THESIS

MACROSCOPIC MANIFESTATIONS

Submitted by

Benjamin Hamilton Isaiah

Department of Art and Art History

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Master's Committee:

Advisor: Haley Bates

Gary Voss
Catherine DiCesare
Robert Wilson

ABSTRACT

MACROSCOPIC MANIFESTATIONS

From the latter half of the twentieth century through the present, scientific experimentation, investigation, and observations allow our species to attain a level of unprecedented understanding of the physical world. Our tools are capable of perceptions more advanced than ever before in human history. Technological advancements make visible that which we have never before been able to witness or comprehend, from the smallest transformation of scale and the subatomic particles composing all things in our physical environment, to the greatest galactic super-clusters that we inhabit. Forms in our Universe are determined by natural physical laws and reactions set into motion far into the past, proceeding from the Big Bang. Events occurring at scales humans perceive to be hyper-microscopic ultimately determine the outcome of realities at our existence as seen through the human observational reference frame. In turn, events occurring at scales exponentially larger than the human scale also govern the realities existing at scales beyond our familiar frame of reference, realms that the Euclidian mind can only perceive as the abyss. *Macroscopic Manifestations* captures moments and events occurring at transformations of scale both massive and miniscule, frozen in time. This sculptural work forms associations between objects occurring at unfamiliar scales of existence and objects occurring at the familiar human scale of existence. Demonstrating the resemblance innate to objects at every scale of existence, much of the work contained herein is representative of microcosmic and macrocosmic phenomena, and emulates structures apparent in terrestrial marvels, the flora and fauna of Earth.

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The body of work that I have developed over the last three years in Colorado State University's Master of Fine Arts Program directly addresses relationships present all around us in the physical world. Whether or not these relationships are visible to the naked eye they are nonetheless extant. For example, likenesses between the structural makeup of matter occurring at a scale similar to that of our own bodily cells and matter occurring at a galactic scale can be surprisingly similar. However prior to the human development of tools allowing us to visualize these phenomena and thus enhancing human sight, these comparisons have never before been fully realized. The twenty first century and the Age of Information has made scientific imaging of natural phenomena, great and small, easily available to many of us. As time continues we are becoming increasingly aware of the infinite interiority and exteriority of our Universe, its fractal nature, and the relationships between what we can and cannot see. The primary objective of my work is to make evident structural and formal relationships manifested by matter occurring at the smallest and largest scales that we can currently perceive with modern technology.

My fascination with microcosmic and macrocosmic relationships began at the early age of seven. I procured a copy of a significantly advanced, fifth grader's, natural science textbook from a library book sale. I soon became intimately familiar with every page, though some sections I found to be vastly more interesting. Those which I found to be most fascinating were the chapters concerning the atomic model, representations of our immediate celestial neighbors within our solar system, and the behavioral depictions of each. The chapter discussing these phenomena concluded with the phrase, "All matter in the Universe was long ago contained within a point no larger than

the period at the end of this sentence." It was at this moment that I was for the first time utterly perplexed by a scientific thought.

It was not until I began my formal undergraduate academic career that I was exposed to notions of the similarities present between the mannerisms and behavioral patterns evident in the visible world and those which exist at invisible scales. Since the Ancient Greeks first conceived the notion of fundamental, indivisible, particles that in essence made up our physical world, a multitude of theories have arisen associated with these atoms (as they came to be known).[1] In the beginning it was thought, these building blocks must certainly be the smallest scale at which matter could possibly exist. The Greeks speculated about the form that these tiny pieces would take were they visible to the naked eye, presuming that a minute sphere must be the most suitable of the possible structures that atoms possessed.[2] Over the course of the last two millennia humanity never lost its figurative sight of the atom, nor its curiosity concerning our inability to witness these elusive particles. In attempts to gain a more in-depth look into the makeup of our world, and to satisfy our never-ending inquisitive tendencies as a species, humans developed ever-more complex tools to locate the truth behind the atoms that composed everything in our surroundings on Earth and in outer spaces of our Universe.[3]

Upon entering the Graduate School at Colorado State University in the Fall of 2012 my scientific attention was centered on a prominent research facility in Switzerland. Conseil Européen pour la Recherche Nucléaire, or European Council for Nuclear Research (CERN) was the name and atom smashing was the game, albeit within a massive 26-mile looping acceleration track. This particle accelerator was able to catapult components of atoms to a velocity approaching the speed of light before hurtling into one another and not simply shattering them into pieces but creating new particles that previously had not even existed. The resulting explosion captured within the

solenoid of immense detectors began to produce some of the most stunning digitally rendered images depicting the nature of matter as it is separated into a great number of component parts.[4] Each subatomic particle dissipates within the chamber in a dazzling display of movement and energy. This was my first bona fide taste of the beauty within every particle that surrounds me, filling my lungs, and composing my flesh I was hooked.

