ARTIST'S NOTE

The Historic Search for Red Sprites: Art Meets Science in *Lightning's Angels*

Peter McLeish

ABSTRACT

Sprites are fleeting, luminous shapes that shoot into the upper atmosphere during large thunderstorms as lightning simultaneously reaches down to Earth. For at least a century, scientists have attempted to confirm and explain the existence of sprites with visual images and data. The author's series *Lightning's Angels* supplements the documentation of sprites by exploring the properties of this natural phenomenon through digitally enhanced oil portraits set to music and displayed in a large-scale multimedia format, such as at a planetarium.

THE ORIGIN OF SPRITES

In the plays of William Shakespeare, sprites are mythical creatures, elusive and playful. In English folklore, they manifest themselves either as small beings like elves or fairies, usually associated with water, or as ghostly spirits. More modern usage of the term denotes a small, delicately built person, or an independent graphic object that moves freely across a computer screen.

Most recently, in the natural world, all these historical attributes of sprites have combined to inspire the designation of an upper-atmospheric optical phenomenon associated with thunderstorms. For nearly a century, the phenomenon went without a name and without even scientific confirmation that it existed. The only evidence was anecdotal. Newspaper reports of red flashes or a glowing sky go back at least a century. The general scientific response, however, was "This cannot be!" Pilots also saw strange flashes of light dancing above the clouds, but never officially reported what they saw, lest it be interpreted as a crazy UFO sighting [1].

Despite this accumulating anecdotal evidence, scientists remained skeptical. In 1989, however, the first camera images of sprites were captured, quite by accident [2] (Fig. 1). Spurred by this serendipitous discovery, inspection of videos taken aboard the space shuttle *Atlantis* [3] in the 1990s elicited 20 more visual specimens. The discovery of incontrovertible evidence produced "a major frenzy of excitement" among scientists and subsequently a great cache of inspiration for at least one visual artist.

I document my artistic interpretation of sprites in a 2002 video titled *Lightning's Angels,* which presents my digitally enhanced oil paintings of sprites in various states of transformation (Color Plate C No. 1). This article includes several thumbnail stills from *Lightning's Angels* as they existed before being animated in multimedia format.

THE SCIENCE OF MY ART

My interest in expressing the beauty of science through paintings and multimedia dates back, formally, to my studies for a master of fine arts degree at the University of Guelph in Ontario. There I completed my first work focusing on a natural phenomenon: *The Glory Project.* Informally, however, my inclinations for bumping the interfaces of art and science reaches back much further. Like many children, I was painting when I was six, but I never stopped. All the while, I was transfixed by science. I witnessed Neil Armstrong's first steps on the moon when I was seven years old. I remember it vividly; watching the moon landing on television proved to be a formative influence.

I recall feeling as I was growing up with my preoccupations with painting and science that their realms were considered mutually exclusive. Some people liked artistic things, while others were drawn to science. Of course, this has not always been the case. One could cite the obvious historical examples: Monet, Picasso and Leonardo da Vinci. My intuition led me in a direction in which the two realms co-existed happily. As a teenager and young adult, I had continued to paint while focusing my aca-

Fig. 1. Photograph of "triple" sprite taken from the space shuttle *Columbia*, 22 January 2003 (orbit 87 of STS-107). This event occurred at 01:53:15.89 UTC (Coordinated Universal Time) and was located almost directly above the atmospheric limb 1,900 km away from the shuttle at 17°E 4°S, over south-western Africa. Normally sprites occur in one region of the sky per event. This triple sprite displayed three simultaneous brightenings in the sky, separated by many kilometers. The three parts of the sprite occurred within one video frame. (© Colin Price/Meidex Team, Tel Aviv University)

