

The PhoTOP and the Art of the Spiral

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Abstract

Spirals have appeared in man-made works of art for at least 20,000 years. In the 20th century, artists including Duchamp, Calder, and Bourgeois returned to the concept multiple times. Here we introduce a novel work of kinetic art that combines classical mechanics and quantum mechanics to produce beautiful spiral patterns.

Spirals in Mathematics

There are many kinds of mathematical spirals. Two kinds are often seen in man-made art works: Archimedean and equiangular (or logarithmic). Although there are other regular and irregular spiral forms, both two dimensional and three dimensional, for this paper we will consider art works based primarily on these shapes.

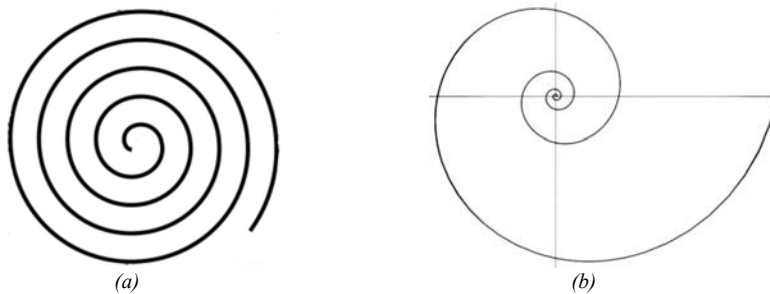


Figure 1: (a) Archimedean spiral; (b) Equiangular spiral.

Spirals in Prehistoric and Classical Art

There are numerous examples of “Archimedean” spirals that predate Archimedes (ca. 250 BC). Even the spirals that are incorporated into the Greek Ionic columns predate him (Fig. 2a). The Neolithic stone carvings found at Newgrange (Fig. 2b) and elsewhere in Great Britain are roughly 5000 years old. The mysterious Scottish stone balls called “petrospheres” containing spirals (Fig. 2c) are of unknown date but are thought to be Neolithic (ca. ~3000 BC). Even older, an engraved deer antler (Fig. 2d) has been dated to about 20,000 years ago.

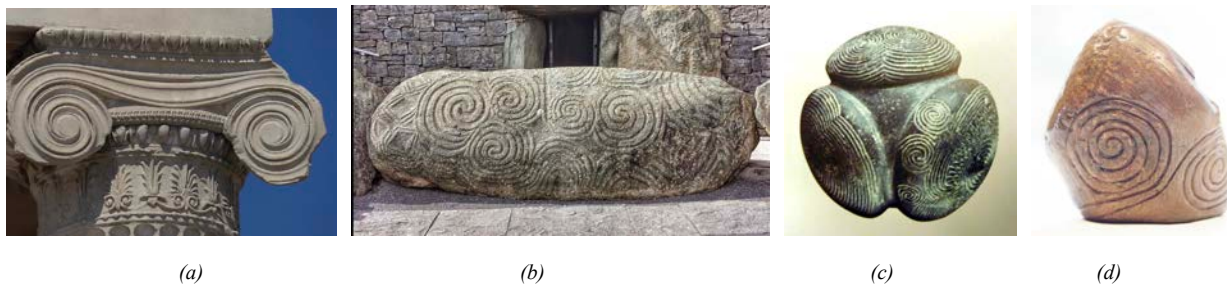


Figure 2: (a) Ionic Column decoration (~ 1m across); (b) Newgrange entry way stone (length ~3m); (c) The Towie Scottish petrosphere (~7 cm across); (d) neolithic deer antler (~ 10 cm across).

Static Spirals in 15th - 20th Century Art

Many artists between the 15th and 19th centuries, most prominently Leonardo da Vinci and Vincent van Gogh, incorporated spirals into their art. By and large, these works were instigated by the artist's views of spirals in the natural world, sometimes to capture in a static image a sense of fluid motion. In the 20th century many artists incorporated spiral patterns into their work. These were often more abstract. Two resources that extensively discuss spirals in art are [3] and [4].



Figure 3: (a) From da Vinci's notebooks; (b) van Gogh's "Starry Night"; (c) A. Calder, "Prayer Flags."

Dynamically Generated Spiral Art

In 1827, the British physicist Sir Charles Wheatstone (who also invented the stereoscope) invented and patented a device he called the "kaleidophone". It consisted of a mirror or polished ball on a vibrating rod. By shining a light on it, the kaleidophone could produce many kinds of Lissajous figures, including spirals. Hugh Blackburn, a professor of mathematics at the University of Glasgow is given credit for having invented the "harmonograph" in about 1850. It consisted of two coupled pendulums that could swing in the x-y direction. With a pen, pencil or paint brush attached to the coupled pendulums, it could draw or paint complicated figures including beautiful spirals. It became quite popular throughout the late 19th century. In 1895, another physicist, the American Carl Barus, invented and patented what he called the "Gyrograph" [2]. It was a well-balanced spinning top that could be spun up with a pull string. It included a tip made of pencil lead. This device could produce many elaborate spiral patterns by drawing them on paper. The images in Figure 4 are taken from the actual descriptive inserts included in the original box that held the gyrograph spinning top (shown in modern photographs of it) along with its pull chord. (Note that the "gyrograph" should not be confused with the better known "spirograph". That device was first invented in 1827 and its modern incarnation draws "roulette" patterns.) What kind of art category do any of these creations fit? It is reasonable to call them "kinetic art" works. However, they might just as easily be categorized as "Play Art" (cf. <https://playart.org>) whose practitioners are said to include such artists as Duchamp, Calder, Agam, Matisse and Vasarely and scientist Roger Penrose.

