

Was ist der Ertrag, der neueren Studien zur Geschichte des Experiments?

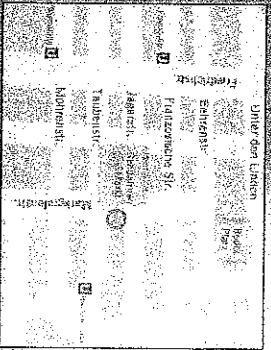
Wie hat sich unser Bild von Wissenschaft verändert, seitdem Ian Hacking's Satz, „die Experimentierbarkeit führt ein Eigenleben“, zur programmatischen Formel für Untersuchungen zur Wissenschaftsgeschichte wurde?

Es geht um eine historisch-vergleichende Formenlehre des Experiments, die an die Ergebnisse der Einzelstudien anschließt, zugleich aber über diese hinausgeht – in der Absicht, zu den charakteristischen Konfigurationen der Experimentalisierungsgeschichte vorzudringen, die weitere Studien in diesem Feld anregen und ausrichten können.

Veranstaltungsorte

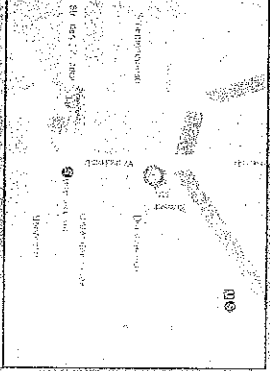
Tagung

WissenschaftsForum am Gendarmenmarkt
Markgrafenstr. 37
10117 Berlin



Abendvortrag

Global Hospital
Institut für Mikrobiologie und Hygiene der Charité
Dr. Heinrichstr. 96
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Tagung organisiert vom Max-Planck-Institut für Wissenschaftsgeschichte (Berlin), Abt. III

THE SHAPE OF EXPERIMENT

BERLIN

2.-5. JUNI 2005

Tagungsort

WissenschaftsForum am Gendarmenmarkt
Markgrafenstraße 37 · 10117 Berlin



Tagung im Rahmen des Projekts
„Die Experimentalisierung des Lebens“
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PROGRAMM

Donnerstag, 2. Juni 2005

- 14:00 Begrüßung und Einführung
Hans-Jörg Rheinberger
Henning Schnidgen
- The "Material Logic" of Experiment
Leitung: Hans-Jörg Rheinberger
- 14:30 Ursula Klein
Material Experimental Traces
Pause
- 15:15 John Tresch
Amperé, Balzac, and the Search for the Absolute in the 1820s and 30s
Henning Schnidgen
- 16:30 Sciences of Falling Down: Time, Body, and the Machine, 1750-1900

Öffentlicher Abendvortrag im Großen
Hörsaal des Instituts für Mikrobiologie
und Hygiene der Charité
Dorotheenstr. 96 10117 Berlin

- 19:00 Jan Hacking
Another New World's Being:
Constructed Right
Now: The Ultracold

Freitag, 3. Juni 2005

- Organizing Experimentation I
Leitung: Soraya de Chadavarian
- 10:00 Hans-Jörg Rheinberger
Experimental Readings
Pause
- 10:45

11:15

Felix Müller:
Purifying Objects, Breeding Tools:
Observational and Experimental
Strategies in 19th Century Gas
Discharge Research
Sven Dierig

12:00

Shape and Beauty in 19th Century
Physiology
14:30 Mittagspause

12:45-

Optimizing Experimentation II
Leitung: Peter Gelmer

14:30

Helmar Schramm:
Singing Flames: (Tidally) Interferences
between Experiment and Play
Pause

15:15

Andreas Hepp:
The POW Camp as Language
Laboratory: Leo Spitzer's Epistolar
Research

Samstag, 4. Juni 2005

- "The Experimentalization of Life"
Leitung: Henning Schnidgen
- 10:00 Björn Brusch
The Garden as a Laboratory: 19th
Century Scientific Gardening
Karin Schidju
- 10:30 An-Aesthetic Revelations: On Some
Introspective Self-Experiments in the
History of Inebriation
Pause
- 11:00 Philipp Felsch:
Cultures of Speechlessness: Scrambles
amongst the Alps, 1800-1900
14:30 Mittagspause
- 11:30
- 12:00

The Experimental Production of Form
Leitung: Andrew Pickering

14:30

Mark Hansen:
Experimental Life: Movement and
Individuation in the Information Arts
Pause

15:15

Gernot Gube:
Design of Physical Reality: Cognitive
Strategies in STM-Picturing
Julia Kursell
Shaping Differences: Helmholtz's
Experiments on Tone-Color

16:30

Sonntag, 5. Juni 2005

- The Experimental Production of Form II
Leitung: Julia Kursell
- 10:00 Peter Gelmer:
Shameless and Shapeless: Laboratory
Life in Early Science Fiction
Pause
- 10:45 Joseph Vogl:
Goethe's Colors
11:15 Andrew Pickering, Friedrich Steinhilber
Commentaries
- 12:00

Balzac's *Electromagnetic Alchemy* in The Quest for the Absolute

John Tresch

1. *Expanding the shape of experiment*

In order to trace the shape of experiment, sometimes we have to consider other sites than those in which experiments physically take place. Scientific research draws on motivations which come from a wider culture; the meaning of the objects it investigates is forged not only in laboratories but also in philosophical and literary discourses aimed at various audiences. In addition, crucial historical layers contributing to the moral and metaphysical implications of both specific experiments and the "experimental life" are imposed by the popular press and artistic and literary representations of the sciences in a given place and time. These wider contours of experiment are particularly important if we are studying the physical science of the early nineteenth century and the fields which emerged from Laplacean studies of imponderable fluids. Merely internal analysis of these sciences would skew our attention away from what made these phenomena so interesting in the first place, and from the ontological – even metaphysical – significance of various experimenters' desire to move beyond Laplacean mechanism.

Nowhere is this as true as in the case of electromagnetism. The visible and material effects of electricity and magnetism can suggest the action of immaterial spirit; dynamic and dangerous, alive with potential, these phenomena have persistently drawn ideas and images from distant and neighboring fields into their atmospheres. Successful efforts to limit, define and operationalize them as scientific and technical objects have not managed to sever their symbolic, psychological, imaginary and religious associations. Such connections were strong in France in the 1820s and 30s, when the interactions between electricity and magnetism were definitively established and systematically explored by André-Marie Ampère, "the Newton of electrodynamics." In 1820, François Arago announced the discovery of the Danish natural philosopher H.C. Oersted that when an electrified wire was brought into proximity with a magnetic compass needle, the needle would move. Because this discovery directly contradicted a fundamental assumption of the terrestrial physics of Laplace – that light, heat, magnetism, and electricity were distinct, independent substances – and because of a distrust of the *Naturphilosophie* with which Oersted was associated, many in France dismissed Oersted's claim as "more German dreams." But Ampère, with help from his collaborators and institutional allies Arago and Augustin Fresnel, immediately set about reproducing the Dane's effect, and over the course of the next three years planned and conducted a series of experiments and equations which secured the basic principles of electrodynamics. He continued to elaborate and defend his theories until his death in 1836.¹

This paper considers the context for electromagnetic research in post-revolutionary France; along with writings in natural history, philosophy, and politics, it focuses on one text by Honoré de Balzac, *La recherche de l'absolu* [*The Quest for the Absolute*] (1834), in which Ampère's major research foci, electrochemistry and electromagnetism, were given prominent attention. As such it prepares the basis for a broader understanding of Ampère's experimental work, whose internal details have been abundantly studied both in their own right and as a case study for various

historical and philosophical arguments about the nature of experiment.² In this paper my very limited goal is to provide a background for a reconsideration of Ampère's electromagnetism, a study which will have to await another setting. To adapt a phrase of Gaston Bachelard, my aim is to sketch in the outlines of electromagnetism in this period when it is considered as a *cosmic substance*: as the locus of moral, emotional and symbolic values, forged in a cauldron of intuitions, attitudes and expectations drawn from both scientific and extra-scientific channels.³ Ampère has been identified as one of the possible inspirations for the main character of Balzac's *The Quest of the Absolute*, a major novel about modern science from this period. Like Ampère, whose mixture of Newtonian mathematics and force laws with romantic and nature-philosophical interests in the ether and a vision of the universe as united by fundamental, dynamic forces, Balzac has posed difficulties for historical classification. His works' emphasis on passion and the emotions, his larger-than-life characters, the "organic" themes in his "natural history of society" *The Human Comedy*, the uncontainable energy in his writing and his life all have earned him recognition as a definitive romantic author. But at the same time, his work has been praised by authors from Marx to Lukacs to Sartre for its extreme *realism* and unflinching analysis of the underlying mechanisms of capitalist society. Directly influenced by the sciences of the time, including studies of electricity, chemistry, and magnetism, devoted to patient descriptions and analysis of the material conditions of existence, while at the same time leaving openings for the fantastic and mysterious throughout his works, Balzac was sacred monster not unlike Ampère.

