

WRITING SCIENCE

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FROM ENERGY TO INFORMATION

REPRESENTATION IN SCIENCE AND TECHNOLOGY,
ART, AND LITERATURE

EDITED BY

Bruce Clarke and

Linda Dalrymple Henderson

STANFORD UNIVERSITY PRESS
STANFORD, CALIFORNIA

Stanford University Press
Stanford, California

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Printed in the United States of America
on acid-free, archival-quality paper

Library of Congress Cataloging-in-Publication Data

From energy to information : representation in science
and technology, art, and literature / edited by Bruce Clarke
and Linda Dalrymple Henderson.

p. cm.— (Writing Science)

Includes bibliographical references and index

ISBN 0-8047-4176-X (alk. paper) — ISBN 0-8047-4210-3 (pbk. :
alk. paper)

I. Technology—History. 2. Science—History. I. Clarke, Bruce.
II. Henderson, Linda Dalrymple. III. Series.
T15 .F78 2002
509—dc21
2002070394

Original Printing 2002

Last figure below indicates year of this printing:

11 10 09 08 07 06 05 04 03 02

Typeset by G&S Typesetters, Inc. in 10/13 Sabon

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Vibratory Modernism: Boccioni, Kupka, and the Ether of Space

LINDA DALRYMPLE HENDERSON

Although painted in the same year, 1912, Umberto Boccioni's *Matter* (figure 6.1) and František Kupka's *Amorpha, Fugue in Two Colors* (figure 6.2) would rarely ever be juxtaposed in an art history lecture. Their differences far outweigh any similarities or seeming connections between them. Although Boccioni's subject can be discerned as the relatively volumetric, material form of his mother, seated on a balcony, any sense of ponderable matter and gravity has disappeared from Kupka's remarkably flat, two-dimensional image. The broad planes of pure color in Kupka's painting present a stark contrast to the gradations of light and shade and the flurry of individual brushstrokes animating Boccioni's complex surface. Yet, these two paintings stand as exemplars of what might be called *vibratory modernism*—and, at base, they are united by the shared, if differing, responses of their creators to the ether, an entity largely forgotten during the later course of the twentieth century.

The term *ether* has recently reentered popular discourse in the context of computers and the “Etherneter.” But, as Bruce Hunt's essay in this volume establishes, at the turn of the twentieth century the concept was well known as the imponderable medium thought to fill all space and to serve as the vehicle for the transmission of vibrating electromagnetic waves. Although Einstein's special theory of relativity of 1905 challenged the mechanical underpinnings of the ether hypothesis, that theory gained acceptance among scientists only gradually and was not widely popularized until 1919. Thus, the ether continued to loom large in the popular imagination through the 1910s and into the 1920s, even after most scientists had dispensed with it as a fictional construction.¹ For the lay audience the ether was virtually synonymous with space, and it thus offered a new conception of the space that had been the subject of painters for centuries. During the 1890s, conventional ideas of matter, the artist's other primary focus, were also changing rapidly due to the discovery of the X-ray in 1895 and the subsequent identification of the electron and various radioactive emissions.² Early twentieth-century artists were thus confronted by radically new conceptions of both space and matter, and the ether played a central role in this new paradigm of physical reality.

The artistic response to the ether generally took two distinct forms, and

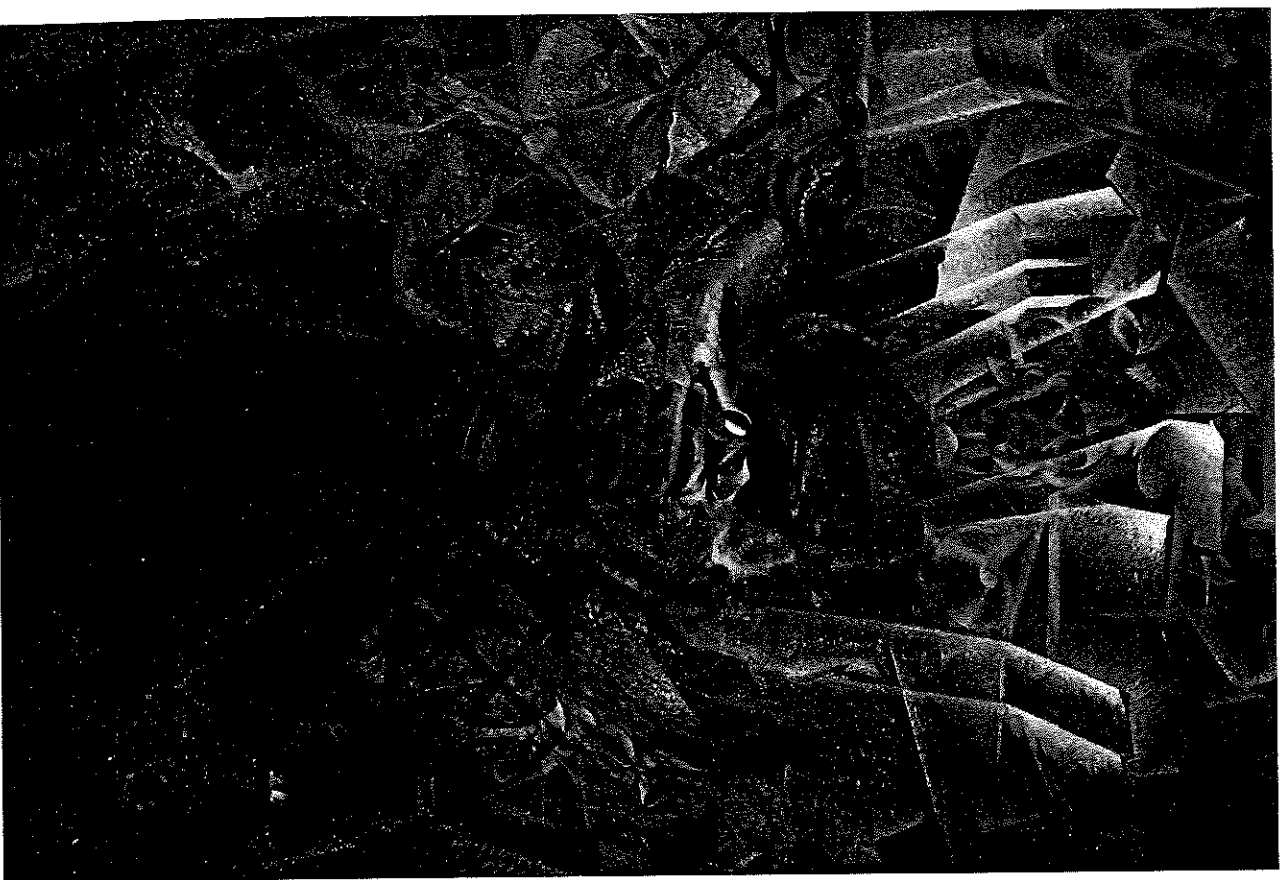


FIGURE 6.1. Umberto Boccioni, *Matter*, 1912. Oil on canvas, 88 $\frac{7}{8}$ × 59 in. Private collection. (Photo: Luca Carra, Milan).



FIGURE 6.2. František Kupka, *Amorpha, Figure in Two Colors*, 1912. Oil on canvas, 83 $\frac{3}{8}$ × 86 $\frac{3}{8}$ in. National Gallery, Prague. © 2001 Artists Rights Society (ARS), New York / ADAGP, Paris.

the paintings of Boccioni and Kupka are emblematic of that contrast. Some artists, such as the Italian futurist Boccioni, sought to give physical form to the ether as a space-filling medium. “What needs to be painted,” Boccioni declared in a lecture of 1911, “is not the visible but what has heretofore been held to be invisible, that is, what the clairvoyant painter sees.”³ For Boccioni, one of those things to be revealed was the vibrating etherial medium itself.

Other artists—as well as poets—found in the ether and the Hertzian waves of wireless telegraphy an effective model for a new kind of artistic communication and, as a result, a stimulus to reconceive the very nature of painting (and the painted canvas surface) as well as poetry. This was the case for Kupka, the Czech pioneer of abstraction working in Paris. By late 1912 he had come to think of his paintings as vehicles for a telepathic, vibratory transfer of thought, a view shared by the Russian-born German Expression-

ist Wassily Kandinsky. Marcel Duchamp would ground his *Large Glass* project of 1915–1923 in yet other applications of the theme of electromagnetic wave vibrations.⁴

Prominent poets such as F. T. Marinetti, Guillaume Apollinaire, and Ezra Pound responded to the notion of wave-born vibratory communication as a new model for their literary craft. Marinetti declared the futurists to be the inventors of “wireless imagination,” and Apollinaire’s 1914 poem “Lettre-Océan” celebrated the Eiffel Tower’s new *télégraphie sans fils* (TSF) station with words radiating like waves from the verbal signs of the tower at the page’s center.⁵ Pound described poets as “on the watch for new emotions, new vibrations . . . sensible to faculties as yet ill understood” and urged them to write “in new wavelengths.”⁶ Responding to Italian futurism and the French cubist presence in Barcelona during World War I, the Spanish avant-garde likewise embraced the vibratory model of wireless transmission. The sole issue of the periodical *Arc-Voltaic* (figure 6.3), published in February 1918, bore a cover design by Joan Miró complementing the “Vibrationism of ideas” and “Poems in Hertzian waves” explored within by the painter Rafael Barradas and the poet Joan Salvat Papasseir, respectively.⁷

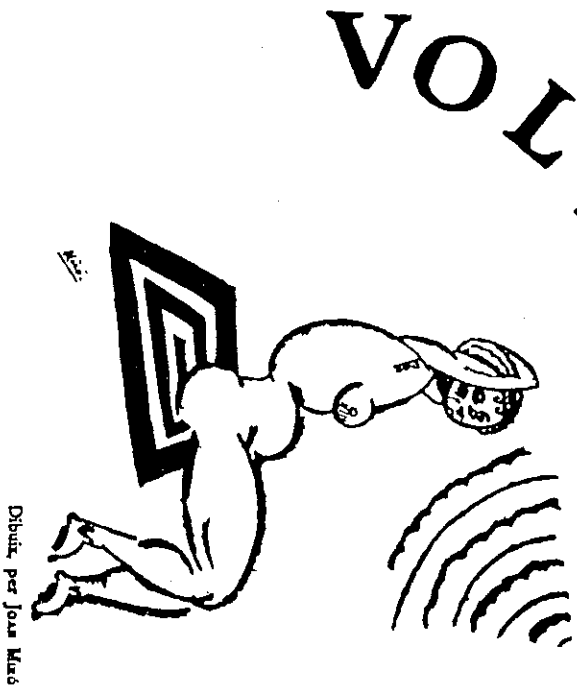
Although the concept of a mysterious world-filling substance can be traced back to Aristotle, Newton had posited an aether he described as “exceedingly more rare and subtle than Air, and exceedingly more elastic and active.”⁸ The characteristics of the ether as theorized by Maxwell and the physicists who followed him seemed curiously contradictory. The ether must have both the rigidity of an elastic solid (necessary for the transmission of vibrating waves) and the rarefaction that would allow it to “pass through even the densest matter, as easily as water through a sieve.”⁹

