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VISUALIZING THE UNIVERSE – THE INTERSECTION OF ART AND ASTRONOMY

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ABSTRACT

This article presents a colloboration between a research astronomer and a professional artist. The paintings resulting from this transdisciplinary work are inspired by stories of recent astronomical discoveries, and by images from ground– and space–based telescopes. During the collaborative process, the dialogue between the scientist and the artist emerges as a new language that changes the perspective of each. The work remains true to science while utilizing the possibilities of the oil–based medium. The aim of this project is to extend the art–science conversation to audiences viewing the work.

KEYWORDS: astronomy, art, astronomical images, painting, fine art, visualization

1. INTRODUCTION

The beauty of the night sky and the mysteries of the universe have captured the imagination of both scientists and artists since the beginning of recorded history. We are struck by a profound sense of wonder and amazement when pondering the cosmos. As two individuals who have made both science and art a lifelong pursuit, we have a mutual interest in exploring astronomy through painting. Our collaboration, born of shared interest in the beauty of astronomical phenomena, led to the series of paintings "From Craters to Cosmos."

Astronomy and art have a longstanding relationship. Astronomy is an intensely visual subject. Before photography, the only way to represent objects in the sky was with a drawing or a painting. Artists of the past helped astronomers see and record natural phenomena, which in turn stimulated questions about our place in the universe. Art communicated ideas which enriched the culture and led to advances in ways of visualizing remote and unfamiliar environments. Even in the age of digital imagery, art is important for connecting us to the skies.

The intersection of art and astronomy is important for a broader cultural reason. In 1959, C.P. Snow delivered a lecture where he lamented the gulf between science and the arts. He argued that practitioners on both sides should build bridges, for the progress of human knowledge and the benefit of society (Snow, 1961). Inadequate education and the burgeoning growth of knowledge mean that most average citizens have low science literacy (National Science Board, 2016). Meanwhile, scientists tend to be narrowly trained in their discipline and funding the Arts and Humanities is low. More scientists and artists need to reach across this divide (Gould and Purcell, 2000). Then they might, as Shakespeare expressed it in his play *As You Like It*, "find tongues in trees, books in the running brooks, sermons in stones, and good in everything."

2. HISTORICAL LANDMARKS

Since the night sky was an essential tool for timekeeping and navigation, it's not surprising that some of the oldest human cultural artifacts involve astronomy. In the caves at Lascaux in France, beautiful and technically accomplished art appears to enshrine phenomena of the night sky (Pasztor, 2011). Throughout history, artists have had an intense interest in the natural world. In the *Codex Leicester*, Leonardo da Vinci explores the patterns of shadow and light that cause the Moon to have a cycle of phases (Figure 1).

