THEORY

"Science is a tool to think with, just like art..." This publication contains transcriptions of conversations between the artist Alexandra Hunts and Charles M. Marcus, professor in Condensed Matter Physics at the Niels Bohr Institute in Copenhagen. Roland Barthes famously wrote: "Interdisciplinarity consists in creating a new object that belongs to no one." This epistemological homelessness echoes through both Hunts' and Marcus's immigrant condition, and the histories of 20th-century art and science.

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Theory is a form of organized estrangement from dominant values

– Rosi Braidotti

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ALEXANDRA HUNTS CAN'T YET SEE

Art Hub Copenhagen

ALEXANDRA HUNTS
Can't Yet See

FOREWORD

In 2019 Ukrainian-born, Amsterdam-based artist Alexandra Hunts took up residency at Art Hub Copenhagen in the thematic studio program “Life in the Future of Science and Technology,” and she started to do research on the city in which she was a temporary denizen. Having worked in the past with Leiden University and other scientific institutes, she came across Copenhagen’s prominent place in the history of quantum physics. Although it is as arcane as any modern science, quantum physics left a deep impression on the history of consciousness of the 20th century with Einstein’s relativity theory and Bohr’s philosophy-physics. Today a thinker such as Karen Barad – author of another of our publications – has renewed the relevance of the field, also for the arts.

Through a friend, Hunts was introduced to Charles M. Marcus, professor in Condensed Matter Physics at the Niels Bohr Institute in Copenhagen. The two met over coffee, “and I tried to do my best to ask interesting questions,” as Hunts puts it. During subsequent visits to the Institute she started recording her conversations with Marcus, and at the end of her residency the two of them gave joint performances at Art Hub Copenhagen and at Kunsten in Aalborg. The present publication contains transcriptions of the exchanges they had on these occasions, in which ideas were bounced and tested and cross-referenced on the subjects of – among other things – borders and voids, identity and the absolute, and the volatile but indelible nature of information. Hunts’ interest in quantum physics is motivated by her experiments with what she terms *material as philosophy* in her work with photography, installation, and sculpture. In her own words, “Science is a tool to think

with, just like art." In this spirit, her conversations with Marcus exemplify what interdisciplinarity can yield: not necessarily with a view to solve problems – when art is in the mix we are relieved of that expectation – but rather to build different orientations in the world. To Hunts, interdisciplinarity is about more than going beyond one's own sphere of expertise, and it also exceeds an integration of knowledge. Instead she sees it as a triangulation, a thinking-together on a topic that is of mutual importance to the fields concerned, and to the surrounding society. A kind of *Wechselwirkung* between disciplines that reaches into social space and makes its mark on all subjects and entities involved.

This diffraction of disciplinary integrity can reveal tangles of histories and materials, call to account habitual ways of thinking, and make us see the bigger pictures – as well as the fragility of systems and structures, whether epistemological or social. The current war in Ukraine looms in the background of Hunts and Marcus's conversations, and the immigrant condition – that feeling of "not belonging," as Hunts phrases it, that is shared by Marcus and herself – is also an undertow. Roland Barthes famously (and wonderfully) wrote that "Interdisciplinarity consists in creating a new object that belongs to no one." You might say that Hunts and Marcus's immigrant condition echoes the epistemological homelessness that Barthes sees as the creative aim for interdisciplinarity.

Art institutions and the humanities have widely acknowledged interdisciplinarity, to the point that the notion today is business as usual. However its institutional reality is often less open-armed than it is typically declared to be, and barriers (formal, conceptual, political) remain in place to protect the bounds of knowledge.

To be sure, there are good reasons for safeguarding knowledge production in our time of post-truth manipulation of information and occasional hostility to scientific research, including from the side of governments. For interdisciplinary co-creation to prove itself necessary, there must be an acknowledgment both of the inherent limitations to disciplines' ability to make sense of the world, and the relevant difficulties in the exchange between them. How else could you achieve that feeling of not belonging, of being out of your depth with what you know in relation to the most compelling problems in the world?

A dialogue in which both sides play with their hard-won specialization and professional intuitions with a receptivity to uncertain outcomes is made possible by a scholarly ethos that resists the tendency of disciplines to reproduce themselves, as much as by styles of thinking based in serendipitous attitudes and personal rapports. When interdisciplinary dialogue ignites it is about radical stuff – about how we understand things, how we can communicate about them, and the adventure of sharing readings of reality from points of view that at the outset may have seemed widely different or even alien to one another. "We are alive because we're not in equilibrium," Marcus comments at one point in the following pages. Surely the lack of equilibrium is a condition of possibility for art, too, and for the creation of new sense-making and knowledge.

Lars Bang Larsen
Director of Artistic Research,
Art Hub Copenhagen

Untitled, Lviv, Ukraine, from Alexandra Hunts' personal archive, 2020.

EVERY PARTICLE NEEDS AN ANTIPARTICLE. (CONVERSATION WITH THE SELF)

PARTICLE:

What shapes us? Are we shaped by the past that constantly influences our present? Or is it information and knowledge that change our ideas of who we are? Can we understand ourselves in the present? What determines us, that pure state of ourselves?

ANTIPARTICLE:

By answering this question you might want to start with: "Where am I from?" I was born in 1990 in Ukraine, when it was still part of the USSR. It became independent the following year, in 1991. Later on, I moved to the Western part of Europe.

Today Ukraine, a country that is just three decades old, is once again fighting for its right to existence. That journey of thirty years, from totalitarian terror towards freedom, has ended in a battle. It is a history that becomes more and more chaotic.

PARTICLE:

According to the second law of thermodynamics, the universe tends towards entropy. It is continuously developing into increasingly disordered states. One way of explaining this is that if you could go back in time, you would encounter more and more developments and influences that have formed the state you are in now. But unfortunately we can't go back; we're stuck inside irreversibility caused by the loss of information.

ANTIPARTICLE:

Indeed. Let's look at the life of Kasimir Malevich. Born in Kiev into a Polish family, he later moved to Moscow where he created his most important artworks. His mother tongues were Polish and Ukrainian, but he was also fluent in Russian. So his identity was a very complex one. Some authors argue that Malevich's Suprematism is rooted in traditional Ukrainian culture, due to the years he spent as a child in Ukrainian villages. He is almost the only artist of that time who dared to work on the topic of the Holodomor, a terror-famine in Soviet Ukraine that killed millions of Ukrainians between 1932 and 1933, and which was not recognized as genocide until as late as 2006.

This is an example of how information from the past influenced the decisions and subjects that appeared later in Malevich's work.

PARTICLE:

It is interesting to wonder if the past will leave a mark and stay with us forever. Does the universe have a memory? Can we trace the trigger from the past that caused the present? In quantum mechanics, there is an interesting many-body problem. This physical problem pertains to the properties of microscopic systems made up of interacting particles in any number greater than three. These particles interact with each other and form extremely complex, dynamic quantum systems. Information that enters one of these systems spreads to all the particles, but in such tiny amounts that it is hard to retrace it – just as, if you spread one sentence within a group of a hundred people, giving each of them half of a letter, the sentence would be

in the group but it would be almost impossible to reconstruct it.

ANTIPARTICLE:

There is no actual loss of information, but the greater the number of particles, the more the information in the system will dissolve into an untraceable substance.

PARTICLE:

That means that, with time, information will dissolve yet will also remain forever at a kind of unconscious level, hiding in the background. We can transfer this to the field of historical memory and say that this is why it might be hard to not speak about Ukraine without its Soviet past, about Malevich – or Alexander Rodchenko, or Lyubov Popova, or Varvara Stepanova – through the prism of a shared Soviet/Russian avant-garde movement. Or the historical trauma that has an impact on the psychological and physical health of generations to come. It's necessary to try to decolonize one from another, by analyzing present events without deleting the past.

ANTIPARTICLE:

No information ever goes away, so its amount is overwhelming, and to understand what it means and where it comes from is very difficult. In the case of the Internet, data that has once been online can never fully be deleted, though it could be hard to find the original context it was placed in. This is why our view of the world is necessarily incomplete. It could be interesting to look at our past with this in mind, to trace our roots, to engage with our collective history and the boundaries that formed us.

PARTICLE:

Would it even be possible to break down those boundaries and liberate ourselves from the restrictions of their shapes? The boundaries of history, or of the place in which we live – or the boundaries of our mind? Or are we forever imprisoned and can only move within them? Do the boundaries have limits?

