Interface between Literature and Science
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Cross-disciplinary Approaches to Latin American Texts

Edited by
Victoria Carpenter
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ACKNOWLEDGEMENTS

I would like to thank the contributors to this volume, whose dedication to the project has been unwavering. Sam Baker and Amanda Millar at Cambridge Scholar Publishing have given their time and advice and remained patient throughout the last stages of the project, when many circumstances beyond my control almost derailed the publication. I would also like to thank Michael Carpenter for his unwavering support, and Samantha Carpenter, who spent quite a bit of her 2014 summer holidays helping me set up the volume.
The boundaries of science and literature are permeable; they are continuously crossed and illuminated by a variety of narrative forms and their interpretations. Changes in our perception of the world are informed in equal measure by scientific and humanistic disciplines. The link between literature and science has been examined in many studies, most of which reach the conclusion that “science is unavoidably connected to other kinds of discourse because it uses language, which is never a pure mediator of reality, but a human construct which incorporates metaphor, narrative pattern and the inflections of society and culture” (Moran 2006: 160).

In his seminal essay “The Two Cultures” (1959), Snow discussed the way science and literature can interact to produce a new type of discourse, and suggested that a third culture will emerge when literary and scientific intellectuals start communicating and sharing ideas. However, over 50 years later it does not seem to have materialised the way Snow thought, although the popularisation of science has been very successful, with many celebrated scientists writing about complex scientific matters for wide readership (see Dawkins 1998, Greene 2004, Hawking 2001, to name but a few). So, where is the difficulty in bridging the two areas? Perhaps, we have not yet reached the point where the relationship between literature and science is “interchange rather than origins and transformation rather than translation” (Beer 1990: 81), although Ruston stresses that “we should neither dismiss the literary from the scientific nor the scientific from the literary” (Ruston 2008: 11). This statement suggests that there is no issue in using science (something that deals with “objective reality”) to analyse literature (something that is more symbolic).
Other studies incorporating scientific discourse into literary analysis followed suit. Some examine the “mutually constitutive [i.e. essential] nature of literary and scientific discourses in Britain during the later eighteenth and early nineteenth centuries” (Herringman 2003: 2). Others consider the interrelation of literature and natural history “as currency in more symbolic forms of commerce: applied science, global and imperial exchange, cross-disciplinary appropriations, and other forms of cultural production and reproduction” (ibid.). While these studies recognise the existence of disciplinary boundaries between literature and science, they also see an opportunity to adopt a “self-consciously interdisciplinary method” to study literary texts that depict scientific discoveries, following on the works of Golinski (1992), Safir (1999), and other scholars of English Romanticism and its links with contemporary scientific developments. Similarly, the convergence of thought from all areas of inquiry is often emphasised: “[the] streams of inquiry flowed in a similar direction, the converging courses of which changed the intellectual terrain of modern thought” (Hayles 1984: 15). Hayles uses the notion of fields to examine narrative complexities in the works of Lawrence, Nabokov, Pirsig and Pynchon, her selection governed by the evidence of “varying degrees of [the writer’s] knowledge and sympathy toward science” (ibid., 25). We propose to take a step further and disregard the link between the writer and science, instead treating both literary and scientific texts as products of human mind and therefore abiding by all the rules it creates, scientific and humanistic alike.

Taking a text as a unity of narrative and linguistic phenomena, we would seek the same unity in the means of examining it. We do not propose to replace all discourse analysis with a cross-disciplinary science-based approach. Instead, we propose to employ this theoretical stance when more conventional means fail to explain (or even explore) the intricacies of a text. We purposefully do not separate literary and non-literary texts here because we believe that this tactic is applicable to any type of discourse that does not yield itself fully to subject-specific methods of analysis. Both literary and non-literary texts use language to the same end and are governed by the same rules of meaning conveyance, grammar and syntax. Both exist in the surroundings defined by the rules of the micro and macroworld—so why should these two frameworks be separated to the extent of opposing each other, especially when the texts in question appear ungovernable solely by either one? We argue that scientific discourse can also be analysed through the prism of literary theories, since all texts are governed in varying measure by the unity of contexts that characterise their nature, the process of their creation, and
their place in the cognitive realm of humanity. This approach will allow us to question the nature and limitations of scientific research, while opening up more venues to explore scientific creativity that crosses the subject boundaries of science and humanities.

Scientific progress over the past three hundred years can be described as tending from the disparate to unifying. A similar approach to literary texts would be justified, especially since literary texts have become more complex in many respects. It could be argued that the complexity of scientific discoveries has had an effect on literature. Equally, it can be argued that the unifying theoretical tendencies are equally applicable to literary analysis. The two areas deal with knowledge and discovery in order to explain what causes, drives and informs a phenomenon. It would therefore be logical to apply the same principle of simplicity and unity to text analysis. Something has to give—either a unified text theory needs to appear, or else we could search for a unified theory outside the scope of literary analysis. Our volume aims to demonstrate that the two sets of theoretical foundations are interlinked: discourses of science and culture studies are describing the same phenomena in different settings or context.

