alyssa Favreau

Queerness is essentially about the rejection of a here and now and an insistence on potentiality or concrete possibility for another world.

- José Esteban Muñoz

As great scientists have said and as all children know, it is above all by the imagination that we achieve perception, and compassion, and hope

- Ursula K. Le Guin

I use the power of dreams that are now impossible, not totally believing in them nor their power to become real, but recognizing them as templates for a future within which my labors can play a part.

- Audre Lorde

Today, we can strive for one million tiny utopias each dreamt up by a single person.

- Fiona Raby and Anthony Dunne

And then you become pure awareness,
and the concept is
that is what we really are,
and that this entire material universe,
including our body,
Phenomenological field of phenomena.
A field of phenomena being encapsulated
within this consciousness,
and so the idea that I am alone,
or the idea that I am an individual,
is actually, interestingly enough,
you're already not.

It's false. It's a distortion.

'Cause you're the thing and the observer
simultaneously meeting together, and that creates the illusion
of self.

I mean, if the universe was a dolphin,
then, basically,
our bodies would be a fishing net.

We're all kind of entangled in ourselves.

- Duncan Trussell and Pendleton Ward

The future enters into us in order to transform itself in us
long before it happens.

- Rainer Maria Rilke

Perhaps poetry is another of science's deepest roots: the
capacity to see beyond the visible.

- Carlo Rovelli

We understand the world in its becoming, not its being.

- Carlo Rovelli

Reality isn't something that exists outside of oneself.

- Richard Cytowic

A rule in science is that nature reveals itself through exceptions.

- Richard Cytowic

We do not love in order to live: we live because we love

- Carlo Rovelli

Seeking means: to have a goal; but finding means: to be free, to be receptive, to have no goal.

- Herman Hesse

Thank you Clarinda Mac Low, Chris Prentice, Ever Bussey, Fiona Raby, Anthony Dunne, Roben Torosyan, Sage, Adrienne, Guin, Mariel, Ruby, Alejandra, Barnzly, Justine, Ricky, Marc, Leo, Steve, to all of my interlocutors, colleagues, family, friends, and lovers. To all of those I have met along this journey and those who I could not have done it without. To everyone I have had the honor and pleasure of sharing a little piece of life with. With love, Six.

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