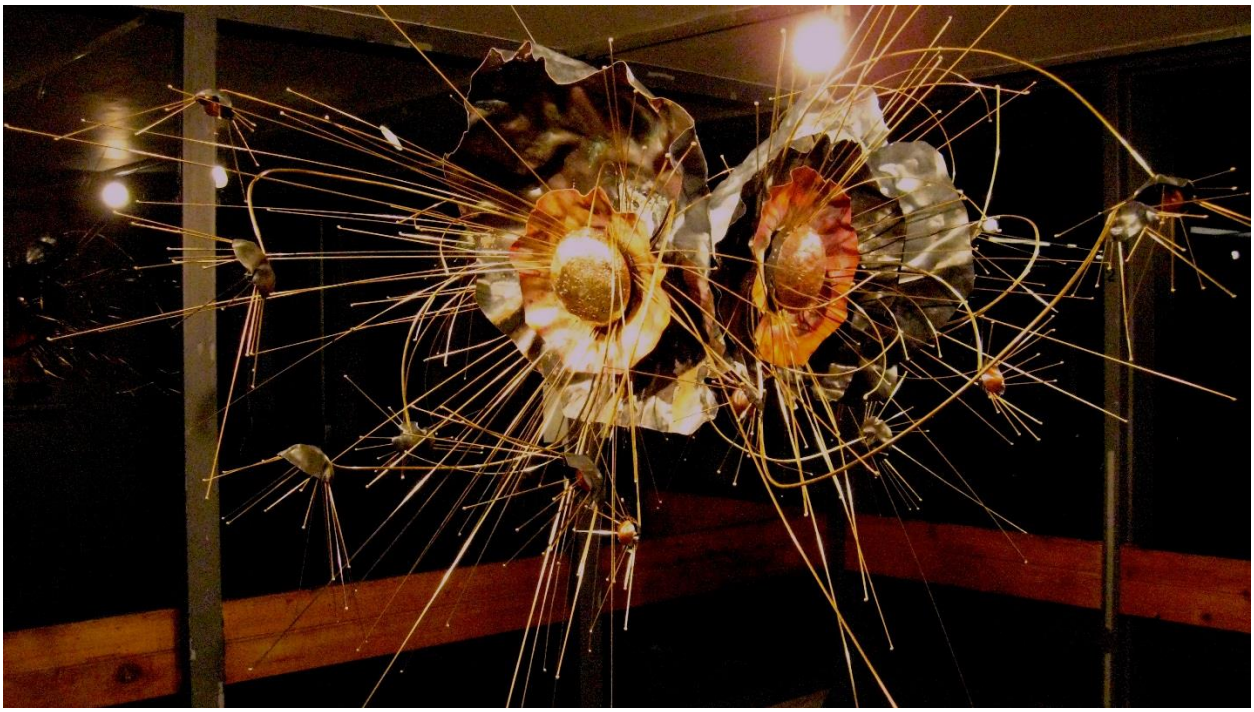

Fig. 1: LHC, 2012. 5' x 6' x 6'.

My preliminary explorations into the experimentation being conducted at the Large Hadron Collider at CERN led to the creation of "*LHC*" in 2012 (Fig. 1). I employed sheets of steel and copper, forged and formed, and arranged radially, alluding to the concussive forces produced at the point of atomic collision within the collider. Between each layer of sheet metal emanates a radial array of brass rods curving gracefully into the surrounding space mimicking the individual trajectories of the subatomic particles.[5] The rods terminate with a spherical point representing the mass of each fragment released from the atomic nucleus during the collisions.

Fig. 2: Island Universe. Josiah McElheny. Tate Museum of Modern Art. London, UK. 2008.

Within this body of work I drew formal and conceptual inspiration from a fellow contemporary artist, Josiah McElheny, who like myself teeters precariously on the border between sculptural art and functional craft media. McElheny's installation works in glass specifically inspired the style and presence that I felt was necessary in my own work. His installation pieces are some of the most dramatic and enticing forms I had ever approached in a space. The glass forms manipulated by McElheny and employed in *Island Universe* (Fig. 2) are stunning, each bearing a reflective transparence, trapping and bending the ambient light. This feature of glass as a medium serves as a metaphor for how space-time is trapped and bent, dependent upon forces present at a given region within the Universe. In this work, McElheny attempts to describe explosive events releasing the greatest magnitude of energy that is beyond what the human mind can imagine, the Big Bang at the beginning of our Universe.[6]

While I attempt to describe an explosive event occurring far more minute magnitude of energy discharge in *LHC* (Fig. 1), the resemblance is strikingly similar. These representations of events occurring at polar opposite scales of existence do not simply bear coincidental similarities to each other but also to varying forms of familiar natural phenomena. The work of McElheny bears a noticeable resemblance to seed structure of floral reproductive systems. These are some of the same associations my audience responded to in *LHC*, in which metalwork is visually transformed into the petals and pistils seen in the plant life sharing our familiar, perceptible scale of existence.

This piece set the tone for future works. I found its scale and presence within space to be critical to the overall success of the piece. It was also the first time that I received such a direct and unanimous response from my audience with regard to the intentionality of the work. I developed a visual language that demonstrated formal resemblances between some types of terrestrial flora and fauna, existing at our familiar frame of reference, and more unfamiliar atomic and subatomic realms. These associations acted as an underlying layer of conceptual information that the work possessed, which I attributed to the success of the piece as a whole.

Inspiration also came from the digitally-rendered models of collisions captured by the research team at CERN, which mapped the motion of every particle released during the atom-smashing experiments (Fig. 3). I perceived these images as beautiful and striking still-life portraits of events at an invisible microcosmic transformation of scale frozen before my very eyes. My primary motivation behind the development of this early work was to transform the scale of my viewer to equal that of the atomic scale. By doing so I could allow them to exist within the space of the collision chamber and witness the event unfolding before them.

