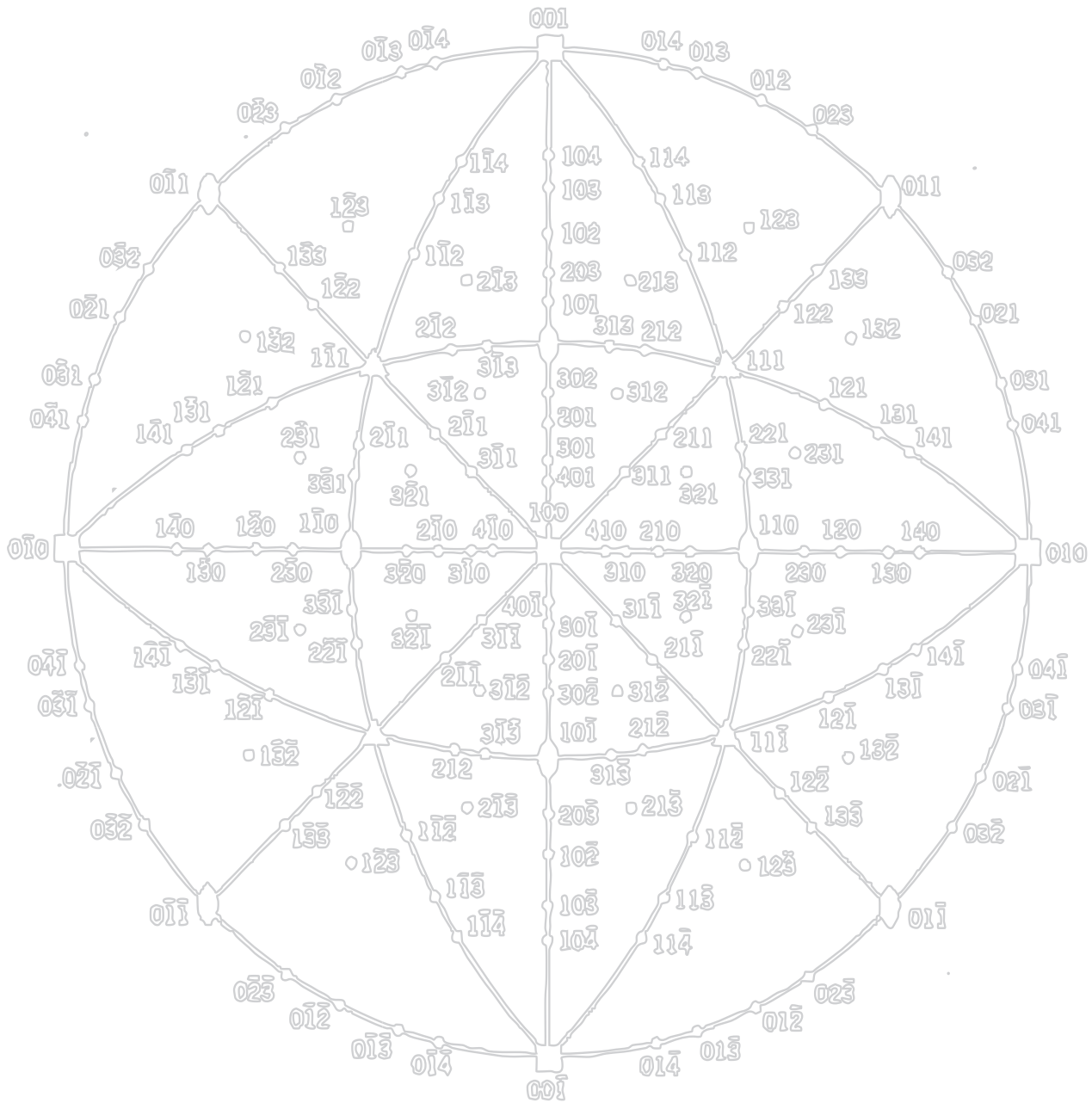


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FOUND IN TRANSLATION
Master of Arts 2026, Written Thesis



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And Chantal

I hold my womb, the space within me
I make space for you

In my womb,
the chaos of the universe reflects upon itself
for the first time
sentient.

Look around, how exquisite the perfection of your universe
its symmetrical constellation

Come, join this jolly spectacle. For
wherever you sit
I am the center.

Leaving Art & Science behind feels unreal. When I first stepped through the wrapped-up doors of the dusty and loud PSK construction site, which was at the same time an office and with time became a classroom, I still remember feeling nervous, curious, and just as incredulous as I am right now. How did I end up here? I looked around; everyone looked just as confused as me. Some people sat on the floor and others had welcoming faces. Little did I know how lucky I was for the encounters which awaited within those dusty walls. I spent a good part of the first year exploring the labyrinth topographies of PSK with Martina and watching sunsets on the rooftop with Claus. Being in awe of Charlotte, Sabrina, Naoki and Karl's beautiful minds and of Chloe's immense sensitivity to her surroundings. Feeling supported by Lucie, Francesco, Marton, Els, Paolo, Eugénie and Carmen, mesmerised by Ou, and held by the powerful presence of Mala and Hanin. Dancing and talking through long evenings with Xavi and Sophie, and having sweet Camille join our little family.

I am forever thankful to the Angewandte framework for allowing me to meet my dearest Klimentina, Morgane, Masha, James, Winnie, Maxi, Marlene, Cris, Margo, Hannes, Samo, Veza, Brooklyn, Hussain, Jana, Fiona, Manu, Dusty, Anahita, and many more inspiring souls. And for my chosen family in Slovenia.

Mara, Yeonwoo, and Felix have become especially important in my life, and my dearest fearless comrades from DAFP taught me what no school ever could.

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A special thanks goes to the one and only master of plaster, Roman. To Noah for the beautiful visuals, Winnie for the graphic design, and Masha for the exhibition design.

Forever faithful to my soulmate Petra.

To my parents and grandparents, and to the best siblings one could wish for, Kai and Tarik Adam.

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1. INTRODUCTION

Found in translation is a body of work resulting from the last few years of research in structural biology, sculpture, history, philosophy of science, and media theory, tracing their common inceptions and present entanglements, which brought about a practice of scientific model-making, both physical and digital. The scope of this project goes far beyond what I could present in this short thesis, which I aim to use as a historical and philosophical introduction into the topics of my research.

Models are essentially our way of making the invisible tangible, which involves several layers of abstraction and scaling. As our minds commonly make sense through relationality, models are often a point of reference, an idealised representation in a pool of objects, subjects, phenomena or theories, which has an ambivalent effect of simulating both generalisation and accessibility. But while models have been studied for a long time in the context of their representational value, the interest of my study is to shift the focus on their operationality and worldbuilding.

In the case of scientific models the norm is to insist on objectivity and models are often interpreted as mere conceptualisations or representations of the realities that surround us. A simple thought experiment might clarify how such claims seem insufficient. Thinking of a train toy model and its tracks, through the process of play and interaction, such a miniature can constitute a whole world, a cosmology of its own which might expand beyond the mere model into logics, tactics, desires and decisions.

In fields concerned with morphology, such as structural biology, models are a form of tool which aids in the process of shaping a theory. But the molecular models we construct in the lab are constitutional of the ways we perceive, conceptualise and embody the same molecular and cellular realms which are under scrutiny.

Structural biology and similar fields have a very short legacy of tapping into the mystical and ontologically ambiguous scales of the atomic and molecular realms. But the genealogy of spatiotemporal perception which allowed scientists to construct such a specific sense of atomic morphology has somewhat unexpected origins. Or at least unexpected for the objective archetype, as it spans from centuries of studies centering the human organic body and its morphology.

My work traces these origins both conceptually and materially, following my own experience in the scientific practice researching the structure of the protein calcineurin. Intersecting media within a nonlinear narrative, it emphasises the multitude of stacked disciplines, sensualities, orientations, beliefs, materialities which contributed to the ways we build/solve and use protein models today.

As the conceptual formulation of my thesis is rooted in philosophy of science, I firstly give my research a theoretical framework, which lays the foundations to my understanding and position within the contemporary scientific discourse.

The main question of this thesis turns to be concerned with epistemology of space and the anatomical body, but it leaks into other fields as well. I am primarily interested in the ways in which we constructed the paradigms which allow us to conduct the study of structural biology today. *What was included and what was omitted? What produces the logic with which we address issues at the molecular level and how can these observations address questions of objectivity and subjectivity? How did we construct the morphology of the entities we study and how is this principally a worldbuilding process?*

2. THEORETICAL BACKGROUND

2.1 A Matter of Consequence

When reflecting on the problems of Western science and its history, it is wise—even if only briefly—to refer to its early legacy in Greek philosophy. While researching for this thesis, I found it mesmerising how questions and ideas proposed hundreds of years ago remain as relevant today as much contemporary theory. We keep returning to the same problems, which at times gives me the impression that contemporary philosophy is turning in a loop. I have long been curious about the riddles of the Western metaphysical tradition, and so I took a break from the laboratory to study it. A path that inevitably led me to the doctrines of the Presocratics, as well as to the Renaissance and the problems of modern science. Questions such as: *How can we know, and to what extent? How do we relate to the reality that surrounds us? What is knowledge? What is matter? And ultimately, who are we within this cosmos?* These are questions to which I by no means claim to have answers, particularly as I am not a trained philosopher. Yet during my training in chemistry and biochemistry, I could not shake the feeling that deeply philosophical implications lie embedded within science and its many worlds.

What disturbed me was how rarely metaphysical questions were addressed – indeed, how actively they were avoided. Philosophy was often regarded as superfluous or irrelevant. Data became doctrine. As scientists, reflecting too deeply on the meaning and implications of our research, whether in relation to politics, bodies, or society, was strongly discouraged, or at least not at all supported. And yet, science, art, philosophy, and spirituality have been separated into distinct disciplines only relatively recently, through processes of institutionalisation. Over the past few years, my focus has shifted almost entirely toward breaching these disciplinary boundaries. With this text, I attempt to articulate some of the intuitive questions I have been meditating on while working as a chemist and biochemist specialised in structural biology, alongside the beliefs I have developed through my subsequent artistic research.

One of the first issues that puzzled me during my studies in biochemistry was the problem of teleology as inherited from the Greek philosophical

tradition. Teleology is the view that to understand something fully, one must understand what it is for, its final cause or intentionality. Since antiquity, Western philosophy and with it science has been deeply entangled with the notion of causal chains. During the Enlightenment, some thinkers went so far as to universalise causality, positing it as a fundamental law of the universe, alongside linear time. This represents a distinctly Western preoccupation. In much of the majority world, time is rarely conceived as linear, even though imposed systems of timekeeping are now used almost globally. This is not to deny that time can be traced, there is undoubtedly a “before” and an “after” that can be felt or measured, but rather to question how such tracing is conceptualised, a topic I will return to in a later chapter.

Western thought is fixated with grounding all ideas in linear logic. With the advancement of computational technology, this has finally encountered an alternative, a nonlinear logic. Traces of such thinking appeared earlier in statistical mechanics and in Hamiltonian formulations, but a more explicit concept emerged with nonlinear causality fields in neural networks. It was observed in computation that an event could be triggered by a field of causes reflecting, bending, mirroring each other and, the other way around, a small event could trigger a big effect. For example a single malfunction, like a virus or an off-switch, can stop the functioning of the entire machine or system¹. This correlationist idea binds components together within complex systems through what has been described as the “circular causality of the net.” Crucially, this reconceptualisation altered Western understandings of time. Whereas control had previously been distributed spatially, like balls on a billiard table, it now became temporally diffused, exponential. It is as if space folded and time itself accelerated.

