

# Sculpting Ionized Plasma

Jean-Louis Lhermitte

## A DIALECTIC OF ARTISTIC AND SCIENTIFIC PRAXIS

My research into form in art using plasma (i.e. light) has led me to explore areas too far removed from scientific theory or practical application to retain the attention of the physicist. Plasma is a state of matter—ionized gas—which is the most widespread in the universe (in, for example, the sun) but rarely occurs naturally on earth (as lightning), except as humans have recreated the conditions to make its presence possible. Nevertheless, light, which appears in the depth of the sculptural surface, constitutes a magnificent example of sculptable “matter.” This article analyzes the development of my artistic approach, which has allowed me to advance from a two-dimensional (2D) visual system to a three-dimensional (3D) system, i.e. a tangible object of sculpture that requires new knowledge and new tools to produce other types of forms.

### The Subconscious and the Imagination

On one hand, developing the creative potential of my system has involved diverting and perverting the parameters of the system through a kind of culture of play and of the impossible. On the other hand, this work has required me to consciously and unconsciously question myself and my senses in order to search for new forms in strict accordance with the concept and praxis of my project.

### From Sign to Meaning, from Memory to Light

The subconscious origin of my work with light is essentially situated in my experience in arc welding for the metalworking industry. Later, I asked myself what a series of abstract forms turned upside down would represent [1]. Even inversion is a function of direction and orientation. This brought to my work the principle of balance between two forms, or “conceptual opposites” (Fig. 1).

My project of “ionic sculpture” (an ironic reference to a well-known style from ancient Greece) originated in 1977 with my research into trace and memory, which resulted directly from my ideas concerning conceptual opposites.

I had explored with a number of people various constructions of spatial memory. The purpose was to try to find passageways to unknown places through gestures integrated into artworks, which I intended to become concrete, specific creations in plastic form, using recognizable signs. This involved, for example, tracing a path through a field and trying to follow this path back; or drawing circles and then trying to find their centers. Drawing a wineglass and filling it with “drawn wine” was another example. I did all this as if blind, or as though my eyes were covered. I recorded this mapping of fleeting traces

with light-sensitive film in a stationary camera. As a revelation of the unconscious, the traces appeared to me as a succession of light events positioned in space. This allowed me to imagine the idea of the “continuous and discontinuous messenger” found in *Le marcheur lumineux* (The Luminous Wanderer) (1977) (Color Plate B No. 2).

What remains in our memories after we have tried to cut loose from the inhibitions that result from a graphic gesture rendered on a piece of paper? This question, which arose during what I call my “light trace” period, brought me to my first plasma sculpture in 1982.

## MATERIAL PLASMA

New questions about the power of signs as a means of expressing the subconscious occurred to me between the conceptual phase of this work and that of concrete implementation. Which materials and which systems could fulfill my conditions, namely to be light and matter at the same time?

### How to Curve Light in 3D Space

The concepts of tension and ionization, to mention only the most important, became my common visual denominators, with electricity as their energy source. From those first transcriptions of light inscriptions on film surfaces in 1982, I moved toward 3D volumes. I made a flat mural sculpture containing ionized and electrically excited gases. The system's constraints were to serve as generative obstacles.

The “illuminated gases”—clouds lit in different colors, produced in glass enclosures—were linked to each other by passageways, areas of pressure and depression, areas of transition between being and non-being. Subsequently, I called this principle “illuminated thermodynamics.” The same concept inspired me to create the sculpture *+ et -* (+ and -) in 1996.

I originally intended this first glass enclosure to be flat, but ultimately it became an egg-shaped shell fitted with five elec-

## ABSTRACT

The author investigates an imaginary world between art and science, looking back on 20 years of his exploration of “material light” in sculptures created using plasma ionized by electric current.

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Translated by Peter De Craene and M. Mioni.