1.

WHEN WE CLOSE OUR EYES

ALEXANDRA HUNTS: Let's talk while we watch the water in this glass evaporate. To make objective measurements, observers must be removed from the systems they study. The relation between the observer and the observed frames the great debates of Bohr and Einstein.

Alexandra Hunts, *Substance of Time and Space*, 2016. 154 images of a glass of water photographed every 12 hours, day by day until the water had evaporated. The photos are folded and put together in an archive of evaporation that displays the diminishing water level on their margins. (pp. 11–14.)

Let us start with God. In medieval art, God was represented as something abstract, or a part of something bigger – like a hand, for instance. And people always wanted to overcome our human, individual point of view and understand the whole – or at least enter a larger view, right? But in the attempt to find this totality, humans have invariably had to deal with the limitations of body and imagination.

This fresco, the Holy Trinity by Masaccio in the church of Santa Maria Novella in Florence, is the first known depiction of God as a human being. You can see how this is a Renaissance-era, humanistic representation of God by the way in which the vanishing point in the image is on a level with the viewer. This is a huge change: a realization that God, as a limit to our being, is kind of a human.

What I want to ask you is, how can this be related to the development in science that happened with Copernicus's model of the universe in which the Sun replaced the Earth at its center? Maybe you can tell us about this, and later about how a quantum physics perspective is influenced by the observer?

CHARLES MARCUS: This interaction between the two of us has led to many hard questions that we scientists don't often think about. What I can say is that from the time of Copernicus – around the same era as that fresco– up until now, there have emerged greater and greater degrees of relativism: at the beginning, for instance, all the clocks in the universe were understood to run the same; there was a single framework within which everything could be described. Something like, we saw what God saw. Then Einstein showed us that these clocks we'd been using to measure everything didn't really synchronize the way we thought they did; and it depends on whether you're moving or not, whether you regard clocks as synchronized. And that all the lengths and the geometry of space were similarly relative. Then Bohr and that gang came along and told us that what we thought was solid, real, and deterministic – objects are there, of course, even when we close our eyes – may *not* be there when we close

our eyes. They might be there, or they might not be there. To this day, no one knows what to do with this situation.

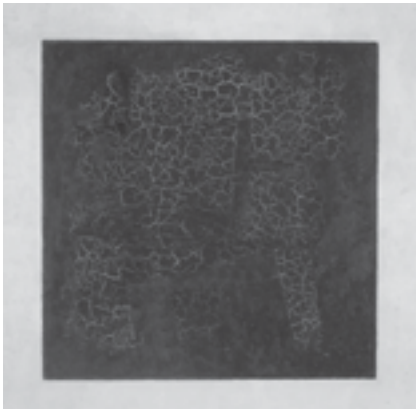
AH: As humans we can always try to see something from a different position, but we will never be able to see from the central/universal position, will never be able to see the totality. We will never reach that. It seems as if we need something else, something universal to be responsible for the reality we observe. A kind of "universal creator."

CM: As scientists, we are drawn to knowing and understanding reality, which, first, means believing that such a thing exists. I would say scientists take pleasure in finding something that we can regard as "true," which means we have to assume a notion of truth. But then if Einstein and Bohr and everyone keep taking these things away from us and saying that everything is shifting and dependent on perspective, it does leave us with the question of what, if you take us observers out completely, is left behind? And the question that I think the artist is asking is: What's the framework within which something absolute can be discussed? And is there any framework at all? It's hard in both art and science to find it and hold on to it.

AH: Let's try to draw a thread between art and science, because I think these fields are kind of connected. And the fundamental idea behind quantum physics is probably a good metaphor for that: when things or entities exist on their own, but still there are connections that are visible or not visible. This is something that I'm very curious to talk about.

2.

SEEING THE WORLD THROUGH OBJECTS



Kazimir Malevich, *Black Square*, 1915, 79.5 × 79.5 cm, oil on linen canvas, Tretyakov Gallery, Moscow.

AH: I often return to geometry, standards of measurement, basic physical phenomena such as gravity, evaporation, or light, in order to start from the "beginning," a pure state, in order to find the origin of our development, the origin of the universe. Starting with them, I can try to create something fundamental. As a term, "icon" is often used to refer to Eastern Orthodox religious paintings, but it is also a symbol of the divine. Kazimir Malevich's *Suprematist Composition* is an icon of 20th-century art. It stands for the dislocation and dispossession of the history of the 20th century.

CM: Within the quantum world the idea of the "absolute" disappears. Each reality is related to a certain observer.

AH: Kazimir Malevich's most famous concept, resulting in the *Black Square*, was presented for the first time during the futurist opera *Victory of the Sun* in 1913. Malevich developed the costumes and the decoration for the opera, and at the end revealed a prototype of the *Black Square*. The opera celebrates the victory of chaos and absurdity over ordinary life. The *Black Square* hides the whole visible world behind the canvas: This disruption of one order gives rise to a new, different order, without canceling out the first. Both can exist at the same time. So these are very much the same concepts that were developed at the same time in art and science.

CM: It's interesting to learn that certain themes which emerged in the history of modern art trace a certain parallel path in the history of modern science. I guess we'll never know if the times made certain ways of thinking popular in both, if one drove the other, or if both were driven by other influences. Einstein was, after all, examining patents for synchronizing railway clocks.

AH: It is indeed interesting, and revealing, to draw parallels between developments in art and quantum physics. As someone who is a last human product of the utopian Soviet idea, I like to look back to Malevich as its greatest artist. The *Black Square* is an icon of my cultural heritage. In general, the so-called Russian avant-garde movement reached its popular height during the Russian Revolution in 1917. It was an artistic movement with the aim of rethinking existing traditions and building a new, liberated interpretation of the world together with a new state and governmental system.

CM: From a scientific point of view, these questions also began to be posed in the years

between 1900 and 1930, especially in this city, Copenhagen. Many of the foundations laid down during this remarkable period haven't changed up until the present. You could even say that by 1930 the ideas were in place that set the course for modern physics. Our view of reality has been augmented since then, but not fundamentally changed. The Copenhagen interpretation, as it is now called, concerns the role of the observer not just in seeing the world but also by observing or determining it. You can ask, "Is that about us? Can an insect determine reality? What about a rock? What does it take to make reality?"

AH: It's interesting that you can still challenge science: that there are so many questions which don't have answers and maybe will never have answers. But we are all trying to reach this kind of total reason in everything. Like, understanding the total reason for being here and being humans in the world by using math, calculating possibilities, shaping the world into a geometric structure, as geometry is a universal language we have agreed on. But geometry doesn't represent something "human." Humans will change and dissolve, they will die, but geometry will always stay unchanging and will survive. Alexander Rodchenko, another artist from the same period as Malevich, believed that everything is mortal, just like human beings: Everything has an ending, and energy has its end. But he was curious to figure out how to overcome our own mortality and create something universal, so he promoted the idea that the structure and geometry in constructivist art were oriented to the fact that geometry will always survive. Geometry is a purified and simplified version of our reality – a universal version.

You said before that, within the quantum world, the idea of the "absolute" disappears. Do you think that the absolute can be something isolated and on its own, or is it always in contact with the environment? Can we enter the idea of an infinite and an "absolute" through geometry? Can something be completely independent? Or is it always entangled with the rest of the world?

CM: I have an opinion about that. "Correlated with" or "*entangled* with" are phrases that you hear used in quantum physics – in the sense that everything we experience is not just going into us, but also that we're impacting it in some way that leaves an indelible mark on the world. And it does so in ways that are much more complicated, it seems, than the way it feels.

We were talking about how, when you touch something, you leave a mark on it forever. And when that thing touches something else, it not only leaves its own mark but also the mark that *you* left on *it*. And that it all happens very, very quickly. And, you know, "You say 'quickly.' Can you quantify it?" Sure, you can even quantify it in picoseconds (or whatever) of time before the touch leaves a mark.

You probably can't see it, but maybe you can smell it. But the upshot is, you get forced into realizing that we're somehow connected, although it doesn't feel like it. But isn't it nice and pleasing and surprising that modern physics forces us into the idea that we're all connected, and that's something that can't be escaped? I like that result. It makes it feel very relevant to our lives.