Neither Balzac nor Ampère worked in isolation. Both thrived on historically specific forms of sociability and the often fickle enthusiasms of Parisian salons and circles, and their social and intellectual milieux significantly overlapped. Consideration of Balzac's major themes and representations of contemporary scientific theory and practice thus help us trace broader outlines of the shape of experiment at the start of the industrial age, leading us into domains underexplored by even the most thorough and insightful studies of Ampère's electrodynamics, as it makes explicit ambitions and horizons which can only appear implicitly in scientific research during this period, marked by emerging norms of specialization, impersonality, and refusal of "speculation." From this point of view, Ampère and Balzac's work, both of which demonstrate a fascination with convertible fluids, machines which realize their transmutations, and the centrality of technology in improving nature and human society, were directly in line with a major line of cosmological thought in post-revolutionary France. Running through the exact and qualitative sciences as well as politics, philosophy, literature and the arts, this constellation of ideas and practices combined

¹ Classic and recent texts on Ampère and electrodynamics include Christine Blondel, *A.-M. Ampère et la création de l'électrodynamique (1820-1827)*, Paris: Bibliothèque nationale, 1982; Olivier Darrigol, *Electrodynamics from Ampère to Einstein*, Oxford, New York: Oxford University Press, 2000; P. M. Harman, *Energy, Force, and Matter: The Conceptual Development of Nineteenth-Century Physics*, Cambridge History of Science, Cambridge, New York: Cambridge University Press, 1982; Mary B. Hesse, *Forces and Fields; the Concept of Action at a Distance in the History of Physics*, Westport, Conn.: Greenwood Press, 1970; James R. Hoffman, *André-Marie Ampère*, Oxford, UK: Blackwell, 1995; L. Pearce Williams, "Ampère, André-Marie," in: *Dictionary of Scientific Biography*, edited by Charles C. Gillispie, New York: Charles Scribner's Sons, 1970, pp. 139-47.

² Honoré de Balzac, *La Recherche de l'absolu*, in: idem, *La Comédie humaine*, vol. 2, Nouvelle édition publiée sous la direction de Pierre-Georges Castex, Paris: Gallimard, [Bibliothèque de la Pléiade], 1976-1981. Quotes used in this paper are taken from the translation by Ellen Marriage, *The Quest of the Absolute*, Sawtry, Cambridge: Dedalus European Classics, 1986.

aspects of romanticism *and* mechanism. We might call it *mechanical romanticism* – an apparently paradoxical name which highlights the polarized treatment usually given to the first half of the nineteenth century by historians of ideas. Romanticism is usually linked the mind, imagination, subjectivity, and with vague, intuitively or speculatively grasped powers of nature. While presented in histories of art and literature romanticism as the naïve, primitivist, or subjectively tormented predecessor of modernism, in the history of science, *Naturphilosophie* is often taken as a dead end. I would not deny that certain projects of romantic visionaries were overly optimistic, solipsistic, crazy, and often wound up in tragic ends or renunciation by their older, wiser selves. While I can't make any claims about romanticism in general here, what I wish to show are two cases in which the subjectivist, imagination-heavy, immaterial, delirious and doomed view of romanticism simply does not hold up. In the cases of Balzac and Ampère, romantic impulses and themes were connected with attention to the precise, concrete, practical, predictable, and *mechanical*.

My analysis has been greatly helped by Madeline Fargeaud's magnum opus, *Balzac et "La recherche de l'absolu,"* but its overall direction is slightly different than hers and that of many other studies of science and literature. Instead of using scientific texts to explain the origins of certain literary images or an author's flights of the imagination, here the literary text broadens our perspective to better understand the implications of the period's scientific research. Accordingly, this detour through the works of one of Ampère's literary contemporaries aims at a perspective different from many admirable studies which have focused on the mathematical and experimental innovations of Ampère. Giving a sense of contemporary views of the personal and cosmological stakes of scientific research in order to show the broader, "non-scientific" notions which informed these investigations, it provides a different framework for understanding Ampère's research. The aim is to provide a solid sense of what a fantastically powerful, strange, and fluid phenomenon 'electromagnetism' was at the start of the 19th century and what made it particularly attractive as an object for experimental study – even, or especially, for the scientist we now celebrate as having provided it with a "rational" form.

2. Ampère and Balzac make the scene

Though a considerable literature exists on the formal institutional settings for scientific practice at this time, as well as, increasingly, the histories of specific journals and printing houses, for a long

³ Gaston Bachelard, *Le rationalisme appliqué*, Paris: Presses universitaires de France, 1949, p. 223. In a case study in the history of chemistry and electricity, Bachelard recounted how researchers at the start of the nineteenth century had noted an unusual smell produced when oxygen is exposed to electric sparks. In 1839, Schonbein, one of François Arago's correspondents, claimed to have identified the cause of this smell: ozone. According to Bachelard, ozone soon suffered a "cosmic overvaluation." Led by his adherence to a two-fluid theory of electricity, Schonbein suggested an analogous substance created by *negative* electricity, "antozone," which was then identified as an enabling cause for epidemics. Ozone and its phantom sister became central objects in a wide-scale though short-lived hygienic movement to map their appearance and absence as indicators of insalubrity. "In these conditions," Bachelard writes, "it would be a long and difficult task to bring into the laboratory this 'cosmic substance'" (p. 223). Ozone was an object entangled with too many disorganized phenomena and cultural expectations to reckon it according to a true proportion or *ratio*; for Bachelard, a "cosmic substance" is necessarily an *irrational object*. My use of the term suggests that these extra-rational associations are crucial for understanding the actual meaning and intentions going into the scientific research of such objects.

time the informal and interstitial sites in which less predictable social interactions took place have been neglected. But as new attention to the cultural settings of ideas has developed (especially concentrating on the French Revolution), we have greater historical insight into some of these milieux. The remarkable circulation of ideas which defines this period went hand in hand with a lively ferment of salons, circles, academies, reading rooms, and journals, both in Paris and the provinces; in these changing scenes, politicians, artists, scientists, dandies and ladies of fashion mingled and exchanged perspectives. The paths of Ampère and Balzac through these dense networks of people and ideas in the French capital overlapped at many points.

Despite an image of Ampère as a marginal and eccentric outsider there is abundant evidence that he thrived on intellectual exchange in diverse settings. It is well known that he was a major contributor to the theoretical and institutional opposition to Laplacean science in the Academy of Science and the Ecole Polytechnique. Along with "general Arago," Ampère championed and contributed to the wave theory of light of Fresnel (who lived in Ampère's home for several years). For his first decisive electromagnetic experiments, his audience was a list of anti-Laplacean dissenters: Humboldt, Fourier, Fresnel, Arago. This opposition to Laplace, one of Napoleon's favorite figures during the restoration, also intersected with open opposition to one of the most prominent natural historians under the empire, Georges Cuvier. In the famous Cuvier-Geoffroy debates of 1830, Arago openly took the side of Geoffroy Saint-Hilaire, who was often portrayed in the press (much like Arago) as a scientist of the people, the defender of speculative originality, and the enemy of sterile specialization. Though Ampère was at times on friendly terms with Cuvier, his first candidacy to the Institut was shot down by him and Laplace, who awarded the post to Cauchy. As Arago demonstrates at length in his 1836 *éloge*, from the 1820s Ampère launched various criticisms against Cuvier's claims about the fixity of the species and his divisions of kingdoms and embranchments, in concert with Geoffroy's highly detailed arguments about the existence of "a single animal" and the unity of form.

