Electric and Magnetic Dreams in Romantic Europe : The debate about the representation of Nature in the late eighteenth and the early nineteenth centuries

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THE DEBATE ABOUT THE REPRESENTATION OF NATURE IN THE LATE EIGHTEENTH AND THE EARLY NINETEENTH CENTURIES

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To my daughter Hannah

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Introduction

This book is inspired by the research that I carried out from 2000 to 2005, which was first presented as a Phd Dissertation on the 26th may, 2006 at the *Universidad Autónoma de Madrid* with the joint supervision of *Ecole des Hautes Etudes en Sciences Sociales/Centre Alexandre Koyré*. During this five-year project, the support of various institutions such as the *Universidad Autónoma de Madrid*, the *Université Claude Bernard/Lyon I, Le Musée de l'électricité*, the *Centre Alexandre Koyré* and *l'Académie des Sciences*, as well as the guidance of Javier Ordóñez, Jean Dhombres and Georges Asch made its achievement possible. Even though the present work deals with the original insights put forward throughout that dissertation, I would confess that my initial interest on the historical value of the Romantic Era has been considerably transformed as a result of six years of postdoctoral research at the *Centre d'histoire des sciences et des techniques* in Paris, the Queen Mary University of London, the Bakken Museum of Electricity and Life (Minneapolis) and the Institute for the History of Medicine and Health at the Geneva University.

I consider, however, that the evolution from Romantic science to my present commitment to the history of emotions, is a completely logical step in my professional career, as this bourgeoning program of research has helped me to focus on the central point that led to my involvement in a PhD: to consider the relationship between the humanities and the sciences in order to understand all sort of knowledge as a form of culture, which is not only the result of our capacity for reason, but also of our feelings, passions and sentiments[1]. In other words, I am fully convinced that our contemporary attraction for examining how emotions have been represented in the past in relation to codes, norms and institutions, reflects a wider appreciation about the limits and dangers involved in the understanding of our Western civilisation as a mere product of reason, just as Romantics noted almost two centuries ago[2].

[1] The history of emotions is a recent term coined by scholars such as Rosenwein, B., "Worrying about Emotions in History", *The American Historical Review*, 107 (3), 2002, pp. 821-845; Reddy, W., *The Navigation of Feeling: A Framework for the History of Emotions*, New York, 2001 and Stearns, P. and Stearns, C., "Emotionology: Clarifying the History of Emotions and Emotional Standards", *The American Historical Review*, 90 (4), 1985, pp. 813-836 in order to refer to a multidisciplinary program of research that integrates the scientific, social, cultural and political aspects of the evolving conceptions of emotions.

[2] Burke, P. "Is there a Cultural History of Emotions?", in: Gouk, P.H. and Hills, H. (eds.), *Representing Emotions: New connections in the Histories of Art, Music and Medicine*, Burlington, 2005, p. 35.

Looking back to the time when I was a young student of philosophy, I remember that what attracted me to the topic of Romantic science was that its very expression seems to embody a provocative contradiction. While the adjective "romantic" is usually defined as a late eighteenth and early nineteenth-century aesthetic movement prone to the sentimental side of human being ; the word "science" denotes a rational activity aimed at the systematic study of the structure and behaviour of the natural world, by using techniques such as observation and experiment that are supposed to be completely free of subjective aspects. Can we speak about a passionate science, when scientific knowledge is characterised by its objectivity ? Did scientists really achieve the neutralisation of their emotions when they were carrying out research in their laboratories ? How can we integrate this neglected affective aspect in scientific practice from a methodological point of view ?[3]

These were some of the issues that I wished to address when I started to write my PhD. During this five-year project, history became, for me, not only a concrete passion that led me to look through old and dusty manuscripts, but also a new way of dealing with philosophical problems from the point of view of what the French tradition has usually called "historical epistemology" as represented by the works of scholars such as Gaston Bachelard, Georges Canguilhem, Michel Foucault and more recently, by those of Ian Hackings, Lorraine Daston and Arnold Davidson[4]. This approach helped me to understand that the two cultures, the humanities and the sciences –which Charles Snow discussed in his seminal work published in 1959– had not always worked in the past as they work in the present[5]. History taught me that there was a time when scientists were also artists, physicians and philosophers, who translated their theories into poetry. History allowed me to discover a short-lived period, which was marked by a collective desire to create a unified vision of knowledge against the increasing specialization of modern disciplines, but also –and more importantly– against a simplified representation of mankind, which had usually been portrayed through the mere capacity of the abstract thinking.