Yet the classical notion of causal chains insists that cause and effect can be traced back to a prime origin, an inception, an initial creation. This is important to note because, as we will see later, Newtonian classical mechanics, which has dictated our imagination of space, objects and motion for centuries, relies greatly on such an understanding of linear time. We can refer these notions back to an intellectual transition in ancient Greece around the sixth century BC, which saw a gradual

1 Kevin Kelly, *Out of Control: The New Biology of Machines, Social Systems, & the Economic World* (Basic Books, 1994).

transition to a belief in *logos* rather than in myth-based knowledge. For ancient Greeks *Logos* maintains a rational explanation of reality using justification and reason, it explains the rational order of the cosmos. *Logos* is the law of change that unites opposites, but also the thought that conceives of this order. It was Heraclitus who first gave *logos* its philosophical sense and he defined it as the mediating “force” between *arkhê* and *physis*, origin and process. Roughly said, *logos* is what gives structure to the chaos of becoming. *Arkhê* means something like beginning, origin, rule. Without *arkhê* nothing could be, everything comes from it and exists through it². Presocratics all had a different choice of *arkhê*, which was often referred to through natural elements like water, fire, air and earth, and later to more rational explanations like numbers and *nous* (mind)³.

The formulation that might be more interesting in relation to Western scientific thought is *physis*, since in the context of Greek philosophy it refers to the concept of nature. It is important to note that it does so in a different way than the “objective” Nature we think about today. The meaning of *physis* is closer to meaning “to grow”, “to arise”, “to emerge”, “to unfold”. The process through which the origin, *arkhê*, comes into being. Heraclitus wrote something that roughly translates to “*physis* loves to conceal itself” (fragment 123), and suggests at the same time *physis* can be revealed through *logos*⁴. If I understand what Heraclitus meant, then it follows that the concept of Nature as we define it today, the objective “natural world”, is simply one manifestation of *physis* through *logos*. It was already evident to Heraclitus that *logos* is not merely a positive process, *logos* can be “done wrong” as well.

Returning to the concept of teleology we can see how this linear logic comes to rise: from a point of inception (*arkhê*), natural processes (*physis*) unfold towards a final purpose (*telos*) and all this can be experienced through the ordering power of *logos*. I think this could have two interpretations in respect to *logos*. If we take *logos* to be the rational process of the human mind which, within our consciousness, orders nature to appear to us in its morphology, then we are quite

2 Jonathan Barnes, *The Presocratic Philosophers* (Routledge, 2002)

3 Neo-Platonism | Internet Encyclopedia of Philosophy, n.d., accessed December 15, 2025, <https://iep.utm.edu/neoplato/>.

4 “Heraclitus – Fragment 123,” *The Numinous Way*, January 12, 2011, <https://perceiverations.wordpress.com/heraclitus-fragment-123/>.

close to the modern concept of Nature. But if we take logos to be independent of human conception and more similar to a force which gives the cosmos a seeming order, then we might be getting closer to a quite recent interpretation of natural processes proposed by Ilya Prigogine and Isabelle Stengers in *Order Out of Chaos*⁵. Their theories are foundational to the development of complexity theory, which I will discuss in a later chapter, and give us a valuable way to think away from teleological, linear chains of causality.

Lorraine Daston and Peter Gallison famously trace the modern understanding of Nature through a thorough analysis of how the conceptualisation of objectivity morphed in relation to the philosophical conceptualisation of subjectivity, especially the one put forward by Immanuel Kant⁶. What I appreciate in the way the authors go about this question is how an effort is made to take into account the messiness of such epistemological movements and their involvement in the strong changes of thought currents they catalysed. To refrain from using a strictly teleological understanding of history, I find it important to acknowledge how ideas that might seem quite different do not mutually exclude each other but are instead contained in each other's formulations. These are worlds which exist simultaneously and sometimes even reinforce one another, voluntarily or not. In a similar way, the authors of *Objectivity* explain⁷:

“The emergence of objectivity as a new epistemic virtue in the mid-nineteenth century did not abolish truth-to-nature, any more than the turn to trained judgment in the early twentieth century eliminated objectivity. Instead of the analogy of a succession of political regimes or scientific theories, each triumphing on the ruins of its predecessor, imagine new stars winking into existence, not replacing old ones but changing the geography of the heavens”.

Complex processes are not conceivable in terms of origin and disappearance, creation and death, beginning and end. We can recognize that some happenings have a “before” and an “after”, but processes

5 Ilya Prigogine and Isabelle Stengers, *Order out of Chaos: Man's New Dialogue with Nature*, 5. (Bantam Books, 1988).

6 Lorraine Daston and Peter Galison, *Objectivity*, First paperback edition (Zone Books, 2010).

7 Ibid.

are much more complex, intricate and intertwined. Epistemological paradigms are a scattered, but certainly not random, interplay of experiences, beliefs and ideas, which redirect the grounding of *logos* through discursive practices and the values embedded in them. Such a process is in turn manifested in the conception of the social self, the identity of the subject.

I am pointing out this nonlinearity because I have so rarely encountered decolonial methodologies being embedded into scientific discourses. Or an acknowledgment of how so many of the ideas Western science is “producing” have been known and practiced by indigenous and non-Western communities for centuries.

I have often heard people questioning the critique of Western thought by pointing out all theory and philosophy which attempts to do so is in turn tight to Western philosophy itself. I feel the need to make a distinction about such claims – modern Western legacies of knowledge can not be equated with Greek philosophy, which influenced so many other doctrines. There are centuries in between which radically changed the way people in the West think and behave, especially because of Christianity⁸. We can and should not just skip all of the middle ages and pretend like they never happened or left a huge mark on modernity. Not to mention the slave trades and multiple genocides Europeans committed, often in the name of God and later under the pretext of science⁹. With every new colony, Europeans imposed their doctrines and ideologies on the colonised, who, over time, incorporated parts of these beliefs within their own thought traditions. Likewise, it can and should not be assumed that Western thought is purely and exclusively made in the center of the empire. Anyone from the global majority can testify to white man’s culture of stealing. When we critique Western thought it is not to dismiss every bit of it, but to subvert its mechanism of upholding imperial and colonial violence and prejudice.

Linda Tuhiwai Smith asks us to reflect on the question of the importance of history for indigenous people in her book *Decolonizing Methodologies: Research and Indigenous Peoples*. She clearly criticizes the “project of history” as an Enlightenment and a modernist project, but

8 Samuel Y. Edgerton, *The Mirror, the Window, and the Telescope: How Renaissance Linear Perspective Changed Our Vision of the Universe* (Cornell University Press, 2009).

9 Silvia Federici, *Caliban and the Witch: Women, the Body and Primitive Accumulation*, Second, revised edition (Autonomedia, 2014).

recognizes the importance of heritage for indigenous people. History is very important for indigenous communities, but the notion of history itself greatly differs from the Western one. When adopting such a critique she explains that the Western feminist and poststructuralist deconstruction of the notion of history did partly take into account the context in which this history was fabricated within the enlightenment and modernist projects. But what is important to emphasize is, as Tuhiwai Smith clearly puts it, such critique and circumstances are, and have been, well known to indigenous people for a long time, without the need for academic theories and intricate concepts¹⁰. And even though decolonial and indigenous methodologies now became a trend in the West, especially in the “art world”, I rarely encounter a serious acknowledgement of the knowledge, culture and wisdom which is being stolen and incorporated. This allows generalising tropes of primitivity, simplicity and naiveness to be assigned and upheld within discourses about anything nonwestern. Nonwestern influence happens on small discursive scales, which are often disregarded in favour of more general concepts. David Theo Goldberg explains¹¹:

“These more finite discursive expressions may themselves constitute smaller discursive fields, in much the way that a large transportation system is divided into zones. The sum total of these intradiscursive shifts could add up to or prompt transdiscursive alterations. By contrast, very general concepts can stretch across any number of discursive orders, acquiring new interpretations as they assume the values inherent within each, waxing and waning in strength across the stretch of time... The more general the expression, the more ahistorical it pretends to be; so the more malleable and pliant it tends to become, and the more susceptible to theoretical if not practical vacuity. Indeed, the more theoretically fluid the expression, the more will its currency tend to turn on assuming the significance of legitimate and established discursive practices and expressions. These ‘chameleonic’ concepts are especially dangerous, for they hide their discriminatory or exclusionary significance behind more readily acceptable conceptual schemata. This captures a central feature of the concept of race in modernity.”

10 Linda Tuhiwai Smith 1950–, *Decolonizing Methodologies: Research and Indigenous Peoples* (London : Zed Books ; Dunedin, N.Z. : University of Otago Press, 1999., 1999).

11 David Theo Goldberg, *Racist Culture: Philosophy and the Politics of Meaning*, Transferred to digital print (Blackwell Publishers, 2004).

On the other hand gazing upon the past from the present, constructing history, is a process which happens on a different scale from the now we are immersed in. Human cognition is not capable of logically tracing the past in all its “particularity” and complexity. While the dimension of time seems to collapse in the now, both past and future exist within the present. The imperial narrative project of history was developed as a methodology of categorizing, slicing and imposing a very specific mode of storytelling and worldmaking on the complexity of the past. A methodology of order intended to extract, exerting a function to compress, to grasp the ungraspable, render the opaque legible. One forever ingrained in the technologies and data of the present. And not even a succession of political regimes or scientific theories can completely erase the traces of its predecessors and make such a clear cut substituting them completely. It has become obvious time and time again how such cuts are virtual, but they do have very real consequences.

A telling example is found in cartography and the fictitious lines demarcating borders which exist only on maps constructed upon colonial violence, lies and biases. Lines drawn to protect the inside from the outside, the home from the othered alien, to keep the stolen goods within the fortress. These imaginary lines changed the material essence of our realities and bodies to uphold a very specific order and hinder movement. An order which is not only felt and experienced, but which changes the substrate of our realities¹². It is worldbuilding.

Modern Western science carries this colonial legacy within its assumptions and practices. The contemporary scientific and cognitive crisis reflects an inability to engage meaningfully with these histories. Opacity and obscurity are degraded in favour of the light of rational transparency and precision; indeterminacy and chaotic noise are controlled through the coherence of definition. People who reproduce these colonial structures live in a constant state of cognitive paradox, a superposition of moral superiority and delusion, as the “systems” under pressure refuse to cooperate. Violence is acknowledged as a historicised past while, at the same time, individuals remain actively involved in constructing a world that upholds those very patterns of violence. As I spent a significant

12 Bernhard Siegert and geoffrey winthrop-young, *Cultural Techniques* (Fordham University Press, 2015)

part of my life within Western academia being groomed to become a good scientist, I often felt a strong urge to question certain fixed truths that form the basis of how scientific concepts are established. I asked myself how the various scientific models—mine mostly concerned with molecules and their interaction pathways—which I was learning, using and actively constructing, were implicated in the world I was building. In structural biology we build abstract worlds to render scales we cannot experience tangible. Phenomena we can only access through measurement and data. I want to trace the influences which lead to the existence of such a model-world and how these influences shape its becoming.