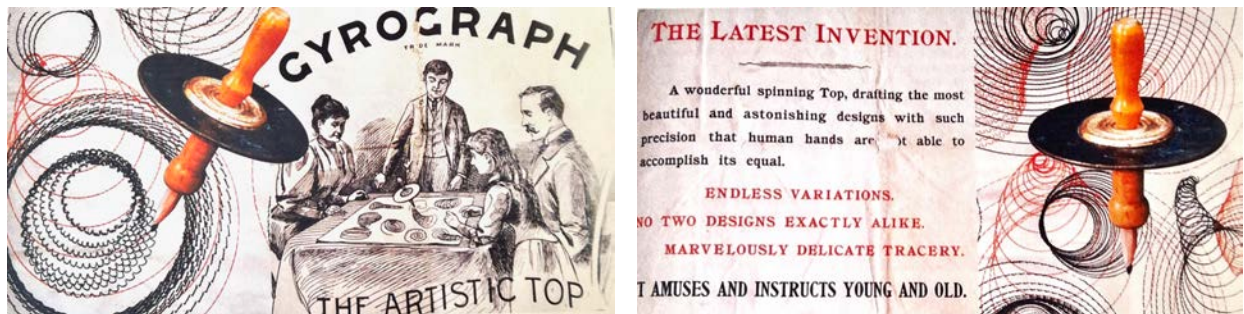


Figure 4: Gyrograph

20th Century Kinetic Spiral Art

In the 20th century, the French/American artist Marcel Duchamp experimented with several kinetic spinning objects to produce various optical effects. His “Rotoreliefs” were produced as a set of 6 two-sided paper disks to be spun on a turntable. One of these disks shown below has a spiral image on it. When spun, the Rotoreliefs produce various perceptual phenomena, including three-dimensional depth effects. Duchamp, along with Man Ray, produced a movie they called “Anemic Cinema” which incorporated similar effects. In the 1970’s, the “Op” artist Peter Sedgley produced a set of six “Video Disques” that, when spun, produced a variety of optical effects. We have also included in Figure 5 one of the “Harmonograms” [5] created by Ivan Moscovich using his own patented 20th century harmonograph.

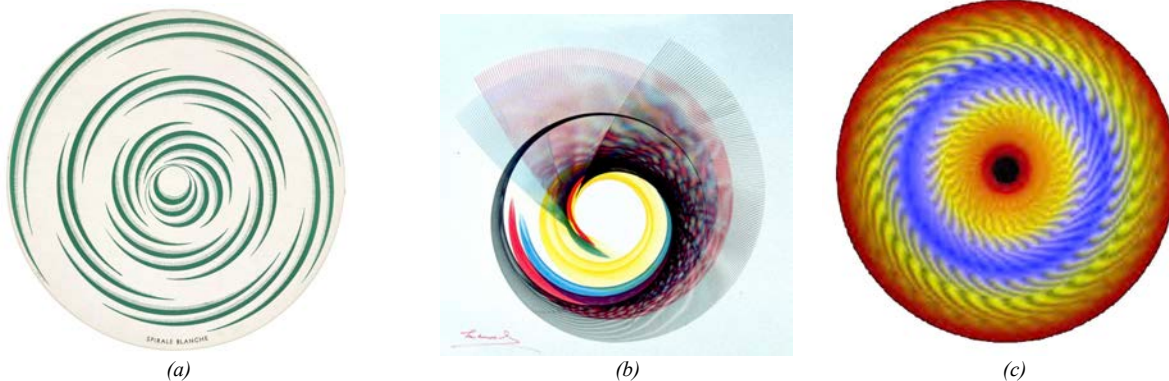


Figure 5: (a) Marcel Duchamp “Rotorelief” entitled “Spirale Blanche”; (b) Ivan Moscovich “Harmonogram”; (c) Peter Sedgley “Video Disque”.

The PhoTOP

I developed the PhoTOP over the past 5 years. It arose because of two enduring interests of mine. I have had a long-term fascination with spinning tops [6], arising from work I had originally done in the 1970’s on spinning and precessing neutron star dynamics. Separately, between 2000 and 2015, I developed a range of hands-on educational materials and software about light, optics, color, and visual perception as part of my NSF funded “Project LITE: Light Inquiry Through Experiments” [7]. Included in these developments was a kit of optical materials, including phosphorescent vinyl sheets that could be activated by suitable frequency laser pointers. My newly developed PhoTOP consists of a circular disk (12 cm diameter) and spindle with a phosphorescent (activated ZnS) layer coating on one surface. It was designed to be combined with a near UV/deep purple 405nm laser pointer or an LED flashlight. The PhoTOP can be spun by hand and the laser pointer beam moved back and forth shining its “black light” over the surface at varying rates “painting” a phosphorescent green light image emitted from the surface of the disk. The resulting green spiral patterns are visible for several minutes after the laser pointer is turned off.