[3]Recent research on how emotions integrated themselves into the history of science can be consulted in Withe, P. "Emotional Economy of science", *Isis*, 100 (4), 2009, pp. 792-797.

[4]Bachelard, G., *La formation de l'esprit scientifique*, Paris, 1938 ; Canguilhem, G., *Essai sur quelques problèmes concernant le normal et le pathologique*, Strasbourg, 1943 ; Foucault, M., *Histoire de la folie à l'âge classique*, Paris, 1961 ; Daston, L., "Historical Epistemology", in: Chandler, J., Davidson, A.I. and Harootunian (eds.), *Questions of Evidence: Proof, Practice and Persuasion*, Chicago, 1984, pp. 239-271 and Hacking, I., *Historical Ontology*, Cambridge MA, 2004. Classical and recent views on the meanings of historical epistemology have been recently summarised in a conference, which was held at the Max-Planck-Institut für Wissenschaftsgeschichte (eds.), *Epistemology and History. From Bachelard and Canguilhem to Today's History of Science*, Berlin, 2012, Preprint 434, pp. 7-13.

[5]Snow, Ch.P., *The Two Cultures*, Cambridge, 1998.

In this way, Romanticism allows me to question the cultural representation of a passionless, rational and cold scientist, who had nothing to do with literature, politics, poetry, philosophy and painting. The study of personalities such as Johann Wolfgang von Goethe, Johann Wilhelm Ritter (1776-1810), Mary Shelley (1797-1851) or Andre-Marie Ampère (1775-1836), who cultivated literature, the arts as well as philosophy and the sciences, provided me the best examples with which to demonstrate that Romanticism was a cultural context with undefined, constantly moving frontiers that had encouraged the proliferation of polymaths rather than specialists trained to work in a particular field of knowledge. This particularity should be understood in connection with the social circumstances in which this movement took shape. It was a tumultuous epoch marked by a series of political upheavals that transformed not only European politics, but also the way of understanding science by means of the creation of new institutions such as the Parisian *Ecole Polytechnique* or the introduction of important institutional reforms such as those led by Wilhelm von Humboldt (1767-1835) in the German university.

From the French Revolution to the Revolutions of 1848, the physiognomy of science would completely change as a result of another revolution in the scientific world, which Andrew Cunningham and Nicholas Jardine have called a "Second Scientific Revolution" through "which was formed the federation of disciplines which we call today science", such as modern physics, chemistry and biology[6]. Medical knowledge and practice also underwent a deep epistemological crisis, which, at the end of the eighteenth century led to a broader discussion about its scientific foundations in French and German communities[7]. Furthermore, the cultural identity of the scientist, the scientific personae –according to Lorraine Daston and Otto Sibum's terminology– was also redefined throughout the nineteenth century as indicated through the apparition of new words like "scientist", *der Naturwissenschaftler*, *le scientifique* that were coined in order to recognise the increasing political power of this social group in Western society[8]. All these social transformations would mean that romantics would become the last natural philosophers, just before the advent of Positivism in the mid-nineteenth century. They dreamt of elaborating a unified vision of knowledge, which reintegrated calculus, verses, paintings and scientific observations together with enthusiastic

[6]Cunnigham, A. and Jardine, N., "The Age of Reflection" in Cunnigham, A. and Jardine, N. (eds.), *Romanticism and the Sciences*, Cambridge, 1990, p. viii.

[7]Arquiola, E. and Montiel, L., *La médicine en révolution. Sciences et philosophie de la nature au tournant du XVIIIe et du XIXe siècle*, Paris, 2012.

[8]Daston, L. and Sibum, O., "Introduction: Scientific personae and their histories", in: Daston, L. and Sibum, O. (eds.) *Scientific personae: Special issue of 'Science in Context* (1/2), 2003, pp. 1-8.

reflections on man and the diversity of natural world, in an age when academic disciplines were being created. In doing so, they were defining themselves as a kind of Quixote living in a time to which they did not belong[9].