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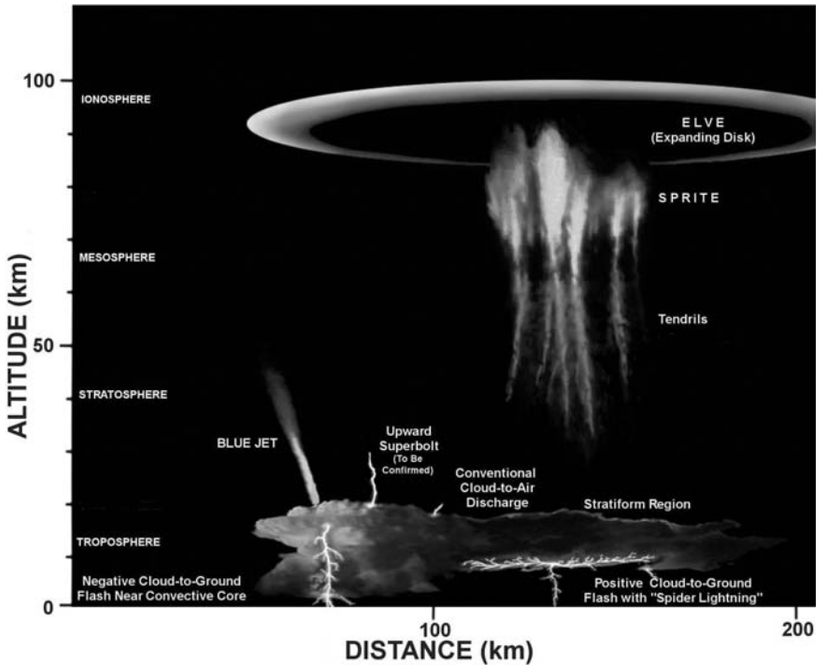


Fig. 2. Three types of upper-atmospheric optical phenomena, named red sprites, blue jets and elves, which are collectively known by atmospheric physicists as Transient Luminous Events (TLEs). TLE image created by Walter A. Lyons and published originally in W.A. Lyons et al., "The Hundred Year Hunt for the Sprite," *Eos, Transactions, American Geophysical Union*, vol. 81, pp. 373–377, 2000. (Copyright © 2000 American Geophysical Union. Reproduced by permission of American Geophysical Union.)

demic studies on science and math, in preparation for what I believed would be a career in architecture. When I started architectural/design training, however, my creative impulse finally took over. I designed wild buildings, with no regard for practical parameters, such as accommodating the need for a toilet. My designs clearly were too wild. This prompted me to switch to an undergraduate degree in fine arts.

In undergraduate work, I became known as a figurative artist. My first series of portraits explored the hidden personae of masked figures, motivated by Carl Jung's idea that "the face becomes the mask" [4]. The series included, among others, a football player, a motorcyclist and a deep-sea diver. My portrayal of the deep-sea diver evolved into my next project (a series of 40-×-26-in. paintings titled *Light in Dark)* via an obsession with bubbles and how they reflect and refract light in water. In painting the diver, I spent more and more time getting the bubbles exactly right. Before long, I noticed I was concentrating more on the "backgrounds" than on the "subjects" of my paintings. My work veered toward the abstract, focusing on atmospheres and environments. The background became the subjects—I painted only the bubbles.

By this time, I had arrived at a predominantly science-focused university, which provided me with endless expert sources for research and inspiration. I sought out physicists, biologists and chemists and picked their brains for details that would enlighten my work. Since I had a solid background in the sciences, I understood their work without requiring translation into general and popular terms. In fact, not only did I understand the technical details of these conversations, I was able to understand the scientific theories by visualizing them. As I delved into the details with these scientists, one thing led to another, and I discovered *glories.*

Like a sprite, a glory is an upper-atmospheric phenomenon—it is a faintly colored series of rings of light, like a circular rainbow, atop clouds. The rainbow emerges when rays of sunlight pass, in a backward diffraction of light, through a cloud containing water molecules, or bubbles, which are uniform in size.

My portraits of glories were very small—6 × 6 inches—but I was struck with the desire to project them on a large scale—20 meters or more. I could envision myself inside the environment of my own work. I wanted the depiction of glories to be as close to life size as possible. I wanted the viewer, when peering into my 20-meter projection of a glory, to have the sensation of witnessing this phenomenon firsthand.