The process of theoretical unification in the sciences has been a difficult one. The existence of two mutually exclusive theoretical frameworks as the only explanation of the nature of the universe is the best example of the lack of unity between two theories. Greene sees this “uneasy union” of theories as a sign “that there must be a deeper, unified truth that overcomes the rift between general relativity and quantum mechanics and that can be applied to everything. We have one universe and therefore, many strongly believe, we should have one theory” (Greene 2004: 336). This approach echoes our view of the difficulty of applying many (often disparate) theoretical approaches to analyse a single text. If a text (literary or otherwise) exists in a relatively coherent form, able to support all its internal conflicts and permutations, there should be a theoretical approach capable of explaining these narrative strands within one coherent framework. This could be accomplished by applying the language of quantum theory, with its remarkable unity of different physical possibilities in an amalgam called a superposition of states, to literary analysis. Just as quantum theory allows for a unified explanation of multiple histories, so does literature. Furthermore, just as the use of scientific theories in the analysis of literary texts has revealed and explained hidden patterns, the application of literary theories to scientific discourse may uncover yet unseen (or even unfathomed) explanations of the analysed phenomena.
Greene cites another reason for seeking a unified approach. There are certain things that cannot be explained by one or the other theory. For example, neither theory can explain what happens inside a black hole because its centre is “both enormously massive and incredibly tiny, and hence […] falls on both sides of the purported divide: we need to use general relativity because the large mass creates a substantial gravitational field, and we also need to use quantum mechanics because all the mass is squeezed to a tiny size” (ibid., 337). A more fascinating and hitherto uncharted territory is the explanation of the origin of the universe. Scientists are unsure as to what exactly happened because the conflicting coexistence of the two theories does not provide enough insight into the moment the universe started to exist.

While the texts we are examining in this volume are not as all-encompassing or self-contradictory, their idiosyncrasies do not lend themselves easily to traditional literary analysis. Certain aspects of the narrative remain unexplained, and when new theoretical perspectives are added the existing interpretation is either challenged or completely refuted. On the other hand, piling up potentially mutually exclusive theories seems to be counterproductive; Greene supports this view by stating that when scientists discover an area of knowledge where “known laws of physics break down under any circumstances, it is a clear signal that we have not reached the deepest possible understanding. After all, the universe works; as far as we can tell, the universe does not break down. The correct theory of the universe should, at the very least, meet the same standard” (ibid.). Similarly, if a text exists in a relatively coherent form, able to support all its internal conflicts and permutations, there should be an approach capable of explaining them within one cogent theoretical framework.

Latin American literature offers many examples of the interconnection between literary and scientific discourse. Notwithstanding the often explored relationship between Jorge Luis Borges’s literary themes and contemporary scientific discoveries, a more general question should be asked: is the influence of scientific thought a privilege of the select few or is it indeed an all pervading experience in Latin American literary narrative from late modernism to the present day? In addition to Pratt’s seminal work, a number of more recent studies addressed the representation of scientific discoveries in Latin American literature (see, for example, Glick et al 2001, Barrera-Osorio 2006, Canizares-Esguerra 2006, and Safier 2008); however, these studies have not explored the potential of applying the rhetoric of science to the analysis of literary texts. The present volume will address this issue by widening the scope of analysis. We will explore the texts that overtly incorporate scientific
content or are structured in such a way that immediately reminds the reader of a scientific phenomenon; we will also examine the texts that are presented in such a way that a conventional literary analysis does not help penetrate the many narrative layers that the text comprises.

The volume opens with the essay “Writing at the Interface: Toward an Overview of the Relationship between Literature and Science” (Beardsell). Since it is argued that changes in literary genres are the result of artistic experiment and developments in society, Beardsell endeavors to correct the omission of the influence of science on literature. He emphasises its role in the process, not merely as an indirect influence on the general social background but as a direct provider of inspiration for themes and technique. After exploring the ways writers inform themselves about scientific discoveries, Beardsell examines the impact of science on literature from the nineteenth century to the present day.

It would be unthinkable not to include the study of Jorge Luis Borges’s writings in a volume on the interrelation between science and literature. Borges’s contribution to this theme has been examined by many with varying results; most of these studies focus on the nature of time in Borges’s stories. The two essays in this volume, “Borges and the Multiverse—Some Further Thoughts” (Moran) and “Spatiality and the Scientific ‘I’: Location and Perception in the Stories of Jorge Luis Borges” (Richardson), concentrate on other aspects of Borges’s writings. Dominic Moran’s study traces the origins of one of Borges’s best known stories, “El jardín de senderos que se bifurcan”, to the works of the English science fiction writer Olaf Stapledon. The essay links this unacknowledged intertext with other, more explicit literary allusions in the story (especially to the Chinese novel “The Dream of the Red Chamber,” but also to Goethe), and considers the ethical as well as aesthetic reasons behind Borges’s electing to write in apparently “fantastic” fashion in two wartime stories: “El jardín” and “Tlön, Uqbar, Orbis Tertius” (also influenced by Stapledon’s work).

Richardson’s essay explores the theme of space and place in “El Aleph,” arguing that the uniqueness of Borges’s writings is the way they accentuate the links between the human capacity for cognitive speculation and scientific discovery, and the way individuals are required to face the emotional ramifications that the process of situating ourselves entails. The theme of space exemplifies this by emphasising the need we feel to understand, as “scientifically” and as objectively as possible, the nature of our place in the universe, while also making us realise the broad range of consequences of such “situatedness”. Richardson concentrates on the dilemma of individuals in Borges’s work, who are aware of the “places”
they find themselves in, and who link this awareness to an attempt to comprehend the nature of the universe they inhabit. The essay starts with some reflections on the story “El Aleph,” examining it as paradigmatic of the challenge faced by those who search for explanations of the world, and goes on to broaden the discussion by ranging over related issues as they arise in some other classic stories from the collections *Ficciones* and *El Aleph*.