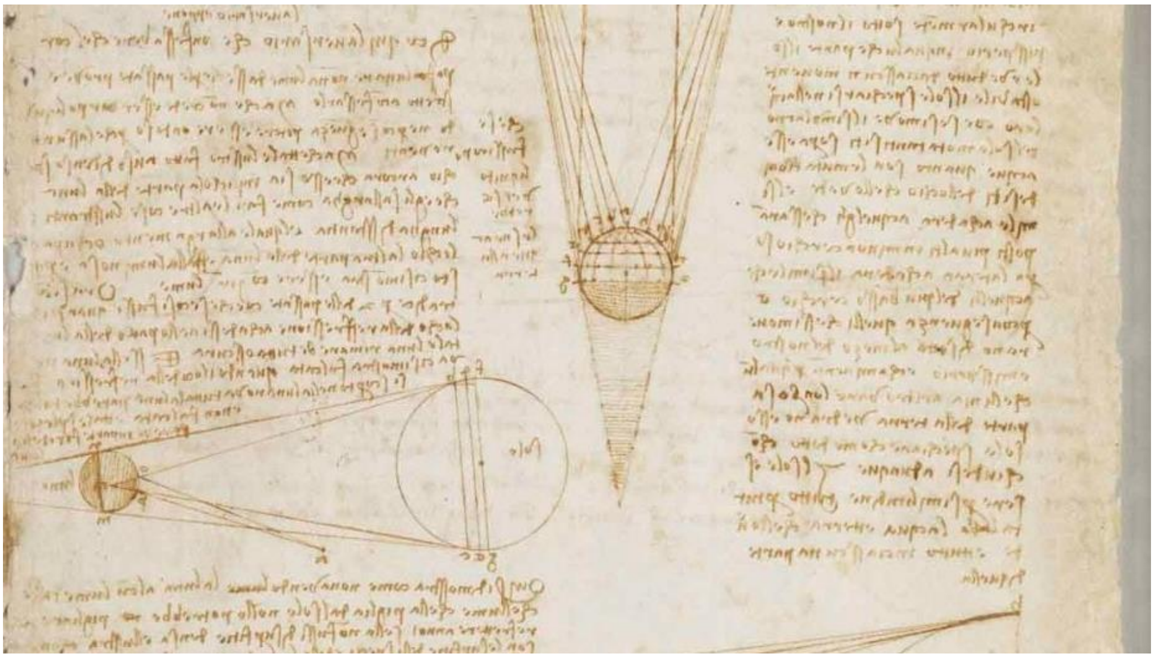

Figure 1. A drawing from the Codex Leicester (1504–1508) of Leonardo da Vinci, now owned by Microsoft co–founder Bill Gates. Leonardo knew that the Moon shone by reflected light from the Sun. In another drawing he represented the pale glow on the dark portion of the crescent Moon, shown by Kepler a hundred years later to be sunlight reflected from the Earth. Credit: Leonardo da Vinci, in the public domain.

A few years later, the great German artist and printmaker Albrecht Dürer made the first perspective rendering of a terrestrial hemisphere (Figure 2). Dürer greatly influenced the cartographic and anatomical science of his time (Dackerman, 2011). See also the discussion in Snyder (2007).

Figure 2. The first representation of the Earth as a polar projection, by Albrecht Dürer and Johannes Stabius (1515). This was several years before proof of a spherical Earth came from Magellan's circumnavigation voyage. Credit: British Museum, in the public domain.

A hundred years later, art and science came together again in the hands of Galileo Galilei, whose careful drawings of the moons of Jupiter and the star fields of the Milky Way cemented the Copernican Revolution. By showing the Moon to not only have craters, but also features like valleys and mountains (as shown in Figure 3), he gave support to the "many worlds" idea that the Earth is not unique as a geological body in space (Galileo, 1610).

Figure 3. Sketches of the topography of the Moon, showing geolgical features and craters, by Galileo Galilei, from the Sidereus Nuncius (1610). These images tethered the idea of "many worlds" like the Earth in space. Credit: public domain.

As another example of the harmonious relationship between astronomy and art, consider Johannes Vermeer's 1668 painting *The Astronomer* (Figure 4). The Dutch painter left a modest legacy of 34 confirmed works, but he is thought to be one of the greatest painters of the Dutch Golden Age. Scientists were a favorite topic of Dutch 17th century painting, and Vermeer was familiar with the scientific advances of the day (Eskridge, 2003). Earlier that century, both the telescope and the microscope had been invented in Holland, transforming astronomy and biology.