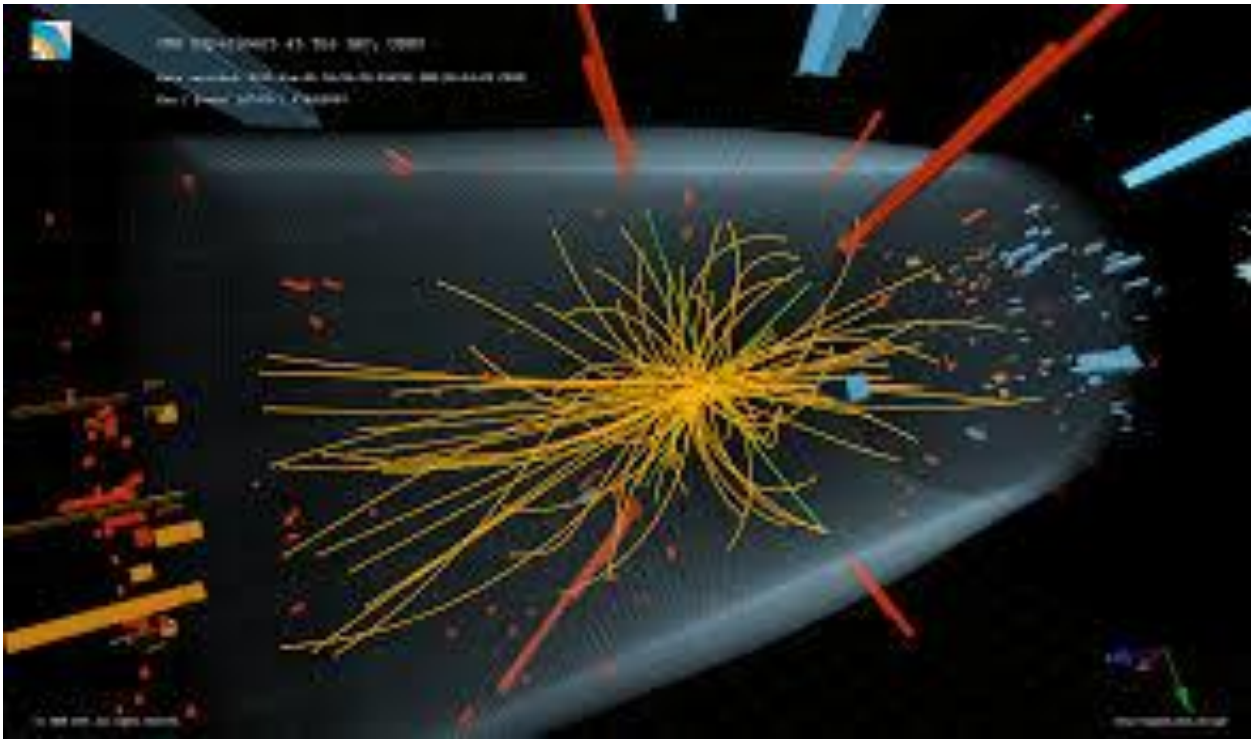

Fig. 3: Digital Rendering of Collision. CERN. http://home.web.cern.ch/ 2012.

Even more astounding than the images of forcefully discharged subatomic matter within a collision chamber are the implications that subatomic research will have on our very existence. The creation of new particles in this way is reminiscent of the beginnings of our Universe before the Big Bang, granting us a glimpse back in time so many eons ago. Time before this great primordial event is difficult to fathom and mesmerizing to imagine.[7] As I attempt to conceptualize the moments following the blast as if frozen in time, I also look to the beginning of all things for inspiration. It is my belief and aesthetic philosophy that an ephemeral echo of this moment still lies deeply embedded within the nature of all things in the Universe.

In 2013, I made the acquaintance of Robert Wilson, a world renowned high-energy subatomic particle physicist in the Department of Physics at Colorado State University. After some extremely stimulating conversations with Wilson and my associate committee members,

concerning my work, processes, and visual source material, I began to shift the focus of my research and ideation from the modern implications of experimentation within the field of physics to the theoretical origins of particle physics. This move was largely driven by research pertaining to how our contemporary physical models came about. I became particularly interested in the work of Ernest Rutherford and Henry Moseley that was being conducted at the beginning of the 20th Century. Rutherford had determined that the particles that composed the nucleus of the atom were in possession of a positive charge. This explained the reason that the subatomic particles, which seemed to be in orbit around the nucleus of the atom, bore a negative charge.[8] These nuclear forces were essentially balancing each other out as they spun past each other at great speed.

Rutherford's colleague and fellow physicist Henry Moseley, who was simultaneously investigating the relationships between the subatomic particles and their relationship to atomic structure, supported Rutherford's model. Moseley experienced an epiphany when looking at a model that Rutherford had proposed in which he made a comparison between the structure of an atom and that of our very own solar system.[9] Two centuries earlier Isaac Newton had stated in his Law of Universal Gravitation that planetary motion was governed by an inverse square law of attraction. This is to say that celestial bodies are falling in an independent course through space but are attracted gravitationally toward another body and would then assume the average of the two paths, translating to its orbital route.[10] Mosely then applied this Newtonian principle to that of his own research concerning the orbital paths of electrons circling the nucleus of a given atom. Moseley concluded that the distance that exists between the nucleus of the atom and the orbital path of its innermost electron is inversely proportional to the charge of the atom's nucleus. This gave each specific element that had so far been identified a number which in modern chemistry has become the atomic number.[11]

The scientific theories put forth by Rutherford and Moseley serve as a tangible example of how Universal forces similarly affect matter at greatly dissimilar scales. I found this notion to be a significant revelation in my research for the continuation of my body of work. Gravity provided an explanation for the apparent relationships and formal similarities in the manner by which matter arranges itself at scales minute and massive alike. It is easy to equate the model of the atom to a tiny solar system as the behavioral likenesses are nearly identical, excluding that rate at which human perception of time allows us to perceive each phenomenon respectively. However, more recent scientific exploration uses new laws of quantum mechanics to redefine how we understand this model.[12]

We are greatly familiar at this point in human history with the surface of the Earth and its only moon, as these objects can be considered to exist at our familiar scale of existence. Although the formal nature and behavioral patterns of our planet and moon are quite similar to that of the atom and its electron(s), our current magnification technology does not allow us to become as intimately familiar with the surfaces or textural characteristics of these miniscule particles. My goal in the next group of works was to enlarge the scale of those particles that are not visible to the naked eye and present them at a magnitude great enough to be engaged by my viewer in a more intimate manner, transporting these forms into the human scale.

During the creation of *Orbital Force Structure* (Fig. 4) I employed steel and brass sheets that were forged into spherical forms, alluding to the configurations into which matter has the tendency to arrange itself universally. This predisposition is due to the energetic forces, namely Strong and Gravity, to which all matter is exposed. I represent these arrangements of matter by creating one central spherical form with smaller spheres arranged in the surrounding space. This

composition is understood by the viewer to be associated with the nucleus or even the Sun, a central celestial body exhibiting gravitational attraction to smaller surrounding bodies.[13]

Fig. 4: Orbital Force Structure, 2013. 5' x 6' x 6'.

The hyperboloid forms which also inhabit the space surrounding the large central sphere mimic the path and force trail of the particles as they circumnavigate the central body which attracts them. At our observational frame of reference, energy and force in the Universe is, for the most part, invisible to the naked eye, much like the particles themselves. We are only able to see the paths of the objects. My objective in *Orbital Force Structure* (Fig. 4) is to transform the very scale at which an observer exists and transport them to one far more miniscule. In doing so, I created a theoretical surface for these objects, a feat we are not actually capable of achieving.

When the viewer has been reduced greatly in their relative magnitude, their perception of the emanation of nucleic forces becomes tangible and physically visible.