The remaining essays continue to apply the rhetoric of scientific discourse to literary analysis. “Out of the Darkness into the Darkness: Time Travel in Ernesto Sábato’s *El túnel* and Connie Willis’s *Blackout* and *All Clear*” (Carpenter and Halpern), is a comparative analysis of Ernesto Sábato’s novel *El túnel* and Connie Willis’s duology *Blackout* and *All Clear*. The essay considers literary representations of time travel in the context of time travel paradoxes. Carpenter and Halpern’s analyses of the novels on the studies are informed by the rhetoric of the principle of self-consistency, which states that in time travel, the changes of the past are permitted only if they lead to the present from which the traveler comes. In other words, one cannot go back in time and kill oneself or change the reality to such an extent that the present as we know it ceases to exist. When tracing “actual” time travel (in Willis’s works) or metaphorical “change of the past” (in Sábato’s novel), this study leads to the conclusion that the nature of time in these novels is the same. Time is self-consistent yet apparently deterministic.

The theme of observation and self-observation is the focus of the essay “Quantum Mechanics and *Mise en Abyme*: The Reader as Observer” (Trauvitch). The essay presents an analysis of Gabriel García Márquez’s novel *Cien años de soledad*, combining the principle of *mise en abyme* and the basic tenets of quantum mechanics. In quantum mechanics, measurement and observation affect and determine the state of the observed system. Trauvitch argues that a similar process is followed when analyzing literary texts, especially those containing the metafictional trope of *mise en abyme*. In quantum mechanics the measurement determines the state of the particle; in literature the reading of *mise en abyme* determines the story path, effectively changing it. Therefore, the reader can be seen as the observer, the reading is similar to the measurement, and in *mise en abyme* the text changes as a result of the act of reading. Infinite loops are created by the frame narrative, through which the reader moves every time reading is “applied” to the text at the point where the primary and embedded fabulas merge and create a recursion. In the next loop the text is the same in terms of the signifier (the words on the page do not physically change), but very different in terms of the signified—the story itself changes, as it
is now embedded within the first reading, and so on. Trauvitch’s essay considers wider implications of this connection for literary analysis, as the application of scientific terminology to literary analysis helps shift the discipline-specific paradigm towards a truly cross-disciplinary worldview.

“Strings, Branes and Hidden Texts in *Obsesivos días circulares* by Gustavo Sainz” (Carpenter) uses the rhetoric of quantum mechanics to examine this convoluted text, which presents a fascinating case of textual multiplicity. The few analyses of the novel agree that it is a story of the narrator’s descent into madness, yet little has been made of the complexity of its delivery and the novelty in the presentation of simultaneous texts. Carpenter examines *Obsesivos días circulares* from the point of view of quantum mechanics, expanding upon her previous studies of the unconventional literary production of the Onda (the Mexican countercultural movement of the 1960s), which has earned the Onda its dubious reputation. Since this form cannot be fully explained within the framework of traditional literary analysis, a new approach to these texts has been suggested. The essay traces several recurring text fragments through the novel to determine whether they are independent texts joined together by a common denominator, or whether they are evidence of a single text, hidden behind the main narrative line; the rhetoric of M-theory (as it stands at present) is used for this purpose. The concept of “textbrane” is applied to the analysis of these fragments in order to offer an alternative view of what appears to be a collection of disparate narratives. Rather than trying to combine an ever increasing number of theories to explain ever smaller components of a text, the essay uses a single theory (lying outside the traditional scope of literary studies) to explain the disparity of the narrative in *Obsesivos días circulares*. Considering that other more mainstream approaches have all but failed to fully explain this text, this method should shed more light on what appears to be an impenetrable jumble of overlapping narrative lines.

Using evolutionary theory, Hoeg’s essay “Teaching the Latin American Novel: Evolutionary Theory and Fernando Contreras Castro’s *Unica mirando al mar*” examines various themes represented in the Costa Rican author Fernando Contreras Castro’s novel *Unica mirando al mar*. The main themes are economic exchange, environmental problems, education and social mobility, and language and narrative propensity in humans. This essay argues that a biological turn in literary criticism is a valid and valuable addition to previous Marxist, social constructivist, and postcolonial approaches to literary analysis. Hoeg’s essay is another example of how a change in the analytical approach reveals a hitherto hidden layer of meaning of a literary text.
In “From Darkness, Light: Reading Ilya Prigogine at the End of the World,” Kurlat-Ares explores the influence of Prigogine’s writings on Argentinean literature of the late 1990s and early 2000s. Of a vast body of Prigogine’s research on complex systems and thermodynamics systems far from equilibrium, his study of the impact of time on self-organised systems became one of its more important (and perhaps most controversial) legacies for social sciences. This was particularly transparent in Argentina during the period of a vast cultural transformation. The way Prigogine denies determinism as well as the way he analyses the dynamics of evolving systems seemed to provide an objective, non-politically charged answer to the discourse of the dictatorship (1976-1983). On the other hand, it provided an opportunity to talk about history outside the realm of the semantics of the radical left. So, despite what other scientists might say about Prigogine’s scientific work and his philosophical conclusions, in countries like Argentina, his work provided a metaphorical language to talk about politics without grounding the discourse into already disputed and marked spaces. Such language appeared in the works of science fiction writers (such as Carlos Gardini), as well as writers from the provinces (for example, Mempo Giardinelli). Kurlat-Ares’s essay examines how and why the vocabulary of chaos theory, particularly in Prigogine’s interpretation, became so prevalent in Argentinean literature of the late 1990s—early 2000s.