Ampère formed many of his closest intellectual friendships early. As a young man in Lyon, he participated in meetings of the Society of Arts and Letters (where his interest in electricity was reinforced by a visit from Volta). Along with a close-knit group of friends, some of whom would also attain fame in their own right, he was one of the founders of a "Société chrétienne." From before the revolution, Lyon had been a center for illuminist thought and remained so throughout the twentieth century; it was home to many disciplines of Saint-Martin and later in the century could claim spiritualist Allan Kardec as one of its natives.⁴ Theological and mystical themes were a constant topic of interest for him and his friends, who included the anatomist and Director of the Royal Veterinary School of Lyon, Brédin, the anthropologist and linguist De Gerando (one of the founders of the Société de l'Observation de l'Homme), and Pierre-Simon Ballanche, who, as will be discussed later, had a stellar career as romantic prophet of politics and religions. When Ampère arrived in Paris in 1804 after the death of his first wife, Ballanche and DeGerando gave him an entry into various social and intellectual circles. Degerando notably presented him to the circle of philosophers around Maine de Biran, one of the first French Kantians, with whom Ampère began a long correspondence on metaphysics. Ampère also had ongoing conversations

⁴ J. Buche, *L'école mystique de Lyon, 1776-1847. Le grand Ampère, Ballanche, Cl.-Julien Brédin, Victor de Laprade, Blanc Saint-Bonnet, Paul Chenavard*, Paris: F. Alcan, 1935.

about the classification of the sciences with Frédéric Cuvier and the polymath chemist Eugène Chevreul.

Restoration Paris offered many other occasions for literary and scientific worlds to meet. Those with an interest in mysticism and theosophy were drawn to the salon of Madame de Krudener, frequented by Ampère's friend from Lyon, Ballanche, and where Dr. Koreff – the Prussian student of Mesmer who initiated E.T.A. Hoffman into animal magnetism – was also a fixture; there is evidence that Ampère attended this salon, which featured discussions of illuminism and theosophy and performances of magnetism. Ballanche later became the confidante of the legendarily beautiful Restoration hostess, Julie Récamier, in whose salon oppositional politics and liberal Catholicism were mixed with romantic literature. Ballanche acted as patron and chaperone for Ampère's son, Jean-Jacques, who despite setbacks as a playwright and suitor to the much older Mme. Récamier, later attained great fame as a historian and literary critic for romanticism's key journal, *The Globe*.⁵ Madeleine Fargeaud, in her magnum opus, *Balzac et la Recherche de l'Absolu*, suggests a strong possibility that Ampère – who composed verses of nature poetry in French and Latin throughout his life – may have met Balzac in the company of Jean-Jacques, whose many friends included Prosper Mérimée and sons of other notable savants: Adrien and Alexis de Jussieu and Fulgence Fresnel.⁶ Jean-Jacques later wrote, "I take great pride in two things: I knew M. de B[alzac] while he was thin, and unknown." Other famous salons of this period included Charles Nodier's at the Arsenal, which was the center of romanticism under the Empire and Restoration, and that of Madame Merlin where Arago was a habitué; Georges Cuvier also hosted a salon which both Ampères frequented along with literary friends. It was Ampère's hope for several years to arrange a marriage between Jean-Jacques and Cuvier's daughter, a possibility which appears to have sent Jean-Jacques in flight across Europe. Socialité savants were vectors for the ideas developed in cabinets of *physique* and *histoire naturelle*. In this kaleidoscope of social and intellectual scenes, one could shine as brightly with scientific as with literary *bons mots*.

Furthermore, in the offices and on the pages of the new mass-circulation of literary journals – made possible by steam printing and periodic relaxations of censorship – such juxtapositions and meetings took a written form and were made available for broader consumption. *The Globe*, the *Revue des Deux Mondes*, and the *Figaro* (one of whose founders was Arago's brother, Etienne), are a few of the longer-lasting of the new journals of this period; they combined reviews and excerpts of romantic literature, liberal political arguments, and discussions of the newest sciences. Evening orations, among them Arago's weekly public lectures on *Popular Astronomy*, were also a site for the mingling of romantic luminaries like Balzac, George Sand, Victor Hugo with liberal and reformist political actors and an interested public.

For Balzac, other opportunities for scientific socializing arose while he lived on the Rue Cassini in the 1820s and 30s. Fargeaud suggests that the physiognomy of *The Quest for the Absolute's* central character may have been modeled on that of Arago, the Observatory's director. A short walk brought Balzac to the Observatory's residence, where he was a frequent guest thanks to his

⁵ Auguste Viatte, *Les sources occultes du romantisme: illuminisme, théosophie, 1779-1820*, Paris: H. Champion, 1969.

⁶ Madeleine Fargeaud, *Balzac et "La recherche de l'absolu,"* Paris: Hachette, 1968, p. 179.

friendship with Etienne Arago – François' brother, a Carbonarist conspirator, Vaudevillian playwright, and mayor of Paris in the Second Republic, and with whom Balzac wrote one of his first published works. These remarkable neighbors presented him to the physicist Mathieu (Arago's brother-in-law) as well as Félix Savary, a student of Ampère's to whom Balzac dedicated his fantastic novel *La Peau de chagrin*. They also connected him with the Observatory's opticians, who took time from off from the fabrication of astronomical lenses in the summer of 1834 to make the novelist "*une lorgnette divine*" – a divine pair of opera glasses.⁷

These contacts provided Balzac with excellent guides for his readings in the current debates in chemistry and physics, especially as he wrote *The Quest*. The project obsessively pursued by the hero Balthazaar Claës – to fabricate a diamond electrochemically by applying electricity from a massive Voltaic battery to carbon in combination with other substances – had in fact been the topic of debate and the dream of many inventors discussed in the Academy of Sciences in recent years, with Arago and Davy showing keen interest in the possibility. One of these inventors, Thillorier, had also pursued with Arago's support a new kind of metal made of carbonic acid which was expected to revolutionize steam engines; Balzac refers to carbonic acid repeatedly and to the procedures of electrochemistry. In addition, Fargeaud has located passages from the eight volume *Treatise of Chemistry* by Berzelius which Balzac appears to have lifted with minor modifications, including one in which the Swedish chemist refers to the hopes of the alchemists in showing how certain flowers produce out of their own substance new compounds of metals, demonstrating the equivalence of organic and inorganic substances – the alchemical vision of living matter. Likewise, Claës research turns around the dynamic powers of electricity and its relation to chemistry, topics of great interest to Ampère throughout his life. As much as he created the myth of the obsessed scientific researcher reproducing nature's rarest treasures, Balzac adapted it from the examples offered by the leading scientific lights of the day.

3. Electricity and the fluid imaginary

What kind of *thing* was electricity in the first half of the nineteenth century? It was considered variously as a fluid, as two fluids, as a state of matter, as a modification of the ether. It was also frequently associated with other equally elusive fluids. Surveying the sea of discourses on other invisible, imponderable, and possibly unreal fluids in France, which included light, heat, electricity, magnetism, caloric, nervous fluid, gases and miasmas, oxygen, and "vital fluid" in the first half of the nineteenth century, one is inclined to speak of a *fluid imaginary*: a reservoir of notions which melded with troubling ease from one into another, whose distinctions, intersections, metaphysical bases and ontological statuses were extremely difficult to pin down.

Claims of the existence of a single substance which undergoes modifications to produce the diverse forms of matter and souls has been traced back to Presocratic cosmologies and to the Stoics' notion of *pneuma*. It has also been cited in the works of alchemists and early modern natural philosophers like Gilbert (who took magnetism as a cosmic principle of matter and motion) and Maxwell, and informs discussions of electricity and magnetism throughout the early modern period. Enlightenment-era variations on this theme can be found in vital materialists like

⁷ Fargeaud, Balzac et "*La recherche de l'absolu*," p. 98.

La Mettrie and Diderot: thanks to the cultural relays of figures like the Grimm brothers, the *philosophes* "philosophie de la nature" seized the imagination of many in the late German Enlightenment, providing a materialist vision of a world animated by dynamic forces and contributing along various pathways to *Naturphilosophie*.⁸ *Naturphilosophen* and their fellow-travellers held to a view of the universe in terms of fundamental powers in opposition – forces, not substance, a precursor to the philosophy of energy; such an idea has been shown to be operative in the writings of Oersted, a demonstrated precursor for many of Ampère's physical views, as well as in the works of Schelling, Ritter, Davy, and Faraday.

The history of the (re)reception in France of such ideas was closely entwined with the changing fortunes of mesmerism ("le magnétisme" or "le magnétisme animal"). In the last decades of the eighteenth century, cosmological abandon in identifying the correspondences and conversions between invisible fluids and matter reached its wildest extremes in the works of Mesmer and his disciples. In 1784, a commission by the Académie des Sciences was widely read as denying the existence of a single "mesmeric fluid" which penetrated matter and had affinities to thought, will, and celestial phenomena. However, both the title and argument of Darnton's influential *Mesmerism and the End of the Enlightenment in France* suggest that the wide-ranging theories of the magnetists had been brought under rational control by 1800. Most historians of French physics have reinforced such claims by focusing on the internal histories of specific fields or phenomena and processes of experiment and debate taking place primarily within the institutions legitimated under the Empire and Restoration. The position advanced by Laplace, presented in the first two decades of the century as Newtonian orthodoxy, was that *light, heat, electricity, and magnetism* were independent, weightless (or imponderable) fluids which, despite their lack of mass, were subject to Newton's laws of attraction. These fluids were assumed to consist of microscopic particles which repelled each other (hence the tendency of light to diffuse itself when unfocused) but which at a macro level had attractive powers: Coulomb's earlier, exemplary discovery that the inverse square law applied to electric attraction was cited as a key justification of these claims. Volta's creation of the same effects as Galvani by means of his famous battery was seen by many as a further step towards rationalizing electricity.