The choice of a book title such as *Electric and Magnetic Dreams in the Romantic Europe* responds to this utopian character revealed by Romantic scientists, who put forward an ambitious program aimed at providing an integrated vision of nature by means of describing its fundamental forces. Nature –as Alexander von Humboldt (1769-1859) said– was a Cosmos, a harmoniously unified network that revealed its essence through the interactions between geography, climate, flora and fauna. Although a great number of works have dealt with the influence of this Romantic conception of nature in European science, such as the collective volumes edited by Stefano Poggi and Maurizio Bossi, Andrew Cunningham and Nicholas Jardine, as well as more recent publications such as Robert J. Richards' *The Romantic Conception of Life*[10] ; this book focuses on showing the ways through which electricity and magnetism became scientific metaphors that contributed to interpreting nature as well as the human behaviour, including the basis of animal sensibility, which –according to the philosopher Jean-Jacques Rousseau (17712-1778)– offered "a fairly clear analogy for souls to the magnetic faculty of the bodies"[11].

The first chapter of this book reviews some of the most relevant interpretations, which have been proposed in order to identify the vague contours of this movement. While Arthur Lovejoy did not believe in the existence of a coherent Romantic movement, other historians such as Isaiah Berlin regarded the period from 1770 to 1840 as embodying a major rupture in the Western World[12]. Taking Charles Baudelaire's definition of the Romantic Movement as starting point, the first chapter attempts to evaluate to what extent this "new way of feeling" had promoted the evolution of late eighteenth and early nineteenth-century sciences[13].

As the French poet ventured in the Salon of 1846, Romantic Art was intimately linked with the advent of an exquisite sensibility resulting from the discovery of the inner world of the self, which was centred in modern subjectivity. However, this new way of feeling announced by Baudelaire was not only an exclusive

[9]On the cultural significance of Quixote as the character embodying the limits of the representation, see Foucault, M., *Les mots et les choses. Une archéologie des sciences humaines*, Paris, 1966, p. 61-2.

[10]Poggi, S. and Bossi, M. (eds.), *Romanticism in Science. Science in Europe, 1790-1840*, Boston, 1994 ; Cunningham, A. and Jardine, N. (eds.), *Romanticism and Sciences*, Cambridge, 1990 and Richards, R. J., *The Romantic Conception of Life: science and philosophy in the Age of Goethe*, Chicago, 2002.

[11]Rousseau, J.-J., *Rousseau Judge of Jean-Jacques. Dialogues*, Hanover, 1990 p. 112.

[12]Rousseau, G.S., *Nervous Acts: Essays on Literature, culture and Sensibility*, London, 2004, p. 175.

[13]Baudelaire, Ch., *Œuvres complètes: Curiosités esthétiques*, Paris, 1868, vol. 2, p. 85.

mode of being Romantic amongst artists, philosophers and literary man and women, but also amongst certain natural philosophers, who portrayed themselves developing delicate sentiments and passions towards the study of nature in their writings[14]. Thus, Romantic sensibility did not only appear as a distinctive feature that explained the difference between ancient and modern art, but also of a particular philosophy of nature aimed at integrating experiments and calculus with the celebration of feelings such as the sublime towards nature. In other words, what Romantic natural philosophers were claiming to investigate was a science with heart in which sentiments such as love could provide new modes of observation and experiment nature that would henceforth be regarded as an unified whole in which all parts were interacting.

As explained in the section entitled “Feeling Nature”, the representation of nature as an organism during the Romantic period would lead to the conception of the first ecological qualms, as demonstrated by the rise of a particular feeling of being at one with the whole environment, which is still at the heart of our contemporary manner of understanding ecological thinking. It is no wonder that the contemporary Ecocriticism tradition has turned its interest to Romantic thinkers in numerous publications regarding them as the origins of a veritable “Green movement”, which appeared from the perception of nature as “a remote, mysterious and magical place that existed in sharp disjunction from the smoke, crowed streets and noisy machinery of the city”[15]. The Romantic effort to restore the lost harmony between humankind and the natural environment in metaphysical terms should be understood as being intimately related to certain social condition such as the early nineteenth-century process of industrialisation, which had transformed the natural environment into an urbanised landscape by means of introducing technology into all aspects of human experience. Thus, the Industrial Revolution involved a change of awareness towards environmental problems and also, a broader cultural transformation concerning the affective experience of one’s self in one’s relation to nature that arose from the conviction that human existence was suffering a painful separation from its natural origins. This is why ecological concerns came to light in the Romantic Era: because collective anxieties about the possibility of Earth’s destruction began to be perceived as the fatal destiny of the modern world.