2.2 From Light to Body and Back

The dualist distinction between subject and object in scientific discourse is a fairly recent one, yet it has haunted scientists since its earliest formulations. Constellations of experiments within a research methodology require the observer and the observed to be separated in a justifiable way. The object is to remain naïve about the scope and nature of the experiment, while the scientist must be as neutral as possible, not to contaminate the results or project subjective desires onto the supposedly objective scientific framework. An obvious hierarchy is thereby established and maintained in the name of scientific objectivity.

The co-evolution of subject and object in scientific research is linked not only to developments within the field, but also to broader discourses during the transition from Renaissance to modernity. The ongoing conversation between disciplinary domains has produced various enquiries into this split and has continually struggled to bridge it. Can we move beyond the distinction between the rational and the empirical, cognition and matter? For me, this is a fundamental question, as it pertains to my role as a scientist and researcher and to the knowledge I produce. Even while writing these texts, I feel trapped within the dualist loop, finding myself looking for answers in times far from now. Returning often to the Enlightenment, searching for the contingency of its resolution to become a necessity.

When I first encountered the subject-object split in philosophy of science, my thoughts had already been consumed by a strange feeling that arose

during my repetitive work in the laboratory. I often felt like the research I was conducting was somehow out of context, and the assumptions I could make were limiting. The thought of the complexity governing life within a cell kept creeping up on me, and I felt I was exerting a reductive force upon my “object”, my protein. Experiments were difficult to design and even more difficult to execute. I could work for months and, if I was lucky, produce a single graph. Then I slowly came to realise my doubts might actually hold the key to this puzzle. What if the daily dance I performed to obtain results was not a choreography I was dancing alone? If I listened carefully and posed my questions strategically, the resistance I encountered within my experiments would become an answer to my inquiries. These questions were, of course, asked materially, by adding ions or changing the temperature, but it still felt like a conversation. I was translating the language of molecules.

This made me reflect on how science is perceived in a broader discourse, outside the homogenous walls of scientific institutions. The world was going through the COVID pandemic, one of the most significant planetary crises, and I had just begun my training as a biochemist. I leave to you the pleasure of imagining what that entailed, since every second boomer I met at the time seemed to be an anti-vaxxer. The widespread doubts about the legitimacy of scientific research made me wonder: why are people so convinced that the world is a fleeting place from which we can never truly learn much or gain any certainty? Trapped in our minds, have we sentenced ourselves to speculate our way through our own phenomenological perception? This perplexed me, as I could clearly recognize the collective effort of science bringing up quite some relevant answers about the world, which in turn, had real and tangible consequences for reality. This distrust had, in part, little to do with science itself, but rather with a general scepticism toward the implications and applications of the field. The privatisation of drug production and the outrageous consequences of the pharmaceutical lobby go beyond the scope of my essay, but are certainly central to this issue on social, economical and political levels. But on a fundamentally epistemological level, where is the catch of obsessing over objectivity and instrumentalism?

Through my readings, I came to understand that there is a consensus on light having played a crucial role in the developments that linked science and philosophy over the last few centuries, particularly through

the Enlightenment¹³. When I considered this within the framework of my own research, I realised that almost every measurement I had ever made involved, in one way or another, the use of light. A few exceptions came to mind, such as measurements of weight or thermodynamic affinity. But light, or more precisely electromagnetic radiation, was otherwise implicated in almost all material interactions, forming the field of spectroscopy.

The fact that most STEM analysis today relies in various ways on electromagnetic radiation is analogous to the historical role light played in gradually separating observer and observed. Aristotle's observation of light phenomena during an eclipse in the 4th century BCE is the earliest known description known to date of sun rays seeping through small gaps between leaves of a dense canopy. Looking at the ground, he noticed many small crescent-shaped suns and deduced that cones of sunlight must have had their apex in the holes of the canopy, projecting symmetrical cones on the ground. He experienced the eclipse through a projection, observing the phenomena indirectly.

During the Islamic golden age in the 10th century, astronomer, physician and mathematician Hasan Ibn al-Haytham (Alhazen in the West) expanded Aristotle's early experiments with light and wrote the *Kitab al-Manazir* (*Book of Optics*, cca. 1011 to 1021), which laid the foundations for the study of optics¹⁴. Roger Bacon based much of his studies on Ibn al-Haytham's scriptures, expanding the field of optics in the thirteenth century¹⁵. Bacon is often credited with the invention of the camera obscura, as he became the reference for most medieval and Renaissance European studies on optics – then known as “perspective”. He never explicitly described a camera obscura, but it is likely that it was already well known in his time, and he saw no need to detail it, since many scholars of the period mentioned it as a means of observing solar eclipses¹⁶.

There was definitely a spiritual dimension at play in the medieval

13 Donna Haraway, “Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective,” *Feminist Studies* 14, no. 3 (1988)

14 “The Oxford History of Islam,” in *The Oxford History of Islam*, ed. John L. Esposito (Oxford University Press, 2022)

15 Boris Abramovich Rozenfel'd and Ekmeleddin İhsanoğlu, *Mathematicians, Astronomers and Other Scholars of Islamic Civilisation and Their Works (7th-19th c.)* (Istanbul : Research Centre for Islamic History, Art, and Culture, 2003)

16 John H. Hammond, *The Camera Obscura, A Chronicle* (CRC Press, 1981)

fascination with the camera obscura. Bacon, though an empiricist, was first and foremost a Franciscan friar, and medieval Europe maintained a long-established notion of darkness as the medium through which the glorious light of God could be perceived. Consider only the dark interiors of Gothic cathedrals and their expansive stained-glass windows through which light illuminated the house of God. Elina Gertsman writes about the importance of the cathedral windows in the transmitting light into dimly lit cathedral spaces, framing this as a crucial architectural choice for conveying the religious symbolism of transformative and purifying light¹⁷.

Even though I often encounter a reference to light within the conceptual framing driving the Eurocentric imperialist and expansionist discourses, I want to momentarily highlight the essential role of darkness as the medium through which the divine light of God was able to expand. Darkness and fear of the empty space it carries, horror vacui, is an essential metaphor in medieval Europe for establishing a playing field within which yearning for light becomes vital. It quite clearly reveals the desire to overcome darkness, perhaps move it “elsewhere”, and reminds us of the dire circumstances in Europe caused by the Black Death. The response to widespread economic and population crisis caused by the pandemic was a complete subjugation of women in Europe through more than two hundred years of witch hunts and the genocide of ninety five percent of the indigenous population in colonized Abya Yala, followed by the slave trade¹⁸. Darkness is until today a synonym of ignorance in the West, of the unknown, a space to conquer through the benevolent light of God and reason. During Bacon’s time, Christian Europe was undergoing a deep crisis, as described by Samuel Y. Edgerton in his book *The Mirror, the Window, and the Telescope*¹⁹:

“...Catholic Europe was not only without easy access to its sacred umbilical center but it was ravaged by other apocalyptic catastrophes, like the distressful schism in the Church when the papacy itself was torn apart by national rivalries, the devastating bubonic plague in which nearly a quarter of the

17 Elina Gertsman, *The Absent Image, Lacunae in Medieval Books* (Penn State University Press, 2021)

18 Federici, *Caliban and the Witch* (Autonomedia, 2014).

19 Edgerton, *The Mirror, the Window, and the Telescope* (Cornell University Press, 2009).

population of Europe perished, and the unnerving fear of militant, advancing Islam during the hundred-year siege of Constantinople and its traumatic fall to the Turks in 1453.”

Bacon left us one of the clearest articulations of the desire to reinvigorate Christian faith through scientific and technological progress, in order to counter the advancement of Islam and conquer Jerusalem “back”. He believed that through the study of the quadrivarium, the four mathematical strands of the Artes Liberales, and especially Euclidean geometry and perspective, the theory of light and vision, Christian leaders could renew enthusiasm for the Crusades. In a separate section of his principal treatise *Opus Majus*, written in the 1260s, Bacon wrote a part entitled *On the Value of Optical Marvels in Converting the Infidel*. In it he described how light rays reflected from a concave mirror can be used as giant “burning” mirrors to be deployed in warfare and burn enemy cities, or how the geometrical sciences can be used in religious representations and visual arts to serve the Christian project²⁰. The mirror, as we will see later, played an important symbolic role in medieval understandings of light and Christian faith.

Although the Church gradually lost power and influence after the Enlightenment, the Christian “reconquista” lived on just as Bacon would have wished – as light, which remained central to Western science and technology all the way into the digital age. Ironically though, the decline in ecclesiastical authority was entwined with the growing interest in the scholastic study of light, namely optics or Renaissance perspective, as we will see later. The more one looked, shining light into the darkness, the more Nature revealed itself in all its awe-inducing strangeness. A light that shone so brightly it penetrated bodies and scales, sidelining the Church’s position as mediator between human and God. Aptly, the term *perspectiva* was coined around the time *Kitab Al-Manazir* was being translated from Arabic to Latin and came from the Latin word *perspicere*, meaning “to see through”²¹.

Constructing a notion of space and constructing a notion of the body have been simultaneous and interdependent processes of world-building. It is difficult to think about morphology without considering the space

20 Daston and Galison, *Objectivity*.

21 Rozenfel' d and İhsanoğlu, *Mathematicians, Astronomers and Other Scholars of Islamic Civilisation and Their Works (7th-19th c.)*

in which forms are imagined. And although today there is a broad consensus regarding the configuration of space and its dimensions, this was not always the case. Painting traditions prior to the Renaissance demonstrate how space was represented before the invention of perspective, creating depth through hierarchical size, shadows, or overlapping forms. Many artists globally depicted objects more out of need or a personal preference, resulting in what we now call reversed (or divergent) perspective. Interestingly, this is the most intuitive approach for humans learning to draw, even though optics (since Euclid) had shown that the eye perceives distant objects as vanishing toward a horizon or vanishing point²².

The invention of linear perspective, even though likely known by the Greeks already, is usually credited to Filippo Brunelleschi around the year 1420. What he developed was a mathematical system of representation in which parallel lines converge towards a single vanishing point or horizon²³. A vanishing point towards which everything vanishes and the point from which all originates, a teleological projection of linear logic and the perfect supporting structure for the propagation of God's light illuminating from unity to divine beauty.

From this moment onward, Western art became distinctive for its use of linear perspective. Art from the global majority in which this method has not been adopted yet is judged as "naïve" by Western viewers until this day, irrespective of its sophistication and intricacy. This smug tendency, an unfortunately pervasive Western vice, originates from the belief that perspective is rooted in rational, scientific geometry producing a universally absolute realism. Such beliefs obviously lack historical grounding. Edgerton writes about the not-so-scientific advent of Brunelleschi's linear perspective, explaining²⁴:

"... Brunelleschi's mirror will be revealed as the key component signifying why he conceived of geometric-optical linear perspective in the first place, especially in the still profoundly religious ambience of medieval Florence. Brunelleschi employed the mirror for the same reason as expressed by Saint Paul in his famous First Epistle to the Corinthians 13:12, 'At present we see indistinctly,

22 "Mathematics - Geometry, Measurement, Topology | Britannica," December 13, 2025, <https://www.britannica.com/science/mathematics/Applied-geometry>.

23 "Linear Perspective | Definition, Examples, & Facts | Britannica," December 3, 2025, <https://www.britannica.com/art/linear-perspective>.

24 Edgerton, *The Mirror, the Window, and the Telescope*.

as in a mirror, but then [in heaven] face to face.’ Indeed, Brunelleschi’s remarkable achievement, as he first understood it, was not the opening of the door to secular observation of objective nature as has customarily been claimed, but ironically a last gasp of the spiritual Middle Ages.”