Outside the intra-Academy debates between Laplacean orthodoxy and its heterodox opponents, the possibility of identifications between the imponderables and living forces was still a source of great interest. In 1806 natural historians sought to clarify matters by reducing the proliferation of fluids in the sciences:

The multiplicity of names that savants have given to the universal electric principle has thrown confusion into the diverse applications that they have made of it: some have called it *elementary fire*, others *nervous fluid*, some of them *animal magnetism*, some of them *vital air* (*air vital*) or *oxygen gas* [*gaz oxigène*]: but it is obvious that all of these names indicate the same agent which exists in earth as much as in air, which all bodies, especially living bodies, have the property of condensing."⁹

⁸ Peter Hans Reill, *Vitalizing Nature in the Enlightenment*, Berkeley: University of California Press, 2005.

⁹ J.J. Juge Saint-Martin, ancien professeur d'histoire naturelle. *Théorie de la pensée*. 1806, quoted after: Fargeaud, *Balzac et "La recherche de l'absolu,"* p. 147.

Even while Volta was refuting Galvani's notion of a distinct substance of bioelectricity, one of his nearest allies in Paris, Étienne Gaspard Robertson, was in 1800 stressing a spooky vitalist reading of electricity both to the Académie des Sciences and to popular audiences. To the former he reported, "Couldn't this extraordinary fluid be the first of the acids available in nature? Couldn't it be the first agent of the living movement, that the ancients called *nervous fluid*? Couldn't it be a veritable poison?"¹⁰ To the latter he offered demonstrations of the electrical effects of the city's most powerful batteries as the first act of his famous "Phantasmagorie" spectacle, held in an abandoned convent near the Palais Royal. Although these demonstrations took place in a well-lit room, with audience members encouraged to inspect the scientific equipment on display, this open-handed "rationalistic" unveiling was profoundly ambiguous in a way comparable to much popular science of this time. With the second act, spectators were ushered into a pitch black room to the eerie sounds of a glass harmonica, and were terrified/moved/delighted/amused by the immaterial images of disembodied specters: a murdered Caesar, Marie Antoinette, and Robespierre. However rational and evenhanded was Volta's presentation of the electric battery, its potential for fantastic – or phantasmagorical – readings was always present.

Historians of the physical sciences have largely ignored the massive revival that animal magnetism underwent in France in the 1820s and 30s. Mesmer's main disciple, Puysegur, continued to teach his doctrine of a universal fluid, taken up briefly by the charismatic polytechnician Alexandre Bertrand, and the eminently respectable Deleuze at the Muséum d'Histoire Naturelle wrote a series of patient and modest books giving an explanation of new mental states produced and observed by Dupotet at the Hôtel Dieu and by R. J. Georget and hygienist Léon Rostan at the Salpêtrière, fifty years and more before the better-documented experiments of Charcot and Janet.¹¹ What is the nature of this fluid, whose motions appear to be at the root of these astonishing psychological conditions? What is its connection to other fundamental substances? Deleuze inventoried the possibilities:

Is it the same as light? Is it a single thing variously modified by the channels that it runs through? Is it composed of many different fluids? Electricity, caloric, mineral magnetism, the nervous fluid, etc. ... are they its modifications? Is it subject to the law of gravity? What is its movement, and what causes direct its movement? We do not know.¹²

New societies and journals devoted to the study of the medical uses of magnetism and to its principles of action appeared. Again and again, the idea that this fluid might be at the basis of many other phenomena, a kind of *prima materia* like that of the alchemists, was uttered: *Archives du Magnétisme animal*, we read, "The more research we do, the more we discover that the means of nature are simple. The *electric, magnetic-mineral, or organic* fluid, consists perhaps in a single elementary fluid, which is modified in different manners."¹³ This public interest led to a new

¹⁰ Robertson in Giuliano Pancaldi, *Volta: Science and Culture in the Age of Enlightenment*, Princeton, N.J.: Princeton University Press, 2003, pp. 230-231. Pancaldi notes Napoleon's enthusiasm for the Galvanic reading of the Voltaic battery, as well as his announcement of a significant prize for discoveries in electricity which motivated Ampère to begin research in the field as early as 1805.

¹¹ For a helpful overview of the situation of animal magnetism in France after Mesmer, see Alan Gauld, *A History of Hypnotism*, Cambridge: Cambridge University Press, 1992, pp. 111-140, 163-178.

¹² *Histoire critique du magnétisme animal*. Paris, 1813, Tome I, p. 81. quoted in Fargeaud, Balzac et "La recherche de l'absolu," p. 146.

Commission on Animal Magnetism, sponsored by the Academy of Medicine, with the participation of physicist François Arago and Bailly begun in 1824.

The connection between the two sorts of *magnétisme* was more than a homonym. In the debates about magnetism at the Académie de la Médecine, the analogy between the action of magnets and the effects described by proponents of animal magnetism was strong enough to produce a motion in even the sharpest minds, nearly reversing the long-held opinions of one of the commission's most distinguished savants. According to the transcription of the discussion at the Academy of Medicine, Bailly "recalled the profound impression that the report of M. Husson had made and expressed the regret of being obliged to oppose it, put forth that *at one moment he was strongly shaken in favor of the belief in an animal or organic magnetism*: it was when he received knowledge of the experiments by means of which M. Arago managed to impress a rotatory movement onto a copper needle by means of a piece of magnet which he made to turn at some distance, despite the interposition of a sheet of paper. He was astonished that the magnetizers had not taken advantage of this fact in favor of their doctrine."¹⁴ One of the series of experiments inaugurated by Ampère and followed out variously by Arago and Ampère made this distinguished savant, who had taken part in the commission of 1784, turn his head.¹⁵ Strong words were exchanged in the discussion, with some making an equation between the disputed magnetic fluid and nervous fluid which, though given scientific credence, had never been observed in an autopsied brain. Lines were drawn here as they had been in 1784, though the reference to the necessity of having *faith* and exercising their *will* to bring about a successful cure (as emphasized in Puysegur's work), the key words on the one hand of the religious restoration and on the other of the "post-revolutionary self" put forth by Maine de Biran and Victor Cousin, suggested a mutation of the debate into explicitly post-enlightenment terms: neither reason, nor simple sensationalist observation, would explain mesmerism's action. A deeper source is required, either in the hidden structures of human psychology, or in the divine.¹⁶

Balzac closely studied these contemporary debates about animal magnetism in which light, heat, magnetism, and electricity were closely associated with life, thought, and will. There are direct relations between his interest in the physical "fluids which are known only by their effects" as he describes them in the "Preface" to the *Human Comedy*, the mesmeric fluid, and the fluids rampant in materialist psychology (Cabanis' nervous fluid) and natural history (Lamarck's view of transformation and adaptation via "canalization" of fluids into new organs, and the interest, witnessed especially in Humboldt as well, on the fluids which served as the external milieux for all

¹³ Quoted after Fargeaud, *Balzac et "La recherche de l'absolu,"* p. 150.

¹⁴ Note however that Bertrand argued strongly against the fluid interpretation of animal magnetism, advocating instead that it was a means of bringing about cures by acting on the imagination of the patient – the effects it brought about through suggestion were nevertheless real.

¹⁵ Ultimately, however, Bailly refused to recognize the existence of a magnetic fluid, citing a fear of exposing the Academy to "the ridicule which is attached to all of those who concern themselves with animal magnetism," and of being associated with "the jugglers" who have already taken advantage of investigation. To avoid this mockery, he does not rule the question out of court; instead he suggests that the study animal magnetism be placed in the hands of licensed physicians "as is done with all other subjects."

¹⁶ Discussion de l'Académie de Médecine sur le Rapport de M. Husson, p. 517, in: Alexandre Jacques François Bertrand, *Du Magnétisme Animal en France, et des jugements qu'en ont portés les sociétés savantes*. Paris: J.B. Baillière libraire-éditeur, 1826. On nervous fluid, see p. 521.

organisms, to say nothing of contemporary theories of miasma and salubrious vs. insalubrious atmospheres). A major clue is the way in which, shortly after the publication of *The Quest*, Balzac made frequent mention of Geoffroy Saint-Hilaire's notion of "unity of composition," a single animal structure unfolded to different degrees in all living forms; as suggested earlier, Geoffroy's opposition to Cuvier, as the representative of an establishment science built on stability and eternal-fixed species was a rallying point for anti-Laplacean and politically progressive scientists in the 1830s.