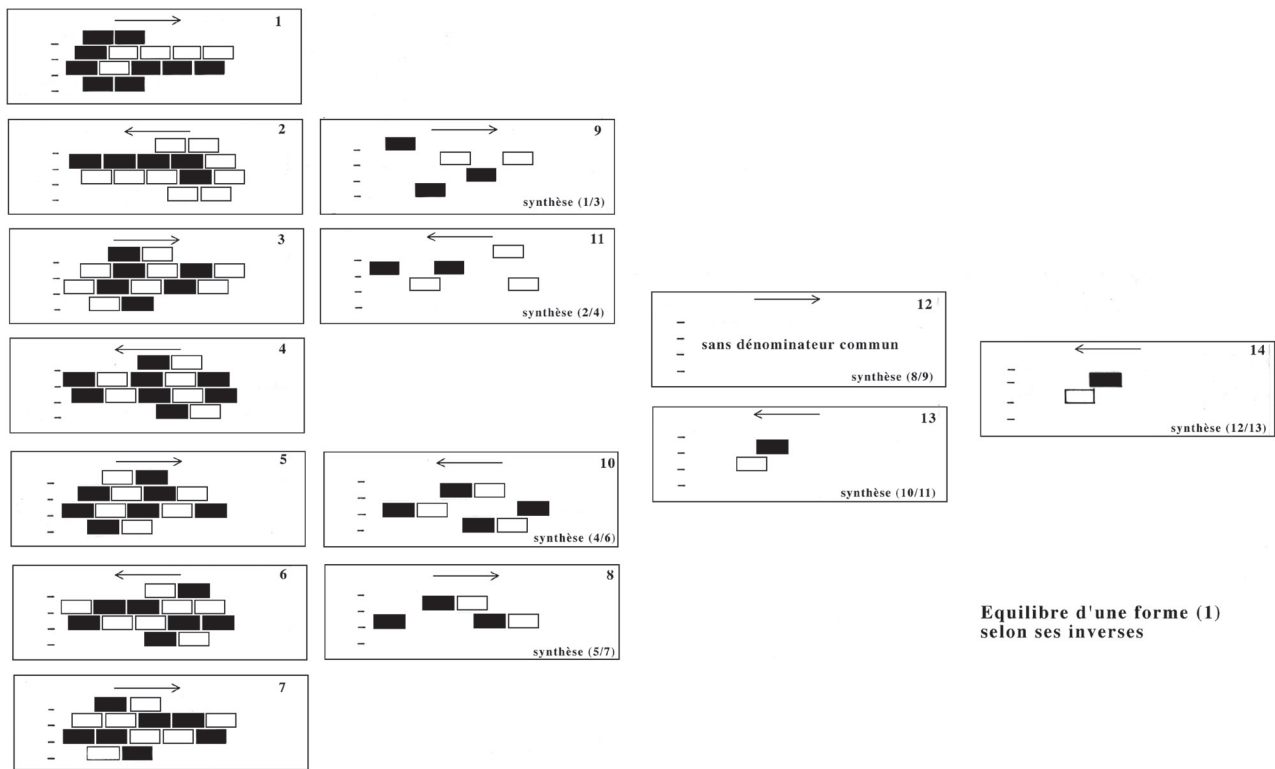


Fig. 1. The equilibrium of an inverted form: corrugated paper, 111 × 66.5 cm, 1973. (© J.L. Lhermitte)

trodes (while common sense on this matter would have dictated only two). The resistance of the glass to the atmospheric pressure both allowed and constrained the construction of a scenic field.

Following this experiment, I obtained varying forms of plasma by manipulating rare gases under differing pressures in the laboratories of a neon-sign company. I called these forms “luminous strings” (Fig. 2).

In this work, a continuous link between traces in a landscape, such as threads of light, became, through plasma, strings that organized themselves into webs, with knots as their linkages. These arcs would have only a spectacular value, however, if they did not generate a network structure between themselves. This totality of symbolically related dynamic interconnections would constitute for me a basis for research into new plastic forms.

## SCULPTURE AND PLASMA

In order for physicists to discover what they would come to call “plasma,” it was necessary for them to conceptualize its physical behavior and identify the laws by which it worked. This was made possible by the discovery that the extraction of an electron from an atom caused an *ion* (Greek for “the one that goes”) to be formed.

A material form presupposes links between different elements. The form of plasma is constrained by a field of force that conditions its aesthetic existence. In the case of a solid medium, its short-distanced intermolecular field plays the principal role. Its form thus remains uniformly attracted by a gravitational field. With plasma, the use of a magnetic field allows the exploration of new forms inaccessible under normal conditions.

Plasma exists under different conditions. That is to say, it is in a transitory zone between “object” and “non-object” to a far greater extent than is a solid body, and so has a far more diffuse form. A sculpture in plasma, an ionized gas, is generated by an electrical field and the capacity for long-distance interactions between its ions. The existence of the form will thus offer a sort of discontinuity, which opens the question of links and messengers.

The temporal existence of plasma requires a balance or quasi-balance: the difficulty of realizing this quasi-balance makes creations fleeting. Electrical fields can reduce the effect of Earth’s gravitational field to a negligible level. Visually, at least, and with the exception of the phenomenon of convection in the string phase, the forms appear to escape gravity.

