16

SEPTEMBER

2011

OBSERVATIONS ON THE UNCERTAIN

Krystal South

I. One can never know with perfect accuracy both of those two important factors which determine the movement of one of the smallest particles—its position and its velocity. It is impossible to determine accurately both the position and the direction and speed of a particle at the same instant.

—W. Heisenberg

II. You might picture it this way:
You're standing in the middle of a small room. The wall ahead of you is all mirror. That behind you is also mirrored. When you stand in such a place, watching your image reflected ad infinitum, you can usually see, after a dozen of so repeated reflections, that your images recede in a gradually accelerating curve, in one direction or another—up or down, or to one side or another. After a while you notice that the reflections are not infinite at all, but rather disappear behind your own image. And you can't see the spot where the vanishing-point actually vanished: you are occluded by your own image or by its frame.

—Donald Preziosi

To use our human language here to attempt at a description of that which mathematics expresses so elegantly is a disservice to the science, but here I am stuck in an effort to make sense of what I know and encourage an understanding and budding love of complex theoretical physics to you, dear reader. I am an amateur physicist autodidact and an artist who first fell in love with physics through the images their experiments produce. I see enormous parallels between my research into art and physics, and this is my attempt to formalize these uncertain observations.

I. A Very Brief Physical History

The Classical Newtonian Model of physics reigned over our understanding of the physical world for well over 200 years. The three laws, written by Newton in the *Philosophiæ Naturalis Principia Mathematica* of 1687, simply expose the relationships between matter and earthly forces. Classical mechanics is governed by these laws, and functions with accuracy for things and forces at an observable scale. An intrinsic interest of science is in dissecting the stuff of stuff, peering deeper into the microscopic parts that make up the whole, for instance the discovery of the atom and then Rutherford's 1911 discovery that the atom had a nucleus, and that the nucleus could be split. What became obvious as physics experiments increased in accuracy, and the scale of our human vision was mathematically exacted was that Newton's equations did not seem to apply at the atomic level, and that a shift in our understanding was about to occur.

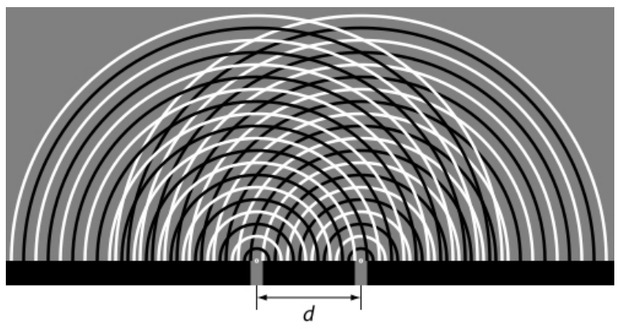
After the publication of Albert Einstein's special theory of relativity, we had a new understanding of mass and energy equivalence. With the identification of a fixed speed of light, the Newtonian era was ending, and the era of Quantum Mechanics was beginning to take hold.

Another effect of special relativity was the Lorentz transformation, which marked the beginning of our ability to visualize a post-Newtonian space-time. This meant we realized that we existed in a three-axis field after hundreds of years of Galilean invariance. This shift from a two-dimensional to three-dimensional understanding of our position in space is synonymous with Alberti's 1435 publication of *De Pictura*, a formal manual to perspectival artistic depiction, which had already been floating informally around for a few hundred years. The way that we see the world was drastically changed by both, to such a degree that an enormous surge of upheaval in the arts and sciences soon followed. Surely quantum mechanics, and the many advancements it has brought (think microwaves, lasers, fast Internet...but basically everything modern to some degree!) can be seen as a second Renaissance? (See also: time dilation.)

Christiaan Huygens was an influential Dutch physicist (among other things) who in 1678 postulated that light was a wave, comparing the behavior of light waves to ripples in water. Newton published *Optiks* in 1704 postulating that light was made up of particles; citing reflection, refraction and interference as evidence for his claim.