And indeed, this interest in fluids which combined and transformed themselves to produce life, growth, and thought had resonance beyond the sciences. Strong connections were made by various other actors between the desire for a single substance to unite all of physics and a vague but compelling desire for "unity" at the level of politics and ideology. The pendulum swings of successive regimes since 1789, the perceived specialization of the modern sciences, the social upset brought by changing modes of production, and the rise of a sterile and egotistic individualism brought by the abolition of the corporations led many to see the present as mere anarchy. A search for unity was in harmony with political projects of reform, from those of a reactionary theosophists like de Maistre to those of utopians like Fourier, the Saint-Simonians, or Comte. It also fueled research ambitions in both marginal and mainstream sciences.¹⁷

Dreams of remaking the world from the smallest particles of matter up to the heavens often turned to the past for inspiration. A trope which united many of these projects of unification was *alchemy* which assumed the connectedness of all existence and looked to the external labor of purifying matter as a means of learning, through analogy and sympathy, the steps of the internal work of purifying the spirit. Hénin de Cuvillers, writing a history of animal magnetism, suggested that "alchemy... is the mystical part of chemistry."¹⁸ The notorious Polish scientist Hoëné Wronski, mathematician, engineer, translator of Kant, and probable con-artist, gave his prophecies alchemical accents in a text from 1818:

Absolute reason, this verb inside of us, being considered as virtual reality, can not itself be considered except by the principle of all reality – that is, by the absolute, which it must in fact create to give itself its own reality. And there lies the great *Mystery of creation* which messianism must unveil.¹⁹

Such talk – in which German idealism, mysticism, mathematical science, and industrial millenarianism were combined – was hard to avoid in France in the first half of the nineteenth century. These kinds of discourses set the background for the rise of romantic literature and for the political and ideological controversies which led up to 1848. Despite the well-built defenses of the official sciences, discourses also informed scientific debates wherever issues including

¹⁷ See J. Goldstein, *The Post-Revolutionary Self: Politics and Psyche in France, 1750-1850*, Cambridge, MA, London, England: Harvard University Press, 2005 on "horizontal fragmentation" as the problem faced by the post-revolutionary self. See P. Bénichou, *Le Sacré de l'écrivain, 1750-1830. Essai sur l'avènement d'un pouvoir spirituel laïque dans la France moderne*, Paris: J. Corti, 1973 and P. Rosanvallon, *Le Moment Guizot*, Paris: Gallimard, 1985, both of which argue that a search to re-establish the "spiritual power" to unite society was the definitive political issue of this period: a philosophical and intellectual consensus which could be achieved by more fluid instruments than a one-way state apparatus of command and obedience.

¹⁸ Hénin de Cuvillers, *Le Magnétisme animal retrouvé dans l'antiquité*, 2e ed., Paris, 1821, p. 94.

transformism, progress, utility, or invisible fluids were at stake. Electricity and magnetism often served discursively as a cosmic glue for projects which sought to harness invisible powers to reforge social unity and to make ideas real. As Ampère's close friend Ballanche put it in *Palingénésie Sociale*, the mission of man was "to exercise the intellectual magnetism which tends to spiritualize matter." In Balzac's work, like that of many others in this period, electricity and its analogous (or conterminous) fluids was a symbol and, it was hoped, an instrument for the actualization of spirit in nature.

4. Science through an alchemical glass: Balzac's quest

When we consider the intense intellectual and social exchanges in Paris during the uncertain period between Napoleon's fall and the Revolution and 1848, it comes as no surprise to find that a novelist like Balzac would find scientific research an engaging topic. For many, science was a key plank for projects like those mentioned above for rebuilding an individual, social, and natural unity. His novel, however, shows science in an unusual and rather thrilling light. Setting out on the topic in the summer of 1834, he finished it in less than a month. Conceived as part of his series of novels on "the private life of the 19th century," he hoped it would repeat the success of the sentimental drama *Eugénie Grandet*. According to Fargeaud's reconstruction, however, Balzac's original interest in a family drama was soon overtaken by the opportunity to develop his longstanding philosophical ambitions. The result is a dramatic portrayal of the social dimensions of scientific research, the nature and significance of electricity, and reflections on the legitimate scope of human activity in its technical interventions in to nature. The tale itself is a cosmogram, a representation of what there is in the universe and the proper relations among its parts.²⁰

The *Quest for the Absolute* begins in the recent past, 1812, in the city of Douai in Flemish Northern France. Into a peaceful background of tradition and propriety, an element of *novelty* and *modernity* is introduced when Claës, the paterfamilias of a noble household, returns from Paris after studying chemistry with Lavoisier. As one of the town's leading inhabitants, he leaves science aside in favor of family life, his beloved wife, and the obligations of social respectability. This domestic bliss collapses with the visit of a Polish émigré, a former artillery officer and amateur natural philosopher, who tells Claës of his recent discoveries, and initiates him into the secret of his long scientific quest for *the absolute*. Knowledge of the action of this fundamental principle of matter and spirit, he claims, will grant its discoverer powers far greater than those hoped for by alchemists.

¹⁹ Wronski, *Philosophie absolue de l'histoire*, première partie, p. 1818, quoted after Fargeaud, *Balzac et "La recherche de l'absolu,"* p. 73. Despite public scandals in which he was accused of swindling credulous students out of thousands of francs in exchange for "the absolute," he miraculously retained a reputation in progressive scientific circles into the 1830s. *Metempsychosist* Jean Reynaud wrote an appreciation of Wronski's political mathematics in *palingeneticist* Pierre Leroux's *Revue Encyclopédique*, while Fargeaud suggests that François Arago encouraged the Pole to publish a "new theory of machines" at the moment when the Perpetual Secretary of the Academy was making a case for the French origins of the steam engine. For a bizarre and impassioned debunking of Wronski which includes an interview with his widow and makes use of a newly "rationalized" orthography, see Alexandre Erdan, *La France Mistique: Tableau des Excentricités Religieuses de ce tems*, T. 1, Paris: Coulon-Pineau, 1855.

²⁰ See John Tresch, "Cosmograms." Interview with Jean-Christophe Royoux, in: *CosmogramI*, Melik Ohanian and Jean-Christophe Royoux, (eds.), New York and Berlin: Lukas and Sternberg, 2005, pp. 67-76.

Claës takes up the quest for the absolute like a man possessed. In an isolated attic room of his manor, armed with costly chemicals, metals, and scientific machines, he begins physical and chemical researches which over the course of years will consume his energies, his fortune, and his family, from whom he progressively withdraws, staring at invisible objects and murmuring obscure formulae. After a few years, his devoted, loving and simple wife Josephine discovers to her shock that both her fortune and that of her husband have gone up in the smoke which puffs at all hours from the attic chimney. Creditors demand payment for chemicals and instruments. To the pleas of his daughter and wife for him to stop his research and avoid ruin, he replies "You shall be rich again when I wish it. When I find a solvent of carbon, I will fill the parlour downstairs with diamonds, but even that is a pitiful trifle compared with the wonders I am seeking." (p. 159). Devastated by his inability to renounce science and recognize his family's suffering, his wife falls ill and dies.

Remorse briefly awakens Claës from his trance, but he soon returns to his attic and his experiments. One by one the family's treasures are sold off: the silver and china, the Old Master portraits in the household gallery, the lands from which they had received a guaranteed income, and, finally, the most treasured family heirloom, the "Claës Tulip," a hybrid bulb with all the colors of the rainbow, whose bulbs have been passed down for centuries. In the face of this dissolution, the plucky eldest daughter, Marguerite, takes matters in hand with the unspoken support of the protégé of her mother's confessor, Emmanuel, who has a "heart like a diamond." Marguerite brazenly exiles her father to Normandy. Through various financial contortions she refinances the family lands and restores a number of portraits to the gallery. The two daughters get married off to local notables, and the youngest son, Gabriel, is sent to Paris, where he enters the eminently respectable Ecole Polytechnique.