Some forms of plasma, then, have characteristics unattainable in solid mat-

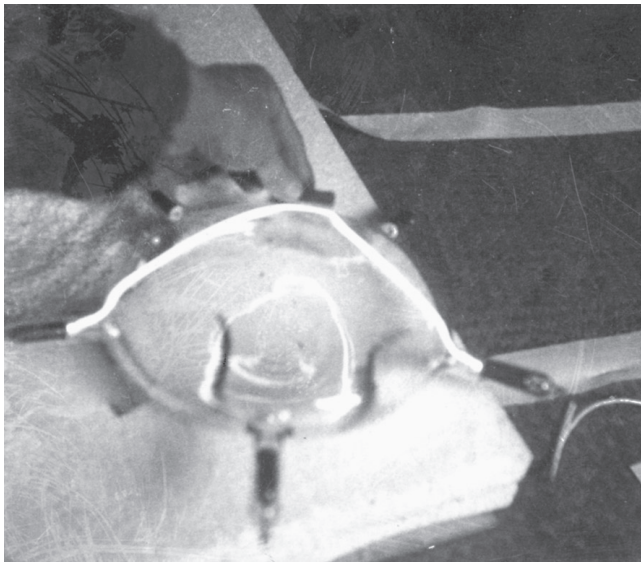
ter because they exploit another force, that of electricity. But the existence of an electrical field inside a volume of gas presupposes that new and somewhat unusual rules will apply. An artificially maintained technological environment is also required to establish the necessary conditions.

Perception is generally linked to an interpretation of existing knowledge. The transitory forms of my work can thus be a field of exploration for both the creator and the observer.

## Strings of Light

In *Machine à Cinétique Molle* (Weak Kinetic Machine) (Fig. 3) I produced strings of light using relatively precise gas pressures to generate a variety of colors, ranging from very beautiful shades of blue through sometimes unnerving shades of very pale green to pink and white. They have particular characteristics I find extraordinary.

These threadlike electric arcs are very elastic. They are linked together at certain points by pulsating “knots;” they are also susceptible to breaking up under the action of invisible forces and then reforming new configurations. This phenomenon presents a dynamic network of forms and forces trying incessantly to find a balance according to nature, i.e. in the pressure and temperature of the



**Fig. 2. Interaction between a permanent magnet and light strings, laboratory test; glass, Ø 370 mm, thickness 75 mm. E: 3000V/25 mA/20kHz, 1982. (Photo © J.L. Lhermitte)**

gas mixture inside the installation. Moreover they are particularly supple and swift in three dimensions and always direct themselves toward the sky, probably due to a convection effect linked to gravity. Thus a magnet can attract or repel them into precise configurations through the glass. This very unstable state of matter could fulfil the conditions of a substance, light, fit to be sculpted at the limits of chaos, which in the first instance needed to be mastered.

Initially, without knowing what would happen, I used five electrodes arrayed like the fingers of a hand, where logic would have suggested six, or in any case, an even number. The fact that one of the feed wires could not be connected to an electrode forced me to link it to one of the poles of the system, thus creating additional instability. The electrical curves searched incessantly for a new balance, fluctuating all the time.

My approach is primarily intuitive, and the space affected by technological intervention offers an imaginary world for the behavior of electric variables inside gas. In this way I organize forms by empirically determining these behaviors and by speculating about changing these behaviors, without knowledge but with a desire to understand. My object is not a scientific demonstration, but an experimental research into new visual signs as foundation stones of spaces and as sources of revelation.

Contrary to the scientific approach, my artistic perspective authorizes an uninhibited madness that allows me new forms of reasoning about future concepts. These lines of tension can be interpreted as forces but also as visual signs representing known and unknown

forms. The whole of my work can be seen as a representation, or even an electrical model with regard to the forms and the forces at work (Fig. 4).