Fig. 5: Michael Good. Open Baroque. www.MichaelGood.com. 2008.

I found formal inspiration in the work of Michael Good, a metalsmith who specializes in a process called anticlastic forming or creating a double compound curve to achieve the paraboloid forms present in this work. Michael Good has long been a pioneer in the techniques that allow double compound curves to be applied to sheet metal (Fig. 5). I found this technique to be particularly relevant to this piece due to the multidirectional nature of the forces I was attempting to represent. The swirling nature of Good's anticlastic forms are specific to this process, forming over snakelike stake to produce a superior reflective quality of light coming into contact with the surface of the work, encouraging further viewer engagement.

In addition to the anticlastic forms, I experimented with various non-traditional casting methods to form the central structures and the particles that were frozen in orbit around them. When fabricating the spherical forms in *Orbital Force Structure* (Fig. 4) I textured several ¼ inch steel plates while red hot with various hammers of texture tools. These plates were then secured in a vise, and a molten brass/bronze alloy (which I specifically chose for its brightness and reflectiveness) was then poured and pressed onto the plates. By repeating this process, I created a series of many-textured components that I then connected by melting in brazing rod solidifying each together while aligned to the inner hemispherical surface of a swage block. Once a grouping of these individual components had been unified, the next group would be positioned and secured into position. Due to the common curvature of the groupings of textured brass/bronze components, the sections could then be brazed together. This formed a continuous curvature, eventually resulting in a spherical arrangement.

I continued to experiment with this mode of construction in the latter half of 2013 with the construction of *Gravitational Arrangement* (Fig. 6). In this venture, however, I formed the individual components with varying shapes of 20 gauge steel sheet. These shapes were each heated until red hot and impressed into a hemispherical swage block having a diameter that was considerably smaller than that of the steel shape itself. This process caused each component to bear its own unique form but also gave each a relatively uniform volume, allowing them to again be grouped and brazed together. These groups were then aligned to a common curvature in a larger hemispherical guide, once again forming the arrangement of a much larger spherical structure.

Fig. 6: Gravitational Arrangement, 2013. 3' x 3' x 3'.

My inspiration in the creation of *Gravitational Arrangement* (Fig. 6) was also derived from another fellow Colorado metalworker who finds great interest in the universal nature of matter and its tendency to occasionally arrange itself into spherical forms. Mark Castator explores the nature of planets and moons in our celestial surroundings, creating various surface qualities from steel. Castator improvises scraps of pipe that have been extruded into varying shapes to create a repetitive but diverse surface quality (Fig. 7).

Fig. 7: Mark Castator. Moons of Jupiter. Walker Fine Art Gallery, Denver, CO. 2013.

I liked this repeating pattern on the surface and decided to create my own rendition of this method of going about constructing my own spherical atomic model. The surfaces of my fabricated spheres are porous in nature, allowing the viewer to visually access the interiority of the form with ease. This is a quality that my work shares with Castator's. Though they remain invisible to our limited human perception, atomic and subatomic particles themselves possess a similar interior space.

In both *Orbital Force Structure* (Fig. 4) and *Gravitational Arrangement* (Fig. 6), it was important to me that the surfaces be heavily textured, implying a busy-ness and complexity that something smaller still exists beyond what now is made visible in the work. Even though the scale

of the viewer has been conceptually reduced, a scale must still exist that is even smaller, far beyond our current scope of imagination and perception. Although these pieces occupy a comparable space to that of *LHC* (Fig. 1), I felt that this work did not quite command the same visual attention. The curving rays of brass rod present in *LHC* allow the piece to extend its tendrils outward in order to confront the viewer in a way that the latter two works are not as successfully able to do. I found myself less satisfied by the latter works than by the explosive *LHC*.

In the Spring of 2014 the form, scale, and layers of information present in my body of work again shifted while working with Belgian design team *Unfold*. I began to integrate the use of digital technology into my familiar medium of metal. I had been in search of a means of applying mathematical designs to the surface of my work, thus referencing patterns present in the structures of natural phenomena. I found fractal geometry, specifically that of the Sierpinski Fractal Set to be most suitable for this endeavor. Fractals are formed in the Sierpinski Model as the triangular geometric arrangement is amplified. It extrapolates infinitely and reiterates itself repeatedly from a basic form.[14]

The Sierpinski Set can be viewed in its same likeness at any level of scale transformation, a characteristic belonging to all geometric fractal sets.[15] I found this truth to be astonishingly similar to that of the nature of matter in the Universe. No matter how far we zoom in or out, when our vision is focused we can conceptualize a similar structure present at any given scale in our visible environment.