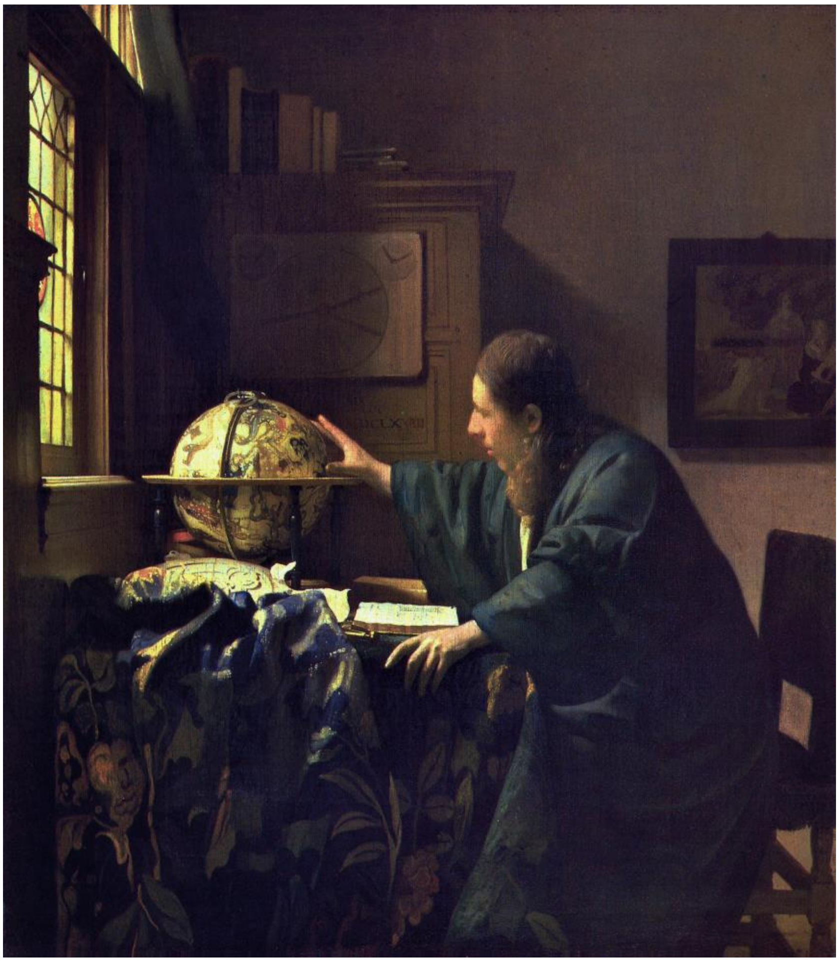

Figure 4. The Astronomer by Johannes Vermeer (1688), currently at the Louvre Museum in Paris. The painting celebrates an astronomer, but also the work and materials of the artists. The sitter for the painting was probably Antonie van Leeuwenhoek, the inventor of the microscope. Credit: Louvre Museum, public domain.

By the end of the 19th century, both science and art were in a ferment of experimentation and discovery. Painters used new pigments and pushed the bounds of color, while physicists tried to understand light and color at a microscopic level. By the early 20th century, many artists were inspired by Seurat's theory of the perception of discrete elements and by Picasso's deconstruction of perspective. Their inights paralleled the work of Einstein, whose relativity theories postulated the suppleness of time and space and the contingent nature of observed reality (Miller, 2002).

The modern era of astronomical art begins with Chesley Bonestell. After successful careers as an architectural designer and a Hollywood special effects artist, Bonestell returned to his first love, astronomy. In 1944, *Life Magazine* published a series of paintings of Saturn as seen from several of its moons (Figure 5). It was as if the artist had been sent out into space; nothing like this had ever been published before (Ley, 1951). Wernher von Braun invited Bonestell to illustrate concepts for the future of spaceflight. His example launched many space artist careers (Miller and Durant, 2001). Bonestell's work plays into a debate over fine art versus illustration (Norman Rockwell is another American example), but for us the distinction is moot.

Figure 5. Saturn as Seen from Titan by Chesley Bonestell (1944). As part of a series of paintings published in Life Magazine, this realistic depiction of a scene no human had seen launched the modern field of astronomical art. Credit: Reproduced courtesy of Bonestell LLC.