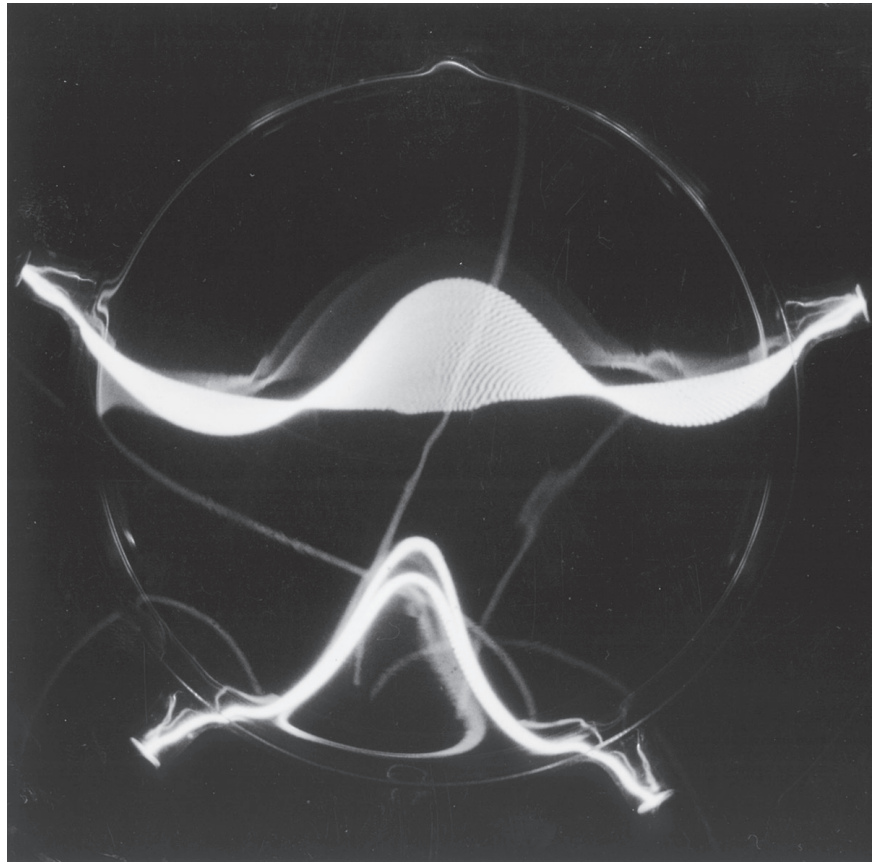
### *Voile de Lumière*

For the project *Voile de Lumière* (Veil of Egg-Shaped Light), commissioned in 1983 by the Cité des Sciences et de

l'Industrie in Paris, I created a luminous 3D veil floating in space. I used the sound produced by the plasma tube, as well as radio music captured by tiny standard receptors, to interact with this image, and to give a more vibrant edge to the whole creation.

I placed 10 electrodes around an egg-shaped enclosure, or bulb, that was flat enough to allow a powerful magnet to act on the strings without distance becoming too important a factor. The high tension had to be commuted at a high frequency in order to make one or more arcs move from one pair of electrodes to the other (Figs 5 and 6). As the high tension could not be commuted in the spaces reserved for the public, I decided in the end to display the chronology of these events through switching the electrical arcs in a succession. The organization of the forms into a network resulted from the disposition of the existing potentials. The first bulb I used, being too flat, did not resist the atmospheric pressure. I replaced it with a solid glass sphere and fitted it with 10 electrodes. Once I finished the sculpture, I invited the public to generate forms from a desk

**Fig. 3. *Machine à Cinétique Molle* (Weak Kinetic Machine), electronic tube, Ø 370 mm, thickness 75 mm. E: 3000V/25 mA/20kHz, 41 × 21 × 51 cm, 1982. Interaction between a permanent magnet and light strings. (Photo © J.L. Lhermitte)**



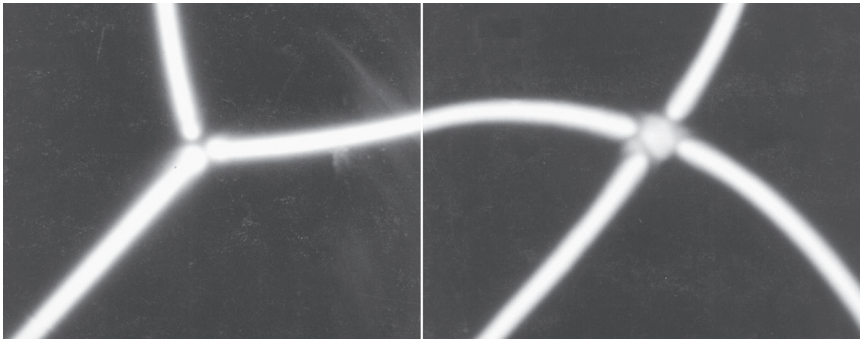


Fig. 4. *Machine à Cinétique Molle, Dark/Sombre Zones*, iron and metacrylate, electronic tube, Ø 370 mm, thickness 75 mm. Rare gas. E: 3000V/25 mA/20kHz, 41 × 21 × 51cm, 1982. Two types of linking threadlike arcs at 120 and 90 degrees. (Photo © J.L. Lhermitte)