Now, you could ask, “How does he know? Just because he studied physics in school doesn’t mean he can know something like that!” The only reason I believe in these connections is because, if you try to understand the world we live in, you find that the simple stories of reality just don’t hold to experimental evidence. You can make up a simple story, but then when you – not even testing it in a laboratory, forget about the laboratory – just, if you look out the window, it doesn’t hold up to inspection and you end up forced into a picture of reality that things aren’t really things until you measure them and all that. And you can’t escape if you take observation seriously. There’s no other viewpoint, as far as we know. And that’s where we are in modern physics. It’s not that the stories are made up. It’s that the stories are forced on us and we can’t escape them unless we start ignoring things that we see.

AH: That might be true, but I kind of disagree with it, because we always try to escape that connection, escape the material context. Just because we think, “Maybe we can enter this kind of a ‘zero,’ the ‘zen state,’ right?” The zen feeling of nothingness; being nothing and being at peace, and just disconnecting with the materiality of materials. In Malevich’s Suprematism, everything tended towards this self-nullification, and in order to enter this nothingness we need to disconnect from materiality. This kind of disconnection may become more visible when you lose touch with the materiality and any representation of that. Everything that was hidden under the chaos of all the connections will become visible – the true/universal thing.

I can agree that the ideas of Malevich were definitely limited or even too utopian. In the end, he and all Russian/Ukrainian avant-garde movements failed as they couldn’t compete with the newly redeveloped totalitarian regime and censorship. Even after reaching the total nullification represented with the *Black Square*, Malevich goes back to figurative painting.

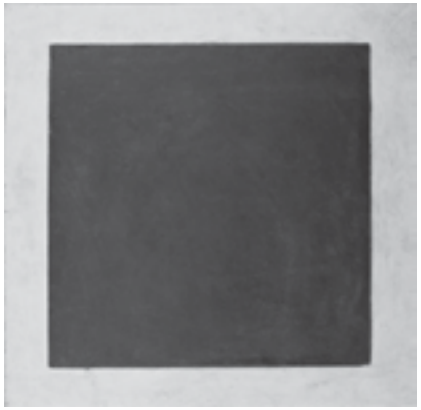
CM: Well, maybe it was right for the times.

AH: The *Black Square* was right during a time of revolution. Then we come back to the idea that maybe this self-nullification and absolute disconnection from the laws of physics isn’t possible because of the context. The context that flows and changes and entangles. Can you tell us about this concept of absolute zero in science?

CM: Okay, but may I ask you your opinion about this painting? More specifically, are the cracks in the black paint part of the work?

AH: Malevich actually made four versions of the *Black Square*. With this work, he wanted to break with materiality and its representation. This painting is like total nothingness: the point zero, the great departure point. But then he thought, “Okay. But if we keep the painting, because it’s still a painting, right, it will crack,” or, like, “Something will happen,” and he was very stressed about it. “It should survive.”

So he made a few copies, just in case one might get lost or something. The cracks are part of the decay process that the paint, of course, has undergone and part of the transformation that the painting has also undergone. So, yeah, this is an example of the environment affecting



Kazimir Malevich, *Black Square*, 1915, 106 × 106 cm, oil on canvas, The Russian Museum, St. Petersburg.

the painting. None of the copies are identical, and not all of them have cracks.

CM: I can tell you what this reminded me of when I first learned about it: something that absorbs everything, as black as black can be. In the 1970s, Stephen Hawking, besides being heroic for his pursuit of science with a debilitating handicap, became famous for the idea that black holes aren't black but that they have cracks in them, like the painting, and that radiation comes out of black holes. If you take the consequences of that idea, now black holes reach out and become entangled with everything. Connection even includes not-completely-black holes.

AH: The *Black Square* is painted with three different colors. The first is burnt bone. The second is black ochre. And the third is another natural component, a dark green hue. Malevich also added chalk to remove the gloss effect of oil paints.

CM: I don't know whether Malevich would agree or whether you would agree, but it seems to me that the notion of a black square or a black sphere is an ideal. Even the blackest thing we can think of still connects with the rest of the universe.

AH: I think I can agree with that, but the *Black Square* is, of course, a kind of exit or entrance. But it's still a painting, and there is an artist behind it, a creator. My fascination with the *Black Square* is, of course, the color that is not a color, and the understanding of this as a kind of escape.

CM: Malevich seems like a theorist, thinking at the level of abstraction to absolute zero and what that means, and about getting rid of everything.

AH: Possibly, but Malevich is very spiritual as well. Suprematism is tightly connected to ideas of religion. The *Black Square* was supposed to be hanging in the upper corner of a room, just like a Jesus or Maria icon in any religious Ukrainian household.

CM: But not in a traditional sense of God.

AH: No, not in the sense of God.

CM: Okay, but it needs connecting to some great beyond. Bohr said that quantum physics requires a complete revision of natural philosophy, that everything we think is going on in the world is not what's really going on. He accepted that quantum physics represented reality, and that it is our misperception of that obscure reality that needed to be discarded. That struck me as being like Malevich.

Alexandra Hunts, *Apples Glow Blue*. Still from video installation, 2020. The work is based on a scientific experiment with a cloud chamber, a particle detector used in experimental particle physics in the first part of the 20th century.

3.

YES AND NO
AND NOBODY KNOWS

AH: What was the beginning of the universe? What was the beginning of time?

CM: Was there a beginning of time? It seems like there was, some 14 billion years or so ago. How do we know? When we look out at night at the stars, they all seem to be going away from us. It doesn't mean we are in the middle; it's easy to picture stars drawn on the surface of a balloon and someone is blowing up the balloon and all the stars on the surface of the balloon are moving away from each other, even though there's no star in the middle. When was the size of the balloon equal to zero?

If you trace the balloon back until it vanishes, you get around 14 billion years. When we look at those stars moving away from us, they look redder than the stars nearby. And if we look out all the way, we see the coldest, blackest space, which is the echo of the beginning of the universe. It's about three degrees above absolute zero, made colder by receding from us.

This was discovered by two men who worked at Bell Laboratories, part of the telephone company. They were putting up an antenna for wireless communication and their antennas picked up a background "hum" at three degrees, coming from everywhere. They were listening to the cold echo of the beginning of the universe. And you can

listen to it, too. If you tune a radio between stations, part of the hiss you hear is the echo of the beginning of the universe.

AH: So if there's a beginning, there should be an end. Could it be that the end of the universe is the black hole? What if I wanted to enter the black hole at some point with the idea of being reborn and rediscovered? Almost like with the *Black Square*. Start it all over again.

CM: You know, during our very first meeting you asked me, "Is there a border to the universe?" And I didn't know. But after thinking some more, I answered, "No, but there are black holes." A black hole, in a sense, is an edge to the universe. It's not the rim of anything, but it's like an internal edge. And then you asked, "Oh, well, can you do that? Can you escape into a black hole?" I think I finally have an answer.

AH: Okay. What is it?

CM: The answer is, "Yes," and, "No," and, "Nobody knows."

AH: Hmm...

CM: It's not *one* of those three, it's all three. The reason I say that, regarding the first two: If you're watching somebody jump into a black hole, what will happen is that this person will advance towards the black hole, but then the geometry of space will change as they get closer to something called the event horizon, which is outside the singularity at the middle. They'll approach it more and more slowly, and they'll never get to the

horizon. So that sounds like a no: No, you can't jump into it. You'll get to the edge and you'll stop.

But what if *you* were the person jumping in? That person doesn't feel anything special at the event horizon. Their clock slows down, too, so they don't even feel themselves slowing down. They just pass right through the event horizon onto the inside. So, from their point of view, they can escape into the black hole. We, on the outside, think they can't. We would say no, but the escapee would say, I did it! We would say, "You think you did it, but you're just stuck on the outside with a slow watch."

Anyway, the person who jumped in can't communicate with us anymore. You could say he's either left the universe or he's tricked himself into thinking that he's left the universe.