From the mid-nineteenth century onward, the ether was also discussed as the possible source of matter itself. Lord Kelvin in the 1860s proposed that atoms might well be whirling vortex rings in the ether. Sir Oliver Lodge and others in the 1890s advocated an “electric theory of matter” grounded in the electron and its interaction with the ether.¹⁰ As Lord Balfour declared of the ether in his 1904 address before the British Association for the Advancement of Science, “It seems possible now that it may be the stuff out of which [the] universe is wholly built.”¹¹ Conversely, with the discovery of radioactivity, scientific popularizers like Gustave Le Bon argued that matter was also in the process of decaying back into the ether—suggesting an image of space as a fluid realm of continuous cohesion and diffusion.¹²

Much like the highly popular notion of a suprasensible fourth dimension of space, with which it was sometimes associated in this period, the ether could be all things to all people.¹³ For example, the theosophist Rudolf Steiner quoted extensively from Lord Balfour’s 1904 address in his periodi-

ARC-VOLTAIC

NUMERO 1
Febrer
1910



Plasticitat del vertic Formes en emoció i evolució - Vibracions- me de idees - Poemes en ondes Hertzianes

J. SALVAT PARISSI, redactor en cap - Gran Via, 613 - BARCELONA

FIGURE 6.3. Cover, *Arc-Voltaic*, no. 1 (February 1910).

cal *Lucifer-Gnosis* in 1908, a magazine well known to Kandinsky.¹⁴ Steiner compared Balfour's text to the writings of theosophy's founder Madame Helena Petrovna Blavatsky, whose 1877 *Isis Unveiled* connected the ancient "aether" as "world-soul" and "astral light" to the modern ether treated in the writings of scientists such as Balfour Stewart and Peter Guthrie Tait.¹⁵

In their 1875 book *The Unseen Universe*, Stewart and Tait had proposed that the ether might serve as a bridge to an imperceptible universe into which the energy dissipated through entropy might be flowing. "In fine," they as-

sert, "what we generally called Ether, may be not a mere medium, but a medium *plus* the invisible order of things, so that when the motions of the visible universe are transferred into Ether, part of them are conveyed as by a *bridge* into the invisible universe, and are there made use of and stored up."¹⁶ In Stewart and Tait's hypothesis of the ether as a vehicle for cosmic energy storage Blavatsky found support for her argument that the "ether, or astral light" might also be storing visual imprints or "daguerreotype impressions of all our actions." Such a "great picture-gallery" containing "the images of events . . . imbedded in that all-permeating, universal, and ever-retaining medium," she argued, would explain the faculty of clairvoyant "psychometric power" or the transference of thoughts and images.¹⁷

Although Blavatsky herself was never particularly interested in the concept of a fourth dimension, Stewart and Tait, in the revised edition of *The Unseen Universe* (1876), made one of the first published connections between the ether and the fourth dimension. Like so many of the subsequent authors who embraced the fourth dimension as the spatial location of an invisible world, Stewart and Tait used the analogy of the relation of lower dimensions to one another: "Just as points are the termination of lines, lines the boundaries of surfaces, and surfaces the boundaries of portions of space of three dimensions:—so we may suppose our (essentially three-dimensional) matter to be merely the skin or boundary of an Unseen whose matter has *four* dimensions."¹⁸ Similarly, the Englishman Charles Howard Hinton, one of the major popularizers of four-dimensional hyperspace and its implications, would propose in his *A New Era of Thought* of 1888 that the ether was perhaps the boundary or surface of contact between the worlds of three-dimensional and four-dimensional existence.¹⁹ For occultists, in particular, both hypothetical constructs—the ether and a fourth dimension of space—could add a scientific or mathematical patina to discussions of the unknown and the invisible.

Distinctions between science and occultism were often not so sharply drawn in the late 1800s and early 1900s as they would be in subsequent eras. Artists like Boccioni, Kupka, and Kandinsky derived support for their theories from both scientific and occult sources, and ethereal vibrations—from X-rays to Hertzian waves—were an area where the two readily came together. The French occultist Albert de Rochas, for example, drew on Lodge's writings on electromagnetism to support his case for the projection of bodily emanations as well as thoughts (figure 6.4).²⁰

Among scientists, the widely published Lodge and his colleague Sir William Crookes, along with the French astronomer Camille Flammarion, were deeply interested in the implications of ether vibrations for psychic phenomena such as telepathy. In his 1897 presidential address before the Society for



FIGURE 6.4. Emanations surrounding a hypnotized subject. Source: Albert de Rochas, *L'Extériorisation de la sensibilité* (1895; Paris, 1909), p. 57.

Psychical Research Crookes had set forth a “table of vibrations,” frequently reproduced in this period, pointing up the vast ranges of vibrating waves in the ether that are invisible to the human eye, which perceives only the narrow band of visible light.²¹ For occultists the vibration model also suggested that sensitive individuals might expand their receptivity to include larger ranges of vibrations: “If we had other cords to our lyre, ten, one hundred, or a thousand, the harmony of nature would be transmitted to us more complete than it is now, by making these cords all feel the influence of vibrations.” Flammarion argued in his 1900 book *L’Inconnu*.²² Or, as Crookes had asserted in his 1898 presidential address before the British Association, “ether vibrations have powers and attributes equal to any demand—even to the transmission of thought.”²³

In the 1910 “Technical Manifesto of Futurist Painting,” Boccioni had declared, “Who can still believe in the opacity of bodies, since our sharpened and multiplied sensitiveness has already penetrated the obscure manifestations of mediumistic phenomena? Why should we forget in our creations the doubled power of our sight, capable of giving results analogous to the X-rays?”²⁴ As this statement and his earlier reference to painting the invisible suggest, Boccioni considered the futurist painter to be clairvoyant—with access to the invisible akin to the penetrating action of X-rays or the vision of a spiritualist medium. Both science and occultism, along with an exposure to French cubist painting in fall 1911, nourished his developing futurist art and theory. Two works, his 1912 painting *Matter* (figure 6.1) and his 1913 sculpture *Unique Forms of Continuity in Space* (figure 6.5), serve particularly well to demonstrate Boccioni’s commitment to representing the invisible ether. Although he was far less concerned than Kupka with telepathy on the model of wireless telegraphy, Boccioni was deeply interested in the projection of states of mind by means of vibrations and referred on several occasions to Hertzian waves. Indeed, his writings and art make clear the results of his positive response to the question he had asked himself in his diary in 1907: “How, when, and where can I study all that chemistry and physics?”²⁵

Like many others at the turn of the century, Boccioni believed firmly in the evolution of consciousness, and he argued that the futurists were “primitives of a new, completely transformed sensibility,” possessed of a “psychic force that empowers the senses to perceive what has never been perceived before.”²⁶ He attributed this development to the “altered conditions of existence” produced by contemporary science “with steam, electricity, motor fuels, Hertzian waves and all the researches of chemistry and biology.”²⁷ Scientific discoveries like X-rays and radioactivity paralleled the “mediumistic phenomena” that so impressed Boccioni, including the “perception of the luminous emanations of our bodies . . . which have already been found to appear on the photographic plate.”²⁸ Armed with his futurist “ultrasensivity,” Boccioni set forth to embody a new conception of matter—dematerializing and materializing simultaneously—in his remarkable painting *Matter*.²⁹

The painting of X-ray transparency that Boccioni had learned from his encounter with cubism in 1911 plays a role in the dematerialization of his mother’s form in *Matter*, just as it had done in his 1911 triptych, *States of Mind* (Museum of Modern Art, New York). In the painting *States of Mind: The Farewells* of that series, for example, transparent views of railroad passenger cars and embracing couples overlay the central image of a locomotive. Yet in *Matter*, there is an unprecedented interpenetration between object and environment, created by the painting’s “compennetration . . . of planes that

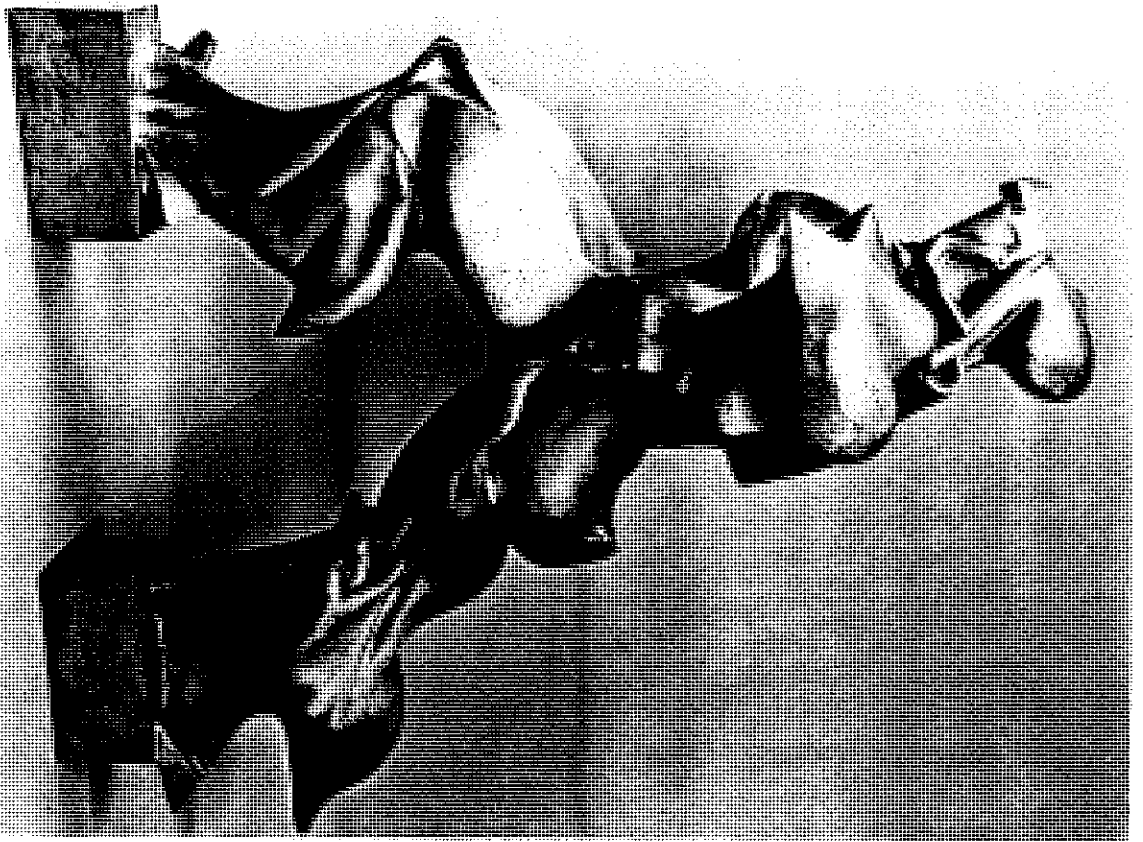


FIGURE 6.5. Umberto Boccioni, *Unique Forms of Continuity in Space*, 1913. Bronze, 43 $\frac{7}{8}$ in. high. The Museum of Modern Art, New York. Acquired through the Lillie P. Bliss Bequest. © 2000, The Museum of Modern Art, New York.