The discovery of the constant speed of light (JUST 186,000 MILES PER SECOND, NO BIG DEAL!!) brought with it an interesting set of discrepancies in our understanding, and as we became able to observe the way that it behaves, it displayed some quizzical qualities. For one, light was seen sometimes as a wave and sometimes as a particle, which made it hard to pin down. Then people much smarter than you or I (fine, maybe you are a physicist, I don't know.) figured out (with math) that it was BOTH, which I would imagine was a rather hard intellectual adjustment to make. This constant rate gave us a new system of measurement for the universe hinging on the beam of light, and a maximum speed was set. (See also: Luminiferous aether.)

Wave-particle complementarity mathematically allows an elementary particle, such as an electron (A Lepton flavor Fermion, in case you were wondering) with all of its quantum properties, to be in two places at the same time, but not observed in both at the same instant. This wave-particle duality, a part of complementarity, was proven by an experiment preformed originally in the first part of the 19th century by English polymath Thomas Young (also famous for decoding the Rosetta Stone.) The finitude of the speed of light implies the impossibility of a sharp separation between space and time. The finitude of the quantum of action implies the impossibility of a divide between the behavior of a system and its interaction with the observer; the notion of complementarity is intended to symbolize this new situation in epistemology created by quantum theory. To parse words, the limits of light-speed unite the space-time continuum in much the same way that the observer limits a quantum system.



An important physics experiment that shattered Newtonian laws was Young's double-slit experiment, wherein light passing through two tiny slits does not follow the path that a classical model predicts. Instead, the waves diffract through the slits, dispersing in interfering arcs from the central hole. Even more interesting is what happens when a single photon, the singular massless unit of light, passes through a hole. The individual photons make up the exact same pattern, defying prediction but proving wave-particle duality. (See also: Schrödinger's cat.)

Werner Heisenberg postulated that the presence of the observer, or measurement of the proton, effected the result of the experiment, thus introducing uncertainty into the observation equation. This uncertainty was seen when trying to measure both the velocity of a particle and predict its future position, something easily achievable on a larger scale using Newtonian physics. When one property was more accurately observed, the other's accuracy was diminished, thus providing a wider range of potential future positions, which opens the door to potential, and mathematically predicated parallel universes. Originally written as *unbestimmtheit* ("indeterminacy") in German, Heisenberg's endnote referred to the theory as *unsicherheit* ("uncertainty"), which stuck with the text in its 1930 English translation. One can see how the first term seems more accurate to what the principle suggests about physical systems, while 'uncertainty' seems descriptive of what the principle suggests about the nature of our reality.

The beauty of quantum physics lies (for me) in the sharpening of the observation of our physical world, parallel to a seemingly built-in uncertainty contained within its particles. After discovering the atom and the nucleus, scientists found neutrons and protons and later within those sub-atomic particles, even smaller particles; these quarks now being divided themselves by high energy physics collaborations around the globe, slowly proving the Standard Model of theoretical physics. This digging deeper continues to reveal new balances, and mathematics stands up as the language best fit to describe further expanding physical discoveries. The boundaries of science, and thus our perceptual world-view, are continually broadened (whether we truly notice it or not) by scientists who, standing upon hundreds of years of empirical inquiry, continue to fine-tune the blurry parts and fill in the holes of our knowledge.

Yet there remain so many unknowns, and the field changes so fast; experimenters are searching for the Higgs Boson particle, a hypothetical elementary particle (you may have heard some people refer to it as 'The God Particle') that will unite the Standard Model of physics and dark matter—that yet-undetectable hypothetical thing that makes up 83% of our universe. This unknown void of our universe is a hole in our understanding, one which could potentially shift our perspective into a new Renaissance. Seeking to measure and contextualize that which we cannot even see, is a noble and in my imagination potentially frustrating goal. But the feeling I get when thinking about such quantum stuff is quite a reward; to be alienated from the self by the unobservability of the very matter that makes up you and me, yet to recognize how deeply and thoroughly the laws of physics affect our every potential uncertain future, and that this uncertainty unites us all.

II. The Uncertainty Principle in Vision & Art

We are surely all aware, if not daily than with surprising frequency, how infallible our vision can be. Trying to read a sign across the street sometimes becomes a battle of the eye vs. the brain, our minds filling in information that the eye cannot clearly make out. We can be convinced that we have seen something that was not physically present, and we can imagine a future impacted by those events—perhaps this conviction of the corporeal is what brought about the dominance of our species in the first place. We have foresight into our future based on what the eye has previously seen. However we got here, we now depend heavily on the eye to make decisions about time and space, and we predict our future positions according to feedback between the eye and brain.

