A Universe Expanding

This installation is inspired by the way humanity views the universe. I found examples of our fundamental need to understand the world in both science and religion. The two share this core motive, but differ greatly in execution. While religion relies on raw imagination, science relies on constrained imagination. This difference determines the nature of these two realms of study: religion is built upon belief, while science finds foundation in thought. Belief can exist independently of fact, while thought requires observation and proof to exist, and is dependent on fact. As we become increasingly able to find proofs to our scientific theories, we are able to replace belief with thought.

The interactive nature of this installation conveys its meaning. The nature of a room in general allows it to create a new space whose contents and energy can be molded and shaped. My room is dark for the most part, and prevents the viewer from forming any concrete observations about it. Only when the ultraviolet lights are turned on are they able to observe the truth within the space.

My installation promotes the observation that humanity knows virtually nothing about the universe around us. Our knowledge is more limited than we prefer to admit, but this truth allows our curiosity to continue to drive science.

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On Space and the Human Reality

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When the universe began, temperature did not exist. Space burned like a trillion suns in unmeasurable heat, allowing the existence of nothing but light energy in its swirling, extreme depths. No visible matter, not even plasma could form in its brilliance. Within a tiny fraction of a second the universe had expanded explosively to an immense size. Another fraction, and gravitational force, electromagnetic, and weak and strong nuclear forces separated from one another, beginning to act as they do today. Photons, quarks, and other particles traversed their newborn universe, decaying into particles and antiparticles as it cooled and expanded. The Armageddon of the early universe began: billions of particles were destroyed for every one saved, but as the temperatures dropped, pair annihilation slowed and ceased. The surviving pioneers are the same particles that make up most matter in the universe today. Protons and neutrons bonded to one another, filling a quarter of the universe with Helium. This hot swarm of particles and simple elements maintained their general state until the temperatures dropped enough for stars to form. Only after this was possible, 300,000 years later, did heavier elements begin to be produced, the supernovae of dying stars blasting the young elements into space to form new, more complex structures. The universe has continued to expand since its birth, and 5 billion years ago, as it entered an era of dark energy, its expansion began to accelerate, and is showing no signs of stopping. Since dark energy's negative pressure is fairly evenly spread throughout space, it continues to push the universe outward at an accelerated rate. It may seem odd, but the universe actually contains very little visible matter: it only comprises of about 5% of everything around us. A further 27% is 'dark matter,' and the remaining 68% is 'dark energy.' The latter two are hypothetical forms of matter and energy. Dark matter is likely not just one type of matter, and it should exist because the behaviors of the universe cannot be explained without more mass than we can see. However as this hypothetical matter doesn't interact with the electromagnetic spectrum, we describe it as being dark. Dark energy is similar in its mystery, and is cosmology's theory for the acceleration of the expansion of the universe:

> "One explanation for dark energy is that it is a property of space. Albert Einstein was the first person to realize that empty space is not nothing. Space has amazing properties, many of which are just beginning to be understood. The first property that Einstein discovered is that it is possible for more space to come into existence. Then one version of Einstein's gravity theory, the version that contains a cosmological constant, makes a second prediction: "empty space" can possess its own energy. Because this energy is a property of space itself, it would not be diluted as space expands. As more space comes into existence, more of this energy-of-space would appear. As a result, this form of energy would cause the universe to expand faster and faster. Unfortunately, no one understands why the cosmological constant should even be there, much less why it would have exactly the right value to cause the observed acceleration of the universe" (NASA).

Of course, every word of the description of the birth of the universe above is guesswork. It is completely composed of theories based on our observations of the cosmic microwave background and the ideas of Einstein and other influential theoretical physicists. We are able to gaze into the past, observing light from the first stars that has just now reached earth, but we can only guess at the truth. After all, our universe is 95% unknown. Even the 5% that we are able to observe we are just beginning to understand. The properties of the macro contrasting with those of the quantum level are adding yet another layer of doubt to our current understandings of the physical laws, and that is confined to the 5%. As a whole, humanity knows very little about the world around us, and as individuals, we know even less.