A detailed account of Brunelleschi’s mirror-based perspective experiments survives until today. It describes how he first painted the façade of the Baptistery in Florence and then drilled a small hole where the entrance door appeared. The viewer would peep through the hole from the back of the panel while holding a mirror in front of it. This way what could be seen through the hole was a reflection of the painted Baptistry. It is plausible that he drilled the hole at what he understood to be the vanishing point of the painting, but I must admit I prefer the gossip about his rivalry with Lorenzo Ghiberti, who had just completed the new Baptistry doors.

2.2.1 Constructing the Body as Ideal Space

Almost as important for the history of linear perspective as Brunelleschi was Leon Battista Alberti, his contemporary who also lived in Florence. Alberti is the one credited with popularising and further developing Brunelleschi’s ideas. In the Renaissance, the camera obscura saw little development, but Alberti constructed a luminous box, the *camera ottica*, which gets sometimes erroneously confused as one²⁵. Nevertheless, his most significant contribution to painting was undoubtedly his “window”, through which he approached perspective quite differently from Brunelleschi.

Alberti used a rectangular frame on which he stretched a grid of very thin strings, subdivided by parallel sections of ticker strings. He placed this frame, which he called *velum*, between himself and the subject to be painted so that “the visual pyramid penetrates through the thinness of the veil.” Although Alberti was well acquainted with Brunelleschi’s mirror method, he was, Edgerton argues, far more interested in “confronting directly the physical ‘here’ of the visual world ... and not its metaphysical reflection.”²⁶ Alberti proposed a cartographic method

25 Hammond, *The Camera Obscura, A Chronicle*.

26 Edgerton, *The Mirror, the Window, and the Telescope*.

of mapping the visual world onto the canvas by subdividing the object of representation with his veil-like geometrical coordinate system. This was a pragmatic decision, allowing the painter to lay out the composition without the need for scratching the figure or measuring from the horizon line or vanishing point²⁷. Edgerton further explains that Alberti's choice of a window, and his disregard of God's mirror, introduced, most inadvertently, a much more secular alternative to linear perspective. Alberti seldom mentions God or spirituality in his *Treatise on Painting* (1450) and instead alludes to the "visual world beyond the window" as owing its beauty to a numinous *Natura*, as if referring to a personified pagan deity rather than the Christian God. Nevertheless, Alberti remained undoubtedly devoted to Christian morals and stories, he simply approached them more historically. He was the first European Renaissance scholar to introduce classical Greek and Roman references into the visual arts, devoted to the idea of *historiae* and its heroic figures as an enhancement of Christian moral subjects²⁸. Most significantly, Renaissance painters did not take up Alberti's method with the same enthusiasm as he had proposed it, until it was rediscovered only a century later by Albrecht Dürer. Dürer described Alberti's window in his still-relevant *Treatise on Measurement* (1526), using it to introduce what he called the "transfer method". Alberti had inadvertently shifted the perception of space, giving Dürer fertile ground for imagination²⁹.



Albrecht Dürer, woodcut of an artist drawing with a perspective device based on Alberti's window, *Unterweisung der Messung*, 1526.

27 Siegert and Winthrop-Young, *Cultural Techniques*.

28 Anthony Grafton, *Leon Battista Alberti: Master Builder of the Italian Renaissance* (Allen Lane, 2001).

29 Georges Didi-Huberman and Drew S. Burk, *Being a Skull: Site, Contact, Thought, Sculpture* (University of Minnesota Press, 2016)

Leonardo Da Vinci had already conducted some preliminary anatomical studies, where he was particularly interested in the construction of the head and skull, and had the opportunity to access a dissected body to investigate its contents. In one of his famous depictions of the human skull, he methodically compares its cross sections to an onion, describing the stratification layer by layer but without assigning any hierarchies.



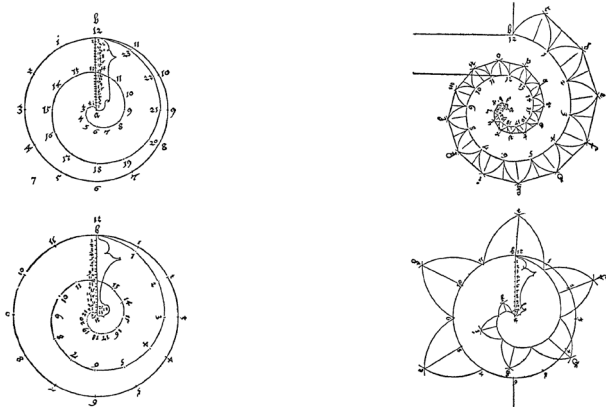
Leonardo da Vinci, The Cerebral Ventricles, and the Layers of the Scalp, *The Anatomy of Man: Drawings from the collection of His Majesty the King Charles III*, cca. 1489.

Leonardo's drawings remain quite simple and far from trying to explain the body as a set of organs, likely because in his time the body was still perceived as a holy unity in divine relation to God, who had supposedly made humans in his image³⁰. Humanist anatomy was a simple reflection of divine beauty and symmetrical perfection. The same can be observed in Dürer's anatomical figures, whose drawings and studies represent idealised bodies in various positions, often in movement³¹. Yet Dürer was different from his predecessors in a fundamental way – he was not at all interested in peeking inside the human body as Leonardo was. Instead, he relied on his vivid imagination and formidable drawing skills, which, combined with his transfer method, enabled him to construct whole

30 Katharine Park, *Secrets of Women: Gender, Generation and the Origins of Human Dissection*, 1. paperback ed (Zone, 2010).

31 Albrecht Dürer, *The Human Figure: The Complete "Dresden Sketchbook."* (Dover Publications, 1972).

new anatomical worlds without ever touching or smelling a corpse³². In his *Four Books on Measurement* (1525), he begins by introducing linear geometry and proceeds with constructing intricate spirals and other morphological forms in two dimensions using mainly Euclid and Ptolemy's methods³³.



Albrecht Dürer, The Spiral Line,
Four Books on Measurement, 1525.

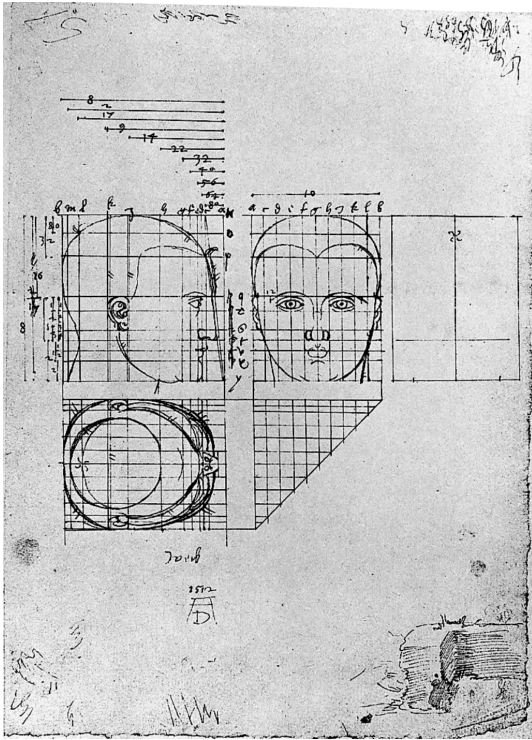
In his later work, the *Four Books on Human Proportion* (1528), he perfected the art of proportions and is still widely praised for constructing symmetrical mechanical bodies through mathematical order and reason – the highest values of the following Machine Age. But as Georges Didi-Huberman points out, that was not his most striking achievement. Rather, Dürer completely inverted the way we look, the way we see and perceive space. His anatomical representations shaped how any kind of body is represented to this day and were fundamental for the mathematical construction of intangible (molecular) worlds. Didi-Huberman makes an astute proposition by pointing out how Dürer's anatomical construction began with the head, just like Leonardo's. Quoting Dürer, he asks: "Indeed, what is it to 'invert [a head] around its foundation [fondement]' ... if not to invert the foundation of visibility itself? Namely, to invert the space that this visibility admits?"³⁴. To invert the head is to perform a function upon the world, to uproot its axis. So Dürer perhaps exerted the first cut between empirical excavation and the construction of an ideal model, unleashing the possibility of a humanly unattainable point of view. Almost a century before Isaac Newton and two before Immanuel Kant, small fractures in the emerging verge between subject and object can be traced within

32 Didi-Huberman and Burk, *Being a Skull*.

33 Andrey Polezhaev, "Spirals, Their Types and Peculiarities," *Spirals and Vortices*, The Frontiers Collection, 2019, 91–112

34 Didi-Huberman and Burk, *Being a Skull*.

his methodology. As I will explain in the next chapter, the disembodied view which Dürer proposed with his transfer method will become essential to the universalist proposition of Newtonian physics and the construction of spaces without humans³⁵. For now it is important to remember that, in contrast to modern optics, medieval optics always relied on an observer: it was a theory of vision and Dürer took a step beyond that.



Albrecht Dürer, The Head Constructed By Means of the 'Transfer' Method, *The Human Figure: The Complete Dresden Sketchbook*, edited by Walter Strauss, 1972.

From Leonardo's and Dürer's approaches it becomes clear how medieval and Renaissance conceptions of the holy delineated regions that neither darkness nor light were thought to reach – places where the human eye was not meant to linger. One such place was the space within: the site of being, the locus of the self. Dürer examined the human head only from afar, through an idea, since the interior of the head is inaccessible to oneself. And, as will become evident shortly, so too is the uterus—the place of *archē*, the origin of *telos*.

Andreas Vesalius, however, was too curious to be satisfied with imagination alone. He went to great lengths to take a good look inside the human body and its skull. By his time, dissection was less controversial than it had been earlier in the Renaissance, yet it was still approached with caution and often performed in private spaces rather than univer-

sities³⁶. Anatomical theatres were a perfect embodiment of this caution: dissections were staged in architecturally picturesque amphitheatres, as though an exotic geographical site were being explored. These theaters welcomed not only students and physicians, but also curious nobles and citizens, who gazed from afar, seated on elevated tribunes overlooking the central table. The cadaver lay upon an elevated marble or wooden table at the centre of the room, while the anatomist, an academic scholar who would never touch the body, stood beside it explaining each step. A barber-surgeon, from a lower class, performed the cuts and did the “dirty work”. Barber-surgeons were tasked with a range of services, from cutting hair to amputating limbs, bloodletting, or pulling teeth. It seemed logical at the time that anyone possessing a razor could be so versatile. Park writes in *Secrets of Women*³⁷:

“It took several centuries before university-trained physicians regularly opened human bodies themselves, rather than leaving the job to lower-status barbers and surgeons, but this had nothing to do with defilement by dead bodies or attempts to legitimate “polluting” activity. Rather, late medieval Christianity saw the human body as one of the principal elements connecting the natural and the supernatural worlds. Like the body of Christ, who died like a criminal, mutilated on the cross, or like the scattered bones of long-dead martyrs, the body was a conduit for divine grace.”

Physicians did not regard such tasks to be beneath them, as Park clarifies, yet the body nonetheless remained an ideal perfection; an anatomical excavation narrated as a kind of fantastic tale. There was, in this sense, no pressing need to touch, cut, turn, and disassemble: representation and theoretical explanation of the body-as-material were sufficient to control it, much as one might control the mechanical parts of a machine. Art historians suggest that these circular theatres, resembling small colosseums, symbolised order and harmony, mirroring the universe³⁸. The body was hence seen as a microcosm of the universe, an ideal space of perfect collaboration to be mastered through understanding.