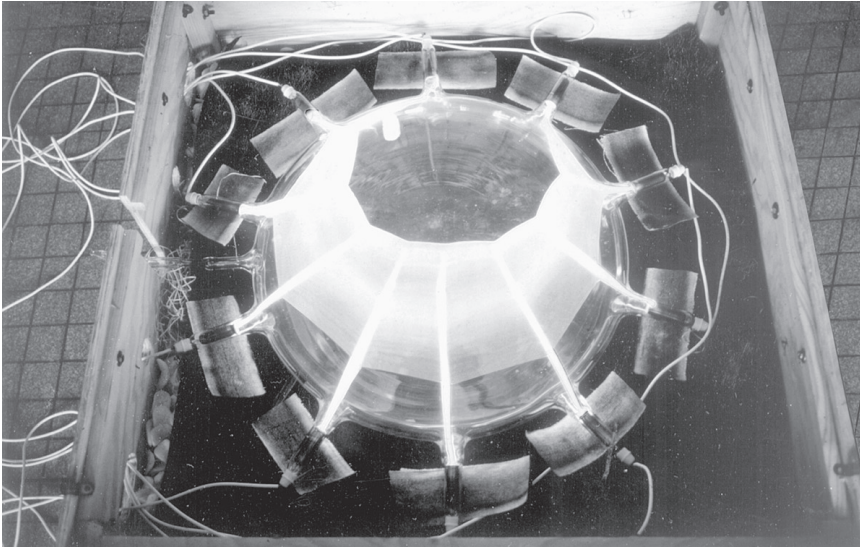
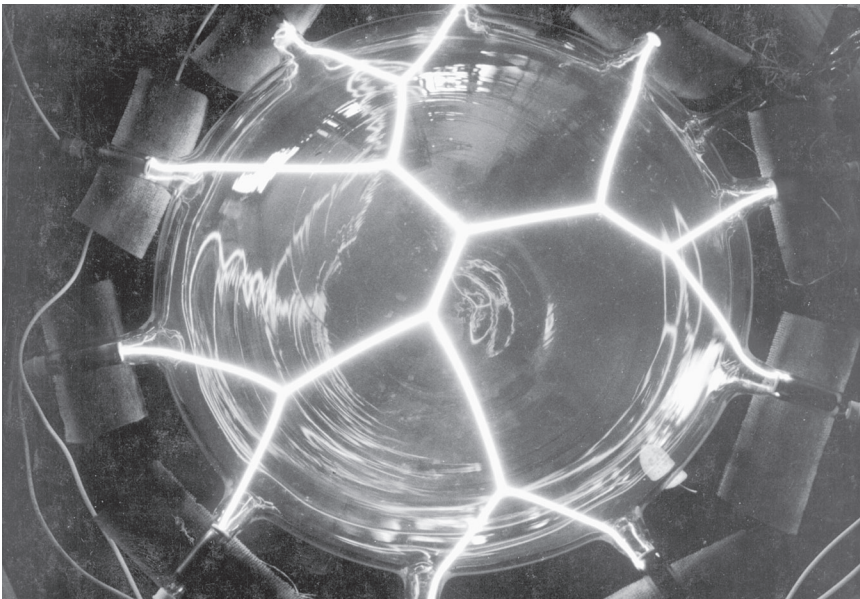


Fig. 5. *Voile de Lumière (Veil of Egg-Shaped Light)*, iron, wood, straw, metacrylate, 10 electrodes, glass electronic tube, Ø 700 mm. Thickness: 120 mm. Rare gas, 5000V/50mA/20kHz, 1983. This piece has since been accidentally destroyed. (Photo © J.L. Lhermitte)

Fig. 6. *Voile de Lumière*, iron, wood, straw, metacrylate, 10 electrodes, glass electronic tube, Ø 700 mm thickness 120 mm. Rare gas, 5000V/50mA/20kHz, 1983. A plasma network in dynamic balance. (Photo © J.L. Lhermitte)



equipped with relays; this created a quite astonishing interactivity. The resulting forms were not reproducible and depended on the on-off order of lighting the feeding wire couples.

At rest, this creature of electricity and light searches for balance in a stable form, while at the same time roaring with the noises that superimpose themselves on the words and music picked up from the radio stations, giving it the semblance of a creature from another world.

“Try to manipulate the strings and to calm the plasma by searching for a point of balance” is the indirect suggestion the work proposes to the public, which quickly baptized this creature “the medusa” or “the brain” (Fig. 7).