The tale's ending stages the tragic futility and essential grandeur of the solitary scientific search. Racked with convulsions, the aged Claës takes to his bed. Unable to speak, "his thoughts seemed to blaze from his eyes;" in his final moments, his daughter mentions a news article about a Polish mathematician's search for the absolute. The old man rose up: "[A] breath of inspiration passed over his face and made it sublime. He raised a hand, clenched in frenzy, with the cry of Archimedes: EUREKA! I have found it!" before collapsing, an expression of despair frozen on his face.²¹ Unable to communicate or test his ultimate discovery, Claës realizes the ambition of his life at the moment of death. We never learn if his search had at last brought him the absolute, or if his deathbed discovery was yet another illusion; what we see, however, is the pathetic wreckage of a man who abandoned his life and the love of his family in the search for the secrets of nature. A struggle and resolution between polarities which underlies the hero's philosophy of nature also plays out in the plot: Claës' titanic ambition to understand and master nature clashes with the piety of his devout wife. The cathartic result is the portrait of a cosmos restored to balance, represented in Douai by the couple of Marguerite and her theologian-turned-accountant husband, and in Paris by the inheritor of the Claës lineage, the son trained at the Ecole Polytechnique, where the mysteries of energy conversion were given practical and civic applications as part of with a vocation of duty and collective sacrifice.

²¹ Balzac, *The Quest*, p. 226.

If the narrative dismantles and reforges unity at the level of its structure, at the level of content one of its central themes is a cosmic unity of different kind: the search for a single principle or substance underlying all phenomena. In the physical theory presented within the book, electricity was closely connected to heat, light, and matter; their combinations were understood to produce the phenomena of life and especially thought, a notion Claës elaborates in conversation with his wife:

Man, representing the highest point of intelligence, is a piece of mechanism which possesses the faculty of Thought, one-half of creative power. And combustion is accordingly more intense in man than in any other animal organism ; its effects may in a measure traced by the presence of phosphates, sulphates, and carbonates in the system, which are revealed by analysis. What are these substances but traces of the action of electric fluid, the life-giving principle? Should we not look to find the compounds produced by electricity in greater variety in man than in any other animal? Was it not to be expected that man would possess greater faculties for absorbing larger quantities of the Absolute Element, far greater powers of assimilating it, an organization more perfectly adapted for converting it to his own uses, for drawing from it his physical force and his mental power? I am sure of it. Man is a matrass.²²

The human being is a combination of materials in an alchemist's test-tube, a "matrass" — a vessel in which materials are burnt and transformed, through processes of electrochemical combustion. Appalled by what appears here to be a monstrous reductionism, his wife asks:

'What! My love for you is —'

'Matter etherealized and given off, no doubt the secret of the universe.'

Balzac's concern here and in other novels was the relations between matter, ether, electricity, thought, love, and will; his hero, Claës, searches for the material techniques to realize thought in nature, to locate the ground at which mind and spirit become things.²³ This quest is frequently associated with alchemy. The Polish scientist who mesmerized Claës into his scientific fixations (a character directly modeled on Hoëné Wronski, mentioned above) claimed to be pursuing the same goal as "all great seekers of occult causes" and students of alchemy, "that transcendental chemistry" (p. 79). His ambition, to produce a diamond artificially, goes even further down this path: "the alchemists themselves, who thought that gold could be resolved into its different elements, and made up again from them, would have shrunk in dismay from the attempt to make the diamond." The "absolute" — the hidden principle of all of matter and life — is the lowest common denominator of the electrical fluids. Knowledge of this fundamental principle will grant mastery over all of nature. The fluid of electricity here plays the same role as the alchemical "*prima materia*."

²² A *matrass* is a long, straight-necked glass vessel in which substances are heated in pharmaceuticals and chemistry.

²³ p. 82. For a view of Balzac's bifocal epistemology of vision, see A. Goulet, "'Tomber dans le phénomène': Balzac's Optics of Narration," *French Forum* 26/3 (2001), pp. 43-70.

THE PRIMITIVE ELEMENT must be an element common to oxygen, hydrogen, nitrogen, and carbon; the AGENCY must be the common principle of negative and positive electricity. If after inventing and applying test upon test you can establish these two theories beyond a doubt, you will be in possession of the First Cause, the key to all the phenomena of nature ... the last word of creation. (p. 78).

Mastery of the absolute hands the researcher a power like that of God. It is the key to creation, a principle underlying all the transformations witnessed in recent electric and chemical researches. Yet the book acknowledges that in the present there was a clear stigma on alchemy and that it could be used as a term of abuse; at the end of the book, Claës' final humiliation is to be cursed as an "alchemist" and pelted with stones by children.

It is as if Balzac needed this excursion into the historical and imaginative resources of alchemy in order to show the complexity of the drama he perceived within modern science, whose self-presentation increasingly laid emphasis on impersonality, specialization, and the rejection of superstition. Balzac was not alone in making this detour. Alchemy was a central point of reference for many romantic authors and artists. Spurred by translations in the 1820s and 30s of E.T.A. Hoffman and of Goethe's *Faust* which cloaked anxieties about modern technoscience in Medieval and Renaissance garb, fantastic works like Gautier's and Esquiros' *Le Magicien*, and Nerval's stories of madness, magic, and the occult sciences offered French versions of these themes. Visual imagery of alchemical and magical symbolism could be seen in both serious and playful forms, from Paul Delaroche's celebrated painting of alchemist Bernard de Palissy to Grandville's allegorical and metamorphic engravings of *Un Autre Monde*. Furthermore, as previously mentioned, a revived interest in animal magnetism – closely linked to alchemy and illuminism in the cosmic philosophy of the discredited but still influential Mesmer – took on such strength that a new Commission to investigate its claims was launched by the Academy of Medicine in 1834.²⁴ Discussions of the Kaballah and the newly "rediscovered" Egyptian Tarot were on the rise, as shown in works of Eliphas Lévi, Paul Erdan (*La France Mistique*), and the liberal Deputy, Eusèbe de Salverte, whose history of the occult sciences featured a preface by Arago. Perhaps more surprising are the ways in which the legitimate sciences showed themselves susceptible to this fad. The chemist Jean-Baptiste Dumas began his lectures on *Philosophie Chimique* of 1836 with a lengthy and largely admiring appreciation of the alchemical roots of his science; in the same text he expressed in contemporary terms a claim that resembled one of alchemists, that "the molecules of diverse simple bodies may well be constituted by the condensation of a single, unique matter."²⁵ Initiated by Deleuze into Animal Magnetism in 1812, chemist Eugène Chevreul also maintained an extensive alchemical library and in the 1860s wrote a vast exposition of the subject. Related themes from Renaissance natural magic appeared elsewhere in the sciences: Giordano Bruno's discussions of multiple worlds found an echo in astronomical discussions in the popular lectures given by Arago at the Observatory, one key site for legitimate science, as well as in oppositional discourses like the cosmologies of Blanqui and Fourier, in which multiple worlds often took Swedenborgian forms.

²⁴ For discussion of the Commission, see Gauld, *A History of Hypnotism*.

²⁵ *Philosophie Chimique*, 1836; *Mémoire sur les équivalents des corps simples* 1857, quoted in Fargeaud, Balzac et "La recherche de l'absolu," p. 320.

In political terms, the reference to alchemy was equivocal: it could nostalgically represent a lost, long-for, and unchanging past, or suggest a time of radical innovation which resembled and anticipated the changes perceived in the present. Around 1800 counter-revolutionary authors like De Bonald and the theosophist De Maistre had presented the middle ages as a highly desirable world of stasis, a paradise lost with the Reformation and whose ultimate disappearance was tragically punctuated by the French Revolution; alchemy and occult science could here be seen as neglected modes of knowledge which worked in harmony with faith. On the other hand, for liberal historians including Guizot, Thierry, and especially Michelet, a version of the Renaissance that focused on innovation and change could suggest an alternate historical trajectory, one which grounded the new social and economic forms that grew out of the Revolution in a distinguished past.²⁶ In this reading, alchemy and magic reflected post-revolutionary hopes of unleashing powers which seemed to fulfill the ambitions of medieval and Renaissance mages.²⁷ In both interpretations, however, the reference crystallized concerns about the power of the human will and intellect to overthrow a seemingly eternal order of society. As recent discussions of alchemy show, the analogy between modern technology and science was not without basis: like modern scientists, alchemists manipulated invisible fluids to identify and harness the underlying principles of nature; both placed a heavy emphasis on labor and craft; in both epochs, human subjectivity and morality were seen as closely entwined with the external world through symbols, technologies, and ritual practices.²⁸

5. Moral and metaphysical dimensions of modern alchemy

These uses of alchemy give us some idea of its appeal for Balzac. Ambivalent images of modernity seen through the lens of alchemy run throughout *The Quest*, which raises but does not resolve fundamental questions about science and technology. The alchemical notion of "the absolute" (or "the One") itself makes explicit a rarely acknowledged ambition still lurking within the increasingly specialized sciences: the search for a single principle or force underlying the varied phenomena of the cosmos, mastery of which would unlock nature's secrets. This hope was part of what kept the public reading the weekly *feuilleton scientifique* and attending public lectures in which such broad questions could be indulged. We might attribute some of the ferocity of anti-Laplacean sentiment to disappointment with gravity or "universal attraction" as failed candidates for just such a cosmically harmonizing principle, which some had seized upon as the possible basis for a secular religion; as will be discussed further below, electricity and the ether were invested with similar cosmic hopes.²⁹

²⁶ See L. Orr, *Headless History: Nineteenth-Century French Historiography of the Revolution*, Ithaca: Cornell University Press, 1990. The classic definition of the Renaissance by Burckhardt was strongly influenced by Michelet's *Histoire de la France*.