AH: There's a famous science fiction writer called Alexander Belyaev who wrote a short story called "Hold on West!" [1] in 1929. The story tells us about a future in which humans live until the age of a hundred and fifty, where science knows almost everything and can give a solution for any problem. The leader of this society is called the "Great Mind." Due to his hard work, he dies earlier than expected. No scientist can provide a solution as to how to keep him alive. But the Great Mind finds this solution: He decides to travel against the rotation of the Earth in order to overcome the time barrier. He boards a spaceship and flies towards the West,

1 Alexander Belyaev, "Держи на запад!" (Hold on West!, 1929), extract translated by Alexandra Hunts, accessed August 10, 2022 http://lib.ru/RUFANT/BELAEW/to_west.txt_with-big-pictures.html

until his contact with Earth is lost. Everyone on Earth is very worried, as they can't imagine life without the Great Mind. So they send out another spaceship with a physicist on board to find the Great Mind. When the second ship reaches the first one, the physicist finds a small baby instead of the old Great Mind.

"The Great Mind was alive. We only had to wait until he grew up to finish his work."

So the question is: Is the universe finite, or is time? Is the black hole the end?

CM: Well, the black hole has an edge. It has an edge, but it's finite.

AH: I have an idea related to quantum physics. We have these two entangled particles, right? They react on each other even though they are separated. That's a proven fact. So let's put one entangled person or particle into a black hole...

CM: Okay...

AH: And then we keep the other one here to give us access to everything that happens in the black hole.

CM: The great thing about that question is that it brings us to the forefront of science. You can't talk to the poor person who jumped, but if you take two entangled particles and throw one into a black hole, and if you measured the one outside, could you learn something about the one that went inside? This is the modern debate about how to understand the information content of black holes. It's a question where gravity, whose theory is well

developed, and quantum physics, whose theory is well developed, don't have any good intersection. Simply, we don't know. But we may get to know later. I don't think that we'll never know.

Alexandra Hunts, *Blind Will Always Walk in Circles*. Steel, silkscreen on textile, hand embroidery, 100 x 100 x 72 cm, 2021. The title refers to the atomic model of English scientist John Dalton (1766–1844). (pp. 31–32.)

4.

CAN ONE HEAR THE SHAPE OF A DRUM?

AH: As an artist and a human being, I'm constantly seeking liberation. Maybe the fact of living in isolation, first in an isolated country with borders to the West, later isolation from the lack of capital and the awareness that everything is interconnected, being dependent on bureaucracy and external powers and forces, results in the idea of liberation that can be reached through a certain form of self-nullification – just like the Russian avant-gardists, rejecting all forms of dependence on cultural, ideological, and political representations of existing society.

The Russian/Ukrainian avant-garde was also very dualistic, with Kazimir Malevich and the Constructivist artist-architect Vladimir Tatlin as the movement's two main ideologists. Malevich succeeded in turning art inward as never before, supremely self-referential and self-sufficient. Tatlin succeeded in turning art outward as never before, as a means of engaging and remaking the external world. The dichotomy first encountered more than a century ago at an exhibition in one legendary apartment in Petrograd, the famous *0,10* exhibition, still persists. This exhibition included revolutionary paintings by Malevich liberated from depiction and representation and Tatlin's assemblages of commonplace materials representing nothing more than themselves – pure materials.

CM: It's a totally new world out there.

AH: It's also like a new window.

CM: Okay, and I think it's all a perfect story. Now, the interesting thing about quantum physics is that it also had a side that was very practical. Remember that this was the early era at Bell Labs and the companies that were beginning to think about science crossing over to technology, to the transistor and these kinds of things.

AH: I start to think about Tatlin, who was kind of saying, "Art? This isn't art. This is fabric or construction. These are samples. Think about the practical world. Get your head out of theory land." This was so beautiful and so artistic, and it was thrilling from an artistic point of view. But he kept saying, "Let's move toward a practical materialism."

CM: It reminds me of the exact duality in the science and technology of quantum mechanics that we talked about very early on: quantum physics as the basis of the information-technology revolution of the 20th century. Einstein theoretically invented the laser. On the one hand, there was a revision of our world view associated with quantum mechanics; on the other hand, there's a practical side, allowing a control of nature in new ways that weren't possible before. To make a useful transistor, we first needed the conceptual breakthroughs of quantum physics. And this reminded me of the complete dichotomy between Malevich and Tatlin.

AH: Yes. That's definitely a good story and one with some interesting connections. The two artists are so different from each other, but they appear in the same moment, in the same place. Maybe these two things had to be developed at that particular time.

Maybe due to the political situation, as the movement was a very political one.

CM: Russian politics in 1917?

AH: Yes, these thoughts and developments in art somehow influenced the start of the Revolution. It's been part of a very philosophical development. In general, there are no other examples of art which have been so politically related. This artistic movement was itself a part of politics, albeit indirectly. The artists formed a new way of thinking together with the state. Promoted by the state. Until they got a little too revolutionary and too influential.

CM: Well, I guess it's good to support anti-authority when you're not the authority. But as soon as you become the authority and they remain anti-authority, then they're anti-you. Can I ask, was there a parallel development in the arts going on outside of Russia? What was it? Was it the avant-garde movement? What are the key names? Picasso, Duchamp?

AH: Both of them are also important thinkers. But it's different art. Because it's still capitalist art.

CM: It feels Western to you? Duchamp, too?

AH: Oh, yes! I criticize him a lot, I guess, but I love him at the same time. He came up with the idea of the found object, which he termed "readymades." In that sense, he was so innovative, like, "Okay, we don't need to create the art piece, I can just choose a piece and put it on a table and that's an art piece." But at the same time, he was part of the capitalist society and ideology

that he was living in. I don't think he could liberate himself from that. He wanted to be provocative and different with his art, but he was still promoting the capital that is somehow represented by the objects.

CM: I still don't understand why he's different from Malevich, Tatlin, and...

AH: Duchamp is still dealing with society as it is. He doesn't change it that much. Okay, he does change the fact that you don't need to be the producer of a work or an object to be an artist; you can take an object and put it in a museum, thereby giving it a new context. But even then, he's still dealing with the museum. He's still dealing with the whole system. He also presents society as a chooser of objects. Not the producer. And that's a bit problematic in my opinion. Almost like creating the new consumption society at the beginning of the 20th century.

CM: What I saw that he had in common with Tatlin was that both saw the barrier between fine arts and practical arts as vanishing. And that, in the case of objects, if you are able through force of will – and it was his will – to force you to not think about its practical function but to see it as just curves and shapes in space, then it was almost an inverse of Tatlin who took slightly more traditional artistic media and, say... constructed them to look like practical things although they weren't particularly practical.

AH: Indeed, Duchamp integrates the industrial manufactured objects into his artworks or even makes them artworks without changing them. But then we're dealing with the concept of authenticity, right? The object is just an object until the artist selects it to be an

artwork. He isn't the producer, because he didn't create it himself. But he emphasizes the authorship by signing his name to it. I think that Duchamp created the idea of authenticity and authorship as commodities, a new commodity that can be traded. And today it's all about copyrights and authorship...

CM: I see. So he played with that idea. It reminds me of the song by Paul Simon called "An American Tune." I really like it. Parts of the melody of that song can be found in Bach. And I think what Paul Simon said was something like, "Yeah, but Bach got it from someone else. And that other guy probably got it from somebody else." Apparently, some parts of Bob Dylan's Nobel Prize speech – it was great, about Moby Dick – were lifted from other sources. And Dylan was like, "Yeah, so what? That's what folk artists do. You think they worry about whether or not a melody was from some other song? Come on! The whole folk tradition is taking things and bending them around and putting them back in and changing them. And it's part of the tradition of folk music." This really challenged the whole notion of originality.

AH: Yes, but I think that originality can also be a kind of reference to something, and that's good. In my work, I always want to refer to something. Everything should always be related to something else, to some other development.

CM: I guess you could say, if you paint on a canvas with paint that you bought at a store and you took a bucket of some liquid and you added your creativity to it, aren't you mixing some engineered material with your creativity?

Alexandra Hunts, *Can You Hear the Shape of the Drum 1*. Steel, UV print on PVC mesh, concrete and found materials, 200 x 180 cm, 2019. The project refers to a mathematical study in which two different shapes of drums were found to produce the same resonance.

AH: Yes, it was a gamechanger when fabricated paint came on the market at the beginning of the 20th century. That was a huge development. Everything changed from that time on. Before this, you had pigments that you had to mix with oil to make your own color.

CM: I see, so part of the creative act was creating the color. And then, it went away. I'm just wondering whether it's related to Duchamp.

AH: It's super interesting when you deal with that fact of fabrication of paint and the product of the painter. And later on, we have Yves Klein, for example, and his International Klein Blue, that he patented in 1957.