### ***La Cascade Annulaire: Art, Nature and Electricity***

Practical experimentation with the known laws of electricity has allowed me to continue developing this type of art. With the project *La Cascade Annulaire* (The Annular Cascade) (1986), I realized a collaborative work with physicist François Bastien [2]. Conceived in 1984, *La Cascade Annulaire* (Fig. 8) was the result of a successful experiment in March 1986 in the laboratories of the French national company Electricité de France. The project was later interrupted for a conjunction of reasons, notably economic ones.

From the first moments of the project, the idea was to use lightning to evoke the unity of earth and sky—as the electrical arc being possibly the fundamental instrument of the sculptural form, the light its expression, and the artwork as a whole, a reflection of nature; this art at the same time can no longer imagine the world without considering the innovations and consequences of technology.

The happening, according to Marcel Duchamp, is a space in which onlookers are placed in equilibrium between attraction and repulsion concerning the event they witness. In certain aspects, technology can be interpreted as a metaphor by which art expresses itself, not only because of the need for daily comfort that it provokes, but also in terms of its resulting negative ecological consequences. We experience, as a result, conscious and unconscious vacillations between the poles of a system in search of equilibrium. That is why *La Cascade Annulaire* can be considered a “happening of technology.”

As the most modern matter on our planet (because it involves electricity),

but also as the most widespread matter in the universe, plasma, I propose, is representative of these concepts of attraction-repulsion, a metaphor of electricity. The experimental propagation of electrical charges also presents a unique characteristic of the system.

The verticality of the thin tube in *La Cascade Annulaire* complements the different plasmas so that there appears an “electrical smoke” of red, blue and sometimes yellow light. The ionized volumes thus produced are very diverse but can be grouped into five categories. The first three are linked to low-pressure effects; the last two, to average-pressure effects.

I have named the different forms seen in the ionized volumes:

- “birds”: spontaneous streaks in a positive column of luminescent electrical releases
- “bubbles”: other fixed or mobile streaks
- “full light”: a positive column without streaks
- “electrical smoke”: a turbulent arc associated with low pressure
- “torch” or “flame”: a type of light string typical of a low-pressure arc.

In this work I seek to contain in a laboratory test tube a tamed and softened lightning, kept “alive” to evoke the confidence and responsibility necessary between people to master and produce the immense energies that will probably be required in the future. The universe organizes itself in an enchanted system of energy; the discovery of electricity has set the stage for a totally abstracted idea of nature. This matter, electricity, could be considered the second main conquest of humankind after fire. From captured fire to created fire, the whole of human history is encapsulated. From fire’s orange-red to the blue of electricity, these images represent past ages when fears and hopes were often mythical. In less than two centuries, 400,000 years of history have been annihilated following the discoveries of electricity and the atom.

Subtle osmoses, superpositions of weft, our death or our life belong only to ourselves. Technology attracts us but repulses us at the same time because of the reality it imprints on the world; technology forces us to invent between the attraction and repulsion.

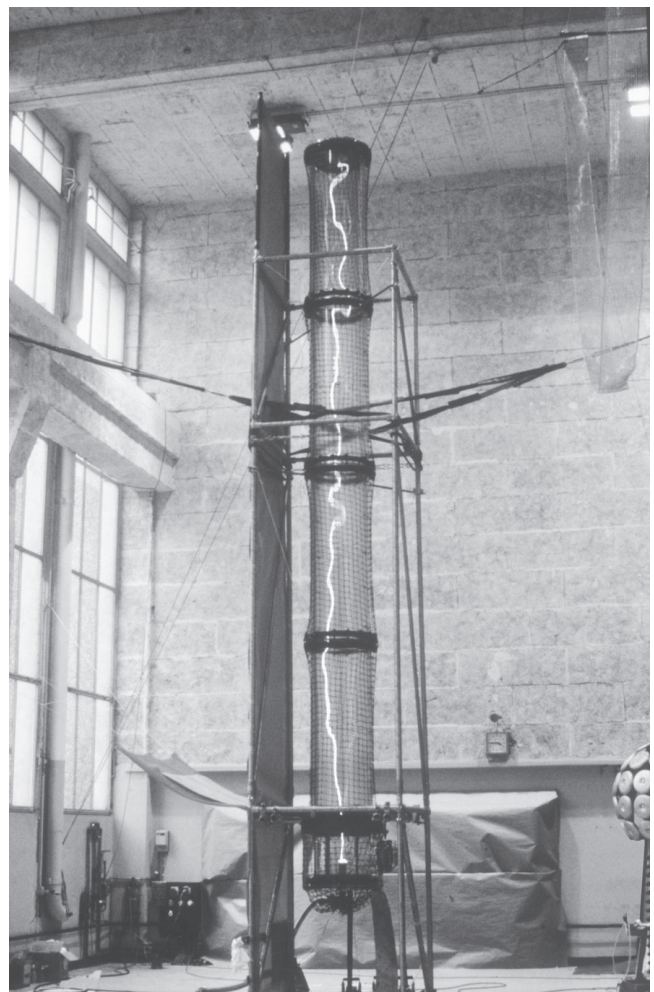
### *L’Ordre n’est qu’une étape du désordre*