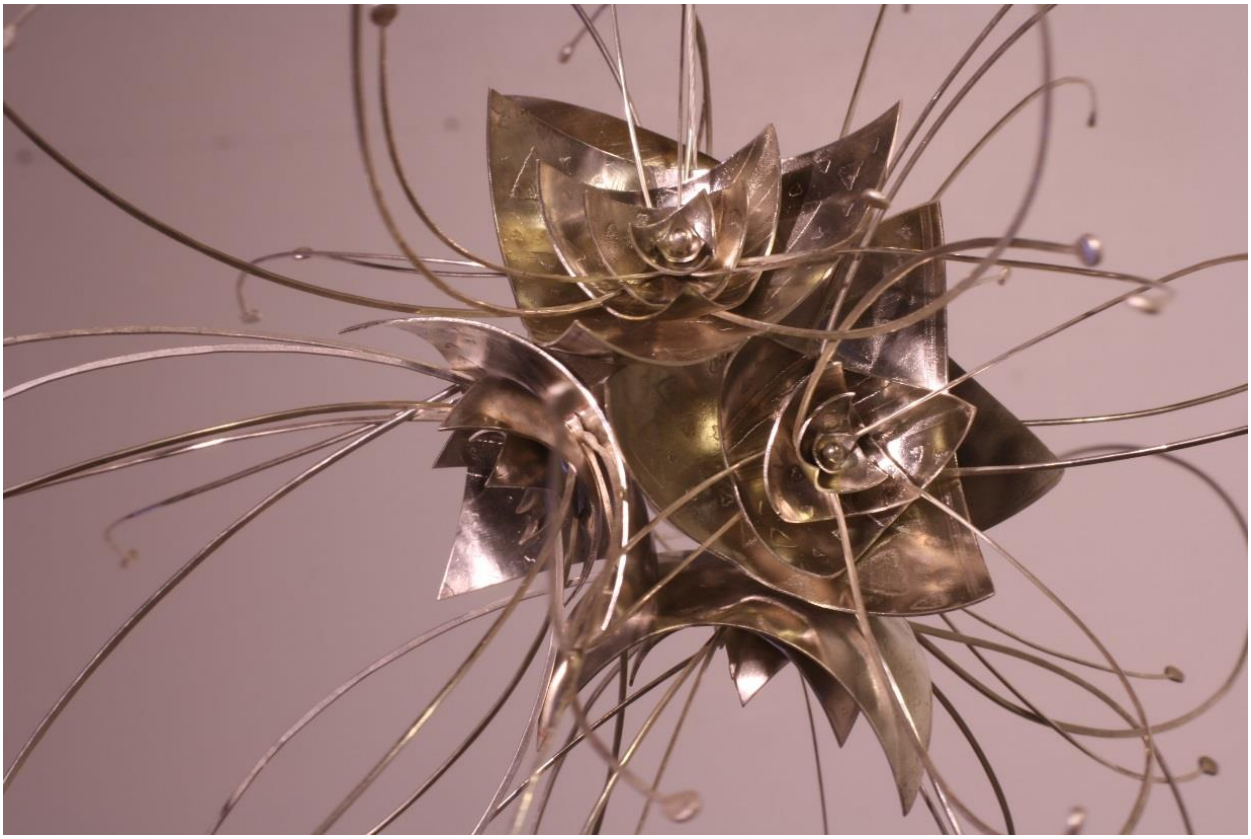

Fig. 8: Limitless Similarities (Detail), 2014. 12" x 12" x 12".

As a solution to the problem of inscribing infinitesimal fractal geometries onto the surfaces of the individual pieces used to create *Limitless Similarities* (Fig. 8), I found digital technology to be most suitable. Instead of piercing all the way through the silver sheet metal I devised my own method of using lacquer as a resist over the entire surface. I then created a bitmap rendering of an expanding triangular fractal set and employed a laser cutter to engrave the pattern perfectly onto the topside. After selectively removing areas of the resist I submerged the silver into a nitric acid bath to chemically etch away desired sections.

Fig. 9: Limitless Similarities (Installation), 2014. 8' x 8' x 8'.

Once the triangular Sierpinski Fractal Set had been etched into the metal, the sheet was then also divided into descending orders of triangles before being assembled into the final arrangement. The patterns created on the surface resulted in a dazzling and overwhelming texture. The individual shapes of the fractal set on the silver grow continually smaller before disappearing into a metallic glimmer. The reduced scale causes the viewer to pay closer attention to detail and become more absorbed into the minute nature of the form rotating in space and the vast fractal textural elements before them.

Similar to my two previous works, I used texture to create a depth of interiority that engages the viewer by almost absorbing them into the space of the work itself. The main difference in the installation and presentation of *Limitless Similarities* (Fig. 9) was the creation of a multitude of

similar forms designed to engage the viewer by physically surrounding them within the work. There is a variance in the scales at which all of the forms in this installation exist. This discrepancy in scale is necessary in order to make apparent the great range of sizes into which matter organizes itself at both the atomic scale and the galactic scale alike.

Fig: 10: Nike Savvas. Atomic: Full of Love Full of Wonder. Australian Center for Contemporary Art. Melbourne, Australia. 2005.

I was greatly inspired by the work of Australian installation artist Nike Savvas who also attempts to visually represent the multiplicity of atomic and subatomic particles flying ceaselessly by. Savvas chooses to engage the viewer by presenting them with quantity and simplicity, employing rubber bouncy balls to serve as her particles suspended in space. Each object, though

separate, operate in unison produce a powerful feeling of vibration. However for *Limitless Similarities* (Fig. 8) I felt a reduction in quantity and an increase in quality and complexity were more suitable to my own visual hypothesis concerning the infinite fractal interiority of particles.

The work of Savvas reads more closely as a representation of the ancient Greek model of the atom: round, non-textured, perfect spheres (Fig. 10). With the amount of objects installed in the space there is little opportunity for detail. For my own installation, density gives way to a complex, formally challenging, central nexus of information. *Limitless Similarities* is fabricated in copper, brass, and silver, all of which possess a reflective surface once polished. This gives the work a radiant glow under the spotlights, reminiscent of the powerful nucleic bonds bonding the subatomic core tightly together.

Up to this point, my research had been an investigation into the characteristics of fractal patterns and the relationships of their geometric structures to those occurring in natural phenomena. Thus far the entirety of my body of work had dealt with minutiae and phenomena existing at the smallest scale currently imaginable. The explosive events depicted in earlier pieces essentially exist at a scale similar to the deepest, most intimate iteration of the fractal set. On the contrary, the galactic scale at which our familiar celestial neighborhood exists approaches the farthest bounds of the fractal set.[16] My formal inquiries began to shift correspondingly in scale, becoming directed towards the events occurring at the outermost reaches of our modern theoretical understanding of the Universe. I used the focus of my research to allow the artistic portion of my mind to begin to attempt to identify the forms super-gigantic events and phenomena such as the Big Bang or the creation of another such Universe would adopt.

Given that physical laws govern the behavior of matter existing all scales, minute and immense, my investigation sought to uncover the formal relationships shared by microcosmic and macrocosmic occurrences alike.