²⁷ The scientific and technological advances of this period appeared within an emergent cosmological references, and point toward neglected cosmological configuration emerging at this time.

²⁸ See Andrew Pickering, "Science as Alchemy," in: Joan Scott and Deborah Keates (eds.), *Schools of Thought: 25 Years of Interpretive Social Science*, Princeton: Princeton UP, 2001. What Pamela Smith has called an "artisanal epistemology" in the case of Paracelsus was echoed in the prominence given to instrument makers in the 1830s and 40s.

Alchemy presupposed a close interaction between the individual practitioner and the objects worked upon; the power it claimed, that of modifying and recreating nature, lent it an air not only of mystery but of moral uncertainty. The threat posed to society by the magical practitioner Claës' quest for knowledge is paradoxically connected and opposed to a wider society. In one way, nothing could be less social than his pursuits: "He had mounted the winged steed of science, and was far from the actual world" (p. 80).³⁰ His distraction puts him at odds with those around him and devastatingly reverses the natural social order. Yet in the very damage it causes, Balzac shows science as thoroughly enmeshed with personal destinies and character as well as the intimate social order of the family. He shows the scientific quest in interaction with a wider world of calculation and the rise and fall of social and financial capital; Claës' tragedy is as much economic as it is moral, and his overreach has the same consequence as that of other ambitious characters ruined by Parisian intrigues. The names of his accountants, Chiffreville and Protez, remind us that the nation and its capital city are built on the fragile basis of numbers or *chiffres* and the protean shapeshifting of raw materials, labor, commodities, and money.

The book's central theme thus opens out into a reflection on the place of technology and science during the industrial takeoff of the 19th century. One widespread reaction to these new, nearly demiurgic powers of modern science is uttered by his devoutly religious wife just before her death. Her simple but profound faith and nearly mute devotion serves throughout the novel as a foil to Claës' abstraction and distraction. When Claës reveals to her that his experiments aim at nothing less than taking up the work of creation, her response is utter condemnation: "Accursed science! Accursed fiend! You are forgetting, Claës, that this is the sin of pride by which Satan fell! You are encroaching on God!" (p. 82). Eating of the tree of knowledge will grant us the powers of the Creator. As later evoked with equal fascination and disgust in Baudelaire's "Litanies of Satan," such powers were often seen diabolical.³¹ The issue of *creating a new nature* was as much a source of reflection at this time as it was in early modern alchemy.

The question of the proper limits of modification is central to the tale. The goal of Claës' electrochemical experiments was to manufacture, grow, or artificially create a diamond. Like crystals, dead matter which appears to grow organically, his experiments – of which we see only a

²⁹ As late as the 1820s Laplace was seeking such a principle as an explanation for all material phenomena in Newton's laws and in universal gravitation; Saint-Simon and especially Fourier extended this principle of attraction to explain social and psychological life. Key disciples of these theorists retained the imperative of unification, but questioned the possibility of a single mode of explanation for all phenomena. Often in discussions of the concept of *association* Comte, Considérant, and Leroux promoted notions of connection (between individuals, classes, vocations, or scientific fields and their objects) in which individual differences are preserved.

³⁰ His relationship with the one person who is with him throughout his research, his valet Lemonquillier, only underlines the point: towards the end there are hints that Claës is using money lent him by the servant, and that the social inferior has some unwholesome, improper grip on his master. Again, science is seen shown as a threat and a reversal of the proper social order.

³¹ Baudelaire's poem concludes, "Gloire et louange a toi, Satan, dans les hauteurs/ Du Ciel, où tu regnas, et dans les profondeurs/ De l'Enfer, où, vaincu, tu rêves en silence! Fais que mon âme un jour, sous l'Arbre de Science/ Près de toi se repose a l'heure où sur ton front/ Comme un Temple nouveau ses rameaux s'épanouiront!" (Glory and praise to you, Satan, in the heights of Heaven, where you reigned, and in the depths of Hell, where, you dream, defeated, in silence! Grant that one day, beneath the Tree of Science, my soul will rest at your side, at the moment when over your head, like a new temple, its boughs will grow forth!). For references to "la science" as implying primarily occult sciences in the works of Saint-Martin, Ballanche, and others, see Viatte, *Les sources occultes du romantisme*.

glimpse – involve a kind of mineral fertilization. One of the most resonant ironies of the novel comes when Claës returns to the family home after being expelled by his daughter. Though humbled by his daughter's generosity and talent, Claës cannot resist taking a glance at the attic laboratory in which he had left his experiments unfinished. What he discovers is both wondrous and appalling. During his long absence, he left his experimental apparatus near a window, exposed to daily sunlight. With this uncontrolled energy source, far greater than any battery, his experiment succeeds where his own feeble attempts had failed: coal left in a flask has been transmuted, without his lifting a finger, into a diamond the size of an egg; as it occurred without his observation, however, he cannot recall the exact conditions in which he had combined the materials. The success is devastating as there is no way for him to repeat it. Here the plot seems to conspire to agree with Claës long-suffering wife: only nature can (and should) produce novelty in the natural order.

But this apparent moral is equivocal. Despite his faults, Balzac's hero is presented in tones marked by awe and admiration. As we learned earlier, to produce a diamond would mean going further than the "philosopher's stone" by which base metals are turned to gold. The steps of the alchemical process are identified by a rainbow of colors: ruby red, raven black, peacock green. Claës' most cherished heirloom, the rainbow tulip, is an analogous symbol of natural perfection. His degradation is complete when he is forced to sell it in order to feed his habit. But while we can see this as a symbol of the traditional harmony which had reigned before the "accursed fiend" of science invaded the home, the rarity of the breed reminds us that like many of the flowers of the Low Countries, this tulip is a *human creation*, the product of early modern bioengineering. As a symbol of wealth, however legitimate and traditional, it may also remind us of the great speculative bubble which grew up around tulips – like the railroad fever which raged while Balzac wrote – and the catastrophic crash brought by irrational exuberance around these "natural" objects. While at one level Balzac's narrative moves us from a state of harmony associated with a natural order of tradition and stable wealth – presenting science and technology as the sinful usurpers of this order – one of the central symbols of this natural order, Claës' rainbow tulip, is a product of the same logic of innovation, modification, and speculation against whose dangers it appears to warn.³² Certain forms of modifying nature are presented as comparatively safe and hallowed by tradition; others, though sublime, lead inevitably to destruction.

Similar tensions unfold in the book's presentation of his scientific instruments: these machines are at once the tools of a deadly reductionism and vessels of the supernatural, a duality which gives them an uncanny power. Instruments enter the tale as costly talismans which demand Claës' constant ministrations, glimpsed uncomprehendingly by all the other characters, who fear their obscure and inscrutable powers. At the same time, Claës' obsession itself is represented as having turned him into a machine: the Polish philosopher speaks in a mechanical voice, and when Claës is in the clutches of the Absolute he has a "listless, mechanical way of walking" (p. 74). This imagery resonates with the language of mesmerism, which appears throughout the book in

³² Many commentators have noted Balzac's attachment to the countryside as a nostalgic refuge from the corruption of his central subject, the French capital of Paris; yet just like the artificiality of the "natural" rainbow tulip, his demonstrations of machinations of a nearly Parisian degree of venality in small towns undermines the assumption of the provinces as the preserve of the pure and good. (as in *Lost Illusions*, *Cousin Pons*).

references to vibrations as a means of emotional communication and to light and fire blazing from characters' eyes.³³ As theorized by Puységur, the magnetic trance involved the transmission of the will of the magnetizer on to that of the subject, making the latter into a passive instrument, one associated with automata in texts from Hoffmann, Gautier, and the stage magic of Robert-Houdin. Claës is enchanted by the very machines of instrumental rationality which would later be seen as playing a part in the disenchantment of the world. To Claës, however, these devices are not his masters but his servants, and will give him power over life itself; this inversion is paralleled by his relation with his servant Lemonquillier, whom we realize by the end of the tale has an *unnatural* power over his nominal master. The tale's central tension is the scientist's belief in his mastery over forces which all others see as mastering him: it is the question of whether his attempt to know the divinely-ordained plan of the universe does not lead him to mistake himself for a divinity. With the deathbed revelation at the book's close, the author leaves the struggle undecided.