36 Alix Cooper, “Homes and Households,” in *The Cambridge History of Science: Volume 3: Early Modern Science*, ed. Katharine Park and Lorraine Daston, vol. 3, *The Cambridge History of Science* (Cambridge University Press, 2006)

37 Park, *Secrets of Women*.

38 Jonathan Sawday, *The Body Emblazoned: Dissection and the Human Body in Renaissance Culture*, Digital Printing (Routledge, 2006).

It was within this context that Andreas Vesalius wrote his seminal *De Humani Corporis Fabrica Libri Septem* (1543), giving an incredibly detailed description of the human body and its organs³⁹. Establishing the anatomical canon that largely persists today, Vesalius could achieve such precision regarding the morphology and spatial arrangement of organs only because he performed the dissections himself. He dared to look deeper, uncovering topologies and cavities, tunnels and voids that together formed a complex human landscape. Yet properly representing these interiors still required imagination. What better technique, then, than Dürer's transfer method, combined with the technically refined practice of woodcut printing of his time? Vesalius did not draw the illustrations himself; he remained, first and foremost, a physician. The work is today attributed to Jan Stephan van Calcar⁴⁰. The woodcut that adorns the opening page of the *Fabrica* reveals much about the beliefs and epistemic concerns of the period, as one quite disturbing detail is worth emphasising: the woodcut depicts an anatomical theatre, a room full of men, and a single woman. The only female body lies on the table, her body the site of science. Park explains⁴¹:

“The precarious nature of fatherhood, and thus of the family itself, centered on the uterus, the dark, inaccessible place where the child’s tie with its father was created, its sex determined, and its body shaped. Generations of Italian medical writers, not to mention legal theorists, theologians, and natural philosophers, struggled to describe this mysterious process in terms that could ground kinship securely in patrilineal descent. Ordinary men and women, in the meantime, wrestled with equally pressing but more practical questions: Is she a virgin? Why can’t we (she) get pregnant? Is it a girl or a boy? How do I know the child is mine? The answers to all these questions lay inside the female body and, more specifically, inside the womb ... Understanding the secrets of women became one of the principal goals of fifteenth- and sixteenth-century medical writers, both because the topic was important in its own right and because it

39 Andreas Vesalius, *Andreae Vesalii Bruxellensis, ... De humani corporis fabrica libri septem*. National Central Library of Rome (apud Franciscum Senensem, & Ioannem Criegher Germanum, 1568)

40 Andreas Vesalius, *De Humani Corporis Fabrica* (Of the Structure of the Human Body), 1555, Woodcut, Overall: 15 9/16 x 10 1/2 x 3 1/4 in. (39.5 x 26.7 x 8.3 cm) page: 15 1/4 x 10 1/4 in. (38.7 x 26 cm), <https://www.metmuseum.org/art/collection/search/358129>.

41 Park, *Secrets of Women*.

was thought that anyone who could probe the complicated and mysterious workings of the uterus would have little trouble understanding the rest of the comparatively simple human frame. This is why the womb appears as a - arguably the - privileged object of dissection in medical images and texts.”

The female figure came to illustrate the anatomy of the interior body in general, as it was most often represented and modelled with an open uterus, in contrast to the male body, which was typically defined by its surface. Once again, the uterus becomes a site, a space of encompassing darkness that must be overcome by the light of divine knowledge. Yet this space remains unconquerable, and the female body becomes the keeper of the ultimate secret: an open abdomen marks the place where God ceases to exist, revealing the “true origin of human life.” All those men in the stalls of the Fabrica look down upon their own birthplace. And Vesalius, pointing toward the uterus, gazes back at the reader, confronting whoever dares open his book with the new reality he has “uncovered.”



Jan Stephan van Calar, Vesalius dissecting the body of a female criminal, *De Humani Corporis Fabrica*, title page, 1543.

My intuition would mark this as the humbling moment in which subject and object collapse into one, yet what occurred was quite the opposite. In a strange turn of events, the body became mechanical. René Descartes,

born only a few decades after the publication of the *Fabrica*, famously wrote of the mechanical body, attempting to describe its functions, including consciousness, through mathematics and geometry⁴². He was already aware that visual perception generates an image upon the retina of the eye, and he therefore concluded that humans do not perceive the material world directly, but only through inner images. The split between mind and body, which Descartes consolidated through his works, returns us to the concept of the camera obscura and its fundamental role in deepening the divide between the ideal and the material world. Or, as Descartes termed them, *res cogitans* and *res extensa*. In *De Homine (Treatise on Man, 1664)*, he introduced the concept of an immaterial mind (or soul) that governs the material body through the pineal gland of the brain, onto which images of the material world are projected from the eye⁴³. The division between a space governed by ideas and one governed by the mathematical laws of nature thus becomes evident. This description closely corresponds to the mechanisms of the camera obscura: Nature, the outside world, can only be perceived as a projection and never experienced directly. Encompassing the body of the viewer, it offers an image of the outside world in ever more mesmerising projections. The light phenomena described by Aristotle and discussed in the previous section evolved into the camera obscura and later into a new apparatus of vision. The physical barrier of the canopy gradually became a critical “in-between” space, from which a new science of the eye emerged, eventually growing into a rupture that detached and transformed into a portable extension of disembodied vision—the photographic camera.

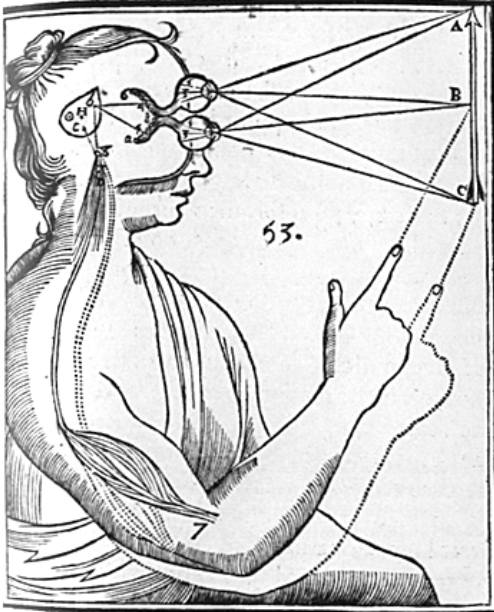
Descartes’ theory of the mind is known today in the philosophy of perception as one of the principal examples of “homunculus theories.” Such theories contain intrinsic fallacies: to argue for this explanation of the mind, one must imagine a homunculus locked within the walls of the mind, “looking” at the projected images in order for them to acquire meaning. This entails an infinite regress of homuncular observers, each nested within the next⁴⁴. The result is a permanent division between

42 Susan R. Bordo, *The Flight to Objectivity: Essays on Cartesianism and Culture* (State University of New York Press, 1987)

43 Theo Verbeek and Erik-Jan Bos, “Treatise on Man,” in *The Cambridge Descartes Lexicon*, ed. Lawrence Nolan (Cambridge University Press, 2015)

44 Victor Caston, “Aristotle and the Cartesian Theatre,” in *Encounters with Aristotelian Philosophy of Mind* (Routledge, 2021).

mind and body, the latter reduced to an entity governed by the same physical laws as inanimate machines: an automaton.



Rene Descartes, Body-mind dualism and the role of the pineal gland, *De Homine*, 1664.

In the years following Descartes, such ideas only deepened the divide between subject and object, as they served the colonial and institutional purposes of the time all too well. Men would not concede to their material nature; instead, they chose to align their mortality with machines, devising further justifications to assert human, specifically intellectual, power over nature. Yet anatomical theatres made man keenly aware of their proximity to death, as the ephemeral corpses on the stage decayed all too quickly. Thus the body was moved from the dissecting table to the display case, as if to declare: “We looked into it, and now we understand it. Long live our understanding!”. To preserve such knowledge, the body needed to be idealised and immortalised, and so it became a model. Anatomists became artists, sculpting exquisitely detailed corpses in wax and creating a lasting visual performance of the ephemeral body. Almost paradoxically, the dissection of at least two hundred bodies was required to mould each wax figure into perfection⁴⁵. These were the forgotten bodies of Western science – women, criminalised bodies, enslaved individuals, heretics, and foreigners.

The wax models lead us back to Florence, where Brunelleschi had transformed the Western gaze through linear perspective several centuries earlier, but also to Bologna, one of the most important centres

45 Monika von Düring et al., *Encyclopaedia Anatomica: A Complete Collection of Anatomical Waxes = Vollständige Sammlung Anatomischer Wachse*, with Museo di storia naturale (Taschen, 1999).

of anatomical wax modelling. La Specola in Florence, founded in 1771, housed the idealised body as a stable object of scientific truth, exemplified by Clemente Susini's Anatomical Venus. The female subject is presented as a model of perfect motherhood, a celebration of fertility. Its predecessor, the Anatomical Museum in Bologna, commissioned in 1742 by Pope Benedict XIV "the Enlightened", reveals a fervent entanglement of scientific and ecclesiastical practices. Vasalius's *Fabrica*, as an atlas of the body, materialised here into wax models: a frozen anatomical ideal of the universal human body as divinely ordained. Ercole Lelli's wax figures of Adam and Eve, commissioned by the Pope, further demonstrate the extent to which cultural assumptions about gender shaped anatomical representation, while simultaneously reminding visitors of their own mortality. The trope of Eve as the disobedient sinner is rendered through her exaggeratedly penitent posture; her hair and hand partially cover her naked body in shame. Lucia Dacome describes Lelli's works displayed in Bologna⁴⁶:

"Naked, ashamed, and distressed, the statues of the anatomy room presented visitors with an anatomical dramatization that evoked the consequences of the Fall: while acquiring knowledge about anatomy, viewers were called to mourn the condition of mortality affecting post-lapsarian humanity... By the mid-eighteenth century, stories of the Fall had extensively populated anatomical literature, staging a recognizable narrative of transience and mortality that helped to orchestrate audiences' affective responses."

Such narratives of mortality and *memento mori* elevated the importance of medicine as a divine remedy for the frailty of humanity after the Fall. It is within this context that the anatomist Anna Morandi emerged as a significant contributor to anatomical epistemology, playing a crucial role in reclaiming the female figure within the anatomical domain. She worked primarily on highly precise wax models designed for didactic purposes, aiding practitioners in understanding the mechanisms of the human body. In particular, she focused on presenting the functions of each anatomical element in relation to childbirth, with the aim of facilitating safe delivery and preventing complications for the mother⁴⁷.

46 Lucia Dacome, *Malleable Anatomies: Models, Makers, and Material Culture in Eighteenth-Century Italy* (Oxford University Press, 2017),.

47 Rebecca Messbarger, *The Lady Anatomist: The Life and Work of Anna Morandi Manzolini* (University of Chicago Press, 2010),



Anna Morandi, Preparato ostetrico, *Museo di Palazzo Poggi* (MPPOS024) 1755 - 1774.

Some of Morandi's most notable works belong to the *Suppelex Obstetricia* collection, commissioned by Antonio Giovanni Galli's School of Obstetrics. In these models, she examined the stages of childbirth with minimal idealisation. Her figures were not intended to be contemplated as spectacle; rather, they were tools for deepening anatomical knowledge and for educating midwives and surgeons in female anatomy. This approach stands in stark contrast to that of many of her male contemporaries, whose models often perpetuated dichotomies such as "healthy" versus "abnormal" pregnancy⁴⁸. Giovan Battista Sandi's works, for example, frequently present sanitised and pristine visions of parturition and intrauterine life. Some even incorporate explicit Christian symbolism, warning midwives of the sanctity of the unborn child, who, if dying before baptism, would be condemned to eternal limbo.