Humanity has a fundamental desire to understand the universe. After we were able to focus on anything other than survival, we have worked to make sense of our home. Cave paintings of mythological tales and great stone structures to tribal and organized religions have all attempted to unravel the secrets of our planet and the space beyond. For tens of thousands of years, probably longer, humans have relied on their imaginations to guide their views of the world. We use them to provide explanations for the puzzling problems of how our world came to be, why we are the way we are, what happens after we die, and on and on. Humans also strive to provide answers to all of our own questions. Before science, this naturally resulted in mythology; in other words, religion. Interestingly enough, religion is still around today. Even though we have teams of humans constantly striving to unravel the mysteries of the space around us, we choose to retain the stories we made up to console ourselves so long ago. We have, as a species, derived a new way to interpret the universe: through proven theories, through fact. The only problem is that the vast majority of us still rely on our imaginations and the imaginations of our ancestors to provide our world-views. Imagination unbounded, that is. Imagination used for fiction, with no constraints. The imaginations that saw the rain as tears of God, an almighty figure that sprung the universe into existence with a sweep of its hand. The imaginations that saw lightning as the spear of a fiery god, and thunder as the ring of his hammer. The imaginations that were able to deal with failed crops and famine because they could blame it on a vengeful deity. Hawking describes the phenomenon:

> "One could imagine that God created the universe at the instant of the big bang, or even afterwards in just such a way as to make it look as though there had been a big bang, but it would be meaningless to suppose that it was created before the big bang. An expanding universe does not preclude a creator, but it does place limits on when he might have carried out his job!" (Hawking).

This is the imagination that has provided the foundation to our understanding of the world. Today, we use our imaginations a little bit differently. We have a basic understanding, built on several centuries of ever-accelerating scientific discovery, that allows us to dream rationally. To imagine with constraints, those being the laws we have discerned from our scientific observations of the universe. We can dream in theory, where we think of what might be, and take those ideas to a lab to be tested and proven (until they're disproven, that is) with mathematics, or chemistry, or astronomy, or particle physics. Today, we can dream in reality. Dreams drive our knowledge foreword in fact instead of in fiction, as they had for thousands of years. As Hawking articulates,

> "In less than a hundred years, we have found a new way to think of ourselves. From sitting at the center of the universe, we now find ourselves orbiting an average-sized sun, which is just one of millions of stars in our own Milky Way galaxy" (Hawking).

So how should humanity see the universe? Our relationship with science is just another branch of our fundamental need to understand the universe. Religion and science stem from this same need to understand. While religion relied on raw imagination, science relies on constrained imagination. This difference determines the nature of the studies. Religion relies on belief, while science relies on thought. Yes, beliefs are thoughts, but belief can exist independently of fact. One can believe in anything. Thought requires observation and proof to exist, and is dependent on fact. This is where religion and science diverge from one another. As we become able to find proof to our theories, we are able to transfer from belief to thought.

Reality as we (as humans) know it is a belief, rather than a fact. This is a result of thousands of years of development of humanity: we find success through division of labor, and

this has fundamentally shaped our perspective on the universe. We have scientists, the lonely 1% who work to find truth through theory, then proof through experimentation. They are scientists, however, and not communications experts, therefore their findings are very often misrepresented by the media, who relays information to the 99%. Because the public does not understand the vast majority of the background information - the ideas and experiments of the past that have led to the new theories and experiments - we are unable to process what they truly mean. We are also fed small portions of the research, which leads us to believe we've found one thing when in reality we've found something altogether different. Because of these shortcomings, humanity's view of the universe is decidedly split. On one hand, we have the extreme minority that founds their perspectives on experimentally proven (again, proof can be disproven) ideas, and on the other we have the rest of us, who take the scraps of information that are fed to us and form perspectives based on our incomplete knowledge. Furthermore, the knowledge that all of humanity possesses, conglomerated, is incredibly limited, so having incomplete knowledge within humanity's scope of knowledge results in very slim chances that we as individuals are correct. However, most of humanity believes we know far more than we do. We have religion, after all, and we can explain away our universe. We know that matter is only 5% of the universe is visible matter. The rest is dark matter and dark energy. Why 'dark'? why not 'light energy'? We don't know, so it is automatically dark, black, unknown, unseen, terrifying. And the 5% is pretty mysterious as it is. The trouble with belief is that, after such a long time spent believing instead of thinking, it is easy to keep the mind closed to new possibilities, even if new information proves the old decidedly false. Such a great portion of humanity has rejected knowledge, because it is uncomfortable. The truth is, we know virtually nothing about the world around us, and this truth can be terrifying. We would rather live our lives with the comfort of believing we know exactly why everything works the way it does. It is predestined. It's the way God intended. It's fate. Science is based upon the knowledge that this vast unknown is the fun part. That we have a fantastic opportunity to try to understand the universe, but we can only achieve this if we make peace with the fact that we know almost nothing.