are colorful, vibrant, efflorescent, atomic," as the critic Roberto Longhi described it in 1913.³⁰ On the model of radioactivity and occult theories about bodily emanations, Boccioni paints vibrating atoms of matter that dematerialize into energy.³¹ Just as Crookes's popular tool, the spinthariscopes, allowed a viewer to observe the emissions of a speck of radium striking a fluorescent screen, in *Matter* Boccioni's divisionist brushstrokes evoke the realm of atomic matter in the process of transformation. Bergson's conception of reality as constant flux was certainly one source for Boccioni, who quoted Bergson's statement that "any division of matter into autonomous bodies with absolutely defined contours is an artificial division."³² However, scientific and occult discussions of the ether as interpenetrating (or even composing) all matter now made it possible to think of matter and ether-filled space simply as degrees on a continuum. As Boccioni asserted in his 1911 Circolo Artistico lecture, "solid bodies are only atmosphere condensed."³³

In *Matter*, at the same time that atomic matter dematerializes into the surrounding ether, Boccioni materializes the previously immaterial and invisible ether-like "atmosphere," creating "a new kind of material body existing between one object and another."³⁴ In his writings Boccioni specifically cites "the electric theory of matter, according to which matter is only energy; condensed electricity and existing only as force," and his painting testifies to the widespread belief that the ether was somehow at the root of matter.³⁵ If Boccioni makes the texture of the ether material and palpable, he also represents the ether by signs of its vibratory waves, including visible light, which was at times cited as the only manifestation of the ether perceptible to the human eye.

Of course, with his futurist "ultrasensitivity" Boccioni adds other ranges of vibrations and thus charges his painting with shafts of electromagnetic light, such as the eerie X-ray-like rays or ultraviolet rays that descend upon and through the sitter from the top of the painting. These rays articulating the painting's surface can also be read as futurist "force-lines" (a concept derived from Faraday and Maxwell) and, given the widespread view that electric and magnetic forces resulted from strains in the ether, as further signs of the ether itself.³⁶ Describing the "atmosphere" (i.e., the ether) in futurist paintings as "the sensible conductor of dynamic forces," Boccioni argued in 1913, "It should be clear . . . why an infinity of lines and currents emanate from our objects, making them live in an environment which has been created by their vibrations."³⁷

Boccioni's ideas on materializing the invisible ether were supported by contemporary scientific theory, but he also drew from occult literature on the exteriorization of thought and mediumist materializations. Boccioni had asserted in his 1911 lecture, "And so, if solid bodies give rise to states of

mind by means of vibrations of forms, then we will draw those vibrations.”³⁸ And in his 1914 summa *Pittura scultura futuriste* he would declare, “For us the biological mystery of mediumist materialization is a *certainty*, a *light* in the intuition of physical transcendentalism and plastic states of mind.”³⁹ Rather than the telepathic model of communication that was to interest artists such as Kupka or Kandinsky, it was the physical manifestation of thought or will that Boccioni sought to represent in futurist painting. Thus, the etherial vibrations condensing into forms around his mother in *Matter* are presumably manifestations of her state of mind, including Bergsonian memory images, such as the horse at the left and the walking man at the right. As such, these memory imprints in the ether might be thought of as the latter-day counterparts to Blavatsky’s “daguerreotype impressions” in a cosmic, etherial image bank.⁴⁰

Boccioni’s determination to make the ether itself palpable as substance and as ultimate sign of continuity is clearest in his 1913 sculpture, *Unique Forms of Continuity in Space*. This sculpture brings together in the issue of continuity the artist’s commitment to the ether and his personal interpretation of the fourth dimension of space. Although Bergsonian philosophy underlies Boccioni’s basic belief in continuity, the theme of continuity was also central to Victorian physics as practiced by figures such as Lodge. In his 1909 book *The Ether of Space*, Lodge quoted Maxwell’s assertion that “the vast interplanetary and interstellar regions” of the universe are so “full of this wonderful medium . . . that no human power can remove it from the smallest portion of space, or produce the slightest flaw in its infinite continuity.”⁴¹ Elsewhere, I have interpreted Boccioni’s sculpture in relation to his motion-oriented futurist response to cubism’s fourth dimension.⁴² But when Boccioni’s commitment to the ether is clarified, it would seem that the continuity suggested by the fourth dimension’s spatial properties *and* by the ether underlie the materialization of the invisible in this work.

Boccioni’s 1914 *Pittura scultura futuriste* boldly claims the fourth dimension for futurism, recasting it in dynamic terms:

With the unique form which gives continuity in space we create a form which is the sum of the potential unfolding of the three known dimensions. Therefore we cannot make a *measured and finite* fourth dimension, but rather a continuous projection of forces and forms intuited in their infinite unfolding. In fact, the unique dynamic form which we proclaim is nothing other than the suggestion of a form in motion which appears for only a moment to be lost in the infinite succession of its variety.⁴³

Boccioni may well have thought of that “unique dynamic form” as a four-dimensional entity passing through three-dimensional space, registering a succession of different appearances. This would be the four-to-three-

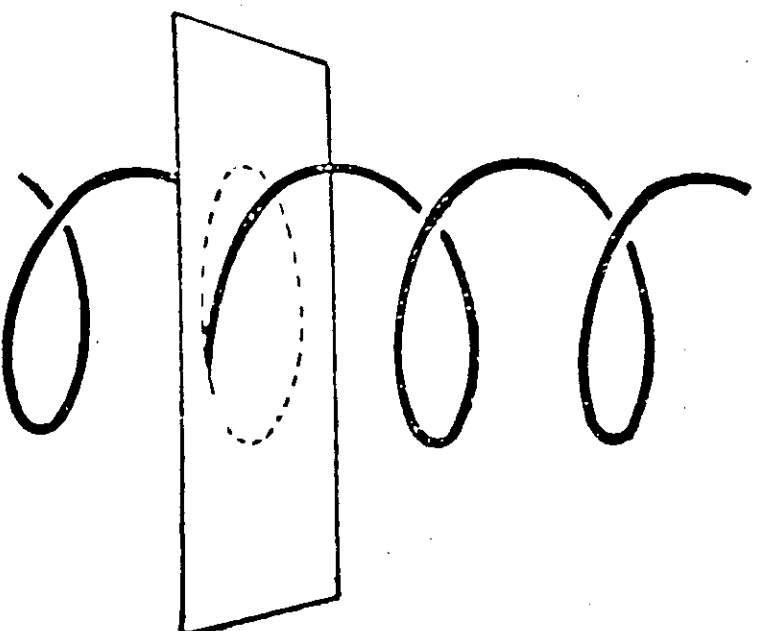


FIGURE 6.6. Intersection of a spiral and a plane. Source: Charles Howard Hinton, *The Fourth Dimension* (London, 1904), p. 27.

dimensional analogue of Hinton’s model of the passage of a three-dimensional spiral through a two-dimensional film, which would register in the film as the “relative motion” of a point tracing a circle (figure 6.6). In reality that “point” would be a succession of points on the spiral, defined as the spiral moved vertically in its “absolute motion.”⁴⁴

Yet Boccioni’s primary goal in his sculpture seems to have been to embody the physicality of the registering medium—in this case the ether as three-dimensional counterpart to a two-dimensional registering film. As he writes elsewhere in his 1914 book,

We want to model the atmosphere, to denote the forces of objects, their reciprocal influences, the unique form of continuity in space. This materialization of the etherial fluid, the imponderable, this transposition into the concrete of what one could call the new biological infinity and which illumines the fever of intuition, is it perhaps just a literary idea? All the human researches of our epoch, don’t they without a doubt aspire to this imponderable which is in us, around us and for us?⁴⁵

If on one level Boccioni tied the “infinite unfolding” of forces and forms in *Unique Forms of Continuity* to a fourth dimension of space, in the end the work also stands as perhaps his most successful materialization of the ether—with its particular effect of “ether drag”—which definitively destroys the closed boundaries of the sculpture. Like paintings such as *Matter*, Boccioni’s sculpture testifies to his commitment to inventing the new languages of form and space he believed were necessitated by modern science.