Relations between man and nature did not only inspire the formulation of the first ecological concerns during the Romantic period, but also a deeper epis-

[14]Sensibility and temperament are interpreted as central features of the Romantic scientific self in Porter, T.M., *Karl Pearson: The Scientific Life in a Statistical Age*, Princeton, 2005 and Steven Shapin, *The Scientific Life: A Moral History of a Late Modern Vocation*, Chicago, 2008.

[15]McKusick, J.C., *Green Writing: Romanticism and ecology*, New York, 2000, p. 70.

temological debate on the ways through which nature should be represented. Chapter two deals precisely, with the problem of objectivity during Romanticism by exploring their complex epistemological implications from an historical point of view. After Lorraine Daston and Peter Galison's work on objectivity, we know that this scientific concept has a history that shows us its relatively recent creation. Indeed, it was during nineteenth-century debates on the nature of the scientific knowledge that objectivity began to be adopted as an epistemic virtue, meaning a representation of nature free from subject alteration. This mechanical interpretation of objectivity that implied the total abnegation of the self in order to represent things as they are would become current only in mid-nineteenth century, just at the end of the Romantic period. Before that time, the scientific representation of nature implied a massive intervention of the natural philosopher, who used his personal skills, including his imagination, in order to depict the true essence of phenomena. This shift from what Daston and Galison have called "an approach true to nature" to the mechanical conception of objectivity occurred during Romanticism and, therefore, we can retrace from this context the historical origins of a philosophical discussion on the meaning of the objective and the subjective dimensions in the scientific knowledge[16].

As the Dane *Naturphilosopher* Heinrich Steffens explained, nature and man were two reciprocal aspects of knowledge, which corresponded with the methodological distinction between objectivity and subjectivity[17].

> Do you want to know nature ? Take a look inside yourself, and in your gradual intellectual enlightenment, you may have the privilege of looking on nature's stages of development. Do you want to know yourself ? Observe nature, and her works are of the same essence as your mind[18].

According to the well-known analogy between the Macrocosm and the Microcosm, romantics were fully convinced that unveiling the secret interactions of nature meant understanding our complexity as natural beings, too. Romantic objectivity, as described by the Steffens' words, implied an original polarity between man and nature, which would be utterly resolved by a metaphysical identity between these two poles of knowledge. This assertion about the identity between the self and nature, which was at the heart of the Romantic conception of objectivity, could be retraced in the program of higher physics called the *Naturphilosophie* led by the German philosopher Friedrich Wilhelm Joseph Schelling (1775-1854).

[16]Daston, L. and Galison, P., *Objectivity*, New York, 2007.

[17]Galison, P. "Objectivity is romantic", in: Friedman, J., Galison, P. and Haack S. (eds.), *The Humanities and the Sciences*, ACLS Annual Meeting, 1999, 47, pp. 15-43.

[18]Steffens, H. "Ueber die Vegetation", in: *Schriften: Alt und Neu.* Breslau, 1821, vol. 2, p. 102. The English translation can be found in Von Engelhardt, D. "Romanticism in Germany", in: Porter, R. and Teich, M. (eds.) *Romanticism in National Context*, Cambridge, 1988, p. 114.

The interest of examining this philosophy of nature flourishing at the University of Jena during the last two decades of the eighteenth century stems from the fact that it would define the main lines of research to be followed in the humanities and the sciences during almost thirty years in this country. In this cultural context, scientists, artists and literary personalities claimed to do a similar creative use of the faculty of imagination in their respective works in order to comprehend nature as a whole organism, whose history could be retraced through its geological formations, the evolution of plants, animals and even, in the form of planetary systems. The poet Novalis (1772-1801), the writer Ludwig Tieck (1773-1853), the brothers August and Wilhelm Schlegel (1767-1845) and the naturalist Lorenz Oken (1779-1851) were some of the personalities that composed this early German Romantic Movement moved by the firm belief that verses, natural explanations and laboratory experiments could harmoniously coexist in the same vision of knowledge.

Only the faculty of imagination allows us to approach unknown phenomena without applying preconceived ideas to them and, furthermore, to challenge mechanical conception by proposing a dynamic conception of matter through the supposition of two alternative forces. As Schelling explained, the notion of imagination and that of force were two sides of the same coin.

> We can think of this product of imagination as a mean of all the possible relationships, which might hold between attractive and repulsive forces. Force is certainly present, but only in our concept ; force as such, not specific force. Force is simply that which affects us. What affects us we call real, and what is real exists only in sensation ; force is therefore that which alone corresponds to our concept of quality[19].