We take pleasure in the eye as well. Visual art is maybe no more than that at times when we look at a work of art and forget to make sense of what we see, feeling only the effect of the visual cues. Other times our eye picks out the formal content; hungrily constructing a story (that implicates ourselves) around blobs of paint or dark portions of photographs that somehow sparks recognition. Surely art toys with our natural reactions, exciting and inciting viewers to make sense: to find themselves in relationship to the work, and use the eye and other bodily senses to dissect the semiotic system of meaning by any means possible.

But the eye can only take us so far, and after Heisenberg, our observations are uncertain. When viewing art we can put our critical goggles on, to see through the fray, protected from any unexpected harm. We can act as scientists in our 'creative laboratory' seeking empirical artistic truth. But, the difference between scientists and viewers of art (paled in comparison) is a lack of empirical anything, infinite methodologies and frameworks, no units of measurement, (except dumb words: sculpture, painting, form, etc.), not to mention nonstop subjectivity. How can we ever feel certain of what we see? Of what we know about what we see? Is this potential for endless experimentation and interpretation that which makes art into capital-A-Art, inseparable from our being and our eyes?

The blind spot in the eye was uncovered in 1660 by Edme Mariotte, a Frenchman who was also a physicist. Mariotte placed a coin over the blind spot in the eye, and the coin disappeared, lost to the *punctum caecum*, a less sensitive part of the retina that does not contain photoreceptor cells. Everyone has one in each eye, but our brains realign and steady our vision within the occipital lobe.

Perhaps art calls our vision out for what it is: mostly immeasurable and often not what it seems, full of artifice, and completely out of our control. But does it expose the power of the human brain, to fill in what the eye cannot actually perceive?

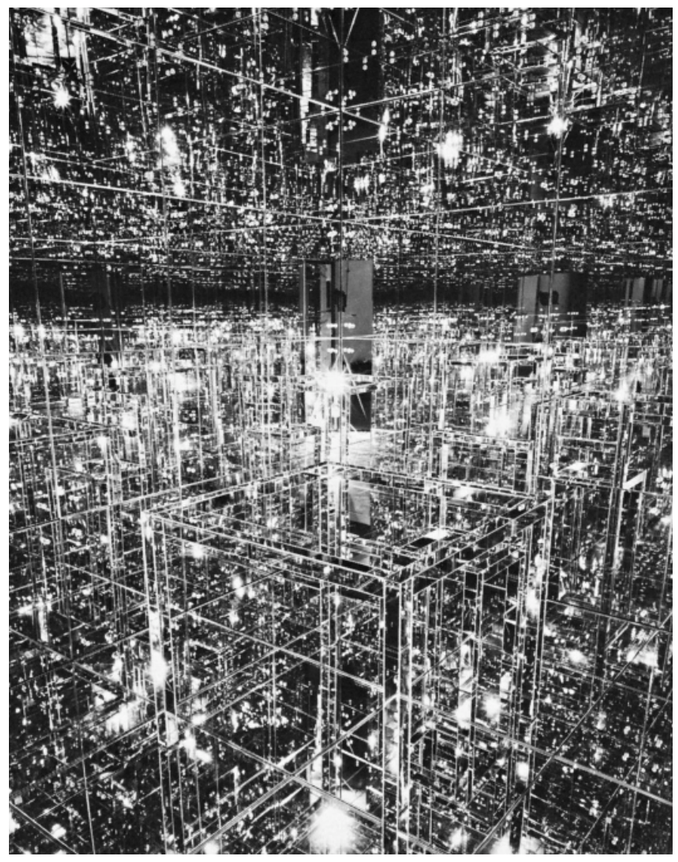
We are all familiar with the tricks of vision, optical illusions that lead us from one conclusion to another, and back. This exchange of pictures; a shift in visual recognition of lines, colors and values, takes us between two potential outcomes for understanding, not unlike Heisenberg's equations regarding the observable properties of particles. In this widely seen optical illusion, which has been floating around since roughly 1888, it seems impossible to see both the young woman and the old woman at once, our eyes flutter in conflict with what we know about the image itself.