CM: Do you know about this blackest of the black, Vantablack?

AH: That's the black pigment which artist Anish Kapoor bought the exclusive rights to for use in his artworks.

CM: What do you mean? Did he successfully patent Vantablack?

AH: It's kind of an insane story. The company Surrey NanoSystems developed this substance called Vantablack, which is like this blackest black developed to help disguise satellites, and then Kapoor bought the exclusive artistic rights to it. It makes three-dimensional sculptures look almost flat.

CM: I think it's kind of funny. Like a new Malevich.

AH: Is it? An "I want to play God" idea. "I own this color – the blackest black." Why would you even want to do that as an artist? To not allow others to use it? Kapoor didn't invent the color, though. In fact, it's not even a color. Black just absorbs all the light, that's it.

CM: Vanta is an acronym for something. It's made out of carbon nanotubes. That's the NT part of Vanta. V is vertical, the NT is nanotube, and two A's must be array or something... arrangement.

AH: I was thinking about the idea of liberation from the perspective of the human body. The body being material, and our mind forever imprisoned within its material representation. This body reacts to different forces, like how a material changes the body and our position in here. And do we become kind of a receiver for all the changes and everything that happens to us, or can we actually be more of a transmitter or a source of signals and operate through that?

CM: Well, let's go back to our very first meeting. I saw at least two pieces of yours that involved waves on water – at least, it looked like on water – and a characteristic of the waves that I saw was that they weren't freely propagating waves, they weren't waves that were starting here and being sent out forever. [*Can You Hear the Shape of the Drum*, pp. 38-47.] They were waves that were bouncing around inside of a confined region. I felt as if the work had a lot of frustration in it, I'm sorry to say. I know we haven't talked about this version before, but the frustration, to me, was the tension between the desire to propagate like an antenna, and to receive like an antenna: to send out information and receive information. That's all fine, and

it had the right shape. It could pick up a television signal, or it could transmit voices, or images, or something like that.

AH: In one sense it did feel a little claustrophobic, like frustration born of something that had tried to get out, to grow, change, and develop, but that had hit a barrier and got stuck bouncing around inside of a confined region.

You know, when I was a child, in Ukraine there were not many cartoon movies yet. Only the old Soviet cartoons. But everyone was really curious about Disney and all the very colorful Western cartoons. In Poland – that is, sixty kilometers away from the city where I was living, Lviv – they had "Scooby Doo" on TV. So at home I could go out onto the balcony and rotate our TV antenna in order to find the signal from Polish TV and watch "Scooby Doo." Basically crossing the border between two worlds, the West and the East. But unfortunately, the signal was always greatly disturbed by the local police who used the same wavelength to intercept messages relating to serious crimes in the early 1990s.

CM: For me, the pictures on the sails or in the sculptures were the image of a failure to propagate. They had started to propagate, but they'd hit a boundary, and they'd been sent back to where they came from. I don't know whether you thought about this while you were creating them, but the picture of a wave bouncing off something and getting sent back to where it came from has an obvious human feel to it, which is the frustration of communication or propagation. Then there's the scientist in me, who saw some very beautiful images of what the reflection of waves meant. In many different

contexts in my own work, the idea of what happens when a wave is confined by a boundary to propagate within a bound region is usually, in one way or another, referred to as a cavity.

So, there's an empty space with boundaries to it, and it's like singing in the shower: when you sing in the shower, because the shower has a certain size, you sound really good.

So why does it sound good? It sounds good because the waves coming out of your mouth are bouncing around inside the shower, it echoes a lot, it goes to your ears, and you can tune yourself to the resonances of the box. And the box, when half of a wave, or one wave, or two waves fit exactly inside the box – it makes a strong resonant condition. That's exactly what's happening in the lab all the time. We make boxes in which there are waves, and often the waves are an electron. An electron can be a wave and a particle at the same time, and if it's a wave and it's in the right size box, then it makes a resonance, just like someone singing in the shower. That resonance shows you that the electron is really behaving like a wave. Now, where life gets interesting is when, for instance, instead of bouncing off the wall of the side of a box that an electron is in, if the side of the box is a superconductor, then a different thing happens. The electron tries to bounce off the wall to come back and make a standing wave, but instead it bounces off the wall as its antiparticle, and it leaves behind in the superconductor a pair of particles. So one particle comes in, it enters the superconductor as two particles, and sends out in the opposite direction...

AH: ... an antiparticle.

CM: Yes, the antiparticle reflects off the wall, and then it goes back and hits the other wall – maybe the other wall is another superconductor – and then it comes back as an antiparticle, hits the other superconductor, deposits two electrons inside, and comes back out as the particle again. It goes back to hit the other wall.

AH: So, it creates this pattern connection.

CM: It makes a pattern that includes... Whenever the wall that it hits is a superconductor, it reflects as an antiparticle, and whenever it hits the wall, it reflects as itself. When it reflects as itself, it reflects just as a ball would reflect. Now something interesting happens. When the ball comes back off the wall – let's say it's bounced ten times off of things before it hits this wall – the one that comes back out will also bounce off of those same ten things. It will retrace the exact chaotic trajectory, exactly backwards.

AH: Okay...

CM: Now you say, "Oh, come on. How could it do that? It was bouncing off of impurities and it was scattering randomly. How is it possible that it can go back and retrace the history backwards, as if it were propagating exactly backward in time?"

The answer is: Well, that's what it does. If you've arrived at some place in your life – let's turn this into a philosophical statement – through random encounters, and you arrive at something, and you

reflect like waves off of a wall or somebody, you think, “Well, once I reflect off, I will continue in my randomness.” But in this particular case of the superconductor, when you come off as an anti-particle, you exactly retrace all of the accidental events.

AH: ... backwards in time.

CM: The waves that scatter in your sculptures are regular scattering, and they reflect the kind of scattering that’s what radio waves do, what electrons off of walls do, what quantum particles do, and in a way, at a more philosophical level, also what people do. It’s like singing in the shower. You reflect off, but when you do you can form resonances.

AH: And that leads us to the question of, “Can one hear the shape of a drum?”

CM: Because I tried to look at the wave pattern and what was bouncing off of the walls, and see the ripples and the waves, and I asked, what was the shape of the boundary that they were bouncing off of? I mean, you must’ve taken a picture of something. So you must’ve set up some scattering edge.

AH: A tank. A water tank, yes.

CM: And you made a choice when you bought the water tank. What shape water tank? You could have bought a round one. You could have bought a square one, or an oval one. Or maybe you made one yourself, and you decided: Should I put the walls parallel to each other or make the tank

shaped like a trapezoid? And maybe at the time you were thinking about it, you thought, “Well, who cares? I’m just going to make this thing and I’m going to make waves in it.” But when I saw it, it reminded me of a famous and very nice math problem, which is: Is it possible that somebody very smart (or a computer) could look at the wave pattern and say something about the shape of the container that the waves had bounced off of? This is the math problem presented in the ’60s by Mark Kac in an article titled “Can One Hear the Shape of a Drum?” What that means is: Is the wave pattern, in this case the head of a drum, fully characterized by the shape of the outer boundary? Does the boundary determine the wave that lives in the middle? It was actually, for decades, an open problem. Nobody knew the answer to the question. Could there be, for instance, two different boundaries that had exactly the same resonances, and the resonances were at the same frequency as the rippling? Not that the pattern would necessarily be the same, but that the resonances would be at the same frequencies, every single one of them. Some years later, the question was answered. No, you cannot hear the shape of a drum. How was this proved? In a very simple way. Somebody found two drums that were different shapes but that had exactly the same spectrum. You only need one example. With one example, the problem is solved. So, can you hear the shape of a drum?

AH: No, I can’t. Does it mean that, as we were talking about the waves inside of my sculptures, they are frustrated because of the boundaries?

CM: Yes.

AH: In that case, if you're not able to unbind your mind, then you can't even know where this frustration is coming from. We can speculate that the influences of our frustrations are still unknown.

CM: They are unknown, but we can say a little bit. We can say more than nothing.

AH: It's a very dubious idea, as it automatically means that we are shut inside our bodily boundaries without the possibility of escaping them: bouncing inside of our own water tanks. The liberation from the grid of the "everyday" was greatly encouraged by the avant-garde in both the East and the West, by getting rid of bourgeois art; a return to the "routine" life and objects is not something we are looking for in the end. So maybe liberation is – becoming unentangled? Can that happen?