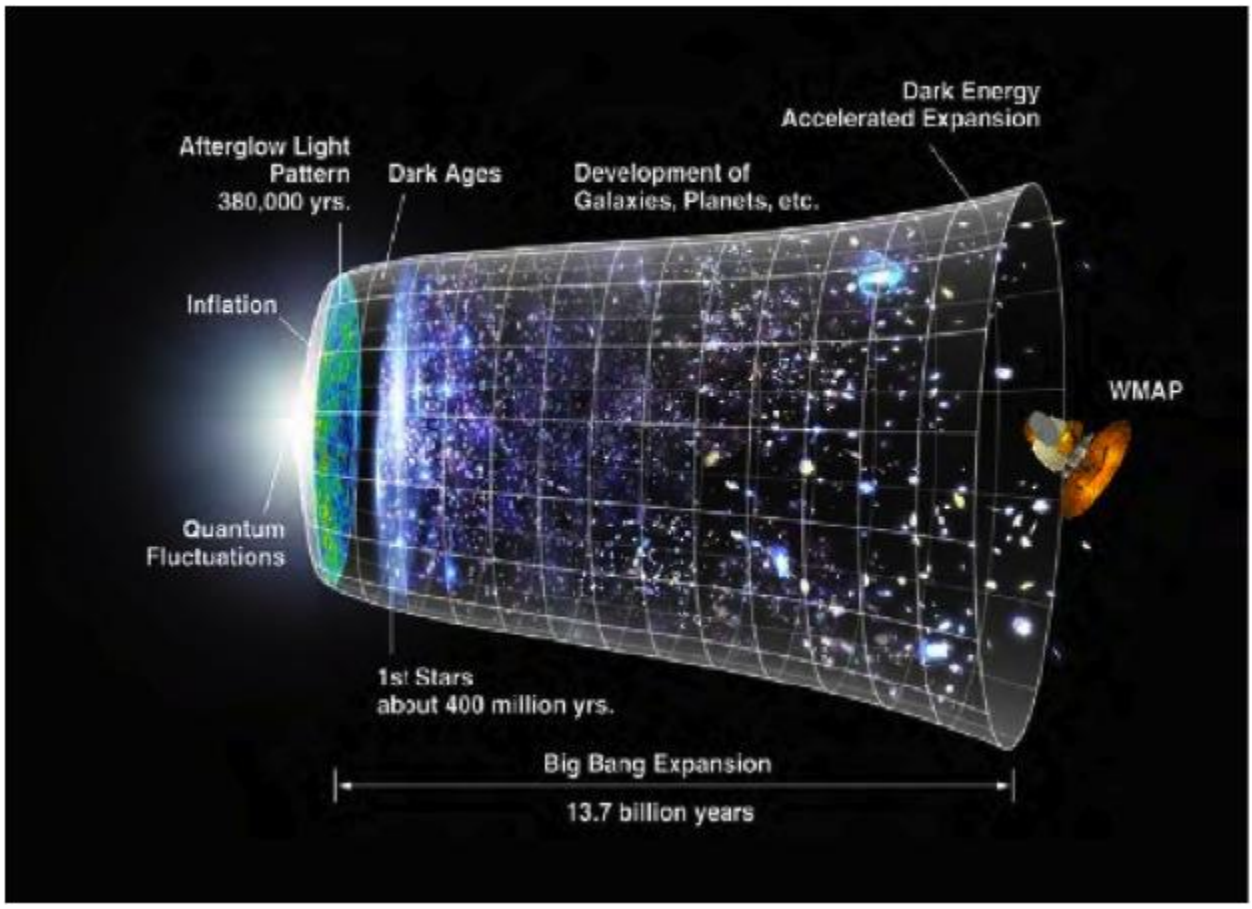

Fig. 11: Inflation Model. www.kipac.stanford.edu. 2014.

For the focus of my thesis work, I looked back at an event first sparking my scientific interest, the Big Bang. Occurring approximately 15 billion years ago, this event in particular is unique due to its unimaginable transformation from the smallest scale to the largest imaginable scale in an instant.[17] The Big Bang is the event of utmost profundity not only to our species but our entire Universe as we currently understand it.[18] Therefore I found it to be a suitable subject matter to focus my research and ideation pertaining to the formal nature associated with this one

great event. I wanted to get a sense of the formal nature of the Universe: in essence, its shape. To begin my design process, I began to explore digitally rendered models of the event, similar to the research that I conducted before starting work on *LHC* (Fig. 1), such as event models from Stanford University's Kavli Institute Particle Astrophysics and Cosmology (Fig. 11). During the initial design phases maquettes representing the explosive force unleashed at the time of the Big Bang were critical in diagramming the outermost reaches of primordial space and time moments after the commencement of their very existence.

During the moments directly following the Big Bang, the Universe in its infancy experienced a period of hyper-accelerated enlargement known to the world of physics as inflation.[19] As in my previous work, it was imperative that I be able to capture these expansive moments of the early Universe frozen in time, thus transporting the viewer to an interval of time directly following the Big Bang. It was also of great interest to examine the relationships between the forms taken on by explosive forces at this gigantic scale and those occurring at the ultra-minute scale, as I had explored in my earlier work. I continued modeling these forms, excited to gain a greater understanding of the event that started everything as we know it. My investigation was also an inquiry to understand a more profound truth about the nature of all things in the physical world, a task that seemed increasingly vast as my research continued. As the paper models began to take form the structure of the object began to resemble the Kavli Institute's representation of the inflating Universe. The steel forms serve as planes that help define the borders between all that is observable and all that is not.

Among the theoretical revelations I experienced during my research for *Macroscopic Manifestations,* the true form of primordial inflation was one of the most striking. Previously I had been under the impression that the Universe at the time of the Big Bang began to inflate

outwardly in all directions in a spherical fashion, resembling more closely the model represented in Josiah McElheny's *Island Universe* (Fig. 2).[20] However I now understand that this notion is not believed by the scientific community to be a truthful model of inflation. Rather, the expansion took on a conical form expanding in an asymmetrical fashion instead. To reference this, my modelling exploration employed elongated triangular shapes in paper, each possessing a curve reminiscent of the curvatures in space-time itself.[21] These paraboloid forms became conic sections themselves, each serving as a likeness of the conical representation of the primordial inflation itself. I stacked, staggered, and varied the relative size of the components to steer the overall composition away from a curving conical representation of the expanding Universe. In order to simulate an exponential expansion the individual forms are grouped in rings. These rings increase in the number of conic sections composing each one, corresponding to the Fibonacci sequence (1, 1, 2, 3, 5, 8, 13, 21, 34…), the same patterns of growth observed in many of the flora and fauna lifeforms existing on our own Earth.[22]

Once the paper models had been solidified as much as the medium would tolerate, I considered the material most suitable for fabricating a gallery version on a larger scale of what the border between these two vastly dissimilar horizons could look like. As a metalsmith having a strong blacksmithing background, iron and its alloys are always a favored option. Iron is also the most pertinent metal to the subject matter being portrayed. Iron as an atomic state played a critical role in the formation of orbiting planetary bodies like our own Earth and also at the end of the life cycles of our Sun's deceased stellar siblings.[23] It is an element that is prevalent throughout the known Universe and is integral to the existence of lifeforms similar to ourselves.