3. THE COLLABORATION

Chris Impey and Dinah Jasensky are a husband and wife team who collaborate on science and art. Chris is a Professor of Astronomy at the University of Arizona who does research on observational cosmology, and Dinah is a professional artist with a background in environmental science. Recently they have worked together on a body of astronomical oil paintings which have been displayed at various locations in Southern Arizona, including the Flandrau Planetarium, Biosphere 2, the University of Arizona's Lunar and Planetary Laboratory, Spacefest 8, Tucson International Airport, and the Fox Theater in Tucson. In this collaboration, process and exchange of ideas are as important as the particular subject matter (Impey and Jasensky, 2015).

Our collaboration arose from conversations about astronomical phenomena that intrigue and inspire both of us. Others have commented on the benefits of a joint, creative process (Wright and Linney, 2006). We conceptualized a body of work that would explore a range of astronomical subjects from the Solar System (craters) to the universe (cosmos). In doing so, we forged a new way to think and talk about the analytical and creative processes. We discussed the technical and scientific details of each subject and how to express them in an artistic and compelling way.

4. PERSPECTIVES OF THE ASTRONOMER AND THE ARTIST

Digital cameras attached to large telescopes have seen objects ten billion times fainter than the unaided eye can, across gulfs of time and space and to within a few hundred million years of the big bang. The "gold standard" of modern astronomical imaging is the Hubble Space Telescope, now approaching thirty years in orbit. Hubble images are so striking and iconic that they are part of the popular culture (Kessler, 2012). With digital imaging, the colors can be manipulated at will, and there are many examples of garish and unrealistic "false color" images on the web. However, astronomers have generally taken pains to balance the realistic representation of physical processes with an aesthetic sensibility (Figure 6), even when the data is recorded at wavelengths beyond the range where the eye is sensitive (Rector et al., 2017).

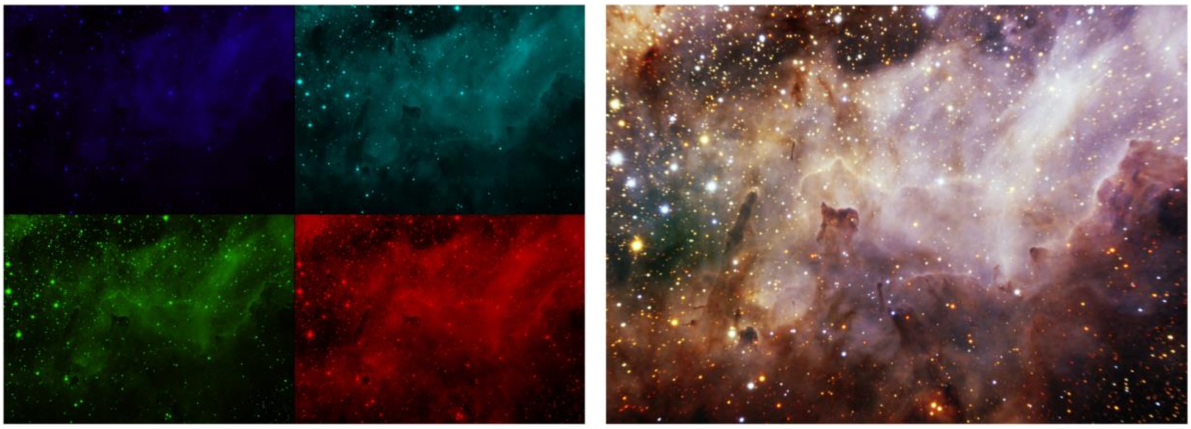

Figure 6. The star–forming region M17 is shown at four different infrared wavelengths on the left, with the infrared passbands mapped to blue, cyan, green, and red. On the right, the individual images have been combined to simulate a full–color image (Rector et al., 2017). Credit: Gemini Observatory/AURA, released to the public.