The alchemical metaphor deployed in the text applied not only to science but, reflexively, to Balzac's own practice as a novelist in a growing marketplace of mass-produced cultural goods. Caught entirely in the cycles of rising and falling fame via the fluctuations of public sentiment and the constant flow of written words, he was one of the first generation of authors to earn his living entirely by exposure to the marketplace. He wrote within a heavily saturated world of journalistic representations made possible by steam printing and by the periodic relaxation of censorship since the empire. In his mad scramble to maintain an extravagant lifestyle he speculated on commercial ventures for the exploitation of new technologies: a printing shop, railroads, and the "acclimation" of plants imported from the colonies: his first fortune was lost in a misguided project for a pineapple plantation near Paris. *Illusions perdues* develops this reflexive parallel most strongly, detailing the techniques of printing and the intrigues of the publishing world in terms analogous to Claës' research: the printer as the stove, the paper and words as the vessel: these are the instruments that allow his thought and will to act upon and transform the world. But Balzac had already assimilated his own composition of *The Quest* to the self-destructive acts of ambitious creation it described. While writing it he confesses, "The book is killing me. It is an immense subject, the finest book I am capable of writing," and indeed it is difficult to separate the travails and torments of Claës from those of his equally obsessed author, whose caffeine-fueled search for methods to create lasting impressions and vital effects brought him to an early demise.

Balzac's novels turned the vague but historically salient concept of *unity* into a cosmological and compositional principle. The highest aim of a science was to identify the ultimate principles of the universe, in which life, matter, and thought would all be addressed and shown in their interactions. Some of his works depicted attempts to realize this aim, in its scientific or mystical dimensions (*Séraphita*, *Louis Lambert*, *Ursule Mirouët*). This unifying position was neither a materialism nor a spiritualism, but rather a way of viewing the mental and the physical as closely bound up with each other and in constant exchange and conversion. He was a romantic, but one with little faith in the imagination alone or in a pristine unmodified nature. His books portray a constant search for the proper medium or instrument to harness and convert the fundamental forces of nature and mind: these include magical talismans (as in *La Peau de Chagrin*), steam presses and literary genres (*Illusions perdues*), or scientific instruments (*La Recherche de l'Absolu*).

³³ See Viatte, *Les sources occultes du romantisme*.

Far from the enemy of romantic ideals, he saw the sciences and new technologies as the obligatory means to realize these ideals.

In the first half of the nineteenth century, *modification* and *transformation* were newly seen as the fundamental mode of relation of humans to themselves, society, and nature. As Guizot put it, "man metamorphosizes things and puts on them the imprint of his personality, transforming them into simulacra of liberty and intelligence;" his one-time interlocutor Auguste Comte likewise aimed at a modification of self and nature through various ritual practices which took as their model the Catholic Church as well as a new order of knowledge and society more in keeping with our true needs.³⁴ Balzac and Ampère's work, far from isolated or idiosyncratic, was directly connected to these new ways of thinking about humans' relations to each other and to the natural world. In these and similar projects devised to adapt to modernity, several themes were held in common: the existence of a single, primary substance underlying all matter, the unity of nature via a complex net of associations and relationships, and the power of the human mind, in conjunction with specific techniques and technologies, to modify the natural order. In these defining themes of the modern age of industry and reason, many saw not only novelty, but a reflection of the much older arts of alchemy.

6. Conclusion: The concrete cosmos

In an essay which links Ampère and other students of electricity and magnetism – Oersted, Ritter, Day – to the broad movement of *Naturphilosophie*, L. Pearce Williams suggested that one of this movement's goals was nothing less than a change in the conceptual frame for understanding the cosmos:

Kant, and more particularly the *Naturphilosophen*, attempted to substitute a new cosmic metaphor. The world of the eighteenth-century *philosophe* was a machine; the *Naturphilosophen* insisted it was an organism. Its laws were laws of development; its basic theoretical paradigm was field theory in which the connections between parts were as important as the parts themselves. Organisms live because they are informed by Spirit, and the *Weltseele* [world soul] was the ultimate substratum of physical reality. Only spirit can understand spirit; science, then, is spiritual in its essence.³⁵

This is a familiar reading of romanticism, and one not without ample justification in writings found in the first half of the nineteenth century. In the cases of Balzac and Ampère, however, this familiar opposition between machine and organism, between knowledge by technological manipulation and knowledge by intuition, between "objective" and "subjective" approaches to nature is much harder to find. Instead we see these strands woven together in a variety of combinations. For all the variety of this period, as well as its abundant fascination with contradiction and paradox, something like a shared *zeitgeist* was forming precisely out of these unusual mangles in science, politics, and literature: a modern metaphysics which incited movement and syntheses between opposed views of a single object – spiritualist, emotional,

³⁴ Guizot, *Histoire de la civilisation dans l'Europe*, 1828, quoted after Goldstein, *The post-revolutionary Self*, p. 228.

³⁵ L. Pearce Williams, p. 17.

mechanistic, utilitarian – and saw everywhere opportunities for a morally ambivalent but highly desirable modification of nature.

The search for analogies and correspondences in the ideas of Ampère and Balzac (or his fictional double, Claës) may smack of the hasty generalizations involved in describing the “worldview” of intellectual figures as found in traditional history of ideas. This field has stood in some disrepute at least since Foucault in *The Archaeology of Knowledge* blasted its use of “the categories of cultural totalities (whether world-views, ideal types, the particular spirit of an age).” Equally annoying to Foucault was the concept of “influence,” a notion “too magical ... to be very amenable to analysis,” which, he continued with erudite sarcasm, “links, at a distance and through time – as if through the mediation of a medium of propagation – such defined unities as individuals, *œuvres*, notions or theories.”³⁶ Although I believe that the strong analogies between Ampère and Balzac identified here make a case for a shared cosmology (leaving space for considerable individual and disciplinary variation), to construct this intellectual object there has been no need to rely on magical explanations of cultural causality. These ideas and attitudes spread without need for action at a distance, thanks to the overlap of these actors’ pathways through salons, circles, institutions, journals, and networks of friends and associates, *milieux* which served as the material “medium of propagation” for these cultural forces and unit-ideas, to use Lovejoy’s term. The aim, then, has been to arrive at the hermeneutic notion of a cultural whole, but to ground this totalizing abstraction in the local, particular, material practices and social connections through which actors described and realized it. This “holistic” aim might appear “romantic,” yet the method is “mechanical:” grounded on direct interactions, concrete settings and observable practices. One object of this paper has been a constellation of ideas and practices called mechanical romanticism; the same name could apply to the method it seeks to develop.

Each in its own way, these projects of utopia and totalization from this period – attempts to present the entire *Globe*, indeed the entire order of nature in a single representation, whether a linked series of novels, a new encyclopedia, a total history, or a complete system of human knowledge – were located in the same cosmological streams whose ripples reached Ampère and Balzac, and which many saw vibrating in sympathy with the concerns of alchemy. This is not to suggest that the *differences* between these emerging fields, like the difference between the *savants* of the nineteenth century and the actual practices of early modern alchemists, are not also significant. As Sainte-Beuve wrote in an anonymous review of *The Quest* in 1834, “M. de Balzac seems to believe that there is but a step between a taste for alchemy and the lessons of Lavoisier, when there is an abyss.”³⁷ But Balzac was not the only one to span this abyss, or to refuse to defer to it. The shared ground in which exchanges and identifications across this divide could appear self-evident – not just in a set of shared ideas, but in networks of acquaintances, social forms and modes of sociability, and ways of *thinking* about practice. As further discussion of Ampère’s work will show, his pursuit of the secrets of electromagnetism and Claës’ quest for the fundamental substances of nature were symmetrical and closely entwined quests for the absolute, nourished in the same material and intellectual *milieux*. These obsessed researchers – one real, one fictional –

³⁶ Michel Foucault, *Archaeology of Knowledge*, London, New York: Routledge 2002, pp. 17 and 24.

³⁷ In the *Constitutionnel*, *Revue Littéraire*, 9 October 1834, quoted in Fargeaud, *Balzac et “La recherche de l’absolu,”* p. 496.

provided the early industrial age with important metaphors and formulae to help understand and realize about the transformation of society and the natural world.