Neither our senses, nor our reason could provide us with a representation of the ultimate structure of matter, of what is infinitely small. This is why Blake's famous verse, "To see a world in a grain of sand" provides the title to the second section of the second chapter : because it represents the Romantic manner of scrutinising the complexity of physical reality and, notably, phenomena such as electricity and magnetism whose manifestations were almost imperceptible for the human being. Therefore, the only faculty capable of elaborating metaphors to unveil nature's secret behaviour, such as the notion of the polarity of forces, was imagination. Imagination was also the way through which Schelling represented nature as an organism, in which all parts were interrelated through the successive transformations of a polarity of forces : sensibility and irritability as well as, electricity and magnetism[20]. According to Schelling, all these natural phenomena

[19] Schelling, F.W.J., *Ideas for a Philosophy of Nature*, Cambridge, 1988, p. 216.
[20] Rousseau, J.-J., *Rousseau Judge of Jean-Jacques. Dialogues*, Hanover, 1990 p. 112.

came to embody the various qualitative transformations of nature showing that no phenomena could be destroyed ; only converted into another.

As explained in the section entitled "The magic virtues of electricity and magnetism", this Romantic idea about the mysterious connections of nature was historically inspired by the rehabilitation of a very different range of esoteric traditions such as Paracelus' Hermeticism or the work of heterodox personalities such as the Jesuit Athanasius Kircher (1601-1680) and the theosophist Prokop Divisch (1698-1765), who have speculated about the nature of electricity and magnetism revealing their connection with the whole Universe. Throughout the discussion of these traditions, chapter three and four attempt to examine in which ways Franz Anton Mesmer's Animal Magnetism and Luigi Galvani's Animal Galvanism provided theoretical models to imagine electric and magnetic phenomena as primordial agents animating nature, which could also help us to study the human psyche and its darkest side: dreams.

While Galvanism supposed the existence of a new kind of electricity –a fluid produced in the brain, which was communicated through the nerves to the body charging the muscles–, Animal Magnetism introduced a new vision of the Universe and a revolutionary medical therapy, which consisted of reinforcing the flow of an invisible magnetic fluid circulating through the body, that was responsible for the individual's health. Although both theories would be soon contested by the European scientific establishment, they would continue to enflame the imagination of late eighteenth and early nineteenth-century natural philosophers and, notably, of those who were moved by a desire to unify the physical world and the human psyche by means of these vital agents.

In particular, the section of chapter three entitled "The magnetic powers of the mind" focuses on examining a new fact announced for the first time by Armand-Marie-Jacques de Chastenet, the Marquis of Puységur (1751-1825), when he was magnetising a patient suffering from pneumonia : artificial somnambulism. By contrast to the convulsions perceived in mesmerised patients, Puységur noted that, under his treatment, the patient seemed to be asleep. However, he was able to answer his questions, diagnose his own disease and when and how it would be cured, revealing a special sense of lucidity. Therefore, Puységur described this discovery as the induction of an artificial magnetic sleep, a state of trance, "*de sommeil ambuliste*", which was a type of regression through which the patient could more easily talk about the sorrows that were at the root of his suffering[21]. Puységur would, moreover, reformulate somnambulism as a way to cure insanity,

[21] De Puységur, A.M.-J.Ch., *Appel aux savants observateurs du dix-neuvième siècle, de la décision portée par leurs prédécesseurs contre le magnétisme animal, et fin du traitement de jeune Hébert*, Paris, 1813, p. 121.

a concept that included at that time, a wide range of diseases that were not directly associated with an organic dysfunction. As explained in this section, which focuses on the exploration the magnetic sleep, Puységur's conclusion would be that madness could be defined as a type of a wakened state, in which a double consciousness was revealed[22].

While chapter three deals with the cultural meaning of Animal magnetism in late eighteenth and early nineteenth French society, chapter four explores the reception of Galvanism in British scientific circles by means of the analysis of Mary Shelley's famous novel, *Frankenstein or the Modern Prometheus* (1818), one of the most sublime Romantic literary metaphors representing the vital connotations of electricity[23]. Inspired by Giovani Aldini's public performances, Shelley elaborated a very personal interpretation of Galvanism inspired by her traumatic experience as a mother, who had lost the majority of her children. As various critical works have established and most notably, Anne Mellor's *Mary Shelley: her life, her fiction and her monsters* (1993), this novel cannot be correctly interpreted without taking into account gender aspects, because the metaphor of Galvanism is intimately related to the natural possibility of becoming pregnant[24]. Therefore, when Shelley described Victor Frankenstein's creation of the monster by referring to the metaphor of the spark of life, she seemed to suggest understanding Galvanism as a natural capacity intimately related to biological reproduction that announced the scientific dystopia of a world in which women would no longer be needed in order to give birth to new beings. Drawing on these considerations, chapter four discusses *Frankenstein*'s scientific background including Humphry Davy's research on chemistry, Erasmus Darwin's natural history as well as Shelley's detailed knowledge on obstetrics, a discipline which had for centuries associated the birth of monsters with the suggestion of mother's imagination.