Giovan Battista Sandi, Preparato ostetrico, modello di utero, *Museo di Palazzo Poggi* (MPPOS054-med) 1746–1750.

48 Dacome, *Malleable Anatomies*.

Darkness had long enveloped only perfectly uniform celestial and human bodies, in accordance with Christian ideals and Aristotelian morphology. A particularly evocative articulation of this perception of celestial bodies is Dante's aforementioned "eternal pearl" moon in *Paradiso*, Cantos II–V of the *Divine Comedy*. The moon, imagined as a perfect sphere, also functioned as a symbol of the Virgin's Immaculate Conception in Christian Europe, alluding to the incorruptible nature of the universe created by God⁴⁹. Universal perfection and harmony thus extended from the celestial realm to the anatomical theatre and were preserved in the wax bodies of anatomical models. Photography would soon alter this vision irrevocably, yet the marble-like beauty of anatomical waxes remains one of the most striking testaments to the Christian epistemology that governed Western science, its models, and its bodies.

The modern history of objectivity is closely tied to the dissolution of universals. Counterintuitive as it may seem from a contemporary perspective, the universal subject, as we have seen, was long "marked by the beauty of its perfect symmetry."⁵⁰

Only later, as photography became increasingly accessible and widely used for scientific purposes, did the model of a perfect, symmetrical universal object or body begin to erode. This transition unfolded gradually, as sciences beyond physics and mathematics gained prominence. The modern body that emerged is fundamentally imperfect, irregular, and marked by specific traits far removed from symmetry.

Daston and Galison describe this shift toward a notion of objectivity and a "science of looking," emphasising the role of atlases in how science was, and continues to be, practised since the sixteenth century. They explain how eighteenth-century atlas-makers looked beyond the surfaces of plants, bones, and crystals in order to construct their underlying universal forms, believing that nature's truth was best represented in this manner. Such early atlases served to unify and standardise Nature, eliminating the individuality of observed entities in favour of general forms that could be collectively studied and understood by a community of practitioners⁵¹. A shift to a modern understanding of

49 Edgerton, *The Mirror, the Window, and the Telescope*.

50 Daston and Galison, *Objectivity*.

51 Daston and Galison, *Objectivity*.

objectivity happened only in the nineteenth century. Photography did not inaugurate mechanical objectivity, but it significantly promoted it. Throughout this discussion, it has been evident that the light of God functioned as a vehicle for an emerging European tradition grounded in vision as an operation of knowledge. We have explored how the notion of darkness was fundamental to the construction of space within which unknown objects could be conquered through the illumination of divine knowledge. Methodologies of spatial representation developed by Alberti and Dürer paved the way for subsequent thinkers who, like Descartes, believed that the material and the ideal worlds were fundamentally separate.

This division between body and mind would only later be translated into a division between subject and object, most notably through the philosophy of Immanuel Kant. The body is thus left behind in the fleeting realm of the mechanical and the material, a shift that led, among other developments, to the emergence of theories of race and eugenics (discussed elsewhere, tba).

As the following chapter will demonstrate, Newton played a major role in consolidating the ideas of the post-revolutionary mechanical age through the persistence of universalist principles – a period in which Western humanity sought to play God and, in doing so, unleashed the chaos of the cosmos.

2.3 Dissecting models of Space

While many arts and sciences of the Enlightenment were deeply concerned with questions of light and vision, discoveries such as the telescope and the microscope opened up much broader, and perhaps metaphysical, questions regarding time and space. Just as human life was irrevocably changed when Adam bit into Eve's apple, Newton was supposedly blessed with God's laws of nature when an apple fell upon his head. Or so the story goes. I wonder whether Newtonian mechanics might also be understood as a function of space in the Garden of Eden. I am sure Sir Isaac Newton believed so, because the laws he described in his *Principia* (1687) were conceived as universal, extending from the

stars to any moving body. Even today, after years of molecular studies, it remains difficult for me to imagine a world that functions otherwise. This is largely because we still tend to represent and idealise molecules, their structure and interactions, within Newtonian terms. When dealing with bodies, it is often hard to imagine their environment as governed by forces other than gravity, and so we frequently represent them as if they were floating in the darkness of outer space. It is the same darkness that once encompassed everything and was brought to life through the light of God, only now it inhabits a three-dimensional space and is conceptualised as nothingness, or vacuum. But as the saying goes, “nothing ever happens in a vacuum.”

Newton’s link between mass and motion could never have been formulated without a mathematical basis for describing the space in which an object is situated. His ideas gained wide acceptance at a time when the feudal system was crumbling and the newly industrialised societies of Western Europe were searching for new forms of order in the aftermath of revolution. Newtonian principles were easily transposed onto this emerging social reality: individuals living together like celestial bodies, peacefully following the law of gravity within their orbits, their interactions describable as differences in attraction or repulsion⁵². *Liberté, égalité, fraternité*. Body and nature alike became mechanical systems governed by simple deterministic laws—laws few seemed inclined to question. If nature was mechanical, it was sufficient to understand how its mechanisms functioned, to measure its parts, and to manipulate them without needing to comprehend them fully. If God was no longer the rational principle behind Nature, Immanuel Kant concluded, then it must be the human mind that generates phenomenal order. Another level, which he called the noumenal, remains inaccessible to human reason and cannot be experienced independently “in-itself”. We can recall the metaphor of the camera obscura and the experience of images inside the brain as mere projections of reality. Kant thus sentenced humanity to eternal ignorance, as for him the transcendental horizon could not be overcome⁵³.

52 Morris Kline, “Mathematical Contributions in the Renaissance,” in *Mathematical Thought from Ancient to Modern Times*, ed. Morris Kline (Oxford University Press, 1990).

53 Immanuel Kant, *Critique of Pure Reason*, ed. Paul Guyer and Allen W. Wood, *The Cambridge Edition of the Works of Immanuel Kant* (Cambridge University Press, 1998),

During a conversation with one of the heads of department at my previous research institute several years ago, we debated the motivations driving researchers in STEM fields. What began as a discussion of the widespread belief that science provides humanity with access to the truth of nature soon revealed its shortcomings. Such a formulation seemed to render science analogous to a religion, something we all agreed was not the point. There is, in fact, a level at which science grants access to reality without requiring faith or belief. Our role as scientists felt closer to that of listeners and narrators. After a lengthy exchange about objectivity, the professor paused and concluded that, ultimately, the driving force of scientific research is its applicability. We seek to understand how things work so that we may shape and use them “for a greater good.” Science and technology, he argued, are ultimately propelled by progress.

Descartes was the thinker who imagined the space within which the reciprocal dance of bodies Newton imagined could unfold harmoniously. In his *Discourse on Method* (1637), he included an appendix entitled *La Géométrie*, in which he combined al-Khwarizmi’s algebra with Euclid’s geometry to propose the Cartesian coordinate system. Within this framework, algebraic equations were used to describe geometric forms, thereby conceiving a space in which objects could move. Although calculus existed in ancient mathematical traditions—including those of Egypt, Greece, China, the Islamic caliphates, and India—Leibniz and Newton are typically credited with its independent development on the basis of the Cartesian system⁵⁴. Leibniz, it must be acknowledged, devoted significant effort to refining the notation still in use today. Calculus became the language of classical mechanics, through which the world was described as a homogeneous space of solid surfaces, where time could be reversed and every corner of the cosmos illuminated by the light of God’s wisdom⁵⁵.

The classical deterministic worldview finds its most compelling

Cambridge Core.

54 Morris Kline, *Mathematical Thought from Ancient to Modern Times* (Oxford University Press, 1990).

55 Martin Davis, *Engines of Logic: Mathematicians and the Origin of the Computer* (W. W. Norton & Co., Inc., 2001).

expression in *Laplace's Demon* (1814), a hypothetical construct proposed in his essay on the mathematical theory of probability. Conceived within a universalist cosmology, Laplace imagined an intellect capable, at a single moment, of knowing the position and momentum of all entities in nature. If such an intellect existed, nothing would remain uncertain: the entire future could be predicted and the entire past retrodicted⁵⁶. This all-seeing demon reveals several key assumptions underlying deterministic conceptions of space and time. First, time is understood teleologically, as a sequence of events in which each is the necessary consequence of the preceding one, governed by Newton's laws. Perpetuum mobile. Second and more troubling, especially in the contemporary age of artificial intelligence, is the belief that with perfect information and sufficient computational power, all events could be known in advance. This assumption implies that randomness is merely a consequence of human ignorance: a residual darkness not yet illuminated by knowledge. Laplace's Demon remained a plausible thought experiment well into the industrial age, even as the steam engine began to erode the ideal of universal perfection. Newtonian mechanics could explain the motion of a steam engine's valves, but not the transformation of heat into motion. Heat appeared to harbour an unknown force, one not fully governed by classical laws. The nineteenth century, the Age of the Machine, accelerated curiosity about the atomic world. Early theories of thermodynamics, still based on Newtonian mechanics, struggled to describe these complex systems, composed of unimaginable numbers of particles moving chaotically under thermal pressure⁵⁷. Boltzmann dreamed of becoming the Newton of heat, yet what he ultimately produced initiated a profound reconfiguration of space at a cosmological scale. Classical mechanics is fundamentally space-bound, but the atom cannot be conceived as a site—it is a probability. Isabelle Stengers and Ilya Prigogine, prominent critics of Newtonian universalism and proponents of complexity theory, write⁵⁸:

“Where classical science used to emphasize permanence, we now find change and evolution. Time has penetrated not only biology, geology and the social sciences, but also the two levels from which it has been traditionally excluded,

56 Prigogine and Stengers, *Order out of Chaos*.

57 Marko Popovic, *Researchers in an Entropy Wonderland: A Review of the Entropy Concept*, n.d.

58 Prigogine and Stengers, *Order out of Chaos*.

the microscopic and the cosmic. Not only life but the universe as a whole has a history.”

What the authors describe is a gradual dissolution of classical space brought about by discoveries rooted in Boltzmann’s probabilistic analysis of complex systems. Furthermore, the light of Western science, which shined bright from God through Galileo’s sacrilegious tube all the way into the 20th century, proved to be both particle and wave. Quantum mechanics emerged in the early twentieth century as a response to profound inconsistencies between classical physics and experimental observations at atomic and subatomic scales. Classical mechanics and electrodynamics, which had successfully described macroscopic phenomena, failed to account for phenomena such as blackbody radiation, atomic spectra, and the stability of atoms⁵⁹. The development of quantum theory marked a fundamental shift in the understanding of nature, introducing probabilistic laws and challenging classical notions of determinism. The origins of quantum mechanics are conventionally traced to Max Planck’s work in 1900 on blackbody radiation. In order to reproduce the observed radiation spectrum, Planck proposed that energy is emitted and absorbed in discrete units, or quanta, proportional to frequency. Although initially introduced as a mathematical device, this hypothesis laid the foundation for a new conception of physical reality. In 1905, Albert Einstein extended the quantum idea by explaining the photoelectric effect through the quantization of light itself, suggesting that electromagnetic radiation behaves as particles later called photons. Further progress came from the study of atomic structure. In 1913, Niels Bohr proposed a model of the hydrogen atom in which electrons occupy discrete energy levels and emit or absorb radiation during transitions between them. But the decisive formulation of quantum mechanics occurred in the mid-1920s. Werner Heisenberg developed matrix mechanics in 1925, emphasizing observable quantities and abandoning classical trajectories, while Erwin Schrödinger introduced wave mechanics in 1926, describing physical systems through wave equations. Despite their different mathematical forms, the two approaches were shown to be equivalent. Max Born subsequently provided the probabilistic interpretation of the wave function, asserting that it encodes

59 Roger Penrose, *The Road to Reality: A Complete Guide to the Laws of the Universe*, 1st Vintage Books ed. (Vintage Books, 2007).

the likelihood of measurement outcomes rather than deterministic predictions. Now this was crucial for the formulation of Heisenberg's uncertainty principle, which established fundamental limits on the simultaneous knowledge of certain physical quantities on the quantum level. These findings finally disproved the possibility of there ever existing an all knowing entity such as Laplace's Demon. These ideas were consolidated in the so-called Copenhagen interpretation, largely associated with Bohr and Heisenberg, which emphasized the role of measurement and rejected classical realism at the quantum level.