Entropy

The first law of Thermodynamics states that energy can neither be created nor destroyed in an isolated system. The second predicts that the entropy of an isolated system increases indefinitely, and the third states that as the temperature of the system reaches absolute zero, entropy approaches a constant value. These laws are essential to our understanding of the timeline of our universe. I view entropy as a tendency rather than a force. It is a natural process that works in tandem with the forces of the universe. When gravity pulls a barn to the ground over several hundred years, entropy is at work as well. When dark matter and/or dark energy force the universe to expand continually, faster and faster, entropy is at work. Entropy is the result of these forces, but it is also the motivator for them. It is the way of the universe. It allows for life to be, but will take it all back as the matter in the universe trends toward equilibrium. As the stars go out, one by one, and galaxies dissolve, and life becomes impossible, as the universe enters heat death, the end of matter. This is entropy at work. Arnheim describes an example:

> "The child's playroom can indeed serve as an example of disorder - especially if we do not grant the child a hearing to defend the hidden order of his own toy arrangements as he sees them. But the messed-up room is not a good example of a final thermodynamic state. The child may have succeeded in breaking all the functional and formal ties among

> his implements by destroying the initial order and replacing it with one of many possible, equally arbitrary arrangements. Thereby he may have increased the probability that the present kind of state may come about by chance, which amounts to a respectable increase of entropy. He may even have dispersed the pieces of a jigsaw puzzle or broken a fire engine, thereby extend- ing disintegration somewhat beyond the relations among complete objects to include the relations among parts. Nevertheless, the child is a very inefficient randomizer. Failing to grind his belongings to a powder of independent molecules, he has preserved islands of untouched order everywhere. In fact, it is only because of this failure that the state of his room can be called disorderly" (Arnheim).

While entropy is always increasing in the system as a whole, this is not the case within small sections. Life, for example, represents a pocket of minimal entropy:

> "How would we express in terms of the statistical theory the marvelous faculty of a living organism, by which it delays the decay into thermodynamical equilibrium (death)? … It feeds upon negative entropy … Thus the device by which an organism maintains itself stationary at a fairly high level of orderliness (= fairly low level of entropy) really consists in continually sucking orderliness from its environment" (Schrödinger).

Quantum mechanics is a fairly new branch of study, but has rocked the physics world in its short lifetime. The discoveries being made go against many of our current understandings of physics, but scientists have observed events that were once thought impossible, like entanglement. The Copenhagen interpretation stated that a particle could be in superposition, a state in which a particle exists in multiple states at once such as spinning clockwise and counterclockwise at the same time, until it is observed or interacted with. It determines that once this happens, the particle is forced to maintain a single state. Schrödinger disagreed, and rebutted with his cat thought experiment:

> "One can even set up quite ridiculous cases. A cat is penned up in a steel chamber, along with the following device (which must be secured against direct interference by the cat): in a Geiger counter, there is a tiny bit of radioactive substance, so small, that perhaps in the course of the hour one of the atoms decays, but also, with equal probability, perhaps none; if it happens, the counter tube discharges and through a relay releases a hammer that shatters a small flask of hydrocyanic acid. If one has left this entire system to itself for an hour, one would say that the cat still lives if meanwhile no atom has decayed. The first atomic decay would have poisoned it. The psi-function of the entire system would express this by having in it the living and dead cat (pardon the expression) mixed or smeared out in equal parts. It is typical of these cases that an indeterminacy originally restricted to the atomic domain becomes transformed into macroscopic indeterminacy, which can then be resolved by direct observation. That prevents us from so naively accepting as valid a "blurred model" for representing reality. In itself, it would not embody anything unclear or contradictory. There is a difference between a shaky or out-of-focus photograph and a snapshot of clouds and fog banks" (Schrödinger).

In this thought experiment, Schrödinger attempts to prove the Copenhagen interpretation wrong, saying that a cat cannot be both alive and dead at the same time. Other theories on the topic predict that whenever a predicament such as the cat experiment occurs, both outcomes occur, simply splitting into two realities, two universes. We cannot yet prove any of these theories wrong or right, so we continue to argue on foundations of logic formed on our experiences of the universe and our predecessors' ideas. These discoveries and thought experiments do prove one thing, however; that humanity will always try to find an answer.

Conclusion

True reality and the human reality are different but draw some interesting parallels. The idea that a particle can spin in opposing directions at the same time mirrors the human condition of belief and thought existing within one collective. The spin of particles draws a metaphor to the spin people put on reality. Entropy, the property that we think will cause the universe to expand into equilibrium and result in a heat death, is something that we as living beings are constantly fighting simply by existing. The pull towards the ever-expanding edges of the universe will likely end life, but that same force was necessary to create it in the first place. Within decay, there is life. Within disorder, there is order. For now. We know so little about our home, but we constantly strive for knowledge. Whether this knowledge is based in thought or belief is up to the individual, but to truly comprehend the universe we must base our ideas in scientific, proven facts.

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