Erwin Panofsky's important 1924 essay, *Perspective as Symbolic Form*, supposes that the development of linear perspective, "in transforming the *ousia* (reality) into the *phainomenon* (appearance) seems to reduce the divine to a mere subject matter for human consciousness," mathematically removing the Earth from the center of the Aristotelian universe and suggesting an infinite one in it's place — a concept that was only conceived as naturally possible with the development of perspective. This oblique projection into three dimensions again parallels the Lorentz perspective of post-STR physics, and more importantly forces a position of the eye, placing the viewer into an orthographic projection of space.

This feedback loop between the viewer's eye, the work and the title seems like a yogic exercise re: the art experience. Again and again we look, absorb and try to relate the work to ourselves and ourselves to the work. The visual language system of artworks is often closed and simple, but our humanity makes it complex and wide open. We extend beyond our immediate perception to draw meaning on top of the brush strokes of paintings; we put feelings into negative visual space. We find language (poetry, even) where there are no words. We see depth in two-dimensional planes, worlds in neat gilt frames.

We try to see ourselves in everything, which becomes transparent in works such as Lucas Samaras' 1966 sculpture, *Mirrored Room*. A room of total reflection, with our image inserted in the work. Here we actually become everything, infinite and identical (though curving through space-time), and there is no ignoring our position as a thing, not as a person but as an element of composition within the work. Or, is it that the thing becomes full of Us, and exposes us more clearly? Our likeness is sly and our possessive ownership of that, even when it is reproduced outside of the self, is a natural instinct.

It seems no accident that light-wave theorist Christiaan Huygens's father, Constantijn Huygens, was also an influential, scientifically inclined



Dutchman who, in 1629, wrote of the transformational experience upon peering for the first time through a microscope.

> Indeed, material objects that till now were classified among atoms, since they far elude all human eyesight, presented themselves so clearly to the observer's eye that when even completely inexperienced people look at things which they have never seen, they complain at first that they see nothing, but soon they cry out that they perceive marvelous objects with their eyes. For in fact this concerns a new theater of nature, another world.

He then goes on to lament the death of the naturalist illustrator Jacques de Gheyn, as he would have been able to accurately depict what was seen through the microscope. Art historian Svetlana Alpers, in her book *The Art of Describing*, postulates that Huygens the elder "assumes that picturing serves a descriptive function," to explain by drawing the surrounding world. The Dutch did this quite differently in their art than the Italians, something linked, perhaps, to their early adoption of Leeuwenhoek's microscope, which showed a world unfettered by linear perspective; but also surely because of another technological advancement that Huygens acquired, a camera obscura. While important to science, these advancements also led to direct changes in art. (See: David Hockney, *Secret Knowledge*.)

So where will the eye take us? We certainly have the benefit of looking, looking back and most importantly (neurologically and beyond), imagining the future. Perhaps this intrinsic uncertainty at the quantum level is an indicator that we cannot observe both the art and ourselves at the same time, and this is what causes our endless readjustment and continual testing of waters, the endless 'boundary pushing' of the art world,. This is what makes in our ongoing relationships with art works, artmaking and viewing (Fuck it–creativity as a whole?) inseparable from our lives: A desire to see beyond the eye–to picture the *energeiai aperion*, the actual infinite, as born from our own observations and continued attempts at describing both the natural world and that which lies just beyond our view.

SEPTEMBER is a forum for creative research and experimental writing, relating to all aspects of the historical and theoretical study of the arts. Examining relationships between the arts, their critical contexts and cross-disciplinary counterparts, SEPTEMBER addresses a broad range of readers. Featuring original, innovative and provocative work by artists, writers and theorists, each issue presents the best, most current texts, which extend a critical understanding of artistic history, dialogue and practice within a well-developed interdisciplinary framework.

See your own blind spot

Affix this piece of paper to a wall. Stand back and look at it. Close your right eye. With your left eye, look at the +. Continue to look at the + as you slowly adjust your distance from the image, moving closer then farther away. At a certain distance, the dot will disappear from sight. This is when the dot falls on the blind spot of your retina. Reverse the process.