In my work *L’Ordre n’est qu’une étape du désordre* (Order Is Only a Stage of Disorder) (Fig. 9), created in 1988, two regimes of energy are in dialogue. One is formu-



**Fig. 7. *Voile de Lumière*, wood, metal, metacrylate, sphere, 10 électrodes, 1.10 m high Ø 1.00 m, rare gas, 5000V/50mA/20kHz, 1983. Shown installed at the Electra exhibition, M.A.M. de Paris; permanent exhibition of the C.S.I. la Villette in Paris. (Photo © J.L. Lhermitte)**

**Fig. 8. *La Cascade Annulaire* (Annular Cascade), metal and polymers, 1.2 × 1.2 × 8 m. Tube: 6.5 m Ø 0.45 m. Rare gas, on arc mode: 10 kv/1A/0-50 Hz. 1986. Experiment performed with Board of Electricity of France. (Photo © J.L. Lhermitte)**



lated by coal and the other by a plasma of the same type used in *Voile de Lumière*, generated from six electrodes. The fundamental basis of this sculpture is an exaggeration of the process of establishing an equilibrium between electrical arcs. When that equilibrium attains relative stability by forming a figure linking the eight arcs, the system then swings back toward disorder. This state of chaos will last until a new equilibrium is found, and so on—this in a totally unpredictable manner with regard both to the trajectories of the arcs and to the realization in time of the chain of processes. Given that the internal atmosphere exerts only a weak pressure, convection paths are formed, offering new passageways for the release of tension. This search for stability can be interpreted as an attempt to use dispersed energy as efficiently as possible.

This very living phenomenon becomes a way of describing space and time through their anchor point, energy. I realized the importance of this type of figure while manipulating the pressure and the nature of my gases to obtain a slow instability in this piece. The title occurred to me as an allusion to those worldviews of absolute order in which social thought is petrified.

### Sculpting Ionized Electrical Fields

The objective of my public installation *+ et -*, initially intended for children, was to produce threadlike electrical arcs

that could be manipulated from a distance with the use of stationary magnets (Fig. 10).

The flat shape of *+ et -* was chosen to stabilize as much as possible the convection effect of the electrical arcs. The installation maintains an atmosphere of rare gas under low pressure in a cavity of 10-cm-thick glass. Seven pairs of electrodes receive current. Threadlike arcs naturally form between the electrodes when the difference in potential is sufficient. The tension creates a network in equilibrium.

At rest, the installation seems alive; the strings of light move as slowly as snakes between the pairs of electrodes. These threadlike arcs, linked by bridges, search for equilibrium, attracted by the electrical potential of the neighboring field.

The strings of light are a visible manifestation of the forces at play where the electrical pathway through the gas is least resistant. What I call “the ballet of the short circuits” suggests some explanations for this effect.

Under the influence of high-tension electrical streams, a population of ions is created in the rare gas under low pressure. Locally heated, ions react against the constraints imposed by the environment—which is strongly electrified by different electrical sources—to create potential differentials. Lazy but in tension the plasma, through its heat, helps generate the next pathway. Like an electric cortège behind its leaders, these

ionic conductors make a furious effort to resist the pressure of followers, pushing to the limits of imbalance.

A child, with the help of stationary magnets, can manipulate the light strings through the glass. The total length of the network can be increased to the limits allowed by the electrical tensions generated by the feeds.

These sculptural forms provide an intuitive, interactive display of the science of morphogenesis through play and observation. As for the sculptor, it allows me to play with the variations of forms induced by the tensions at work.

### TO CONCLUDE AND CONTINUE

On the question of the imaginary and the mystery of creation: The understanding and interpretation of forms derive from the structures (innate or acquired) and cultures that give them meaning. That which we can attribute, beyond a common comprehension, to objects or events, has its value only in the imagination of the one whom Marcel Duchamp called the “onlooker.”