In 2012, the Arts and Humanities Research Council of the United Kingdom launched a new research initiative, “Science in Culture,” thus recognising the importance of the two discourses working together. The introduction to the theme states that “[t]here is growing recognition of the interconnections and complementarity between the sciences and the arts and humanities, the potential for creativity and innovation that these connections can generate and the limits of using scientific approaches in isolation to tackle societal challenges” (Anon. 2012: n.p.). The essays collected in our volume support this declaration as they use a combination of scientific and literary theories to analyse the works of Latin American writers, thus taking a step towards devising a true cross-disciplinary framework of discourse analysis by bringing together humanities and scientific theories. This will help establish new pathways for collaborative research by helping scholars traverse the boundaries of individual disciplines and draw upon relevant components from all. Thus we hope to reduce (and, with time, eliminate) the constraints and limitations of discipline-specific discourse analysis.

The benefits of better understanding discourse in any discipline are clear and far-reaching. The creation of a cross-disciplinary approach to the
analysis of the discourses of humanities and science should be based on
the reciprocal use of science and humanities as systems of knowledge
capable of helping each other deepen the understanding of their respective
fields. Our volume contributes to the development of a new cross-
disciplinary epistemology for collaborative research between humanities
and science scholars. This, in turn, will help us understand how humanities
and sciences have influenced each other’s development, and how the
knowledge in humanities, arts and cultural studies can advance scientific
discovery.

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CHAPTER ONE

WRITING AT THE INTERFACE:
TOWARD AN OVERVIEW OF THE RELATIONSHIP
BETWEEN LITERATURE AND SCIENCE

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The English poet John Keats complained (in 1819) that science took the feeling and mystery out of the beauty of nature:

philosophy will clip an angel's wings,
conquer all mysteries by rule and line. (Keats 1970: 1)

Ten years later the American writer Edgar Allan Poe was even more vehement: science was a “vulture, whose wings are dull realities.” (“sonnet—To Science,” Poe 1965, vol. VII: 22) Most writers have been less negative. The Spanish seventeenth century poet Fray Luis de León, for example, was sufficiently impressed with Ptolemaic astronomy to draw from it for imagery when exhorting people to look up towards Heaven (“Noche serena,” etc., León 1953: 18-20). Poe himself came round to seeing the importance of “verisimilitude, in the application of scientific principles.” (“Note” to his tale “Hans Pfaal,” 1835, in Poe 1965, vol. II: 108) This chapter seeks to show how, despite the views of some like Keats and the early Poe, writers have absorbed the discoveries of science (“philosophy” in Keats’ day), and taken advantage of them.

Although the evidence discussed here will lead to the conclusion that no absolute distinction can be made between science and the arts, it is useful to begin by following the tradition of seeing a mutual contrast. “Science” is taken to concern “the systematized observation of and experiment with phenomena,” while the “arts” are “the various branches of creative activity.”
Keats’ terminology shows how science emerged from philosophy only as late as the nineteenth century. Since then, the acquisition of knowledge about the material world through experiment and systematic study has led to a plethora of applications of science (often known as “applied science”), among them the technological phenomena on which I focus in the last part of the chapter.

It is surprising how little acknowledgment is made of the impact of science in literary criticism. We might expect that major literary changes would be partly attributed to scientific developments, but this is not what we usually find. For example, the British novelist Malcolm Bradbury omits to mention science in his otherwise authoritative account. He begins by acknowledging that developments of some kind around the year 1900 are indeed perceptible:

One of the most important assumptions in modern thinking about the novel is the notion [...] that sometime in the concluding years of the last [i.e. the nineteenth] century or the early years of this one, at a point which is not exactly sensitive but is nevertheless there to be felt, there occurred a change, a redirection, a re-emphasis or a “turn” of the novel [...] (Bradbury 1973: 81)

After summarising the characteristics of the new literature (and I shall be returning to this below), he offers a brief list of the causes of change:

the breaking down of traditional social forms, the growth of cities, the power and pressure of new styles of life, the emergence of a more fleeting and fluid view of the world, perhaps a general moving inward of experience. (ibid., 82-3)

In other words, the causes are found in a combination of mainly social and psychological developments. There may be an implication here that science had an impact on social and individual experience, but there is no hint of any direct link between science and literature. This is an approach that, though commonplace among literary critics, must surely be questioned. Science deserves to be attributed at the very least an indirect role in bringing about the changes in the novel (and in literature and the arts in general) around the end of the nineteenth and beginning of the twentieth centuries. What is more, there is plenty of evidence to suggest that science played a direct part in the changes manifested in the works of certain writers and artists. This chapter sets out to examine such evidence, and to expand the period under review to include the changes that took
place during the course of the twentieth century, and those that are occurring today.