CM: Yeah...

AH: Can you become unentangled?

CM: No.

AH: No?

CM: I don't think you can.

AH: Okay.

CM: But you can picture it. And you can imagine it, and you can take pleasure in the imagining of the unentangled state.

Alexandra Hunts, *Can You Hear the Shape of the Drum 1*. Steel, UV print on PVC mesh, concrete and found materials, 200 x 180 cm, 2019. The project refers to a mathematical study in which two different shapes of drums were found to produce the same resonance.

5.

THE RANDOMNESS OF A COIN

AH: The die is a geometrical shape of a cube, but what happens when you unfold the die? I think it is interesting that when it rolls it can be any number until the point it falls. And only then does it become 1, 2, 3, 4, 5, or 6. It doesn't have the shape which can be whatever, it has a very, very certain shape while at the same time being unpredictable. So, by unfolding the die, I might be able to understand what it is and how it works.

And when trying to produce the die myself, an enlarged steel version of it, the steel somehow becomes the materiality of randomness: a very rough material. It's a material that will change with time, will rust and undergo some kind of a process. It looks as if parts of an unfolded die are trying to escape from the system while playing a game of uncertainty. I mean, even if we know the rules of the game and we can play it, there's always this uncertainty inside the game.

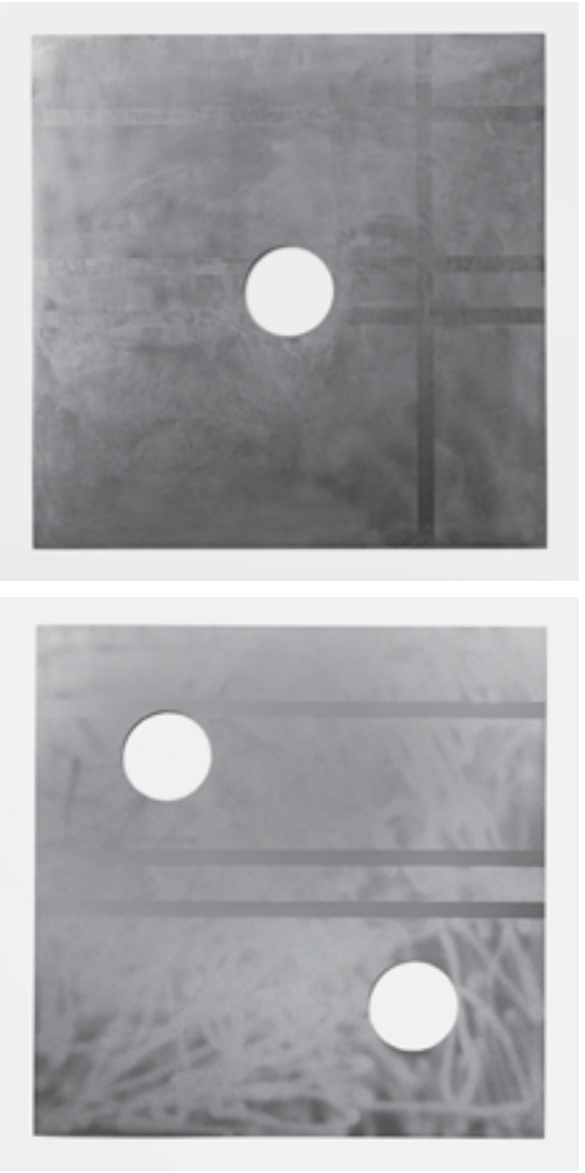
CM: And we play with the uncertainty.

AH: Exactly.

CM: What happens when we unfold the die? The challenge I would like to take up is: What word or phrase are those dice most like? And I know the answer. The answer is black holes.

AH: So, the die is the black hole?

CM: Yes. But for several reasons. The one has to do



Alexandra Hunts, *Objectiveless Composition 1 & 2*. Steel, 59.5 x 59.5 cm, 2019. Based on the debate between Albert Einstein and Niels Bohr about the role of the observer and the observed.

with this famous Bekenstein-Hawking formula that showed that the entropy, or randomness, if you want to say so, of a black hole is proportional to its area, not its volume. Normally, you would think that the entropy of something, related to the logarithm of the number of ways you can arrange its constituents, was proportional to volume (doubling size squares the number of arrangements, so doubles the logarithm). If you take a physical object, and I ask how many arrangements are possible of the material inside, you'd say, "Well, how big is it?" You wouldn't ask what its surface area is, you'd ask what its volume is. But with black holes, this famous formula states that the entropy of a black hole is proportional to its surface area, and this is part of a larger principle called the holographic principle. A hologram is a two-dimensional representation of a three-dimensional object you can capture using phase interference.

By the way, it is the exact same phase interference that makes the swimming pool pattern on the bottom of surfaces: the light adding bright and dark. You can do that with a two-dimensional representation that captures the three dimensions of the bending wave in the two-dimensional swimming pool. You could say that the pattern on the bottom of the swimming pool is, in a sense, a hologram of the three-dimensional surface waves that move on the top of the water. The idea that a three-dimensional object should be characterized by a two-dimensional surface is called the holographic principle. And it's also true for black holes. If you take a three-dimensional object such as a die and unfold it, you'll see that in fact a die is nothing more than the skin of a die. What it is is

its two-dimensional form, and the fact that every bit of information about that die is captured in its two-dimensional layout is an example of the holographic principle that also applies to black holes.

AH: I also mentioned that the material I used for my sculptures is steel, and it can be shiny or not shiny. This bears a relation to one of the first photographic processes called daguerreotypes. Back in the day, they used polished sheets of silver-coated copper for photographs. So you collected copper sheets for your photo album. My sculptures embody this idea of the daguerreotype, and also of how photographs are the two-dimensional representation of the three-dimensional world: the three-dimensional world projected onto two dimensions.

CM: Each of these ideas is about how an object can be represented by its boundary of one dimension less, a three-dimensional object can be represented by its two-dimensional boundary. This brings us back once again to, "Can you hear the shape of a drum?" The boundary determines the inside. Then there's the die aspect of it: the celebration of two kinds of randomness living in the same representation, and it's a kind of randomness, by the way, which is relevant to black holes. Here's what I mean: There are two kinds of randomness in our world. First, there's the randomness that reflects ignorance, as, for instance, when I toss a coin and it comes up heads or tails. Then, there's quantum randomness or fundamental randomness. To start with the first: If I toss a coin, you might say it's random, if it's a fair coin. But of course, it's not random! It depends on how I threw it. So when you toss a coin and it comes down, I'm

ignorant of the details of how you flipped it – but if I had a camera, and a computer, I could probably figure out why it came up heads or tails. There's nothing random about the outcome. That's how almost every random process that we're used to really works. Even when a roulette ball is thrown, and it's going around and around, if I knew exactly how fast it's going and how fast the wheel is spinning and how high the pins are, I could figure out where it's going to land.

AH: Indeed, but you need such huge amounts of information and calculation to be able to make the seemingly random fall of a coin predictable. Everything plays a role, and every small breath, shake of a hand, gust of wind and all other background data will influence the outcome of the fall of the coin. It seems impossible to calculate.

CM: True, but it is still possible. Then there's quantum randomness, which is, we believe, a fundamental randomness. This is of course again the Copenhagen interpretation that says that there is no outcome known to these questions. I might ask, "What's the outcome of a quantum measurement?" And the answer is a 50% chance that it comes up, and a 50% chance that it comes down. What's the probability that if I have half-transmitting glass, a photon goes through or a photon doesn't go through? If you say 50%, then someone somewhere is going to say, "Well, that surely just represents our ignorance." If we knew every detail about that photon, we'd know whether that was going to be the one that goes through or not. We'd know everything about whether a quantum measurement is going to come out zero or one.