Turning to Kupka, a Czech painter living in Paris in the midst of the salon cubist circle, we find an artist equally interested in invisible reality. “Great art makes of the invisible and intangible, purely and simply experienced, a visible and tangible reality,” Kupka had written in his manuscript treatise of 1912–1913, “*La Création dans les arts plastiques*.”⁴⁶ Like Boccioni, Kupka was deeply engaged with science and occultism and the rich interconnections between them. A former spiritualist medium, Kupka attended lectures on physics, biology, and physiology at the Sorbonne, and the physics of electromagnetism—adopted and popularized by occultists as well—was a key stimulus for him.⁴⁷ His pursuit of the invisible in the years before World War I, in fact, can be thought of as a trajectory from an early exploration of X-ray-like clairvoyance to his ultimate adoption of telepathy based on wireless telegraphy as a model for artistic communication. Thus, Kupka initially conceived of his paintings as revelations of the invisible akin to an X-ray plate, and works such as the 1911 *Planes by Colors* (figure 6.7) actually give the appearance of an X-ray plate held up to the light. Here Kupka’s translucent figure also exhibits the characteristic contrasting nose of an X-ray photograph, produced because X-rays penetrate the cartilage of the nose, but not the surrounding bone structure of the head (figure 6.8). Kupka also adopted the metaphor of the X-ray plate for the mind of the artist, describing it as “an ultrasensitive film, capable of sensing even the unknown worlds of which the rhythms would seem incomprehensible to us.”⁴⁸

By 1912, however, Kupka had begun to move away from his transparent renderings of recognizable forms with their X-ray associations. In his subsequent works surfaces are transformed into opaque patterns of color, and a concomitant change is apparent in his theoretical stance. Kupka’s treatise chapter entitled “*Emission et réalisation*” raises the possibility of a future art form that could communicate directly between the mind of the artist and the viewer:

Observing the progress accomplished in diverse domains we may suppose and foresee the possibility of other means—new—of transmission: transmission more direct by magnetic waves like those of the hypnotizer. On this point the future holds surprises; we must wait to see appear X . . . *graphes* or X . . . *graphies*, of which the arrangement will expose events that are invisible, subtle,



FIGURE 6.7. František Kupka, *Planes by Colors*, 1911–12. Oil on canvas, 43 $\frac{3}{8}$ × 39 $\frac{3}{8}$ in. Musée National d’Art Moderne, Centre Georges Pompidou, Paris. © 2001 Artists Rights Society (ARS), NY / ADAGP, Paris.

still poorly elucidated, as much of the exterior world as of the psyche of the artist. By these means, increasingly perfected, the artist will perhaps be able to make the viewer see the “film” of his rich subjective domain, without being obliged, as today, to work laboriously when he realizes a painting or sculpture.⁴⁹

Kupka’s use of terms such as *emission*, *transmission*, and *waves* is not limited to this passage, but characterizes much of the completed treatise. Indeed, by this time Kupka had shifted away from his earlier conception of the artist as a clairvoyant revealer of higher realities to the idea of the artist as an emitter of telepathic waves, on the model of wireless telegraphy. That

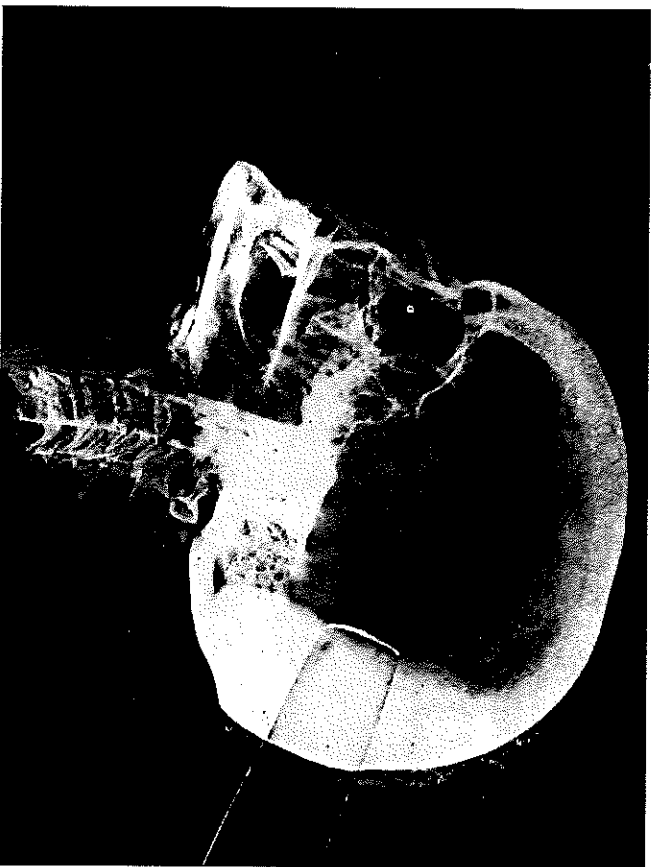
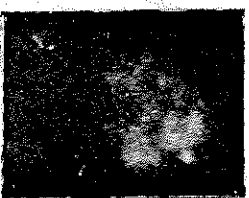


FIGURE 6.8. X-ray of a skull. Source: G. H. Niewenglowski, *Techniques et applications des rayons X* (Paris, 1898), plate 3.

technology involved the generation of a spark discharge in an oscillating primary circuit, which would create a resonant alternating current and resultant spark in a secondary circuit at some distance. As in the case of Kupka's interest in X-rays, however, both scientific and occult sources supported his theories on the possibility of communication by means of vibrations in the ether.

The process of exteriorizing thought had been central to the theories of French occultists such as Albert de Rochas and Hippolyte Baraduc, whose writings are filled with references to emission, vibration, electricity, and ether or ether-like substances. Baraduc drew on occult theories such as Baron Von Reichenbach's Odic force as well as scientific conceptions of a vibrating ether in his exploration of the interaction of the human soul and its surrounding environment. His 1896 text *L'Âme humaine: ses mouvements, ses lumières et l'icnographie de l'invisible fluïdique* documents his use of a photosensitive plate, at times aided by an electric current, to record the different stages of that interaction, including the "luminous vibrations of the soul" he termed *psychicones* (figure 6.9).⁵⁰ For Baraduc, these psychicones recorded the thought or state of mind of the subject, and Annie Besant and C. W.



PSYCHICONE
formé au centre d'un
nimbe odique.
(Avec électricité, sans appareil,
avec la main.)

FIGURE 6.9. "Psychicone." Source: Hippolyte Baraduc, *L'Âme humaine: ses mouvements, ses lumières et l'icnographie de l'invisible fluïdique* (Paris, 1896), plate 19.

Leadbeater in their 1901 book *Thought-Forms* cited Baraduc as the "scientific" counterpart to their own work.⁵¹

Colonel Albert de Rochas, the primary French advocate of traditional magnetism and Reichenbach's Od, took particular care to bolster his assertions by citing contemporary developments in the physics of electromagnetism. He actually added fifteen such appendices to his 1895 text *L'Extériorisation de la sensibilité*. In addition to the writings of Oliver Lodge, Rochas included a remarkable 1892 lecture entitled "Cerebral Radiation" by the American engineer Edwin Houston.⁵² Based on the wave vibrations in the ether documented by Hertz, Houston posited a theory of "thought waves" that could travel through the ether and evoke resonant "molecular vibrations" in a "receiving brain." Foretelling Baraduc, Houston suggested that these thought waves could perhaps be registered on a "suitably sensitized plate."⁵³ And, like Kupka later, he hypothesized that at some future time such graphic records of thought waves might be able to stimulate the appropriate molecular vibrations in the brain of a viewer and give rise to the thought originally projected. As Besant and Leadbeater would do in *Thought-Forms*,

Houston emphasized that what was transmitted was not a recognizable form, but rather “the undulatory movements of the ether created by cerebral operations.”⁵⁴ Such ideas were subsequently reiterated in sources such as Henry Fotherby’s article “L’Éther, véhicule de la conscience subliminale,” published in the *Annales des Sciences Psychiques* in July 1906.⁵⁵

Telepathy and the theory of wireless telegraphy (before it had come into wide commercial use) thus provided a rationale for a direct, abstract mode of communication, free of the identifiable images that remained in Kupka’s X-ray related paintings. Although Houston’s ideas were available in the numerous editions of Rochas’s book, Crookes also stimulated interest in telepathic communication by means of his highly publicized presidential addresses before the Society for Psychical Research and the British Association in 1897 and 1898. Crookes’s lectures, both published in the *Revue Scientifique* and available in occult sources as well, could make an even stronger case for telepathy after the discovery of X-rays and the emergence of early wireless telegraphy practice. Thus, Crookes’s model for “brain waves” was the X-ray, whose extremely short wavelength allowed it to penetrate solid matter.⁵⁶

Although Crookes considered Hertzian waves, with their wavelength in the range of a meter or much longer, to be far too low in frequency to penetrate the brain, he nevertheless connected the brain’s functioning to the technology of wireless telegraphy. Having compared the structure of the human brain (i.e., the narrow gap between nerve cells) to a wireless telegraphy wave detector, Crookes also posited the possible existence of “masses of nerve coherers in the brain,” which would receive ether vibrations and produce “molecular movements in the brain.”⁵⁷ Like Crookes and Houston, Kupka often spoke of the brain in terms of its “molecular state.”⁵⁸ He augmented the telegraphic overtones of the brain’s activity through his use of electrical terminology, discussing artistic creativity, for example, in terms of flashing sparks that equally evoke a wireless telegraphy installation.⁵⁹ Kupka’s woodcut *Fantaisie physiologique*, included in the 1923 Czech publication of his treatise (figure 6.10), gives vivid expression to this new conception of artistic creation as the reception and emission of waves.

A firm believer in the evolution of consciousness, Kupka anticipated the possibility of a future era of completely dematerialized, purely telepathic artistic communication. Recognizing the limitations in the receptivity of his contemporary audience, however, he concluded, “For now, the work of art conceived and traditionally executed” in oil on canvas is still necessary.⁶⁰ That the visible spectrum also consisted of electromagnetic waves allowed Kupka to maintain his electromagnetic theory of art, basing it for the present on visible light and color. Although the telepathic element of that theory

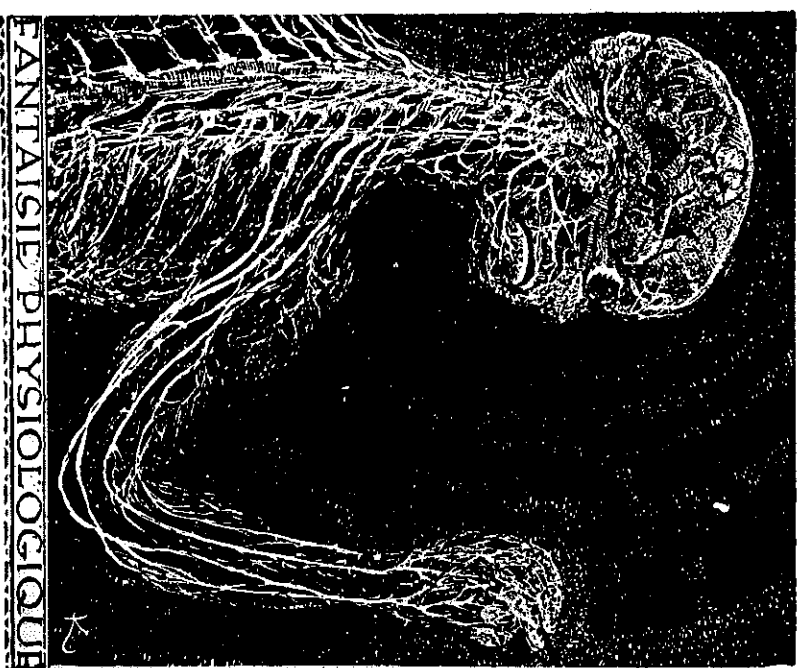


FIGURE 6.10. František Kupka, *Fantaisie physiologique*. Illustration for *Tvoření v umění výtvarném* [Creation in the Plastic Arts] (Prague, 1923), p. 163.

implied transcending the recognized organs of sense, his artistic theory and practice as set forth in 1912 and 1913 ultimately relied upon the production of waves of colored light by the canvas and their perception by the sensitive eye. Thus, for Kupka, paintings such as *Amorpha, Fugue in Two Colors* of 1912 were exteriorizations or emissions of the “vision of the artist,” flat, self-sufficient objects that would in turn “emit,” by reflection, electromagnetic waves of colored light.⁶¹ These waves of visible light stand as the counterpart to Edwin Houston’s thought waves, the abstract patterns captured on a sensitive plate that might then generate molecular vibrations of thought in the mind of a viewer.