The sky as seen by the naked eye is limited to the Sun and the Moon, five planets that appear as little more than dots, a few dozen nebulae and star clusters, three galaxies, and the ragged beauty of the Milky Way. Modern telescopes give astronomers enormous light grasp but they are still limited by what telescopes can see and cameras can record. Large telescopes have small fields of view, so are looking at tiny patches of sky, and the atmosphere blurs the details of distant objects. More fundamentally, our view of the universe is limited by our position in time and space. An artist can visualize a scene that no telescope or spacecraft will ever see: the fog deep within a star formation region, the event horizon of an accreting black hole, or the surface of an Earth–like exoplanet.

A central goal of the collaboration was to go beyond nature as captured by photography and concentrate on the beauty of form, texture or color. The artist can take full measure of the freedom allowed for creative effort and expression. Tools such as composition, value range, color harmony, the quality of light and brushwork are all at the disposal and in the service of the story represented by the painting (Figure 7).

Figure 7. The painting of Mystic Mountain exemplifies the use of color active brushstrokes to convey swirling gas in a nebula where stars are continuously forming. Credit: Dinah Jasensky, "Mystic Mountain," May 2016.

5. THE COLLABORATIVE PROCESS

As thematic ideas were shared and discussed, artistic concepts were formulated and expanded. Some paintings started as purely abstract designs; others were inspired by cutting edge research images such as those from the Hubble Space Telescope. Going through these images together, we developed a concept that the artist used as a springboard to make a unique design for each painting. Throughout the process, scientific and artistic feedback continued to create a result that conveys a shared understanding of the subject matter.

When artists join with scientists to explore interests, they are led to mutual learning and new perspective (Eldred, 2016). Disciplinary boundaries can limit both scientist and artist. The astronomer demonstrates fidelity to astrophysics, with a dependence on photography and digital data, while the artist may not fully understand the scale and structure of astronomic phenomena she is trying to represent. Paintings, however, can elicit reactions and emotions that are not triggered by digital images. Artists use color, texture, and composition to visualize the universe in new ways (Kemp, 2016). Art represents nature in a way that adds to scientific knowledge through the artist's intention and particular perspective (Figure 8). As a result, artistic interpretation remains a critical component of the culture of science.

Exploring the intersection of art and astronomy involves recognizing the strengths and limitations of each discipline. The goal of the collaboration is to combine these strengths and produce work that is more than the sum of the parts. The extra ingredient arises because an artist can visualize a scene that can never be captured by any telescope. When Einstein said, "Imagination is more important than knowledge" he could have been commenting on the relationship between art and science.

Figure 8. Celestial Symphony is a painting born of an abstract idea, emphasizing color and shape that evoke the artist's concept of the harmonies of a stellar nebula. Credit: Dinah Jasensky, "Celestial Symphony," June 2016.

Figure 9. The Crucible depicts a red dying star (cool) with surrounding ejected nebulosity, adjacent to a white hot (warm) stellar nursery. Credit: Dinah Jasensky, "The Crucible," August 2016.

Collaboration benefits the artist by increasing the depth of understanding of astronomical phenomena which alters and shapes aesthetic response. For example, the temperature associated with color is a shared construct that has different meaning to astronomers and artists. In general, an artist represents warmth with yellow, orange and red, and coolness with blue, green and violet (Figure 9). The opposite is true in astronomy. Artists need to dance a fine line to stay true to the physical phenomena, yet elicit the desired emotional response to an image. Collaboration also benefits the astronomer by loosening the grip of a purely astrophysical way of viewing celestial phenomena. It's a reminder that every object in the sky is a story waiting to be told with an evocative painting.

6. THE EXAMPLE OF STONEHENGE

Stonehenge is one of the most famous Neolithic monuments in the world. Built on a plain in Wiltshire, England between 3000 B.C. and 2000 B.C., it served as a burial and ceremonial site for a large part of southern England. The astronomical functions of the monument are a matter of speculation, since the people who built it left no written record, but its use to predict the seasons and eclipses is relatively uncontroversial (Ruggles, 1997). However, debate over the reality and meaning of astronomical alignments continues (Hill 2013). The pristine, dark skies of pre–industrial England are the inspiration for a painting that shows the Milky Way arching over the gigantic stone structure at night. The starting point is a plan of Stonehenge showing cardinal points and the summer solstice alignment that was part of the central intent behind the construction.