Even though Einstein would persistently disagree with such an interpretation, he did contribute, maybe involuntarily, to what became anti-universalist notions.

When he presented his paper dealing with general relativity in 1917, he was trying to form a cosmological model which presented a static, timeless view of the universe. But not much later Hubble and his coworkers showed that the distance and velocity of far away galaxies were proportional, adding to Friedmann and Lemaitre's discovery of the expansion of the universe⁶⁰. The universe was set into motion, accelerating. Newtonian physics can claim a position of universality which penetrates all scales and describes all objects, exclusively because it is not a relative principle. It presupposes the universe is a scalar sliding scale of perfectly uniform space. Newton did not attempt to describe gravitation, he presented it as a law, a rule which everything and everybody simply follows⁶¹. But Galileo had followed an intuition already in 1638 by performing his lantern experiment under the impression that light might have its own velocity. His instruments did not permit its detection at the time, but a few mirrors and eclipses later, it became clear light travels at a constant speed⁶². By the late nineteenth century it was widely understood that light was an electromagnetic wave. One of the first proponents of this idea was Leon Foucault who, in the middle of the nineteenth century, managed to measure the difference in speed with which light traveled through air and water⁶³. This was the moment Newton's corpuscular

60 Penrose, *The Road to Reality*.

61 Prigogine and Stengers, *Order out of Chaos*.

62 Alex Ely Kossovsky, "Galileo's Work on Sound and Speed of Light," in *The Birth of Science*, ed. Alex Ely Kossovsky (Springer International Publishing, 2020)

63 "Léon Foucault | Inventor, Experimenter, Demonstrator | Britannica," November 11, 2025, <https://www.britannica.com/biography/Leon-Foucault>.

theory started coming apart. James Clerk Maxwell delivered the final blow in what is today regarded as the second unification in physics, demonstrating that optical and electromagnetic waves propagate at the same constant velocity (electrodynamics). His derivation of the electromagnetic wave equation yielded the constant $c = 3.0 \times 10^8$ m/s, imposing a new limit that shattered the God's-eye universality of classical mechanics. A distinction between high and low velocities on different scales became an inevitable reality. Additionally, Planck postulated a constant which set a scale for any object's mass by introducing the concept of quanta, as mentioned above. Consequently, electrons ceased to exist as little particular planets which follow the same laws as the celestial bodies. The homogeneity of the cosmos became yet another model in need of dismantling.

Twentieth-century science transformed the world into an intricate dissipative structure embedded in a complex and locally unreal reality. The foundational layer of nature once believed to constitute reality itself became increasingly inaccessible to experimentation. It appears that God does, indeed, play dice, and we have yet to learn the rules of the game.

3. DESCRIPTION OF THE ARTISTIC WORK

3.1 SCULPTURE: The universal object

The sculpture installation is composed of two elements:

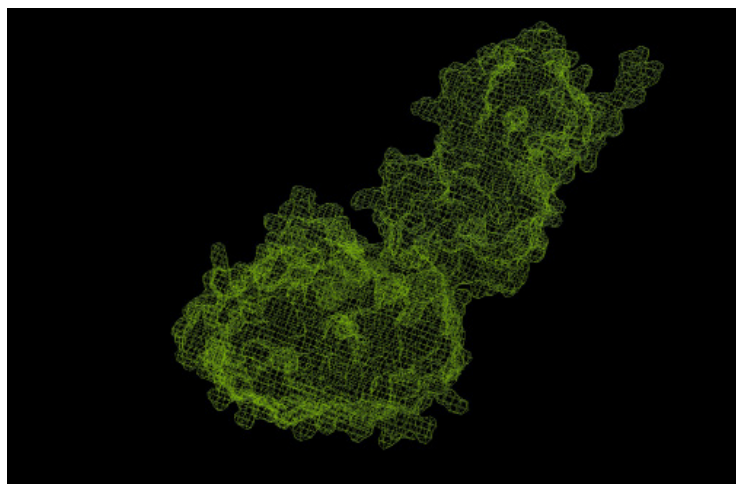
1) An upscaled model of the accessible surface area (ASA) model of the protein calcineurin. ASA is used to calculate how energetically favourable it is to transfer a molecule to a new solvent. Usually, the molecule is transferred from a water-based solvent to a non-polar solvent, which might aid the crystallisation process for following diffraction. The ASA model has a function, it is not only a representation.

I sculpted the positive in clay using the digital model as a reference.

I subsequently applied a silicon layer to the whole surface and covered it in a plaster armour, thus creating a mold of the negative form.

If we assume my human scale sculpture has a size of about 100x50x40 cm and the protein itself a size of about 91.66x51.21x35.07 Å, then the sculpture is a 10^{10} upscale of the biomolecule.

The protein wax model references the wax figures of the anatomical collection first shaped in La Specola, Firenze, in the second half of the 18th century, during the Habsburg rule. The ceroplastic models are the materialisation of a particular time, when the idea of the body, and so the body itself, transitioned from being a universal sacred entity to a functional machine, an intricate system of flesh and veins, cavities and spaces. An object to hold. But also a spatial dimension, a landscape to be explored like a geographical site. God slowly (and seemingly) slipped away under the scrutinous gaze of reason.



ASA grid model of calcineurin (PP2B). Visualised in Pymol (PDB: 1AUI)

2) A series of hands as a reinterpretation of the Durer's praying hands drawing, which is one of the most distributed and reproduced representations of hands. For Descartes, the hands have a direct connection to knowledge and perception of the material world. Some centuries after he drew his famous conclusions on the link between the pineal gland and the hands as a tool to "make sense", the digital world, attempting to transfer human senses to a digital body, bases the first digital user interfaces on the connection between hands and eyes.

Hands are that part of the body which we most identify through.

Working hands, praying hands, nurturing hands.

My wax praying hands are a feminine reinterpretation of Durer's drawing, signifying the hands of a nurturing mother through the open position of the palms. A conceptual connection is created between the technical and methodical way in which Durer approached his subjects and the caring hands of Anna Morandi, the lady anatomist who casted her own hands as a self-portrait. In a gesture of appreciation, I present my self-portrait through performatively repeating her action and casting my own hands in wax.



Clemente Susini, Anatomical Venus, *Museo La Specola Firenze*, 1782.

Both sculptural elements, the protein model and the praying hands, are cast in wax, as this is a material of fundamental importance. In his

essay *Wax Flesh, Vicious Circles*, Didi-Huberman explains⁶⁴:

“Wax also “moves” in the sense that it permits the inscription, the duplication, the temporal as well as spatial displacement of the forms which impress themselves into it, transforming, effacing, and reforming themselves infinitely. Which is why, from Aristotle to Freud, this material has provided the privileged metaphor of the work of memory, and even of sensorial operations in general. But still more, wax “moves” in the sense that it “upsets.” The unstable material par excellence – if stability is understood as the fixed character of qualities – wax presents a disconcerting multiplicity of physical properties. It seems to be a substance unconcerned by the contradiction of material qualities:... “

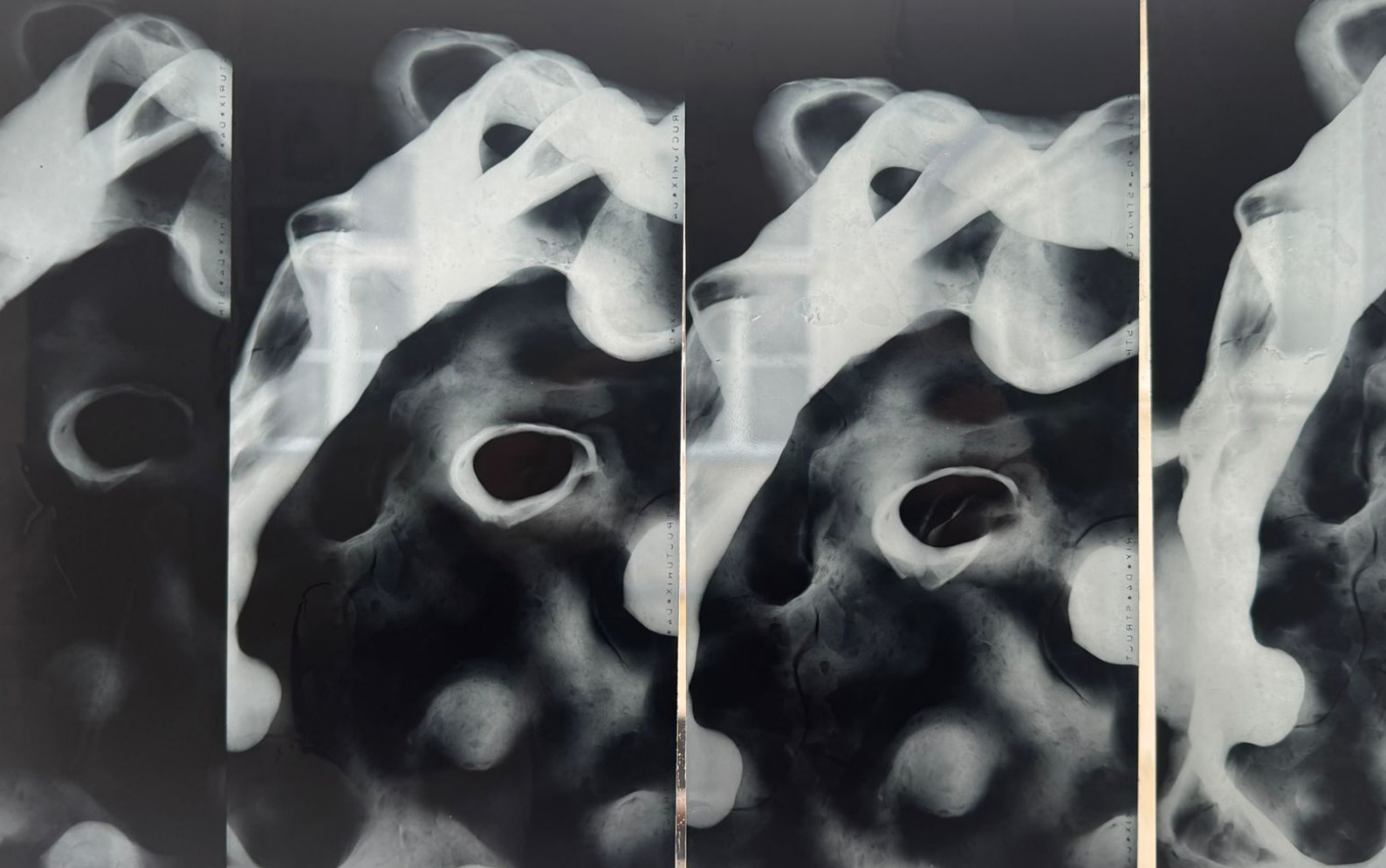


Albrecht Dürer, *Praying Hands*, *Albertina Museum, Vienna*, 1508.