Kupka’s conception of his paintings as generators of vibrations calls to mind the somewhat better-known goal of Wassily Kandinsky to create works of art that would produce a *Klang* or sympathetic vibration in the soul of a viewer.⁶² Having lived on the outskirts of Paris during 1906–1907, the



FIGURE 6.11. Wassily Kandinsky, *Composition VI*, 1913. Oil on canvas, 6 ft. 4¼ in. × 10 ft. Hermitage Museum, St. Petersburg. © 2001 Artists Rights Society (ARS), NY / ADAGP, Paris.

Russian-born Munich resident read many of the same sources as Kupka: not only the theosophists Blavatsky, Steiner, Besant, and Leadbeater, but also occult scientists and scientific occultists such as Crookes, Flammarion, Baraduc, and Rochas. The literature on Kandinsky has tended to focus largely on Besant's and Leadbeater's *Thought-Forms*, but their work was obviously just one manifestation of a much larger fascination in this era with the transfer of thought by means of ether vibrations.⁶³

Drawing particularly on the theories of Steiner, Kandinsky saw the artist as a visionary prophet whose paintings—freed of the materiality of objects—could help usher in the new “epoch of the Great Spiritual” he envisioned for society. As noted earlier, Steiner quoted extensively from Lord Balfour’s address before the British Association, which had suggested that the ether might be the basic “stuff out of which [the] universe is built.”⁶⁴ and such views supported Kandinsky’s anti-materialist stance. Indeed, his 1911 treatise *On the Spiritual in Art* refers specifically to the “electron theory—i.e., the theory of moving electricity, which is supposed completely to replace matter,” the same “electric theory of matter” upon which Boccioni had seized.⁶⁵ In his quest for a pure form of artistic communication, Kandinsky initially used a technique of hidden, apocalyptic imagery, meant to sensitize and spiritualize a viewer. Gradually, however, that iconography was further and further obscured to produce anarchic, chaotic images of pure color and form meant to unsettle the complacent viewer and prepare him or her for a new level of spiritual consciousness (figure 6.11).⁶⁶

Kandinsky was a firm believer in the musical, synaesthetic possibilities of color turning into “sound,” and his paintings give visual and, hence, aural form to the necessary dissonance that he and his composer friend Arnold Schoenberg believed would become “the consonance of tomorrow.”⁶⁷ Although the sympathetic resonance of strings or a tuning fork served Kandinsky as an inanimate model in the realm of sound for his painting’s desired *Klang* in a viewer’s soul, it was the human-to-human communication based on the etherial telegraphy—telepathy analogy that provided the essential support for his theory.⁶⁸ In the light of the new conception of dematerialized matter and ether-filled space, as well as the prevalent model of vibratory thought transfer, Kandinsky’s purest compositions of 1913, like the paintings of Kupka and Boccioni, gain a new cogency and can be recognized likewise as examples of vibratory modernism.

If these artists’ interest in a vibrating etherial medium led to variations in painted pictorial space and form, Marcel Duchamp was prompted to make even more radical formal inventions by his interest in etherial vibrations and the model of wireless telegraphy. Duchamp had matured as an artist in close proximity to Kupka, and, sharing his deep engagement with science, had pro-

duced paintings in 1911–12 that paralleled Kupka's concern with X-rays.⁶⁹ Like Kupka, Duchamp's interest ultimately turned to Hertzian waves, but instead of painting exteriorizations of thought, the younger artist gave up painting completely to function more like an engineer in creating his masterwork of 1915–23, *The Bride Stripped Bare by Her Bachelors, Even* or *The Large Glass* (figure 6.12). For the *Large Glass* project, Duchamp worked on two panes of glass over nine feet tall, using a variety of unorthodox materials including lead wire (with which he “drew” the forms in a precise, impersonal style), lead foil, mirror silver, and dust as well as conventional oil paint and varnish. Seeking to avoid self-expressive painting and drawing, he adopted laboratory-like techniques that approximate in places the creation of electrical and even telegraphy equipment.⁷⁰ The “Oculist Witnesses” at the right side of the lower panel, for example, were the result of Duchamp's scraping away mirror silver applied to the glass, much the way wireless telegraphy pioneers produced a wave-detecting spark gap by inscribing lines in a silver film on glass.⁷¹

Determined to “put painting once again at the service of the mind,” Duchamp had begun in 1912 to make hundreds of notes for the work, which he described as “a sketch . . . for a reality which would be possible by slightly distending the laws of physics and chemistry.”⁷² He ranged through a variety of fields of science and technology to create the humorous “playful Physics” of the *Large Glass*, but electromagnetism and, specifically, wireless communication are central to his “painting of frequency,” as he called the work.⁷³ According to Duchamp's notes, in this scientific allegory of sexual quest the biomechanical Bride (the skeletal form at the left of the upper panel) triggers the mechanical sexual activities of the three-dimensional, gravity-bound Bachelor Apparatus below by means of her “commands.”

Given Duchamp's references in his notes to the Bride's “sparks” and “splendid vibrations,” her possession of an “emanating ball,” and her “electrical control of the striping” (to be carried out by the Bachelors), it is clear that his model for communication in the *Large Glass* was the Hertzian waves of wireless telegraphy.⁷⁴ Beyond the wireless telegraphy antennae atop the Eiffel Tower, the first contemporary experiments in “radio control,” carried out in Paris by Edouard Branly in 1905–6, may have been another stimulus.⁷⁵ Seeking to differentiate the Bride further from the Bachelors, Duchamp had speculated extensively on how to make her four-dimensional. In view of the association of the ether with the fourth dimension in this period, the Bride does seem to exist in an ethereal, wave-filled “paraspaces” possessing the qualities of immeasurability and freedom from gravity popularly associated with the fourth dimension.⁷⁶

While Duchamp's brother, Raymond Duchamp-Villon, wrote of the need

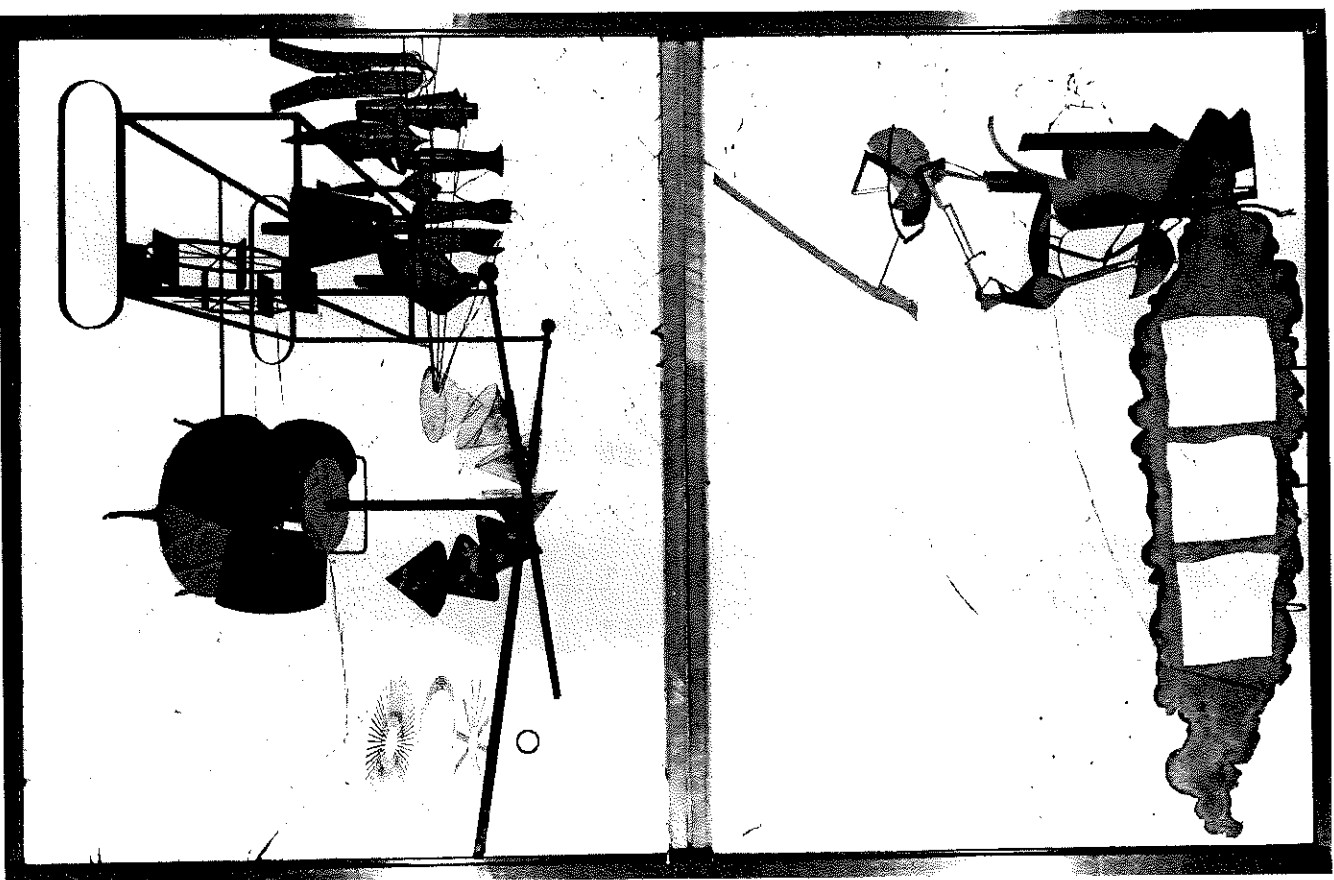


FIGURE 6.12. Marcel Duchamp, *The Bride Stripped Bare by Her Bachelors, Even* (*The Large Glass*), 1915–23. Oil, varnish, lead wire, mirror silvering, dust, and aluminum foil on glass panels, mounted within a wood and steel frame, 109¼ × 69¼ in. The Philadelphia Museum of Art, Bequest of Katherine S. Dreier. © 2001 Artists Rights Society (ARS), NY / ADAGP, Paris.