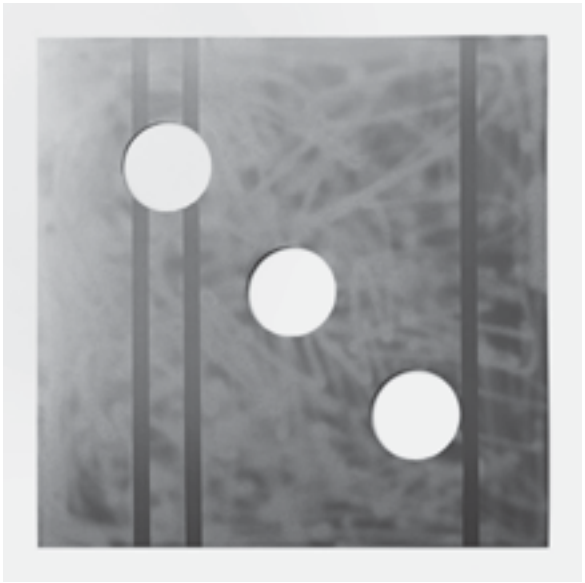
And it was in fact the Bohr-Einstein debate in which Einstein said, "God does not play dice with the universe," using the metaphor to demonstrate that surely randomness cannot be a fundamental truth, that it must reflect some deeper underlying process. And as far as we know, to this day that's not true. To this day the randomness of quantum physics, randomness of black holes, is fundamental. It doesn't reflect an underlying randomness.

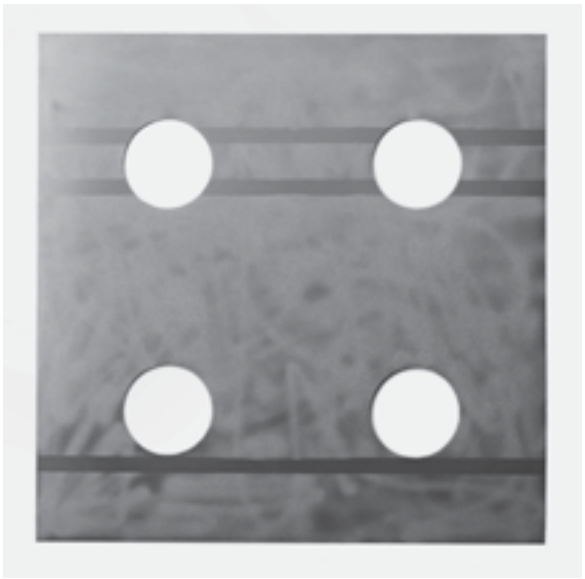
AH: Like an unfolded die?

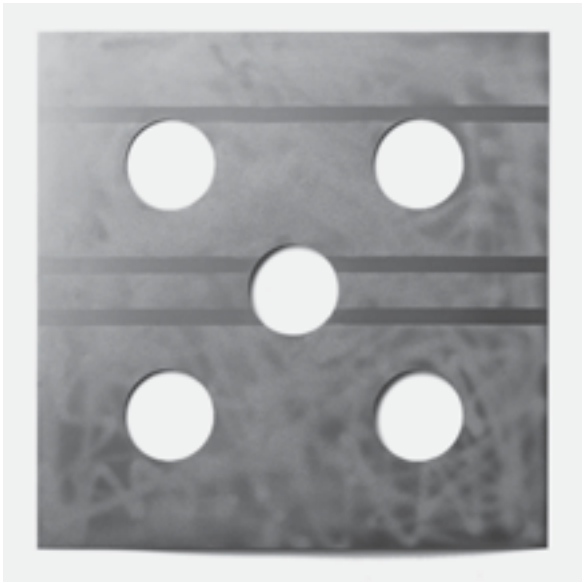
CM: Maybe that too. With these sculptures I think you managed to capture almost all aspects of black holes. One, following the Bekenstein-Hawking formula, is that the uncertainty represented in the die aspect of it is its surface area, not its volume. And that the unfolding, the holographic principle, is represented by the flattening of the die. The idea that there's chaos in the internal dynamics, and the idea that when you put it in the ceiling and there's a hole, just like in the picture you showed me of the installation by Ilya Kabakov, *The Man Who Flew Into Space From His Apartment* – it's an escape. An escape out of the room, through a hole, into somewhere else. An obvious metaphor for falling into a black hole and leaving the known universe. And so, somehow magically by making a flattened die, you captured the holographic principle, chaotic dynamics, quantum physics, and the escape from the universe all in one object.

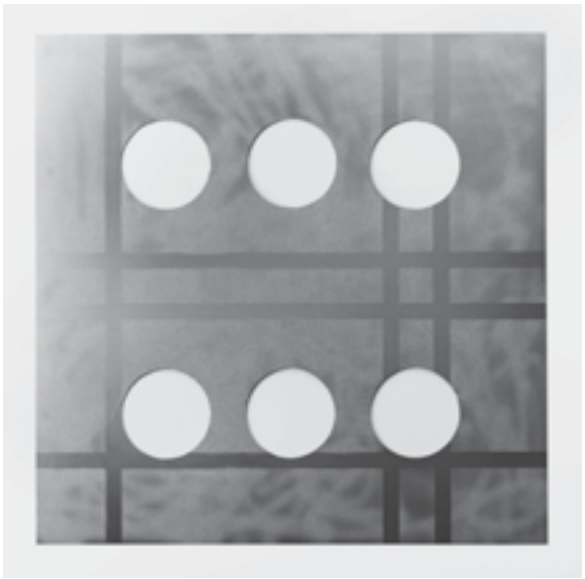
AH: Yes. Maybe.

CM: I think that should be the cover of the book.









Alexandra Hunts, *Objectiveless Composition 1 & 2*. Steel, 59.5 x 59.5 cm, 2019. Based on the debate between Albert Einstein and Niels Bohr about the role of the observer and the observed.

6.

WE CAN ERASE ALL THAT.
SHALL WE?

CM: I like to think about the fact that, in the beginning, there was hydrogen and helium. The helium powers our sun and all of the stars, and the elements that we consist of (oxygen, nitrogen, carbon) were also made in the stars. The heavier elements such as gold can't be made in stars, as there's not sufficient heat there; they have to be made in more exotic places such as when two special stars collide with one another. All of the jewelry that you have that's made of gold came from a star that collided with another star, creating those atoms that eventually made their way into your jewelry box.

The energy from the sun comes to Earth in the form of light, but it also comes in the form of another particle called a neutrino, the "little neutral one." Unlike light, which interacts with our skin and our eyes, the neutrino barely interacts with anything. A hundred billion neutrinos every second pass through every cubic centimeter of this room, through your eyes, through your head. How do we even know they're there?

We know they're there because they carry energy, even though they hardly stop at anything. Most of these particles come from the sun and from the cosmos, and they have names like alpha particles, beta particles, and gamma particles.

When they were first discovered, nobody knew what they were. So they were just given the first

three letters of the Greek alphabet: alpha, beta, and gamma. Now we know that the alpha particle is the nucleus of a helium atom. The beta particle is an electron or its antiparticle, the same electron that flows through the wires of our circuits. The gamma particle is light. It's a photon.

In the atmosphere, the particles coming from the cosmos hit a molecule of air and become other particles: a meson, or perhaps a pion or a kaon. The kaon decays into another pion. The pion decays into a muon, which gives off a neutrino. It decays into an electron, which also gives off two neutrinos. It comes down in a shower of particles to be detected on Earth.

AH: Okay. So now I'm thinking, "Through time we acquire so much information, right? We collect information, so that information may bring us somewhere in order to give us some answers." Can we say that this information, this amount of information is a kind of escape? If we have the information, could it be that the absolute will dissolve and disappear, and the information will be here forever?

CM: Oh, after all the black holes evaporate?

AH: Like us when we have evaporated. Information, the personality of humans: all this will survive the mortal body by the information we leave behind, so the evaporation of a black hole will survive the black hole. Maybe like the way our Facebook profiles will survive our bodies, or something like that. All this information will survive our human forms and through that we can kind of enter an infinity, almost like small particles which will spread out in

the world rather than being condensed in one piece.

CM: After we've all interacted with each other and we're all connected?

AH: Yeah, or exchanged information in that sense.

CM: Yes. I think so. That sounds right to me. The question is whether or not you'll lose, when you get there, something that the lack of equilibrium brings us. Like right now the fact that we're not in some equilibrium gives us some dynamic. We are alive because we're not in equilibrium. Is that a better way to be than when everything is spread out?

AH: Yes, I think that maybe then the flow inside of the borders of our minds and bodies will be outside of the borders. And this information exchange can bring us to that.

Another question: You're developing a quantum computer, right, which will let the information flow – how? Better? Slower? Faster? Will it provide the possibility for the information to exist forever? Will the computer be smart? What will happen? Or what do you want to happen? Why do you even do it?