**How Writers Get to Know about Science**

In a rare sortie into this field, J.A.V. Chapple poses a useful introductory question in his *Science and Literature in the Nineteenth Century*: “How did ‘creative writers’ get to know of scientific discoveries, new hypotheses and procedures?” (Chapple 1986: 5) His answer is roughly as follows: by membership of associations and societies; through the transactions and proceedings of learned societies; through scientists’ own writings; through journals and magazines of an interdisciplinary type; by reading books by popularisers of science; by reading commercial periodicals on scientific disciplines; by reading science in literature; and by what he calls “cultural exchange and shared discourse.” He informs us that there was a general integration of science and culture in the early decades of the nineteenth century, until an increase in difficulty and specialisation meant that by the later part of the century “the accessibility of science [...] was waning.” (ibid., 7) This is a significant and generally recognised point. For example, James Hamilton, a biographer of the British artist J. M. W. Turner, reports that Turner’s familiarity with developments in science was facilitated by his acquaintance with the physicist Michael Faraday, the mathematician Mary Somerville, the anatomist and palaeontologist Richard Owen and the chemist Humphry Davy, and by the fact that meetings of the Royal Society were held in the same building as those of the Royal Academy. But after that pivotal time “science and art were becoming less of a brotherhood” (Brown 2011: 3).

Chapple’s list of the means of access to events in science for nineteenth century writers can still be useful to us in the study of the twentieth and twenty-first centuries, though we must add several media. Radio, cinema, television, the internet, and weekend supplements of newspapers have made popularised versions of science available to everyone, with the result that even some of the highly complex scientific discoveries and theories of the last hundred years or so are regularly introduced into aspects of our lives. The Large Hadron Collider of CERN may be performing sub-atomic particle research that only a small number of specialised scientists can properly understand, but everyone with access to newspapers, magazines, television and radio knows something about its significance. No writer can fail to have seen the headlines in November 2011 about the experiment in which neutrinos were apparently travelling faster than the speed of light.
It should not be forgotten that there have always been authors with a scientific background. Robert Louis Stevenson, who introduced imaginary experiments in chemistry and psychology into his novelette *Strange Case of Dr Jekyll and Mr Hyde* (1886), was the author of essays that included scientific papers. He read a paper “On a new form of intermittent light and lighthouses” to the Royal Scottish Society of Arts on 27 March 1871, and one “On the thermal influence of forests” to the Royal Society in Edinburgh on 19 May 1873. H.G. Wells, most remembered for his fictional rendering of themes of time and human history in novels such as *The Time Machine* (1895) and *War of the Worlds* (1898), studied zoology, became a science teacher, and contributed many early articles on scientific topics to newspapers and magazines before becoming a full-time writer. Lewis Carroll (pseudonym for Charles Lutwidge Dodgson) produced nearly a dozen significant books in mathematics, a scientific field that informed his well-known children’s book *Through the Looking-Glass And What Alice Found There* (1871). The Argentine novelist Ernesto Sábato obtained a doctorate in atomic physics, worked in the Curie Laboratory in France, and taught physics before turning to a career in writing around 1943. In his essays in *Uno y el universo* (1945) he included thoughts on the complexities of quantum physics. The novel *El túnel* (1948) is rewardingly interpreted by using quantum mechanics to understand hidden timeline ambiguities, though his study of Freudian and Jungian psychology have clearly impinged also on *El túnel* and *Sobre héroes y tumbas* (1961).²

In most cases, creative writers do not have a formal training in science, or a professional interest in scientific matters. For them there is to some extent—however large or small—an informal assimilation of scientific ideas. It may be deliberate, as when authors research a topic, or unconscious, as when they respond to their cultural milieu. The latter are the most difficult cases to pinpoint, though in some ways they are the most significant as indicators of human society.

Mary Shelley offered an interesting insight into this process of the assimilation of scientific ideas in her introduction to the 1831 edition of *Frankenstein*. She reflected on the origins of her novel in 1816, when she and her husband were Lord Byron’s neighbours in Switzerland:

> Many and long were the conversations between Lord Byron and Shelley, to which I was a devout but nearly silent listener. During one of these, various philosophical doctrines were discussed, and among others the nature of the principle of life, and whether there was any probability of its ever being discovered and communicated. They talked of the experiments of Dr Darwin [Erasmus Darwin], (I speak not of what the Doctor really
did, or said that he did, but, as more to my purpose, of what was then spoken of as having been done by him,) who preserved a piece of vermicelli in a glass case, till by some extraordinary means it began to move with voluntary motion. Not thus, after all would life be given. Perhaps a corpse would be re-animated; galvanism had given token of such things (Shelley 2000: 23).

After this conversation, long into the night, she could not sleep: “My imagination, unbidden, possessed and guided me” (ibid., 24). There are several illuminating matters here (one being the fact that the woman was a “nearly silent listener”), but the main point for the present purposes is the indirect means by which scientific experiment was accessed by the writer of that early science fiction novel. The author learned of it through conversation between educated people. Not only that, but she learned only hearsay rather than actual fact (“not of what the Doctor actually did [...] , but of what was then spoken of as having been done by him”).

It is worth adding that Mary Shelley’s allusion to galvanism draws on a public awareness of Luigi Galvani’s experiments in bioelectricity. A certain amount of information about these developments was carried by written sources such as newspapers and journals, but a wider and more popular audience was reached by public shows, performances and exhibitions. One of the most notorious of these cases was that of Galvani’s nephew, Giovanni Aldini, who in 1803 attempted the resuscitation of a corpse (that of the executed George Forster) by applying electrical charges to it in front of a paying audience.