The Glory Project was mounted on the domed ceiling of the Planetarium de Montreal. The audience was enveloped not only by the visual horizon of the glory, but also by the transcendental music of *Ave Maria,* composed by Giulio Caccini (1550–1618) [5]. I was enormously encouraged by its reception—one viewer commented that while experiencing the glories in the planetarium, he lost his orientation in the real world and felt as if he were falling into the atmosphere of the glory. The show also attracted television and newspaper reviews and was advertised on SPACE, a Canadian television network. This motivated me to pursue further research on natural phenomena of the upper-atmospheric region. I soon encountered the intriguing scientific history of the red sprite.

The Science of Sprites Meets Art

In 1925, the Nobel Prize–winning Scottish physicist C.T.R. Wilson first proclaimed the existence of brief flashes of light high above large thunderstorms. Wilson's theory proposed that electric fields create ionization at great heights and could therefore give rise to discharges, or "sparks," between clouds and the upper atmosphere [6]. He theorized that such sparks occurred at an altitude of approximately 45 miles and were followed by a burst of upward- and downward-propagating electrical streamers [7]. In 1956, Wilson declared:

> It is quite possible that a discharge between the top of the cloud and the ionosphere is a normal accompaniment of a lightning discharge to earth. . . . Many years ago, I observed what appeared to be discharges of this kind from a thundercloud below the horizon. They were diffuse, fan-shaped flashes . . . extending up into a clear sky [8].

The first sprites captured by science appeared in high-speed video recorded in 1989. Despite the existence of these images and others from the space shuttle as proof, sprites remained elusive to scientific understanding. One reason was that sprites seemed to be infinite in their variety, each as original in shape and form as a snowflake. Also, sprites disappear almost as quickly as they form—the blink of an eye lasts 250 milliseconds, but a sprite often lasts only 10.

Nonetheless, inspired by the visual

proof, two field experiments soon targeted sprites. Davis Sentman, a geophysicist at the University of Alaska Fairbanks, sought to record the flashes from an aircraft flying over the Great Plains in the summer of 1993 [9]. That same summer, detectors were set up on Yucca Ridge in the foothills of the Rocky Mountains, playing on a hunch of Walter A. Lyons, a certified meteorologist at FMA Research, a consortium of atmospheric scientists [10]. Within a day of each other, these two research teams had documented sprites and initiated a new interdisciplinary area of scientific research: Transient Luminous Events [11].

Despite the more frequent sightings of these mysterious upper-atmospheric flashes of light, no formal nomenclature developed. The phenomenon was referred to variously as "rocket lightning," *flachenblitz,* "upward lightning" and even the cumbersome "cloud-to-stratosphere" or "cloud-to-space lightning." This pell-mell naming created much confusion. Finally, Sentman and Lyons isolated two classes of this elusive flash. Sentman called his "sprites," and Lyons called his "elves" (as more species of Transient Luminous Events—TLEs—were discovered, they were named in the same vein: trolls, gnomes, pixies and blue jets [12]) (Fig. 2). Sentman and Lyons had found Wilson's fan-shaped flashing "sparks," but they had yet to conclude what caused them.

In their ongoing search for an explanation, Lyons and others launched a program called Severe Thunderstorm Electrification and Precipitation Study (STEPS), sponsored by the National Science Foundation. What they found was that such powerful sprite-inducing lightning bolts did indeed dwell in the huge thunderstorms that roam the central United States on sweltering, steamy summer nights [13].

Current thinking holds that sprites result when free electrons in the thin atmosphere are accelerated by the sudden change in the strength of the electric field caused by the parent lightning far below. When the electrons slam into molecules of nitrogen, they cause the nitrogen to glow, usually a flickering glow of iridescent reds in the upper and positively charged body of the sprite—hence the name "red sprites"—and blue emissions in the negatively charged lower tendrils [14]. The process is not unlike the aurora borealis, where the energetic particles are supplied by the solar wind, igniting the night sky.