Anna Morandi, *Preparato anatomico coppia di mani*, from the archive of *Museo di Palazzo Poggi (CECOMA 126)* 1755 - 1774.

64 Düring et al., *Encyclopaedia Anatomica*.



3.2 IMAGE: The objective subject

As technologies of the image became more and more accessible, scientists at the end of the nineteenth century started to use cameras as a technology of observation for their experiments. It soon after became clear that the idealised representations of nature brought about by renaissance thinkers were nothing but misunderstandings. Nature was far more chaotic and random expected. So as the camera replaced the eye, the body of the scientist and its faulty perception became a redundant obstacle to the scientific cause.

The disillusionment following this understanding made it clear that there is no unified idealised object and nature is rather an assemblage of particular, ambiguous and completely random shapes and circumstances. Particularity became the primary interest of scientists, which attempted to capture all the anomalies of the outside world through their lenses. But when it came to the human body, the particularities became aberrations and pathologies. Distortions, deformations, rare diseases, genetic conditions. And just as the body became an object of science, so became the mind.

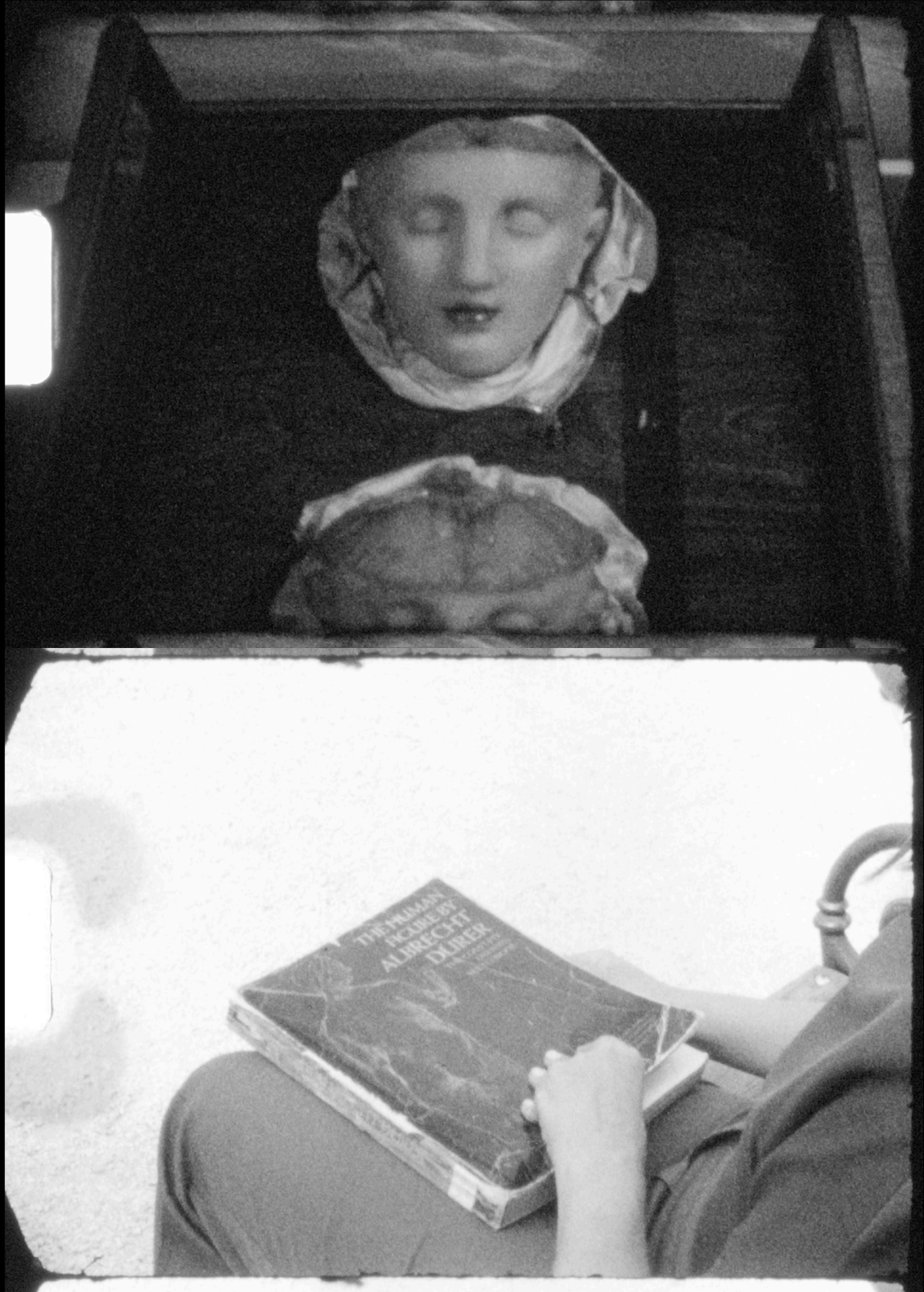
The skull holds the spirit, the essence – it is the site of being itself. As psychoanalysis tried to tap into the abstract aspects of the mind, anatomists used newly developed technologies like X-rays to look, for the first time, into the black box of a living, breathing human with an intact skull. A ghostly and uncanny experience, when what appears on the image is an empty skull, soulless. The deed was done, the mechanical body was finally separated from the subject and his mind.

The objective subject is a large analog print of an Xray scan hanging from the ceiling.

The image depicts an Xray scan of the mold negative which I use to pour the sculpture of the protein. The inside lining, made out of silicone, feels like a skin. Its shape reminds of the intricate folding landscape of the brain and the protective plaster resembles a skull.

For me, the protein is an intelligence, a parallel mind, and not only a geometrical construction within my models.





3.3 VIDEO: Found in Translation

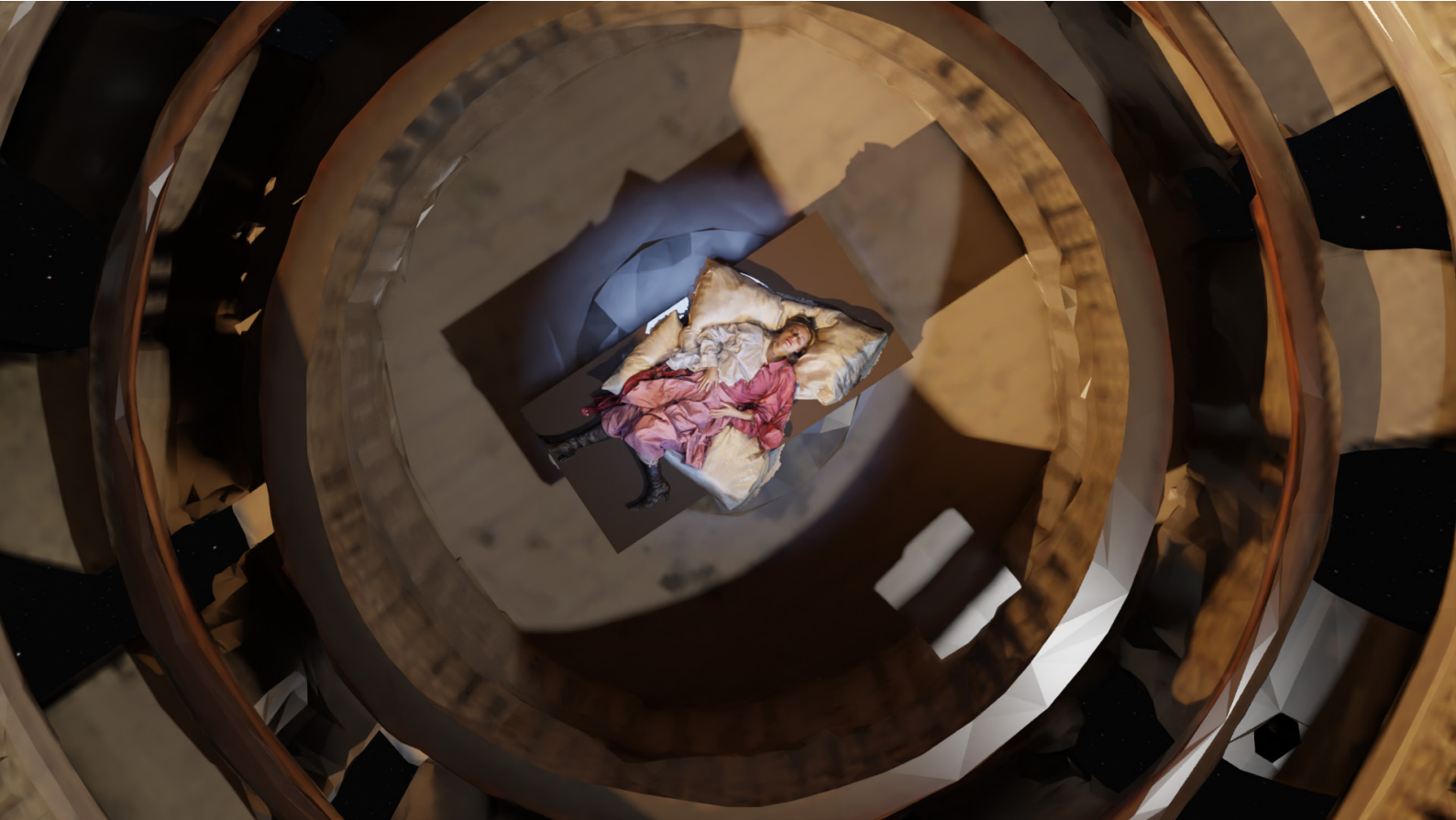
Psychoanalysis had a major influence on scientific narratives in the 20th century, shifting the discourse on objectivity and allowing the scientist and their mind to partly partake in the experimental process again. The unconscious became an important part of the scientist's genius, and only deep knowledge could allow a mind to produce—often seemingly at random—an informed, brilliant idea. The myth of the genius individual in an increasingly individualistic society spread like wildfire within the scientific community. And geniuses were known to have been, predominantly, white men.

R. Barthes

Even if it briefly seemed **that** our individualistic society had abandoned metanarratives and put an end to collective empiricism, the ghosts of past values and paradigms continued to lurk within present practices and processes. Science became so abstract and inaccessible that the metanarrative of science itself has been slowly falling apart. What does it mean to do science today, when our models are centered on uncertainty? What can we learn from tracing the history of such models—histories that deeply involve perceptions of the self and inevitably engage and encompass our bodies?

But also: which bodies were used to construct the scientific models and paradigms we still believe in today, and why are these bodies omitted, hidden, from dominant narratives and histories? How do we reclaim these bodies from lingering in the darkness like ghosts?

I give voice to Chantal, a wax model, and to her anatomist, Anna Morandi, to tell a sapphic story of care and intimacy. A fictional love serves as a vessel for actual historical events. The narrative is informed by my own encounters with the protein model I solved during my experiments as a biochemist and later sculpted, as seen in **the images above**.



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