This last example points to the way the informal assimilation of scientific knowledge was to develop. As science brought about changes at all levels of daily life, from electric lighting to fears of nuclear warfare, some of the information underlying those technical developments became a part of everyday awareness—albeit in a very general and popularised form. Cinema, for example, offered a clear potential for exploring the relationship between different levels of reality: film characters, actors, and the public. In Uruguay Horacio Quiroga wrote the short story “El puritano” (Más allá, 1935) on this theme, while in Argentina Adolfo Bioy Casares developed the idea from film into hologram in one of the finest examples of the genre with La invención de Morel (1940). Sometimes the fame of discoveries such as those of Albert Einstein led to the composition of works of art. The dangers of atomic weapons and the potential benefits of nuclear research, which greatly exercised the public’s mind throughout the world in the mid-twentieth century, encouraged the Mexican dramatist Rodolfo Usigli to fantasise about the subject in his play “El gran circo del mundo” (1950-1968). In this instance, although the inspiration of Einstein
was acknowledged in a prologue, the play itself shows no more than a
general (indeed, a naïve) level of scientific knowledge. In many cases,
however, authors were more fully informed. Michael Frayn’s play
_Copenhagen_ (1998), to take another example from theatre, demonstrates
more than a superficial understanding of the principles of quantum theory,
while the “Postscript” gives a scholarly attention to historical and
scientific detail, and the recommended reading list suggests that Frayn
consulted microfilm in the _Archive for the History of Quantum Physics_ in
London’s Science Museum.

In a BBC interview in 2009 Iain Banks shed interesting light on the
means by which he personally came to know about science: “I consider
myself a reasonably well-informed lay person. I read _New Scientist_ and
_Scientific American_, but I’m not reading peer-reviewed journals to keep up
with the latest science” (Banks 2009: n.p.). Banks proceeded to expand on
his purpose in being “reasonably well-informed.” Some of his books, he
explained, are science fiction:

> My new book is a mainstream novel that borrows science fiction tropes. It
> plays with the idea that there are an infinite number of different worlds. So
> it’s using speculative hard science. And it’s important to the book that
> there’s a degree of respectability about the idea of the multiverse, or the
> many-worlds theory. But in my science fiction, I merrily break as many
> laws as I can get my hands on […] Sometimes I pay no attention
> whatsoever to what’s possible and realistic. It really depends on the novel.
> (ibid.)

Some would want to use the term science _fantasy_ to classify writing
that “breaks laws” in the way Banks admitted here. But such a distinction
from science _fiction_ is not useful to my discussion. Indeed, until the 1900s
it was unnecessary to consider whether literature influenced by science
might be placed in a distinct category, outside the mainstream. Debates
about the nature of literature tended to concern themselves with such
matters as artistic merit, classical quality, and socio-political function or
enlightenment. Only during the course of the twentieth century did the
vogue for short stories, novels and films in which scientific advances (real
and imagined) impinged on the themes, lead to the deliberate creation of a
branch of literature known by the title “science fiction.” Today the notion
of some kind of separation seems to be generally acknowledged, the
dividing line being drawn somewhere between seriousness and fun (with
_fantasy_ an extreme case of fun). But my purpose is to demonstrate that
ultimately there is no such division: science fact, science fiction and
fantasy overlap in mainstream works of literature. Banks illustrated this process despite his honest use of separate categories.

Science and Literature in the Nineteenth Century

“In the early decades of the [nineteenth] century it was largely in the context of nature, and of representations of the natural world, that the conflict of ideas about art was played out.” The spate of publications in the broad field of natural sciences in that period illustrates the fact that there is more than a coincidental link between the rapid advances in scientific study of the natural world and the vogue for Romanticism in literature and other arts.

From Laplace, Exposition du Systeme du Monde (1796) and Linneaus, Elements of Natural History (transl.; 1801) to Lamarck, Histoire Naturelle (1815-22) and Herschel, Introduction to the Study of Natural Philosophy (1831), there was a significant number of books throughout Europe on plants, animals, geology, and the earth. The completion of W. Smith’s “Geological Map of England” in 1815 represented a further significant step. The Romantics’ interest in the “noble savage” has its counterpart in studies of earlier and non-European civilisations such as Blumenbach’s De Generis Humani Varietate Nativa (3rd edn., 1795), and Combe’s Constitution of Man (1828). Archaeological events such as Frere’s discovery of flint implements at Hoxne in Suffolk in 1797 and the publication of Mantell’s The Fossils of the South Downs in 1821 were further important developments.

For the shift to various types of realism in the middle and second half of the nineteenth century, the influence of Auguste Comte’s Cours de philosophie positive (six volumes from 1830 to 1842) is generally recognised as critical. Essentially, Comte argued that what he called the “theological” and the “metaphysical” philosophies would give way to the scientific one, which he named “positive philosophy.” Literature often expressed this prevalence of scientific thought and method by applying a systematic or analytical approach to the reality observed by the writer in natural and urban settings, or in social conditions. One particular form of this art, especially in the novel, was sometimes known as naturalism. The widespread impact of this idea in literature and other arts was noticeable in Latin America as well as elsewhere, and extended well into the twentieth century, with regional novels and novels of the Mexican Revolution.