LIGHTNING'S ANGELS

I saw my first image of a sprite after an 8-hour search on the Internet. Following *The Glory Project,* I wanted to continue working with natural phenomena as my subject matter, particularly phenomena residing in the upper atmosphere. I researched for months and found many possibilities, such as aurora borealis and sundogs. These occurrences, however, had been well documented by both scientists and artists, which diminished their appeal. One day, after an exhaustive search, the words "red sprite" appeared. I opened the page and up popped the first visual image of a sprite. It looked so fantastic that I assumed it could not be real; if it were real, everyone would be talking about it. I soon learned, however, the intriguing history behind sprites, and that this was indeed a newly discovered—or at least a newly corroborated—natural occurrence. I knew immediately that I had found my inspiration for another series of paintings.

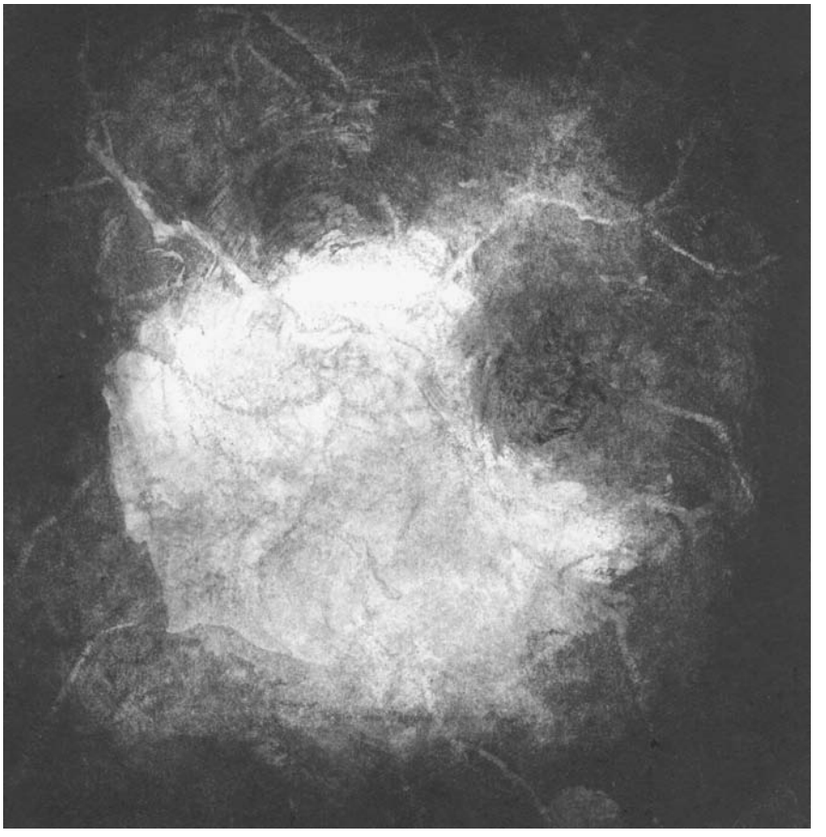
I contacted Lyons by e-mail, introduced myself and suggested that we might collaborate. Such a request was new to him, and over the next 2 months he bombarded me with questions about art and science, testing my knowledge and dedication. Finally, he was convinced and agreed to work with me. Immediately, he wanted a proposal, describing my end of the project, to submit for funding to the National Science Foundation. Several months later our application was approved and our sprites collaboration commenced.

My plan was to produce paintings of sprites based on data provided by Lyons and create visual documentation for aspects of sprites that had not yet or could not be captured by a camera or video. As such, I was contributing to the collective oeuvre on sprites.

I found that the more information I absorbed about sprites, the better I could realistically render their scientific and supernaturally elusive characteristics. Instead of just painting a general series of sprites, I could portray all their nuances, imagined or real. My painting *Start of a Sprite* (Fig. 3) is a good example: it concentrates on the initial electrical discharge that gives birth to a sprite, a stage of the phenomenon that is nearly impossible to document.