for art "to reveal the vibration of thought itself and thereby to provoke states of consciousness hitherto unexpected or unknown."⁷⁷ Duchamp certainly shared none of Kupka's or his brother's goals of mystical consciousness-raising. Yet he, too, may have incorporated an aspect of telepathic thought transfer on the model of Baraduc. Defining the cloudlike "Milky Way" to the right of the Bride as her "cinematic blossoming" or imagined orgasm, Duchamp had hoped to imprint the image photographically on the glass surface.⁷⁸ Since he had explored the theme of bodily emanations or "exteriorizations" like those of Baraduc and Rochas in paintings of 1910-1911, he may well have thought of this image, "the sun total of the Bride's splendid vibrations," as an ironic, sexual thought projection akin to Baraduc's photographic records of the soul's "luminous vibrations."⁷⁹

The kind of automatic, objective recording provided by photography represented an ideal for Duchamp, and the theme of indexical registering instruments is prevalent within the operations of the narrative of the *Large Glass* as well as in certain of his techniques for its production. Just as the fabrication of the Oculist Witnesses paralleled that of a Hertzian wave detector, the entire *Glass* has been compared to a giant photographic plate or X-ray plate, poised to capture visible and invisible light.⁸⁰ "Wiring" instead of drawing his forms, Duchamp had indeed *built* his "painting of frequency" as a kind of apparatus far removed from the traditional medium of painting. His frequency apparatus would undergo an unexpected vibratory permutation after he ceased work on it in 1923. As the *Glass* was shipped back to Connecticut in the back of a flatbed truck after a 1926 exhibition, the glass panes shattered, producing the symmetrical cracking Duchamp said made the work "a hundred times better."⁸¹

Instead of painting or sculpting the ether as Boccioni attempted to do, Duchamp—like Kupka and Kandinsky—reconceived the work of art as an object meant to interact with its environment and viewers. Drawing upon the reigning model of ethereal, wave-filled space, Kupka and Kandinsky focused on a highly personal vibratory communication meant to be projected to the mind or soul of a sensitive observer. Duchamp, by contrast, built an apparatus modeled on an impersonal wave-detector or other registering instrument whose narrative presents in equally detached terms a sexual encounter-at-a-distance bridged only by the Bride's projected vibratory commands.

More attuned to the expressive goals of Boccioni, Kupka, and Kandinsky than to the cool, engineer-like precision of Duchamp, a statement by Edward Carpenter in his 1905 *The Art of Creation* nevertheless effectively sums up a view of nature with which they were all acquainted:

Nature is a great vehicle, an innumerable network and channel of intelligence and emotion. . . . The messages of light and sound and electricity and attrac-

tion penetrate everywhere; and as modern science shows us that the air, the sea, and the solid frame of the earth itself may be the vehicle of waves which without wire or definite channel may yet convey our thoughts safely to one another through intervening leagues of distance, so surely we must believe that the countless vibrations ever going on around, and ever radiating from and impinging upon every known object, are messengers too of endless meaning and feeling.⁸²

For Carpenter and many others in the early years of the century, wireless telegraphy confirmed the probable existence of a cosmic "Internet" through which thoughts might travel from one individual to another. Although today he is also a mostly-forgotten relic of the early modern period, Carpenter, like the ether, was widely known in this period, and his writings would have contributed further to the popularization of the prevalent vibratory conception of nature.

As we have seen, a number of major artists and writers of early modernism were united in their mutual concern with the new paradigm of reality represented by ether-filled space, matter born from and dematerializing into the ether, and the new possibilities of communicating (and seeing) offered by the model of vibrating waves in the ether. For artists, the ether was perhaps the most tantalizing element of the physics of electromagnetism at a time when physics still seemed visualizable—before the advent of the increasingly mathematical approaches of relativity theory and quantum mechanics. Such a new conception of reality had demanded new form-languages to express it. In all its manifestations, the ether served as a potent stimulus for creative invention by artists and writers alike.

18. Kayman, *Modernism of Ezra Pound*, p. 92.
19. Henderson, *The Fourth Dimension*, pp. 6, 17, 339.
20. Karl Pearson, *The Grammar of Science* (1892; London: A. and C. Black, 1900), pp. viii, 103. To claim the shift from "explanation" to "description" as liberatory is not to argue for its universal acceptability. As M. Norton Wise has suggested to me in conversation, it would be difficult to imagine Einstein, to take but one example, as subscribing to such freedom. Nevertheless, the move graphed by Mach, Poincaré, Pearson, and their sympathizers does register a notable turn in late nineteenth-century thought and feeds directly into the particular trope of creativity I advance here.
21. Arthur Eddington, *The Nature of the Physical World* (Cambridge: Cambridge University Press, 1928), p. 301, xvii.
22. Pound, *Chinese Written Character*, pp. 24–25.
23. Mach, *Popular Scientific Lectures*, p. 250.
24. Respectively, in "Modern Art and the Invisible," and "Charles Howard Hunt's Fourth Dimension and the Aether of Space," forthcoming in *Modernism's Fourth Dimensions*, ed. Bruce Clarke and Linda Henderson (Penn. State UP).
25. *The Scientific Papers of James Clerk Maxwell*, ed. W. D. Niven, 2 vols. (Cambridge: Cambridge University Press, 1890), 1:1156.
26. Margaret Morrison, "A Study in Theory Unification: The Case of Maxwell's Electromagnetic Theory," *Studies in the History and Philosophy of Science* 23:1 (1992), 107.
27. Pound, *Chinese Written Character*, pp. 11–12.
28. Bruce Clarke, *Energy Forms: Allegory and Science in the Era of Classical Thermodynamics* (Ann Arbor: University of Michigan Press, 2001), pp. 89–95.
29. See also Donald Benson, "Facts and Fictions in Scientific Discourse: The Case of Ether," *Georgia Review* 38 (1984), 836–37.
30. See my "Mauberley's Barrier of Style," in *Ezra Pound: The London Years: 1908–1921*, ed. Philip Grover (New York: AMS Press, 1978), pp. 155–64.
31. This is an arena shared by the extraordinary novelistic/scientific nexus of Henry and William James. For a fascinatingly suggestive pointer in this direction, see Richard Poirier, "In Praise of Vagueness," *London Review of Books* (December 14, 1995), 10–12.

CHAPTER 6

1. Einstein's general theory of relativity (1916) as well as the special theory became news items in 1919, when observations during an eclipse of the sun that year validated one of the tenets of the general theory. On the slow acceptance of Einstein's theories by scientists in France, England, and America, see Stanley Goldberg, *Understanding Relativity: Origin and Impact of a Scientific Revolution* (Boston: Birkhäuser, 1984), chaps. 7–9. The development of wireless telegraphy by the later 1890s,

grounded in Heinrich Hertz's confirmation of the existence of electromagnetic waves in 1888, was probably the single greatest stimulus to popular interest in electromagnetic waves and the ether. On the ether, in addition to Bruce Hinm's essay in this volume, see E. T. Whittaker, *A History of Theories of Aether and Electricity* (London: Longmans, Green, 1910); and G. N. Cantor and M. J. S. Hodge, *Conceptions of Ether: A Study in the History of Ether Theories 1740–1900* (Cambridge: Cambridge University Press, 1981). On the ether's fictional status, see Donald R. Benson, "Facts and Fictions in Scientific Discourse: The Case of the Ether," *The Georgia Review* 38 (Winter 1984), 825–37.

2. For these developments, see Alex Keller, *The Infancy of Atomic Physics: Heracles in His Cradle* (Oxford: Clarendon Press, 1983).

3. Boccioni, "Selected Notes for the Lecture on Futurist Painting," in Metropolitan Museum of Art, *Umberto Boccioni*, curated by Esther Coen (New York, 1988), p. 239.

4. The brief treatment of Duchamp at the conclusion of this essay is drawn from Linda D. Henderson, *Duchamp in Context* (Princeton: Princeton University Press, 1998), where much of the science and occultism discussed here is addressed more fully. Kupka's engagement with wireless telegraphy is also treated more extensively in chapter 8 of that book. Sections of the discussions of Kupka and Boccioni herein first appeared in Henderson, "Kupka, les rayons X, et le monde des ondes électromagnétiques," in Musée d'Art Moderne de la Ville de Paris, *Frankisek Kupka, 1871–1957, ou l'invention d'une abstraction*, ed. Kriszina Passuth (Paris, 1990), pp. 51–57; or in Henderson, "Die moderne Kunst und die Unsichtbare: Die verborgenen Wellen und Dimensionen des Okkultismus und der Wissenschaften," in Schirn Kunsthalle, Frankfurt, *Okkultismus und Avantgarde: Von Munich bis Mondrian, 1900–1915* (Frankfurt, 1995), pp. 13–31. Although unknown to me at the time of this writing, Friedrich Teja Bach discusses the importance of the theme of vibration (in both occultism and science) for the sculptor Brancusi in *Constantin Brancusi: Metamorphosen plastischer Form* (Cologne: DuMont, 1987).

5. F. T. Marinetti, "Technical Manifesto of Futurist Literature," in *Marinetti: Selected Writings*, ed. R. W. Flint (New York: Farrar, Straus and Giroux, 1972), p. 89. Apollinaire's poem was first published in *Les Soirées de Paris* (no. 25 [June 15, 1914], pp. 340–41) and appeared subsequently in his collection *Calligrammes* (Paris: Mercure de France, 1918).

6. Ezra Pound, "The Approach to Paris, I," *The New Age* 13 (September 11, 1913), 578. For Pound's "on the watch" reference, see "The Wisdom of Poetry," *The Form* 47 (April 1912), 500; in Ezra Pound, *Selected Prose 1909–1965*, ed. William Cookson (London: Faber and Faber, 1973), p. 331. On Pound's engagement with electromagnetic waves as well as his more general interest in both geometry and science in this period (uncannily parallel to Duchamp's own), see Ian F. A. Bell, *Critic as Scientist: The Modernist Poetics of Ezra Pound* (London: Methuen, 1981), as well as his essay in this volume.