Due to iron's rigidity and strength it serves as a versatile and steadfast artistic medium. This characteristic in combination with iron's relevance to the extragalactic nature of my work led

me to the use of sheets of 20 gauge mild steel. I began to experiment with forming the steel into the same conic sections creating curved surfaces the same as had been achieved in the paper mockups. I did not desire the same undulating surface quality similar to that of my previous steel forming efforts in earlier works because I felt it to be unrefined (Fig. 4, 6). An event of this magnitude needed to be approached with a flowing consistency of form that could possess curvature, yet visually appear deep and motionless like the dark vastness of space.

The scale being represented is one that bordered the space between everything within our Universe and the outskirts of what we do not yet understand. I required a curvature from the surfaces I was creating, but it needed to be deep and sweeping, dark and mysterious, full of space, similar to the nature of the majority of our Universe.[24]

Each sheet of steel measured between two and three feet in height, bearing an elongated triangular shape. The most acute angle of each component emanates from an initial point of energy expansion, tapering down to even smaller points. The slip roller is the tool I found to be most practical in gradually guiding the steel sheet forms into their curving conical structure. I began to layer the conic sections, stacking each atop another to amplify the visual weight of the deep crevasses in the border between that which *is* and that which *is not*. As the culmination of the shapes approach a point of emanation, the scale of the triangles is constricted to a size capable of entering the mouth of a long curved cone. This elongated funnel form serves as a resolution to the piece's visual ventral side. This form emanates from the beginning of the explosion and up to the ensuing chaos and resulting inflation of the Universe. This exponentially shrinking tunnel is reminiscent of the wormhole out of which our Universe could have hypothetically been seeded.[25]

As the viewer's line of sight moves upwards from this point the forms grow in expansiveness relative to the passage of time in the moments after the Big Bang. The curved forms

continue to reiterate themselves, growing outward and upward towards a representation of our current point of existence within space and time inside our inflating Universe. During discussions with particle physicist Robert Wilson, in the early stages of the construction process he argued against a strictly vertical orientation due to the lack of any directional orientation in the beginnings of time during the formation of the early Universe.[26] However, my spiritual and cultural relationship to this greatest of all events led me to retain an upward visual movement within the piece, directionally towards the cultural and religious construct of the heavens, on the axis mundi.[27]

As I created more sequential components out of steel, the accumulating weight of the piece in its entirety was becoming a factor to be considered. Given the location of its final installation in the University Center for the Arts, I was aware that it would be necessary for me to set realistic and practical limitations for myself with regard to the load I was asking the ceiling to bear. After seeking guidance from my committee members we reached a conclusion that the upper iterations of the inflating expanse would have to be resolved in an alternative lightweight medium other than the burdensome steel sheets. This was initially quite troubling to me personally, as I am most comfortable forming and fabricating my work from metal. However, I began to search out possible solutions to this installation conundrum. I consulted some of my fellow graduate colleagues who were also simultaneously contending with their own installation-based quandaries. Plastic, a material that arose in conversation, seemed that it could serve as a suitable replacement for the steel sheets and was a mere fraction of the weight.

I located a local supplier in Fort Collins that stocked transparent Mylar in the same overall size and gauge thickness as the steel sheets I had been using to form the conic sections. The challenge now was to find a method to restructure the plastic sheets in order to hold the same form as the steel. This needed to be accomplished without the use of the slip roller. Although it had

performed so effectively with metal, it would prove to be completely useless to forming Mylar. The only method I could devise to cause the plastic to retain an alternative formal state was to direct a considerable amount of heat towards the surface. Too little heat and the plastic would return to its original flat position. Too much heat and the plastic would become unruly and warp into undesirable positions with ripples and inconsistencies. I needed to design a mold into which the plastic sheets could be placed, heated, and smoothed into the desired shape in relation to the original steel forms.

Rather than casting a mold for the Mylar sheets in a material such as plaster or wood, I found that the steel forms themselves served as a very effective surface onto which the plastic could be formed. After clamping one of the steel conic sections onto a work surface, the flat plastic sheets could then be clamped to the steel sheet in order to hold it into the proper position. I then directed a heat gun at the surface of the individual layers of Mylar causing them to collapse and slump into the general curvature of the steel beneath. After the plastic had begun to conform to the desired shape it was necessary to manually press and smooth the heated plastic to encourage it to remain in its now conical form. The edges needed extra attention and additional passes with the heat gun to ensure a level contour with the steel mold into which they were pressed.

Once the majority of the supplementary plastic forms had been fashioned I began to determine the most suitable means of treating the surface of the work. Given that the work was no longer going to be composed in its entirety of an iron based metal alloy, a traditional metalsmithing patina recipe would not be feasible as a surface finish. I desired a darkened surface that would absorb light rather than reflect it, in reference the vast darkness of space at the edges of the Universe. The coating needed to be able to bond to both steel and Mylar, successfully and permanently. It also needed to be able to bend and sway without cracking or flaking off the surface.

The substance I found to satisfy all of the characteristics I was in search of in a surface treatment was a durable, flexible, multi-purpose, rubber coating, known commercially as Plasti-Dip. This rubberized surface layer produces a rich black on the conically curved components and is minimally reflective of incoming light sources. It bonds securely with the surface of both materials employed in my work, and due to its elasticity, will tolerate any torsion being applied to the forms, especially the plastic ones which are much more prone to distortion.