Comte’s argument was itself based, of course, on the extent of scientific research already published or under way. The great strides made by chemistry and physics were marked by such publications as Davy,
Later in the century huge advances in anthropology were made, with works such as Darwin, *On the Origin of Species* (1859) and *The Descent of Man* (1871); Huxley, *Man’s Place in Nature* (1863); Lyell, *The Antiquity of Man* (1863); and Lubbock, *The Origin of Civilization and the Primitive Condition of Man* (1870). Astronomy saw the appearance of Laplace, *Mécanique Céleste* (1825); Whewell, *Of the Plurality of Worlds* (1854); and Lockyer, *Contributions to Solar Physics* (1874), among many major publications. Towards the end of the century physics made especially rapid advances. The famous Michelson and Morley experiment “proved” that ether does not exist (1887); Hertz discovered radio waves (1887); photography advanced with the Kodak box camera (1888); Marconi’s wireless telegraphy began (1895); Becquerel discovered radioactivity (1896); J.J. Thomson discovered the electron (1897); the Curies discovered radium (1898); Rutherford named alpha and beta rays (uranium radiation) (1899); and Planck’s Quantum Theory was formulated (1900).

As will be argued below, many of these scientific publications and discoveries provided inspiration for themes that were to appear in literature. It is important to add that linguistic developments in literature also had important scientific roots, particularly with advances in the field of philology, such as Barnes, *Etymological Glossary* (1829); Muller, *Lectures on the Science of Language* (1861-64); and Bleek, *Über den Ursprung der Sprache* (1867).

But the scientific area of most direct importance to literature was, probably, psychology. Its fast growth during the last third of the nineteenth century was punctuated by the publication of Edward von Hartmann, *Philosophy of the Unconscious* (1869); Francis Galton, *Inquiry into Human Faculty and its Development* (1883); William James, *The Principles of Psychology* (1890); and the various items by Sigmund Freud. The latter presented a paper “On male hysteria” to the Imperial Society of Physicians in Vienna in 1886, and went on to publish “On aphasia” in 1891, and several papers leading in 1899 to *The Interpretation of Dreams*.

Recognition of the role of science in society led to the founding of numerous institutes, societies and associations, such as the Astronomical Society in 1821; the Institution of Electrical Engineers in 1871; the Society for Physical Research in 1882; and the British Astronomical
Association in 1890. In psychology important events included the creation of a Psychological laboratory at Johns Hopkins University in 1883; the first classification of mental disorders in the same year by Emil Kraepelin; the holding of the First International Congress of Psychology in Paris in 1889; and the founding in Boston of the Journal of Abnormal Psychology in 1896.

The focus on European discoveries and publications in this summary is determined by the fact that during the nineteenth century it was Europe that dominated scientific developments in Latin America, as indeed in Western civilisation generally; eventually, of course, the USA would play its own dominant role. There were various ways for the European texts to become known: in their original language, in translation, through summaries in journals, and through lectures and discussions in cultural and scientific bodies. For example, some Latin Americans read Auguste Comte’s positivist ideas in the original French, while most came to positivism through secondary sources such as El positivismo o sistema de las ciencias experimentales by Pedro Estasén y Cortada, or through educators such as Mexico’s Gabrino Barreda (who had attended courses by Comte in Paris), or else through national institutions and in magazines. The debate on Charles Darwin’s Origin of Species could be followed from 1860 in French through F.J. Pictet’s discussions in Archives des Sciences (Pictet 1860: 233-5). The full book became widely available in Spanish in 1921, but the main issues were in the public domain long before. El origen del hombre: la selección natural y sexual was published in Barcelona in 1880. Uruguayan cattle breeders debated Darwin’s ideas in their Revista de la Asociación Rural in 1872 after reading of them in French. In the case of Sigmund Freud’s The Interpretation of Dreams, to take a further example, the key text was first published in German in 1900, in English in 1913, and in Spanish 1923. However, many of Freud’s theories had already been in circulation as a result of his earlier articles.

The arrival of European scientists in Latin America offered additional stimulus to scientific developments. In Argentina, for example, the Italian Octavio Fabrizio Mossotti installed an astronomical observatory of international status that provided observations published in London by the Royal Astronomical Society. Chile’s progress was enhanced in 1826 by the arrival of Antonio de Gorba from Spain to take charge of maths, geometry and geology at the Instituto Nacional. And when Brazil became the seat of the Portuguese empire, with the flight of the monarchy from Napoleon in 1807, the scene was set for Portuguese and other European educators and scientists to join the country’s efforts to progress.
In Brazil, King João’s regime sponsored the creation of institutions modelled on European examples, and in due course similar initiatives occurred throughout Latin America. In Argentina, the University of La Plata (where the author Ernesto Sábato was to hold a post in quantum physics in the 1930s-1940s) became a scientific centre of world class importance through its contributions to palaeontology and astronomy. The Sociedad Científica Argentina was founded in Buenos Aires in 1872, and published its *Anales Científicos Argentinos* from 1876. Chile’s Instituto Nacional, re-opened in 1819, became a location for furthering knowledge of medicine in 1833 and chemistry in 1843, while the Universidad de Chile was founded in 1842 to introduce scientific disciplines. But republics differed greatly in the speed of their progress. For example, whereas Mexico had seen the publication of perhaps the first scientific text in the Americas with Alonso Gutiérrez’s *Physica speculatio* in 1557 (and probably the first work of science fiction with Manuel Antonio de Rivas’ tale of a journey to the moon in 1775), its progress was slowed by the closure of its universities for long periods in the nineteenth century. Nevertheless, the Instituto de Ciencias, Literatura y Arte was founded in Mexico City in 1826, and subsequently Institutos Científicos y Literarios were created in various other cities. During the last two decades of the century positivism was strongly embraced by the establishment, but Mexico had to wait until the post-Revolutionary years of the 1920s for its great acceleration in scientific learning.