7. See *Arc Volatic* (Barcelona), no. 1 (Feb. 1918). Apollinaire's friends Robert

- and Sonia Delaunay were part of the expatriot community in Barcelona and collaborated with Barradas. For information on Barradas, I am grateful to University of Texas graduate student David Jared Morse, who recently completed a master's thesis entitled "Rafael Barradas and *Vibracionismo*: Science and Spirituality in Spanish Avant-Garde Art" (December, 2001). Roger Shattuck discusses an episode in the pre-history of this moment of such interest in invisible vibrations in his essay "Vibratory Organism: Baudelaire's First Prose Poem," in *The Inner Eye: On Modern Literature & the Arts* (New York: Farrar Straus Giroux, 1984), 135–48. Borrowing the phrase "vibratory organism" from Alfred North Whitehead's 1925 *Science and the Modern World*, Shattuck discusses Baudelaire's celebration of the "perpetual vibration" of the "great symphony of daylight" (i.e., visible light and color) in the chapter "On Color" of his *Salon of 1846*.
8. See Keller, *Imfancy of Atomic Physics*, p. 20.
 9. Edwin Houston, "Cerebral Radiation," *Journal of the Franklin Institute* 133 (June 1892), 489.
 10. On Kelvin's vortex atoms, see Cantor and Hodge, *Conceptions of Ether*, 239–68. See also Oliver Lodge, "Electric Theory of Matter," *Harper's Monthly Magazine* 109 (August 1904), 383–89.
 11. "Address by The Right Hon. A. J. Balfour," *Report of the Seventy-Fourth Meeting of the British Association for the Advancement of Science (1904)* (London: John Murray, 1905), p. 7. According to Lord Balfour, "Without the ether an electric theory of matter is impossible" (p. 6).
 12. See Gustave Le Bon, *L'Évolution de la matière* (Paris: Ernest Flammarion, 1905).
 13. On the popular conception of the fourth dimension as well as its ether associations, see Linda D. Henderson, *The Fourth Dimension and Non-Euclidean Geometry in Modern Art* (Princeton: Princeton University Press, 1983; new ed., Cambridge, Mass.: MIT Press, 2003).
 14. See Sixten Ringbom, *The Sounding Cosmos: A Study in the Spiritualism of Kandinsky and the Genesis of Abstract Painting* (Abo: Abo Akademi, 1970), p. 37.
 15. For the quoted phrases, see H. P. Blavatsky, *Isis Unveiled: A Master-Key to the Mysteries of Ancient and Modern Science and Theology* (New York: W. Q. Judge, 1877), I, pp. 129–30, 134.
 16. Stewart and Tait, as quoted in Blavatsky, *Isis Unveiled*, I, p. 188.
 17. *Ibid.*, pp. 182–85. I am grateful to Bruce Clarke for directing my attention back to Blavatsky and these passages. See his *Energy Forms: Allegory and Science in the Era of Classical Thermodynamics* (Ann Arbor: University of Michigan Press, 2001), pp. 173–74.
 18. B. Stewart and P. G. Tait, *The Unseen Universe, or Speculations on Future State*, 4th ed. rev. (London: Macmillan, 1876), p. 221. Gillian Beer also discusses Stewart and Tait's book, the ether, and the challenge of representing the invisible (in this case, in literature) in her essay "'Authentic Tidings of Invisible Things': Vision and the Invisible in the Later Nineteenth Century," in *Vision in Context: Historical and Contemporary Perspectives on Sight*, edited by Teresa Brennan and Martin Jay (New York: Routledge, 1996), pp. 83–98.
 19. C. Howard Hinton, *A New Era of Thought* (London: Swan Sonnenschein, 1888), p. 53.
 20. See, e.g., Albert de Rochas, *L'Extériorisation de la sensibilité* (1895), 6th ed. (Paris: Bibliothèque Chacomac, 1909), pp. 201–2.
 21. See William Crookes, "De la relativité des connaissances humaines," *Revue Scientifique*, 4th ser., 7 (May 15, 1897), 612–13. See also Crookes, "Sir William Crookes on Psychological Research," *Annual Report of the Smithsonian Institution*, 1899 (Washington, D.C.: Government Printing Office, 1901), p. 200.
 22. Camille Flammarion, *The Unknown* (1900; New York and London: Harper & Brothers, 1901), p. 12.
 23. "Address by Sir William Crookes, President," *Report of the Sixty-Eighth Meeting of the British Association for the Advancement of Science (1898)* (London: John Murray, 1899), p. 31. Crookes's address was published in Paris as "Les Progrès récents des sciences physiques," *Revue Scientifique*, 4th ser., 10 (Oct. 8, 1898), 449–57. Although she does not address Crookes, Lodge, or Flammarion, Laura Otis discusses the analogy between telegraphy and telepathy and its importance in literature in *Networking: Communicating with Bodies and Machines in the Nineteenth Century* (Ann Arbor: University of Michigan Press, 2001).
 24. Umberto Boccioni et al., "Technical Manifesto of Futurist Painting," in *Futurist Manifestos*, ed. Umbro Apollonio (New York: Viking Press, 1973), p. 28 (with slight variation in translation: "mediumistic phenomena" versus "the medium"). The primary studies to date of futurism's engagement with the occult are Germano Celant, "Futurism and the Occult," *Artforum* 19 (Jan. 1981), pp. 36–42; and Giovanni Lisa, "Futurismus und Okkultismus," and Katherine Harlow Tighe, "Die Schriften von Umberto Boccioni," in *Okkultismus und Avant-Garde*, pp. 431–44; 469–76.
 25. Boccioni diary, Dec. 21, 1907, in Metropolitan Museum, *Boccioni*, p. 257. For Boccioni's references to Herzian waves, see Boccioni, *Dynamisme plastique: peinture et sculpture futuristes*, ed. Giovanni Lisa (Lausanne: L'Age d'Homme, 1975), pp. 35, 105. This text is a translation of Boccioni's *Pittura scultura futuriste (dynamismo plastico)* (Milan: "Poesia," 1914).
 26. Boccioni, "Futurist Painting" [Circolo Artistico lecture, 1911], in Metropolitan Museum, *Boccioni*, p. 232.
 27. *Ibid.*; and Boccioni, *Dynamisme plastique*, p. 35.
 28. Boccioni, "The Plastic Foundations of Futurist Sculpture and Painting" (1913), in *Futurist Manifestos*, ed. Apollonio, p. 89.
 29. *Ibid.*, p. 88.
 30. Longhi, as quoted in Metropolitan Museum, *Boccioni*, p. 138. Boccioni's application of paint in individual stroke of pure color is rooted in Italian divisionism, a counterpart to Seurat's Neo-Impressionist style. Yet, Boccioni's brushwork is far from Seurat's methodical application of paint discussed in the essays by Shiff and Brain herein. For a detailed treatment of the painting's subject and relation to Boccioni's oeuvre as a whole, see the catalogue of the exhibition *Boccioni 1912 Materia* held at the Fondazione Antonio Mazzotta, Milan, in 1995. The backdrop behind Boccioni's mother on her balcony is the construction site of the Centrale Elettrica or central power plant of Milan.