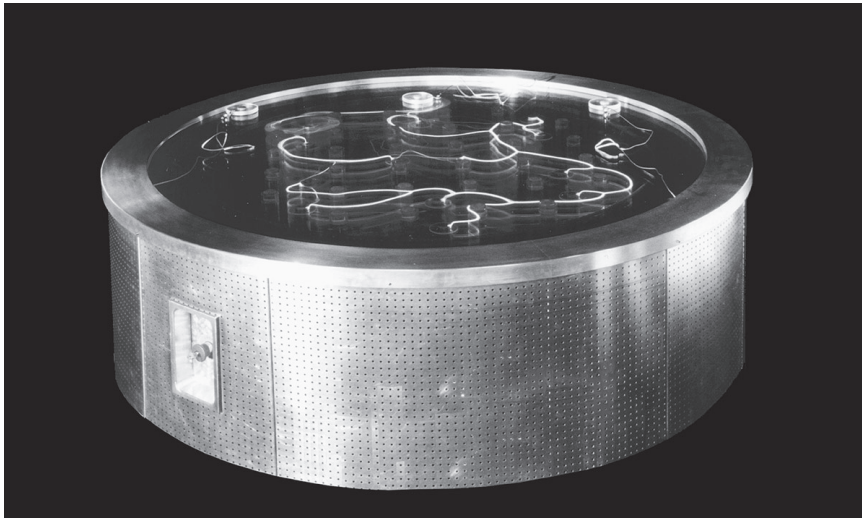
Nevertheless, comprehension of a form is not acquired beforehand, even though, at times, spontaneous sentiments can develop. What added value can we as onlookers contribute on the emotional level? What dimension would this value have? Does our incomprehension of a form also come from a search for the identification of already acquired knowledge?

That which retains our interest is primarily that which we have not discovered, experiences we have not yet confronted. On another level of exploration, there may be a method of constructing a system so permeable that its mere existence would naturally generate a space into which each onlooker could be projected. There are several spaces in which we can move on a strictly aesthetic level while attaching ourselves to known and identifiable meanings by discovering in the thickness of the surface new spaces in which to project ourselves.

To evoke energy through plasmas seems an abstraction that brings us closer to the entire universe because it brings us nearer to the state of initial creation. Everything about plasma brings us back to the origin. Beyond that, the encounter of a material form with another system presupposes reciprocities that go through atomic and energetic commonalities. Different sys-



**Fig. 9. *L'Ordre n'est qu'une étape du désordre (Order Is Only a Stage of Disorder)*, glass, electronics, coal, electronic tube: 6 l Ø ext.: 42 cm, rare gas, 6 electrodes. 3000V/50mA/20kHz, 51 × 51 × 80 cm, 1988. (Photo © J.L. Lhermitte)**



**Fig. 10.** + et - (= and -), metal, electronics, permanent magnet, Ø 1.25 × 5 m, 500 glass, rare gas, 5000V/100 mA/30 kHz, 1984/1996. Shown installed in the “City of the Children” exhibition; permanent exhibition of the S.C.I. la Villette in Paris. (Photo © J.L. Lhermitte)

tems can be built simultaneously in differing space-and-time dimensions to finally evolve into a new balance of form and matter. The chronology of the events and the resulting tension constitute the proper structure of the art, the basis to new questions about memory.

The global apprehension of the cosmos is a creative mystique. It is best achieved by a scientific rigor informed by the introspection of dreams or the revelation of ideas. This border area between the world of ideas and the world of reality interests me as a space of discovery and as an area that inspires questions about my own lack of knowledge and about how to transform my reactions to it into works that can be understood by others. Electricity, then, is for me an element of coordination because it subtly transfers information. The question remains, nevertheless, from what moment does electricity become a

force of transformation and for which types of forms?

Sculpture, on the research level, must connect with the origins of all forms. As a simple form of recognition, sculpture does not evade the profound questions raised by the scientific imagination. The thought goes from upheaval to upheaval toward a new balance: entropy or negation toward entropy. And from one choice or another a sum of consequences and behaviors will result, in the face of which our own potentials can or cannot respond.

Uncertainty offers itself, then, as a universe to be explored.

Do we not each contain our own mirror?

#### Acknowledgments

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#### Notes

1. This phase occurred at Les Beaux Arts de Metz.
2. François Bastien is a physicist at the University of Franche-Comté, Besançon, France.

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#### Glossary

**ionization**—the process that transforms atoms into ions.

**ionized plasma**—gas formed by charged particles (ions and electrons) and whose components share a common behavior.

**plasma**—the fourth state of matter: neither solid, nor liquid nor gas; the most common material state in the universe.

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