It should not be forgotten that many of the explorations and discoveries in the natural world were made in Latin America. In several of the famous cases it was European scientists who published the results of such research, but less well publicised programmes of study were often undertaken by Latin Americans themselves, especially in disciplines related to the natural environment.

These cases illustrate the varied scenarios of Latin America’s scientific development during the nineteenth century, while demonstrating that even with their unequal progress, there was a general pattern. Ideas were following the trends set in European countries, and scientists were arriving from Europe to make their contribution to the new republics. At the same time, Latin American countries were founding their own institutions and training scientists to make their own progress towards greater independence.
Science and Literature at the Beginning of the Twentieth Century

People’s lives were changed in a direct and practical way by the developments in science represented by these publications, events, and new institutions. This was true of street lighting, transport, nutrition, clothing, working conditions, values (moral, ethical and religious), physical and mental health, and many other features of daily life, particularly in the expanding urban areas. Inevitably, the changes in literature at the end of the nineteenth century and beginning of the twentieth were a reflection of all this.

Malcolm Bradbury summarises the characteristics of the new literature (strictly speaking, the novel) in the following terms:

an enormous alteration in the novel’s nature, structure, and mode of activity, so that a new period of style seems to emerge [...] a stylistic milieu in which some practices which had been very close to the centre of fiction as a story-telling art were brought into question; it seems that certain well-established types of narrative presentation, certain kinds and modes of realism, certain poised relationships between the story and its teller, certain forms of chronological ordering and particular views of character, even the belief that a form does not need to exceed the working needs immediately occasioning it, were being restructured to fit the form of a new world. (Bradbury 1973: 81-82)

From this we may infer some more specific points that are well-known literary features of the time. Like daily living, the very “nature” and “structure” of literature were transformed. It was less probable that fiction would have an omniscient author (with a perfect memory), or that the plot would be predetermined, events ordered in a causal sequence, or characters presented with their background, traits and standing. The reader’s participation was less likely to be pre-empted in such ways. There was less certainty about the objective reality of things as opposed to their mental perception by characters, readers, or authors. At times, changes in form could be introduced for the sake of novelty itself, experimentation being a source of excitement and entertainment, though at other times there was at least a semblance of the intent to match the literary form with the subject matter.

Many of the characteristics mentioned here were to develop more fully as the twentieth century progressed, and in certain respects they were to reach their plenitude with the “Boom” in Latin American literature of the 1960s and 1970s (as I shall argue below). But it is important to keep in
mind that some of the ground had already been covered before actual trends were established.

Against the background of advances in psychology, one of the phenomena emerging in fiction during the first two decades of the twentieth century was the so-called “stream of consciousness”—a technique stemming from the notion that the mind operates as a continuous flow of thoughts, feelings, memories and sense-perceptions. It is accepted that the term was first used in a scientific—not a literary—way, occurring in 1909 in William James’s *Principles of Psychology*, and “later introduced into literary criticism by May Sinclair […] in her article on Dorothy Richardson in the *Egoist* of April 1918.” (Kumar 1962: 13-14) Writers such as Dorothy Richardson in *Pilgrimage* (1915-36), James Joyce in *Ulysses* (1918-22), and Virginia Woolf in *Mrs Dalloway* (1925) were among the first to present this technique in the English language.

Meanwhile, the theme of dreams, hallucinations, illusions, and the realm of imagination, long popular in fantastic literature, became a more serious source of creative inspiration as a result of scientific studies of the unconscious mind. Freud is said to have acknowledged that poets and philosophers discovered the unconscious before him, while “what I discovered was the scientific method by which the unconscious can be studied.” (Trilling 1990: 43) Lionell Trilling concluded that much of Freud’s influence on literature is “so pervasive that its extent is scarcely to be determined […] it has been infused into our life and become a component of our culture of which it is now hard to be specifically aware.” (ibid.) And yet there is nothing indeterminate about D.H. Lawrence’s debt to Freud (and Jung), particularly in *Psychoanalysis of the Unconscious* (1921) and *Fantasia of the Unconscious* (1922)—theoretical essays on ideas that inform two decades of his writing, including *Sons and Lovers* (1913), *Women in Love* (1920), and *Lady Chatterley’s Lover* (1928).

Virginia Woolf made a comment that I think suggests the impact of physics as well as psychology on modern novelists’ interest in the mind and their representation of characters’ thoughts: “The mind receives a myriad impressions […] From all sides they come, an incessant shower of innumerable atoms […] Let us record the atoms as they fall upon the mind in the order in which they fall” (Woolf 1994: 160-61). It is only a metaphorical use of the term “atoms,” but it reflects to some extent the assimilation of discoveries about the atomic and sub-atomic world made during the final years of the nineteenth century and the first two decades of the twentieth. In particular, Woolf alludes to the idea of the writer not imposing order on the seemingly random workings of the inner mind.