31. In addition to the writings of Le Bon, occult sources regularly addressed such emanations; see Gaston Mery, "Le Radium et les effluves humaines," *L'Echo du Merveillex* 8 (Jan. 1, 1904), 6–9. The writings of French occultists had a remarkable international currency in this period—both through book circulation and through the reprinting of articles in Italian journals. See, e.g., Albert de Rochas, "Registrazione fotografica degli esseri e radiazioni dello spazio," *Luce et Ombre*, no. 9 (Sept. 1908), pp. 423–36.
32. Boccioni, "Plastic Foundations," in *Futurist Manifestos*, ed. Apollonio, p. 89. See also Brian Peirce, "Boccioni and Bergson," *Burlington Magazine* 116 (March 1974), 140–47.
33. Boccioni, "Futurist Painting," in Metropolitan Museum, *Boccioni*, p. 238.
34. Boccioni, *Dynamisme plastique*, p. 102; see also "Futurist Painting and Sculpture (extracts)," in *Futurist Manifestos*, ed. Apollonio, p. 180.
35. Boccioni, *Dynamisme plastique*, p. 105.
36. On Faraday's and Maxwell's "lines of force," see Whittaker, *History*, pp. 217, 271. The futurists first introduced the concept of "force-lines," which turned the cubist grid into a dynamic system of vectors, in the catalogue of their February 1912 exhibition at the Galerie Bernheim-Jeune in Paris. See *Futurist Manifestos*, ed. Apollonio, pp. 45–50.
37. Boccioni, "Plastic Foundations," in *Futurist Manifestos*, p. 89. For the "sensible conductor" reference, see Boccioni, *Dynamisme plastique*, p. 82.
38. Boccioni, "Futurist Painting," in Metropolitan Museum, *Boccioni*, p. 238.
39. Boccioni, *Dynamisme plastique*, p. 105. Emphasis in original.
40. See again Blavatsky, *Isis Unveiled*, I, p. 185.
41. Oliver Lodge, *The Ether of Space* (London: Harper & Brothers, 1909), pp. 104–5.
42. See Henderson, *Fourth Dimension*, pp. 110–16.
43. Boccioni, *Dynamisme plastique*, p. 73.
44. C. Howard Hinton, *The Fourth Dimension* (London: Swan Sonnenschein, 1904), p. 27. For Boccioni's interest in "absolute" versus "relative" motion, see Boccioni, "Absolute Motion + Relative Motion = Dynamism," in *Futurist Manifestos*, ed. Apollonio, pp. 150–54; and *Dynamisme plastique*, pp. 69–72.
45. Boccioni, *Dynamisme plastique*, p. 104. Christine Poggi has discussed *Unique Forms of Continuity in Space* in terms of gender and the Futurist desire, articulated by Marinetti, to fuse the male body with the machine. See Christine Poggi, "Dreams of Metallized Flesh: Futurism and the Masculine Body," *Modernism/Modernity* 4 (Sept. 1997), 19–43. For an analysis of *Unique Forms of Continuity in Space* and the fourth dimension in the context of futurism's politicized aesthetics and the theories of Bergson, see Mark Antliff, "The Fourth Dimension and Futurism: A Politicized Space," *Art Bulletin* 82 (Dec. 2000), 720–33.
46. Kupka, Preliminary manuscript of "La Création dans les arts plastiques," chap. 7, p. 10 (courtesy Margit Rowell); *La Création dans les arts plastiques*, trans. Erika Adams (Paris: Cercle d'Art, 1989), p. 236. Because the 1989 publication of *La Création dans les arts plastiques* is a reconstruction of Kupka's text made using both the original French manuscripts and the published Czech version (Prague, 1923), there are some critical changes in language. In particular, the editor's decision to replace the term *émission* by *énoncé* (see the text that follows at n.49) unfortunately distances the text from its pre-World War I origins. Kupka's original manuscripts are held today by Pierre Brullé, Paris. For Kupka's career as a whole, see Solomon R. Guggenheim Museum, *František Kupka, 1871–1957: A Retrospective*, curated by Margit Rowell (New York, 1975); Musée d'Art Moderne (Paris), *František Kupka*; and Dallas Museum of Art, *Painting the Universe: František Kupka, Pioneer of Abstraction*, curated by Jaroslav Andel and Dorothy Kosinski (Dallas, 1997).
47. See Guggenheim Museum, *Kupka*, pp. 75–77, 308. For a fuller discussion of Kupka and X-rays, see Linda D. Henderson, "X Rays and the Quest for Invisible Reality in the Art of Kupka, Duchamp, and the Cubists," *Art Journal* 47 (Winter 1988), 323–40.
48. Kupka, Unpublished notebook (1910–1911), p. 21 (courtesy Margit Rowell).
49. Kupka, Manuscript treatise, chap. 7, p. 1; *La Création*, p. 229.
50. Hippolyte Baraduc, *L'Âme humaine: ses mouvements, ses lumières et l'icographie de l'invisible fluide* (Paris: Georges Carré, 1896), pp. 3, 107–22.
51. Annie Besant and [Charles] Webster], *Thought-Forms* (1901; London: Theosophical Publishing Society, 1905), introduction.
52. For Lodge, see again Rochas, *L'Extériorisation*, pp. 201–2; for Houston's text, see *ibid.*, "Note G" ("La Radiation cérébrale"), pp. 231–41. See again note 9 for Houston's lecture as published in the *Journal of the Franklin Institute*.
53. Houston, "Radiation cérébrale," in Rochas, *L'Extériorisation*, pp. 232, 236, 238.
54. *Ibid.*, p. 240. See also Besant and Leadbeater, *Thought-Forms*, p. 14. Houston's original article had suggested that the generation of "ether waves" would require passing light through the photographic image; however, Rochas's translation supports the view, adopted by Kupka, that the graphic image itself could induce the appropriate molecular vibrations in the viewer's brain.
55. Henry Fotherby, "L'Éther, véhicule de la conscience subliminale," *Annales des Science Psychiques* 16 (July 1906), 406–28.
56. Crookes, "De la relativité," p. 613; Crookes, "Sir William Crookes on Psychological Research," p. 201.
57. Crookes, 1898 BAAS address, p. 21.
58. See, e.g., Kupka, Manuscript treatise (handwritten chap. 5, p. 29); *La Création*, p. 207.
59. Kupka, Manuscript treatise, chap. 7, pp. 3–4; *La Création*, pp. 231–32. For the wireless telegraphy comparison, see Henderson, *Duchamp in Context*, p. 102.
60. Kupka, Manuscript treatise, chap. 7, p. 1 *bis*; *La Création*, p. 230.
61. Kupka, Manuscript treatise (handwritten chap. 5, p. 1); *La Création*, p. 146. For the painted canvas as a source of waves in the ether, see *La Création*, p. 255.
62. For Kandinsky's theories, see Rose-Carol Washon Long, *Kandinsky: The Development of an Abstract Style* (Oxford: Clarendon, 1980).
63. See Ringbom, *Sounding Cosmos*, pp. 51–52, 54–55, 122–23 on Crookes,

Flammarion, Baraduc, and Rochas. Although Ringbom's text included an unprecedented overview of "Thought Transference and Thought Images," his focus on Besant and Leadbeater eclipsed his larger contextual discussion. Donald Benson provides the fullest discussion to date of Kandinsky and ether vibrations in "Kandinsky's Dramatic Reconstruction of Pictorial Space," *Annals of Scholarship* 4 (1986), 110-21.

64. "Address by Balfour," p. 7.

65. Kandinsky, *On the Spiritual in Art*, in *Kandinsky: Complete Writings on Art*, ed. Kenneth C. Lindsay and Peter Vergo (New York: Da Capo, 1994), p. 142.

66. For Kandinsky's hidden imagery and its debt to Steiner, see Long, *Kandinsky*. On the role of dissonance and anarchism in the painter's thought, see Rose-Carol Washon Long, "Occultism, Anarchism, and Abstraction: Kandinsky's Art of the Future," *Art Journal* 46 (Spring 1987), 38-45.

67. Kandinsky, Letter to Schoenberg, Jan. 18, 1911; in *Arnold Schenberg—Wassily Kandinsky: Letters, Pictures and Documents*, ed. Jelena Hähl-Koch (London: Faber and Faber, 1984), p. 21.

68. See Wassily Kandinsky, "Stage Composition," in *The "Blau Reiter" Almanac [Edited by Wassily Kandinsky and Franz Marc]*, ed. Klaus Lankeir (New York: Viking Press, 1974), pp. 190-91.

69. See Henderson, *Duchamp in Context*, chap. 1.

70. Duchamp had adopted the model of mechanical drawing for the "non-art" expression he was seeking in his "painting of precision." See Henderson, *Duchamp in Context*, chapter 3.

71. On the Oculist Witnesses and their parallel to Augusto Righi's creation of a spark gap, see *ibid.*, pp. 114-15. See also Hugh Aitken, *Synonymy and Spark: The Origins of Radio* (New York: John Wiley, 1976), pp. 185-86.

72. Duchamp made his "service of the mind" statement in a 1946 interview with James Johnson Sweeney, reprinted in Michel Sanouillet and Elmer Peterson, eds., *Salt Seller: The Writings of Marcel Duchamp (Marchand du sel)* (New York: Oxford University Press, 1973), p. 125, emphasis in the original. For the "sketch" quotation, see *ibid.*, p. 71.

73. Considering the notes to be as important as the *Glass* itself, Duchamp published three boxes of facsimile notes during his lifetime: the *Box of 1914* (16 notes), the *1934 Green Box* (94 documents [notes/reproductions]) and the *1966 White Box* (79 notes). These notes are collected in Sanouillet and Peterson, eds., *Salt Seller*, which has been reprinted as *The Writings of Marcel Duchamp* (New York: Da Capo Press, 1989). Over a decade after his death in 1968, a final group of 289 previously unknown notes was published in 1980 by the Centre Georges Pompidou under the title *Marcel Duchamp, Notes*. See that deluxe edition or *Marcel Duchamp, Notes*, ed. and trans. Paul Matisse (Boston: G. K. Hall, 1983). For Duchamp's reference to "playful physics," see Sanouillet and Peterson, eds., *Salt Seller*, p. 49; for "painting of frequency," see *ibid.*, p. 25.

74. See *ibid.*, pp. 36, 38-39, 42, 44; and *Marcel Duchamp, Notes*, ed. Matisse, p. 4, notes 143, 153. The wireless telegraphy paradigm underlying the *Large Glass* is chronicled in Henderson, *Duchamp in Context*, chapter 8.

75. For Branly's experiments, see, for example, E. Monier, *La Télégraphie sans*

fil, la télégraphie, et la téléphonie sans fil à la portée de tout le monde, 9th ed. (Paris: H. Dunod & E. Pinar, 1917), chapter 7.

76. On dimensional contrasts in the *Large Glass*, see Henderson, *Duchamp in Context*, pp. 80-85; and Linda D. Henderson, "Etherial Bride and Mechanical Bachelors: Science and Allegory in Marcel Duchamp's 'Large Glass,'" *Configurations* 4 (Winter 1996), 91-120.

77. Raymond Duchamp-Villon, "Manuscript Notes," in William Agee, *Raymond Duchamp-Villon* (New York: Walker, 1967), p. 112.

78. See Sanouillet and Peterson, eds., *Salt Seller*, pp. 36, 38, 42.

79. See *ibid.*, p. 42; Baraduc, *L'Âme humaine*, p. 3.

80. See, for example, Jean Clair, *Duchamp et la photographie* (Paris: Éditions du Chêne, 1977), chapter 4; see also Henderson, *Duchamp in Context*, chapter 8, pp. 115-20.

81. Duchamp, as quoted in Pierre Cabanne, *Dialogues with Marcel Duchamp*, trans. Ron Padgett (New York: Viking Press, 1971), p. 75.

82. Edward Carpenter, *The Art of Creation: Essays on the Self and Its Powers* (London: George Allen, 1907), pp. 33-34. Although Carpenter's language echoes the general preoccupation with ether vibrations, he does not actually refer to the ether. In *Energy Forms*, Bruce Clarke analyses (pp. 196-202) Carpenter's ambiguous stance toward the ether as demonstrated in varying editions of the essay "Modern Science: A Criticism" included in his *Civilization: Its Cause and Cure* (London: Swan Sonnenschein, 1889), which was in its fourteenth edition in 1921.

PART 3 INTRODUCTION

1. See again the discussion of Latour in the section "Issues of Representation" in the Introduction. David Phillips has utilized Latour's ideas on inscriptions in his discussion of eighteenth- and nineteenth-century scientific images of patterns registered automatically (e.g., the Chladni figures discussed by Douglas Kahn), nineteenth-century spiritualists' "automatic drawings," and early abstract painting. See David Phillips, "Abstraction and Truth in Nineteenth-Century Imagery," *Bulletin of the John Rylands University Library of Manchester* 78 (Spring 1996), 123-42.

2. On Duchamp's interest in registering instruments and his self-fashioning as an artist-engineer, see Linda D. Henderson, *Duchamp in Context: Science and Technology in the Large Glass and Related Works* (Princeton: Princeton University Press, 1998), chapters 3, 5, 8.

3. Brain notes the important article on registering instruments by Peter Galison and Lorraine Daston, "The Image of Objectivity," *Representations* 40 (Fall 1992), 81-128. The essays of Brain and Kahn in this volume are complemented by Thomas L. Hankins and Robert J. Silverman's chapter entitled "Science Since Babel: Graphs, Automatic Recording Devices, and the Universal Language of Instruments," in *Instruments and the Imagination* (Princeton: Princeton University Press, 1995).

4. Friedrich Kirtler also discusses this "found" inscription in Rilke's "Primal