In its turn, chapter five, "Everything is interrelated", focuses on more empirical matters by examining some discoveries carried out in early nineteenth-century experimental science, which reinforced the idea of supporting the conversion of all natural phenomena. Electricity, magnetism, heat, light and animal reproduction seemed to reveal intimate bonds giving the impression that they announced a new connection between organic and inorganic nature and, moreover, between all fields of knowledge. Thus, in 1800, the Italian Alessandro Volta presented his battery to the public, an invention, which transformed chemical reactions in

[22] De Puységur, A.M.-J.Ch., *Un Somnambule désordonné ? Journal du traitement magnétique du jeune Hébert*, Paris, 1999.

[23] Shelley, M., *Frankenstein or the Modern Prometheus*, London, 1818. A rare copy of Shelley's first edition is preserved at the Bakken Museum (Minneapolis).

[24] Mellor, A., *Mary Shelley: Her Life, Her Fiction, Her Monsters*, New York, 1988. See also her book entitled *Romanticism and Gender*, New York and London, 1993.

electricity. Twenty years later, the Danish Hans Christian Oersted established the connection between electricity and magnetism and the French André-Marie Ampère would prove a few months later that all magnetic phenomena could be understood as electric currents by means of electrodynamics. In 1821, Thomas Johann Seebeck would establish the relation between heat and electricity, the so-called thermoelectric effect and, in 1831 the British Michael Faraday would induce electricity from a magnet. In this context of scientific euphoria, the experimental relationships observed between electricity and magnetism became the paradigm of what Thomas S. Kuhn called the "conversion processes among natural phenomena" announcing that the mechanical representation of the Universe was being destroyed by means of the apparition of a renewed notion of force[25].

Above all, Oersted's discovery would become a crucial element to understanding the collapse of Newtonian mechanics because electricity and magnetism had been explained by means of the presence of the imponderable fluids, an hypothesis, which did not permit the establishment of connections between the different experimental fields of scientific research. Therefore, Oersted's conversion of electricity into magnetism was celebrated amongst Romantic natural philosophers belonging to the *Naturphilosophie* as the empirical proof confirming the scientific validity of Schelling's metaphysical insights. The corroboration of the intimate connections between electric and magnetic phenomena revealed that different natural forces were effectively interrelated and each of them could be transformed into another.

However, Romantic science's triumph would not be welcomed with the same enthusiasm in Paris, where the most powerful scientific institution of that time ruled under the auspices of what the historian Robert Fox has called "Laplacian physics". At the turn of the nineteenth century, the dominant scientific model was associated with the work of Pierre Simon de Laplace and, notably, with his *Traité de mécanique céleste* (1799), which was regarded as the most brilliant completion of Newton's mechanics. Going one step further than Newton, Laplace would propose to quantify all experimental phenomena through analogy to celestial physics, establishing the main lines of French scientific research in the 1800's by means of the hypothesis of the imponderable fluids. These fluids were supposed to act within molecules composed of ordinary matter by means of different types of short-range forces, which were conceived by analogy to gravitational force[26].

[25] Kuhn, T.S., "Energy Conservation as an example of simultaneous discovery", in: Clagett, M. (ed.), *Critical Problems in the History of Science*, Madison, 1959. See also, Ordóñez, J., "The story of a Non-discovery: Helmholtz and the Conservation of Energy", in: Munevar, G. (ed.), *Spanish Studies in the Philosophy of science*, Dordrecht, 1996, pp. 1-18.

[26] On relation of the mathematical treatment used to study electricity and magnetism, see Laplace, P.S., *Traité de mécanique céleste*, Paris, 1805, vol. 4, p. 46.

Despite the scientific efforts made by Laplacian scientists to explain the nature of electricity and magnetism, Oersted's discovery revealed a discrepancy with this highly mathematical model and the experimental evidence provided by his research[27].