CM: We are not content with observing. I think that if artists were content with observing, they'd all just go outside to some beautiful place and look at it. We scientists also have a desire in us to do more than observe, but we don't know how to manipulate and control in this quantum realm. That is, up until now, because it's usually really small and you have to be at nearly absolute zero of temperature,

and there are all these constraints when playing with quantum physics. I think that we're about to enter the era in which we can play in the same way as artists play with media, and create things that have never existed before. And there may be places to go for things provided by quantum physics that we can create ourselves, and that's what quantum computers are for.

AH: These are very interesting and promising but also very controversial ideas. Who will be the ones to play with it? All of us, or just some exceptional group that has access to the quantum computer? I think it could make people more involved with the information given throughout media like the Internet, television, and social media in a more complex and saturated way, which we already completely depend on. But it could also be used as a very strong propaganda tool by the powers in charge.

CM: Maybe, but I think there's another bigger thing involved here, which is that first you have to erase people's intuition about what's true and what's false.

AH: But not in the case of propaganda. You don't have any intuition left... You already believe everything that's being said.

CM: This is why, at least in the U.S., the whole notion of fake news became so upsetting. Because it made many people believe that truth and falsehood were indistinguishable.

AH: But I think that developments in that direction represent something which is happening now. This is just the beginning. Maybe early on there was

some kind of intuition, but now it's gone and we are dealing with the consequences of that: now we have Trump, now we have Putin. Now we have all of that.

CM: Well, many of my Russian friends don't mind Trump.

AH: Oh, no, no, for sure not. Why would they?

CM: Well, okay, but for an American, this is a shock. I think for a Russian, it's like, "This is what politics is." It's a totally new idea for Americans that you should have a person like Trump at the head of government.

AH: I'm not Russian.

CM: I know, you're Ukrainian. I meant Soviet.

AH: Post-Soviet. We lost our track...

CM: Well, we can erase all that. Away we go.

AH: No, you forgot! Information stays forever! Through entanglement.

CM: Yeah.

Through entanglement. I guess, yes. Well, maybe the simplest form of entanglement is, let's say, my memory of this event. Now, if you die tomorrow – it still took place. You don't wipe out this conversation just by dying.

The key question is: "Can you be duplicated?" Or will something always be missing? Are you a machine?

AH: If there's reproduction, that means that the reproduction actually gives life to whatever. So only through reproduction can we still be alive, or almost alive.

CM: I would say something else. What about this: Part of you is here, and part of you is elsewhere because you've become entangled with things you've touched. Now it's going to be very difficult to reproduce you. You'd need to go out and gather all the parts of you that are someplace else.

AH: That's what I mean. Of course we can have information, but that will be just part of a total amount, and not the whole.

CM: Yeah, but it's flying away from you at the speed of light. That's the simplest form of entanglement. What about the fact that there's light shining on you? And the light is shining in my eyes.

AH: Well, it won't shine if I'm not represented by material, right? I mean, if my material appearance...

CM: ... goes away. I'm just saying that if you can be reproduced in other things, maybe we could just send you completely, totally.

AH: Maybe... I think that you can be reproduced but not as a whole: not in one concentrated place, but rather spread out in different things. In different minds, in different experiences, whatever. In that sense you are still reproducible, for sure, and you will definitely stay forever. Is there information behind the black hole?

CM: Yeah, I think that there is. I'll know the answer by the time I have to know.

AH: Okay. Because I think that the information about the black hole is already a question. I mean, we've seen the image of what we thought of as a black hole, but that's not the image of the black hole. That's just the shadow of it. Could that be the information about it?

CM: We are on the outside of it. We are never going to get inside of it. But the black hole will evaporate because it's hot. If radiation is coming out because it's hot in there, then the stuff coming out is getting lighter because it's losing energy. So it goes and disappears. So that information must've gotten out. If you worry about information being stuck on the inside of the black hole, just wait – it'll get out.

AH: But if you say that something can be kind of alive or still be in a flow, just like information can actually reproduce something... then it means that the black hole can reproduce itself.

CM: Sounds right to me.

AH: It's reproducible! If a black hole is reproducible, just as Walter Benjamin wrote in "The Work of Art in the Age of Mechanical Reproduction," that is pure liberation! Benjamin said that new media and new technologies could contribute to a revolution through reproduction, speaking about art that must be liberated from its originality and aura.

CM: This, it seems, is very close to the idea that the material doesn't matter. All that matters is

information. Who cares whether it's a reproduction or not; there's an idea in it. The idea doesn't have authenticity. The notion of authenticity is just irrelevant.

AH: The troubling thing for me is regarding information is that I'm questioning who is in charge of that information, and who is deciding what information you'll get tomorrow in your feed; information is everything. I guess it's like saying that the light above my head is in the power of someone who runs the electricity company. Don't you think that information is a commodity?

CM: I think that it's an unlimited resource. Aren't you a source of information? Like what we're doing here?

AH: I think I'm becoming a commodity, not the information.

CM: Don't you feel that you have a free will?

AH: I don't think I feel free... no, I definitely don't feel free.

CM: You don't think you're free?

AH: No. That's why I'm searching for freedom, right? The whole conversation is about where I can find that. How can I reach that infinity?

CM: Well, then, let's take you out of it and talk about all these free people who are creating new ideas. From Bohr to Heisenberg. You know, they were creating new ideas. Nobody owned those.

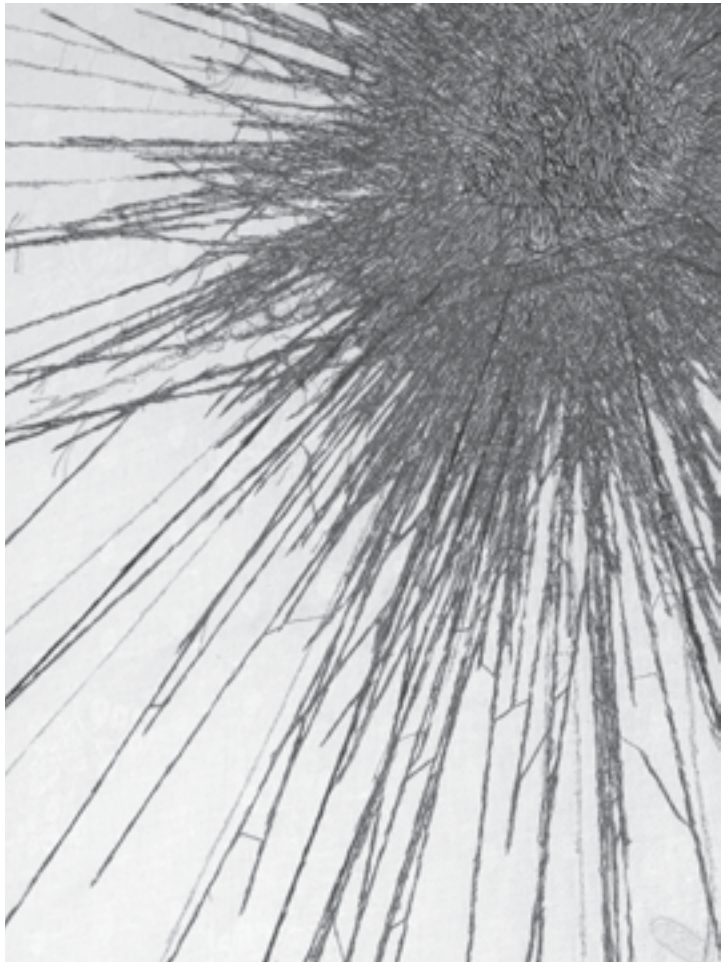
AH: No. But did it give them freedom? The feeling of freedom? Or did they end up being connected, entangled, dependent on the environment and all of that.

CM: They weren't completely free, but they weren't completely owned, either.

AH: So that's like impossible states. Like it's impossible to liberate yourself.

CM: Yes, but it's worth trying.

AH: We're running out of time...



Alexandra Hunts, *GIRLS: Helen*. Embroidery on old Soviet table linen, 220 x 110 cm, 2021. This project is dedicated to all the invisible cosmic particles, and all the invisible female workers involved in the detection of cosmic showers captured by bubble chamber particle detectors.

Alexandra Hunts, *GIRLS: Yaffa*. Embroidery on old Soviet table linen, 220 x 110 cm, 2021.