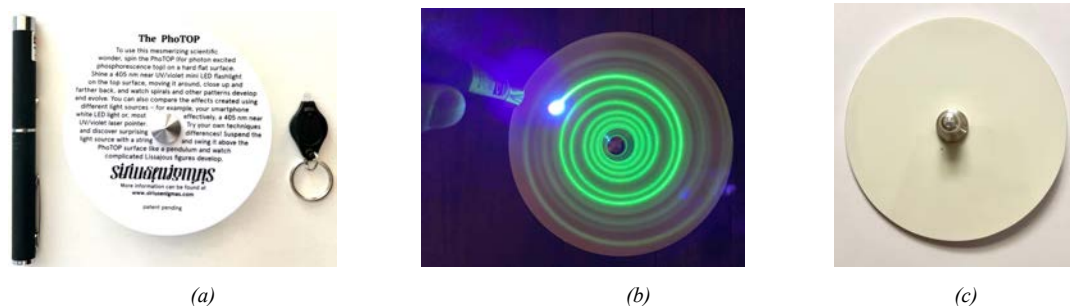


Figure 6: (a) PhoTOP with laser pointer & LED flashlight; (b) laser pointer creating an image on the spinning PhoTOP (photographed in the dark); (c) PhoTOP ZnS side before activation by the laser light.

The patterns result from the phosphorescent emission of light by the activated ZnS (zinc sulfide) surface. The explanation of phosphorescence (as well as the fluorescent light emission employed in Peter Sedgley's "Video Disques", along with the photoelectric effect) are the quantum phenomena for which Einstein was awarded the Nobel Prize in physics in 1921. As a work of kinetic art, the PhoTOP combines the classical physics governing the dynamics of a rotating object with the quantum mechanics governing the phosphorescent emission of light. This is the first spinning kinetic device that combines both classical and quantum physics and that allows for controllable spiral pattern formation by the viewer. Is the PhoTOP a work of art? I think that it is, in the same sense that works of "neon art" (which, like the PhoTOP, provide ephemeral images) are considered "Art" and not just advertising signage. (After all, there is a "Museum of Neon Art" in Los Angeles, and several art books are devoted to the subject.)

The PhoTOP can produce both Archimedean and Equiangular spirals by varying the direction and rate of motion of the laser beam over the spinning PhoTOP surface. The PhoTOP laser pointer can be combined with a pendulum, resulting in many novel Lissajous patterns that can be produced by the swing of the pendulum/laser combination in the x-y directions suspended directly above the spinning PhoTOP.

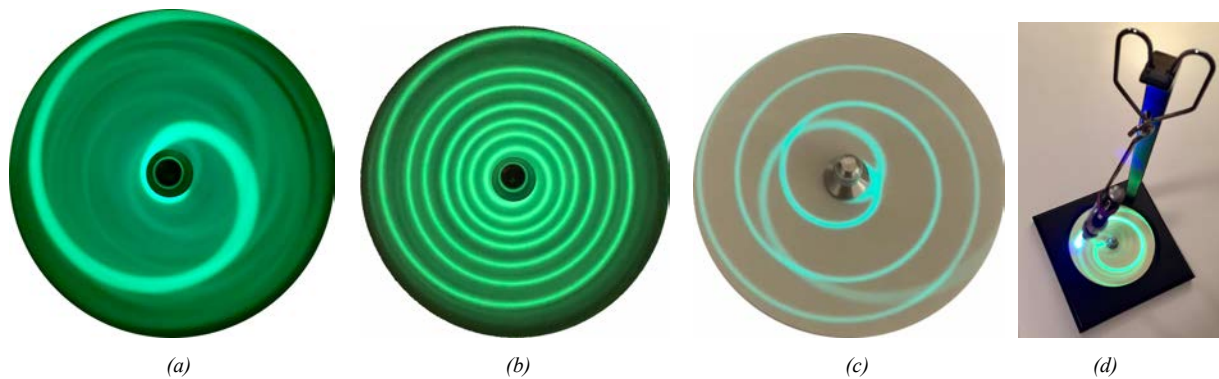


Figure 7. Patterns produced with the PhoTOP: (a) Equiangular spiral (photographed in the dark); (b) Archimedean spiral (photographed in the dark); (c) more complex Lissajous pattern (in daylight); (d) PhoTOP beneath a laser pointer free to swing from a pendulum support.

Summary and Conclusions

Spirals have appeared in manmade artworks for at least 20,000 years. During the 19th and 20th centuries, kinetic spiral art works were designed. I have now devised a new 21st century kinetic artwork called the PhoTOP. It is the latest example in the long history of spirals in art. However, unlike many of its predecessors, it is fully controllable by the viewer (cf. <https://www.instagram.com/p/CSr6Cu7Jym2/>).

Acknowledgments

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References

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