Nevertheless, a bizarre French professor of mathematics, who was interested in physics, philosophy as well as the natural sciences, André-Marie Ampère, would soon realise the importance of Oersted's discovery, adopting it as the starting point for deducing his theory on electrodynamics. Even though, Ampère's electrodynamics is usually interpreted as being one of the best examples of the French style of doing science, as represented by the Laplacian School, its main consequence –the transformation of magnetic phenomena into electric currents– defied the reasoning of the standard model at that time.

Therefore, chapter five attempts to shed light on the reasons that led Ampère to support Oersted's vision on the connection of the natural forces defying the mechanical interpretation of electricity and magnetism established by early nineteenth century French physicists such as Charles-Augustin de Coulomb (1736-1806), Jean-Baptiste Biot (1774-1862) or Denis-Siméon Poisson (1781-1840). How was a professor of mathematics able to provide an explanation to Oersted's discovery in only few months without having explicitly revealed an interest for experimental research on electricity and magnetism during his previous professional career ? Why was his electrodynamics so badly received by the major part of French scientists of that time ? Should we explain Ampère's strange ideas in psychological terms or more closely linked to the cultural affinities that led him to understand electricity and magnetism as two intimately interrelated phenomena ?

By contrast to some historical interpretations such as James R. Hofmann's *Ampère: Enlightenment and Electrodynamics*, this book attempts to contribute an alternative cultural representation of Ampère's scientific work, which emphasises its Romantic influences in order to interpret his main contribution as the realisation of the dreamed unification of electricity and magnetism[28]. Like other European natural philosophers such as Michael Faraday (1791-1867) or Augustin Fresnel (1788-1827), Ampère worked for the creation of an unified vision of physics and, moreover, of scientific knowledge, which would not include the imponderable fluids as central concepts to explaining experimental phenomena. Ampère proposed an alternative explanation to the standard model represented by Laplacian physics to describe the interactions between electric

[27]On Laplacian physics and imponderable fluids, see respectively Fox, R. "The Rise and Fall of Laplacian Physics" *HSPS*, 4, 1974, pp. 89-136 and Heilbron, J.L., *Weighing imponderable and other quantitative science around 1800*, Berkley, 1993.

[28]Hofmann, J.R., *Ampère: Enlightenment and Electrodynamics*, Cambridge, 1995.

and magnetic phenomena in a phenomenological manner[29]. As in the case of Oersted's discovery, Ampère's electrodynamics seems to be the result of very personal project, which involved what the philosopher of science Michael Polanyi called "a tacit dimension", a combination of intuitions and intellectual passions that led him to looking for the unification of electricity and magnetism[30].

Ampère's particular vision of physics has been usually explained by his most important biographers in psychological terms[31]. He was a weird and, even an eccentric man. Although he was professor of mathematics, he was interested in esoteric movements such as Animal Magnetism, somnambulism and phrenology, but –as he said on numerous occasions– his real passion was to contribute to the development of metaphysics. Ampère's concerns made him an outsider in the scientific Parisian milieu. In this respect, chapter six seeks to show to what extent his idiosyncrasy was not only due to psychological, but also to cultural factors linked with the emerging Romantic Movement in France, in which individuals were often portrayed as alienated personalities by the degenerated powers of society.

In particular, Ampère's representation as a polymath rather than a specialist will be examined by means of an especially relevant document, his autobiography, which provides us with a great example revealing the changing physiognomy of the man of science from the Ancient Regime to the Restoration in France. With this aim in mind, Ampère's self-representation will be analysed as sharing a common rhetoric with other contemporary scientific autobiographies, which echoed the late eighteenth and the early nineteenth cult of sensibility in France[32]. The account of his Rousseaunian education in a village near Lyon, Poleymieux-au-Mont-d'Or, the melancholy he suffered after the loss of this father during the Terror in Lyon, as well as his adoption by a such a scientific father-figure as Jean Baptiste Joseph Delambre (1749-1822), were common rhetoric figures in the writings of scientists, who had experienced the impact of the French Revolution on their careers. The exploration of Ampère's autobiography would finally allow us to think about the institutional dimension of this flourishing genre in early nineteenth century French science.