The next step involves using planetarium software to visualize the night sky at different times of the year, to see directly how the orientation of the Milky Way varies over time. In this case, *Starry Night Pro* was used, since it has a layer that can add Stonehenge as a foreground (Figure 10), but any type of planetarium software can map the night sky appropriately for the location of Stonehenge (Persson and Eriksson, 2016). It is important ingredient of this type of software that the sky can be viewed for any epoch in history. Precession of the Earth's spin axis causes the orientation of the night sky to pivot slowly over time, so the sky must be visualized not as it is now but as it was in 2500 B.C. Last, sky maps from wide field astronomical surveys were inspected to identify the appropriate part of the Milky Way and crop it to the field of view suitable for a ground–based perspective. Only then can the artistic work begin.

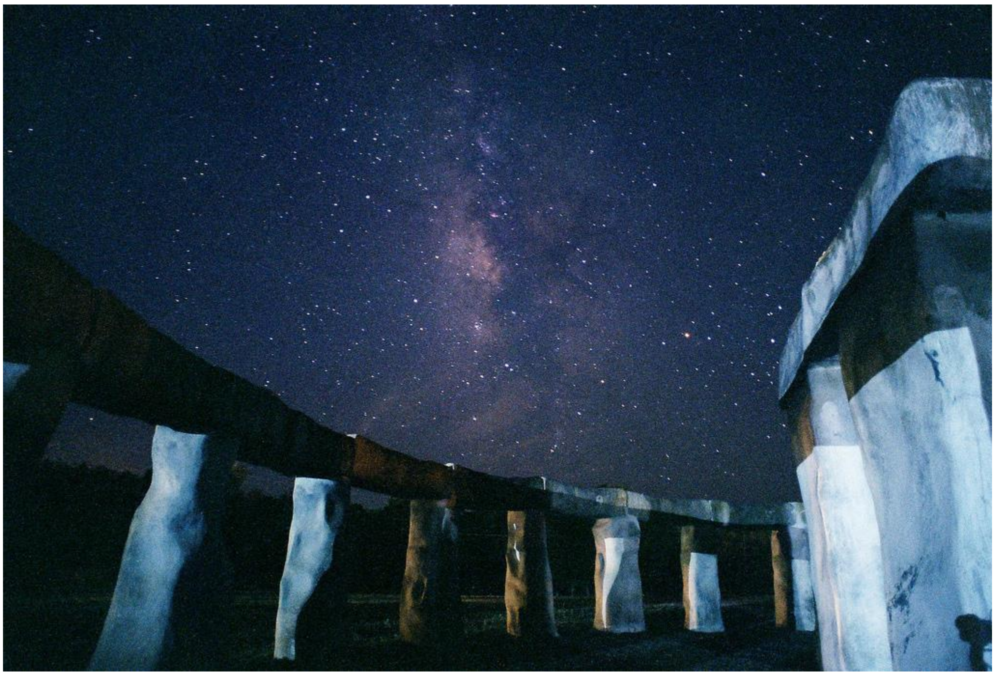

Figure 10. The view from inside Stonehenge towards the Milky Way in the southern sky, as seen early on a June night about 3500 years ago. This visualization has been rendered in the planetarium software package Starry Night Pro. Credit: Simulation Curriculum Corp.

The work of painting began with a series of small sketches to determine composition (Figure 11a), followed by studies to work out values and color (Figure 11b). The concept was then drawn onto the canvas with charcoal (Figure 11c, left). Next, the canvas was covered with a loose acrylic underpainting to nail down the visual relationships and color harmony (Figure 11c, right). Oils were applied, using a wet–on–wet technique (Figure 11d). Throughout the painting process, we discussed scientific concerns and our aesthetic response to the work. The resulting image is shown in Figure 12.