My paintings also attempt to show

Fig. 3. ***Start of a Sprite*****, encaustic, 6 × 6 in, 2002. (© Peter McLeish) As if seen from above.**



sprites from angles not otherwise possible—from directly below, directly above or very close up (usually images are captured from afar and on the horizon). Attempting these compositions dictated the physical and environmental factors in which I worked. I did not paint the sprites with the canvas in front of me on an easel. Rather, I looked down on the work, laying it flat on a large low table. I worked entirely in the dark; I found this to be the best way to paint the crucial component of light into the sprites. I always started a piece at night (occasionally finishing in the morning), with the studio pitch black, except for one light source illuminating the sprite as it evolved.

It ultimately took me 10 months to produce over 200 sprite portraits. I prepared for each by carefully observing, often staring at, photographs and video of red sprites. It was enormously challenging to convey their phosphorescent colors and flickering, fleeting forms.

In order to catch these spritely qualities, I employed my own unique method of encaustic—using a mixture of beeswax and paint thinner, oil paint, oil pastel, oil bar, oil stick and wax pastel on paper. Before I began with the paintbrush, however, I started by drawing. I drafted the entire work with the equivalent of an architectural drawing, mapping out the general forms and then all the intricate, sinewy lines.

Painting began on top of the architectural sketch. I painted layers upon layers of images, trying to achieve a sense of depth. Using the encaustic both "hot" and "cold" facilitated this—when the wax was warm and still malleable I easily smudged it, yielding a transparent effect, and when the wax had cooled, I molded it to form texture. This process generated a multi-dimensional rendering of the sprite. As with the glories, I chose to make the portraits of sprites small, only 6 x 6 inches. My reason for this is difficult to explain. Similar to how clouds move en masse through the sky, sprites occur as an entirety. Working on such a small scale allowed me greater control over their existence as an entirety—if there was a problem with one aspect of the rendering, the small scale made it manageable for me to correct or re-create the piece in one fell swoop, rather than reckoning, "There is a problem in that far left corner at the tail of the sprite; I'll have to wait to fix that tomorrow." I preferred to treat each portrait as a whole. It was almost as if that control gave me the force of Nature in re-creating this natural phenomenon.

After my 200-plus sprite portraits were completed, I edited them down to 26 for inclusion in the multimedia exhibit—a 6-minute video titled *Lightning's Angels*. This video was my part of the collaboration with Lyons, which included his home/classroom multimedia components on sprites and other aspects of the electrical earth, and an interactive web site. In producing the video, I first scanned each painting into the computer to be digitally enhanced. Many people have questioned why I went through this process. I am melding old and new mediums, or translating the old practice of oil painting into the multimedia realm I grew up with.

There are, however, more practical and aesthetic reasons for the practice. As with *The Glory Project,* my sprites may have begun small-scale, but they were to be shown on a very large scale—thrown onto a 30-foot film screen or the roof of a planetarium. If I were to do this without digital enhancement, the image of the sprite would lose its vivid and multi-dimensional effect. In order to maintain this effect, I digitally altered the color and the light-dark contrast, sharpened the fine lines and mottled the texture to excess. To the naked eye looking at these enhanced images, they are overwhelming and unbalanced—the reds are too red, the dark areas are overpowering and the sharp lines leap out. But when the image is projected, the sprites look as upper-atmospheric flashes of lightning should —luminescent and alive.

There is also a symbolic consideration in showing the sprites on film. Filming the sprites in various states of transformation, dissolving one upon another upon another, produces a less static sense of this phenomenon that is, in real life, very dynamic and fleeting. And the dark environment in which the film is viewed is also very important. All my work is shown in the darkness. This approximates the natural realm in which sprites occur.