Ampère was not a scientist in the same vein as the image we have today of this term ; he was more a scientific character shaped by Romantic sensibility, who sought to embrace all knowledge, the sciences and the arts as he showed in his

[29] Caneva, K.L., "Ampère, the etherians and the Oersted's connexion", *BJHS*, 13 (44), 1980, pp. 121-138.
[30] Polanyi, M., *Personal knowledge. Towards a Post-Critical Philosophy*, Chicago, 1974.
[31] See De Launay, L., *Le Grand Ampère*, Paris, 1925.
[32] Shortland, M. and Yeo, R., *Telling Lives in Science. Essays on Scientific Biography*, Cambridge, 1996.

major philosophical work entitled, *Essai sur la philosophie des sciences, ou Exposition analytique d'une classification naturelle de toutes les connaissances humaines*[33]. This less well-known side of Ampère, which mirrored the rise of Romantic culture in France has been explored through manuscripts, letters, philosophical memoirs, literary and scientific works, which I had the opportunity to consult during my research stays at the *Musée de l'électricité* in Lyon (Poleymieux-au-Mont-d'Or) and the *CRHST/La Villette*, where I worked for more than two years on the project "Ampère and the history of electricity" led by Christine Blondel and created with the aim of digitalising Ampère's papers preserved in the archives of *l'Académie des sciences*. A careful analysis of these archives led me to conclude that the traditional historiographical interpretation of Ampère as "the Newton of electricity" did not work from a rigorous historical point of view. Although the physicist James Clerk Maxwell would reproduce this image of Ampère's electrodynamics as being a perfect example of early nineteenth century Laplacian physics, we cannot take it for granted if we wish to analyse the historical controversy between those scientists who defended the existence of the imponderable fluids and those, who rejected this hypothesis to achieve a more unified scientific model explaining these experimental phenomena[34].

If Ampère has been considered throughout the history of science as the prototype of the Laplacian scientist in early nineteenth century French scientific institutions, this is because we have not sufficiently explored his affiliations with the Romantic Movement as, for instance, his recurrent use of philosophical arguments to define his scientific concerns in a new light. In the case of Ampère, the fact of supporting a unified representation of natural phenomena such as light, electricity and magnetism did not imply the rejection of mathematics. Ampère's scientific convictions were the result of a strange combination of brilliant mathematical skills with the influences of other cultural traditions such as the Romantic circle called *l'école mystique de Lyon* or the spiritualist philosophy supported by his close friend, François-Pierre-Gonthier Maine de Biran (1766-1824).

In a broader sense, the study of Ampère's Romantic influences gives us one of the most solid arguments to challenge the idea that the German *Naturphilosophie* was the true scientific movement embodying the Romantic ideas in Europe because, even, natural philosophers who were working in France were able to recognise the urgency of creating an unified physical model, which could explained the different conversion processes. In Ampère's vision of science we can perceive how the idea of the connections between magnetism and electricity had appeared

[33] Ampère, A.-M., *Essai sur la Philosophie des Sciences, ou Exposition Analytique d'une Classification Naturelle de Toutes les Connaissances Humaines*, Paris, 2 vols, 1838.

[34] Maxwell, J.C., *A Treatise on electricity and magnetism*, London, 1873, p. 162.

earlier than in 1820 as a type of intellectual passion whose heuristic virtues would orient his research up to the creation of electrodynamics.

From Mesmer's Animal Magnetism to Ampère's electrodynamics, this book attempts to shed light on the multiple ways through which electricity and magnetism became metaphors, explaining the universe and man's behaviour in a wide range of Romantic theories, which emerged between the changing frontiers of science, medicine, literature, poetry and art. With the publication of this PhD. dissertation, my principal aim is to contribute to a better understanding of these utopic visions proposed by Romantic natural philosophers in which science was understood as a knowledge, which is not opposed to other forms of culture, but that has rather evolved in doing exchanges with poetry, literature and the arts.

In this way, *Electric and Magnetic Dreams in Romantic Europe* can be regarded as critical exercise, halfway between philosophy and history –what Foucault called "a history of the present"– whose central objective is to destabilise our current idea about the existence of two opposite cultures, the Humanities and the sciences, by means of demonstrating that its contemporary operability is only the result of a contingent historical process[35]. As all other human activities, science needs today –as it had needed throughout centuries– imagination, intuition and emotions in order to achieve an account of natural phenomena, in which objectivity can only be understood as a personal commitment of the scientist to finding the truth.

Dolores Martín-Moruno
Geneva, January 12, 2014

[35] Foucault, M., *Discipline and Punish: The Birth of the Prison*, New York, 1979, p. 31.