The application of the black rubber coating onto the surface of the work had brought a darkness, depth, and richness to the piece that I greatly enjoyed. However, I desired some form of decorative surface embellishment to disrupt the monotony of the blackness. The addition of surface ornamentation would function not solely as an aesthetic enhancement but also as an allusion to the timeframe corresponding to the formation of the first stellar celestial bodies.[28] It was therefore imperative that these accompaniments be absent from the ventral portion of the piece, emerging instead within the exponentially inflating dorsal portions. To ensure consistency in size and shape of these additional visual elements in space I required an application tool capable of precise, repetitive, mechanical connections. As I had done in the selection of materials for fabrication, I looked to products of industry for solutions to artistic concerns. I was again rewarded with a resolution to the challenge of locating such a tool. The industrial pop-rivet served as a remedy, providing consistent surface embellishments that could be quickly and firmly installed into position within the upper plastic conic sections.

Similar to my earlier microcosmic works of art, there exists an exponential pattern of growth that is also evident in this macrocosmic representation of the greatest cosmological phenomenon. The natural laws governing augmentation patterns of matter are present all around us whether they are visible or invisible within the physical world. I will consider this work

successful when my viewers can also draw relationships between structural patterns evident in microcosmic and macrocosmic phenomena alike. In addition, my hope is that associations may be formed between the phenomena I represent in my own work and those phenomena occurring at all transformations of scale, including the familiar, conventional scale we as human beings take our form. It is after these insights that have been made manifest in my own mind permeates those of my audience, my own role in this great existence will be realized.

Following my graduation from Colorado State University I foresee the future of my own artistic endeavors to remain firmly rooted in the vein of the physical sciences. The worlds of both the arts and the sciences possess a great commonality in the manner through which they pose questions, formulate theoretical modes of understanding, and affect the way we perceive the world around us. The sciences and the arts hold great importance to humanity due to their occurrence at the confluence between our emotional, manual, and mental sensibilities. The correspondences between these two not-so-dissimilar disciplines could be disseminated to a greater degree amongst scholars of both fields of study as they provide humanity with quantifiable ways of gaining a further understanding the world around. In my imminent professional career as an artist, teacher, and thinker the aim of my work will be to continue to integrate both scientific and artistic concepts and philosophies into my own creative endeavors, and begin to incorporate them into the means by which the next generation can absorb these ideas through interdisciplinary exposure.

Fig. 12: Macrocosmic Manifestations, 2015. 10' x 10' x 10'.

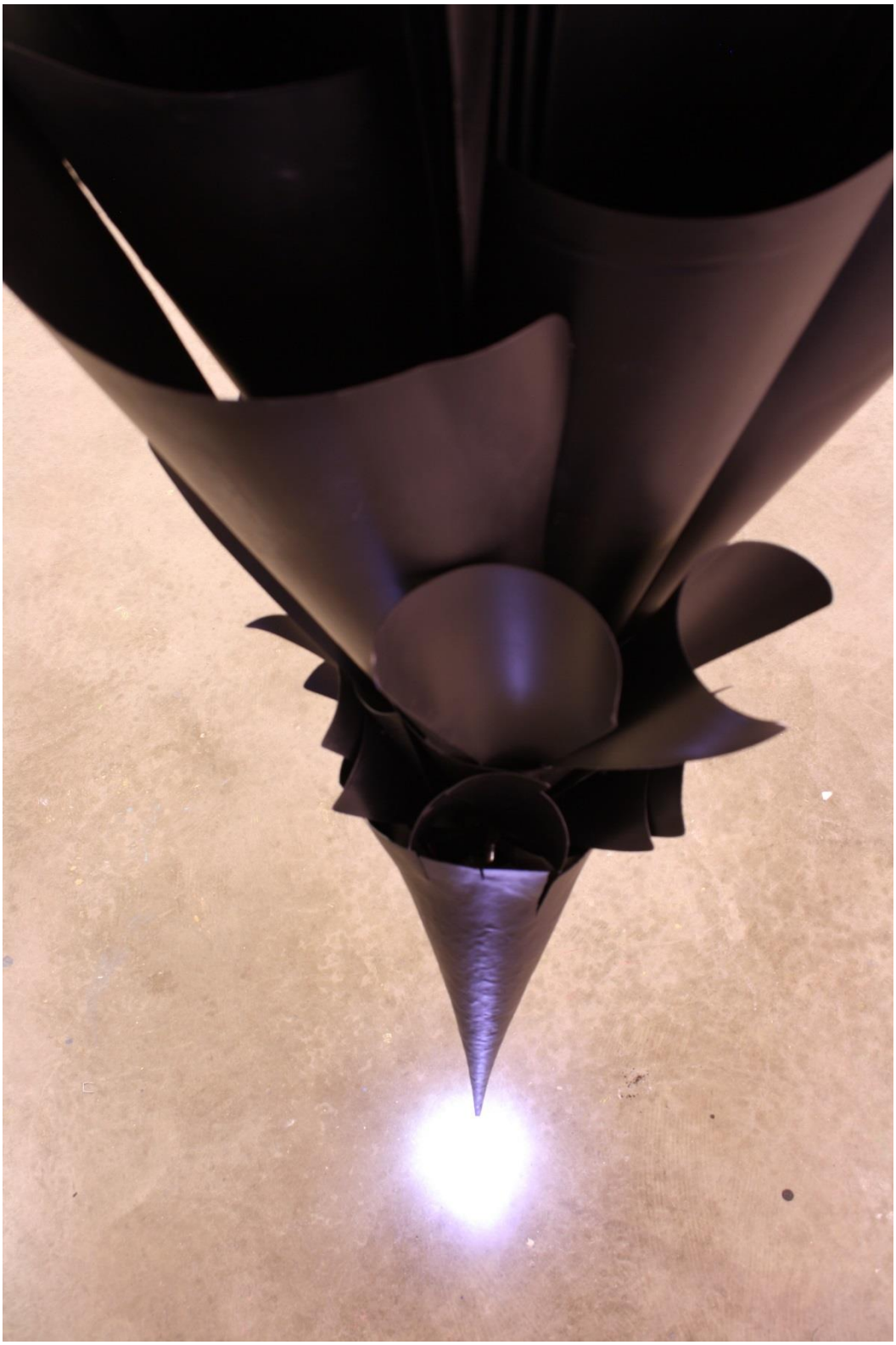

Fig. 12: Macrocosmic Manifestations, 2015. 10' x 10' x 10'.

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