Sprites and the Future

As my artistic and scientific interest in sprites evolved, I made the acquaintance of another expert in the field, Colin Price of the University of Tel Aviv, Israel. At the time, Price was working on a project called the Mediterranean Israeli Dust Experiment (Meidex) (a joint project of the Israeli Space Agency and NASA) to be executed on the Space Shuttle Columbia mission in January 2003 [15]. His Israeli-Meidex compatriot aboard Space Shuttle Columbia was Ilan Ramon, a colonel in the Israeli Air Force. One of Ramon's tasks in executing the Meidex project was to take pictures and gather research data on sprites above forecasted areas of active thunderstorms. Simultaneously, as the optical observations were recorded from space, Price recorded ground measurements. This was to provide one of the most comprehensive collections of data on sprites to date. Several months after the space shuttle mission, I was informed that Ilan Ramon, before the tragic end to the mission, was successful in taking some wonderful images of sprites and transmitting them back to Earth. I did not know Ramon, but I grieved his loss and the loss of the other astronauts. I plan to incorporate the images he captured in a few final paintings for the series. For me, that will be part of Space Shuttle *Columbia*'s enduring legacy. As an artist, I am incredibly grateful that scientific explorers like Ramon have the courage to travel out into our universe, trying to bring us all closer to natural phenomena such as sprites.

Shortly after the tragic loss of the *Columbia,* wild rumors flew suggesting that the shuttle had been damaged by a sprite. A photograph taken by an amateur astronomer in San Francisco was purported to show a "lightning-bolt-like" strike emanating from the orbiter as it flew over the California coastline. NASA has not yet released this image for external scientific review. Neither the description of the image nor the weather conditions at the time, however, support the notion that a sprite could have been the cause of the shuttle's demise. If it was not a sprite, and if the image does not turn out to be simply an optical illusion, then the possibility of another as-yet-unknown electrical phenomenon at the base of the ionosphere will have to be investigated. The quest for uncovering and explaining the natural phenomena that ignite our curiosity will continue.

References and Notes

1. O.H. Vaughan, Jr., and B. Vonnegut, "Recent Observations of Lightning Discharges from the Top of a Thunderstorm into the Clear Air Above," *Geophysical Research Letters* **94** (1989) pp. 131, 179–131, 182.

2. The late John R. Winckler of the University of Minnesota made the observation while testing a low-light television (LLTV) camera for an upcoming rocket launch.

3. During a Shuttle *Atlantis* STS-34 mission, on 21 October 1989 (Orbit 44), using the shuttle's LLTV cameras, the first vertical-appearing discharge was observed and recorded moving out from the top of a thunderstorm illuminated by intra-cloud lightning. Video observations from the space shuttle acquired from 1989 through 1991 provided 17 additional examples to confirm the existence of the sprite phe-

nomenon. Subsequently, the shuttle fleet of Atlantis, Discovery, Endeavour and Columbia documented other sightings in the 1990s.

4. "The relations between the ego and the unconscious. Part 1. The effects of the unconscious upon consciousness. 111. The persona as segment of the collective psyche," in C. Jung, *Collected Works of C.G. Jung*, Vol. 7, 2nd Ed. (Princeton, NJ: Princeton University Press, 1966) pp. 156–162.

5. The duration of my glory project was 3 min 57 sec, which is the entire length of the song *Ave Maria* as performed on the album *Ave Maria* by contemporary singer Vyatcheslav Kagan-Paley (Victor Entertainment Inc., Japan: 1998).

6. C.T.R. Wilson, *Proceedings of the Physical Society of London* **37** (1925) p. 32D.

7. W.A. Lyons et al., "The Hundred Year Hunt for the Sprite," *Eos, Transactions, American Geophysical Union* **81** (2000) pp. 373–377.

8. Lyons [7].

9. D.D. Sentman and E.M. Wescott, *Geophysical Research Letters* **20** (1993) p. 2857.

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12. Lyons [7].

13. Timothy J. Lang et al., *The Severe Thunderstorm Electrification and Precipitation Study (STEPS)*, Rev. Ed. (Boston, MA: Bulletin of the American Meteorological Society, 2004).

14. Lyons [7].

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Peter McLeish is a painter and multimedia artist. For the past 14 years, he has exhibited his work around the world. His work on sprites has appeared in many international forums. His video Lightning's Angels *was recently presented in a lecture by Colin Price entitled "Lightning and Sprites" at the Tel Aviv University Astronomy Club in January 2004, and at the NATO Advanced Study Institute conference Sprites, Elves and Intense Lightning Discharges, held in Corte, Corsica, France, in July 2004.*

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