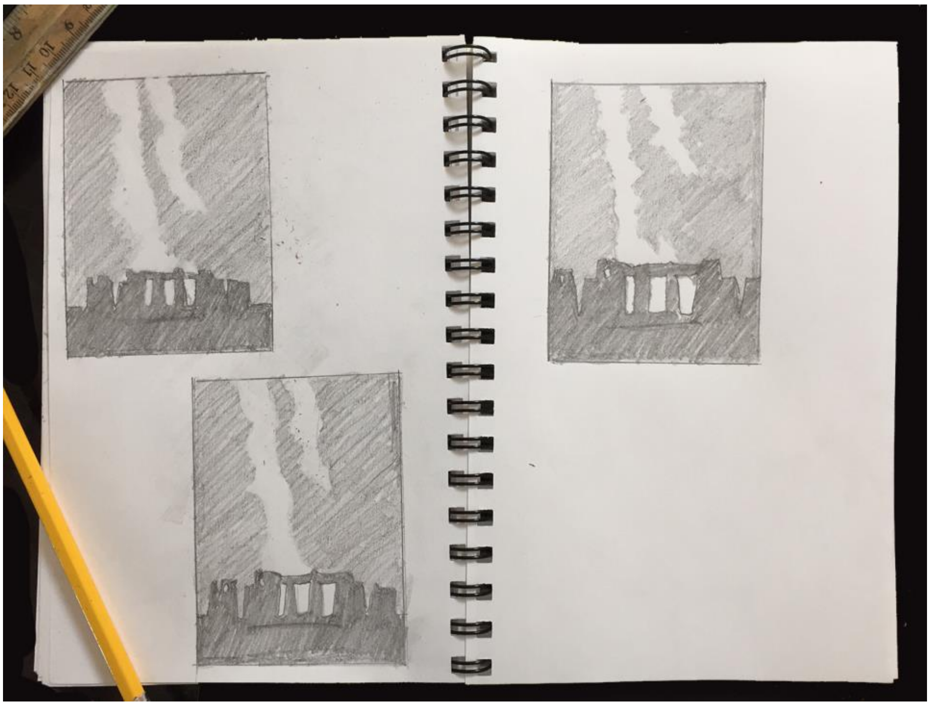

Figure 11a. Thumbnails are small drawings to determine value structure and composition. These sketches show some of the drawings used to determine the size of the Stonehenge in the painting. Credit: Dinah Jasensky, "Thumbnail Sketches," July 2017.

***Figure 11b.** The color palette and color harmonies are explored in a series of small sketches. Credit: Dinah Jasensky, "Color Studies," July 2017.*

***Figure 11c.** A drawing is made then transferred to the canvas in charcoal (left). An acrylic underpainting loosely establishes color and values (right). Credit: Dinah Jasensky, "Drawing and Underpainting," July 2017.*

Figure 11d. A palette knife is used to apply thick paint in opaque areas. Credit: Dinah Jasensky, "Paint Application," July 2017.

Figure 12. Milky Way over Stonehenge. The summer's dark night sky is represented as it would have been seen in the pre–industrial age, acting as a backdrop to this iconic Neolithic structure in the south of England. Credit: Dinah Jasensky, "Milky Way over Stonehenge," July 2017.

7. CONCLUSION

During our work, we talked about the project frequently, from initial concept development to finishing details. We developed a dialogue that allowed fluid movement between scientific and artistic language. We grew to appreciate each other's point of view and learned to see our work through a different lens. We asked and answered questions, but always left room for mysteries. The collaboration continues, with subject matter that ranges from moons and exoplanets to nebulae and galaxies. Each astronomical context is a different challenge in terms of composition, color balance, and choice of painting medium. The abundance of the universe presents the artist and the scientist with unlimited opportunities.

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