

## INTRODUCTION: THE PHILOSOPHICAL AND HISTORIOGRAPHICAL TERRAIN

More than twenty years ago, the late Carleton Perrin likened the current state of our scholarly understanding of the Chemical Revolution to the parable of the blind men and the elephant. While historians of this complex event have a shared sense of being in the presence of a great beast, they mistake the part each of them has touched for the whole thing and hence cannot agree on its nature or identity.<sup>1</sup> As a historical event, the Chemical Revolution is readily identified. It occurred towards the end of the eighteenth century and involved some of the finest scientific minds of Europe in an upheaval of considerable scope and consequence. What is not so easy to determine is the meaning or significance of this event, both for its participants and for subsequent commentators. Nineteenth and early twentieth-century historians of chemistry identified the Chemical Revolution with the conflict between the English natural philosopher Joseph Priestley and the French chemist Antoine Lavoisier over the nature of combustion, with Priestley defending the traditional view that burning substances emit 'phlogiston' (the principle of inflammability) against Lavoisier's innovative suggestion that they absorb oxygen. But the issues joined in this debate went well beyond the question of the empirical adequacy of competing scientific explanations, encompassing methodological, epistemological, ontological, linguistic and institutional issues that related to the very identity of chemistry as a scientific discipline. While generations of historians of chemistry have been united in the belief that the birth of modern chemistry involved a fundamental break with previous chemical theory and practice, they have failed to arrive at any consensus on the identity of the offspring and the nature of its gestation. Did this act of parturition, which brought forth modern chemistry, hinge upon an experimental discovery, a theoretical insight, a methodological reform, an epistemological reorientation, or an ontological purification? Or did it involve the coming of reason to an arcane corner of experimental knowledge, or merely the machination of local sociological forces? The aim of this study is to explore these different interpretations of the Chemical Revolution, elucidate their underlying historiographical principles and philosophical presuppositions, and propose

a new interpretation that recognizes the complexity and temporality of this perplexing and elusive historical event. As an exercise in the historiography of science, it is concerned not so much with the Chemical Revolution as an object of historical inquiry as with the different ways in which it has been described and interpreted by its participants and subsequent historians.

Until recently, the Chemical Revolution was the Cinderella of 'scientific revolutions' in the discipline of the history of science.<sup>2</sup> Demurely wedged between her noisier and more noticeable sisters, the Scientific Revolution of the seventeenth century – which involved the birth of modern science – and the Darwinian Revolution of the nineteenth century – which evoked passionate debate about the origin of life and human destiny – the more prosaic issues associated with the Chemical Revolution attracted the interest of only a handful of historians and historically-minded chemists. This situation changed in the 1960s and 70s however, and the intervening years have witnessed almost as many studies of the Chemical Revolution as occurred in the preceding century. This resurgence in scholarly interest coincided with a historiographical ferment in the discipline of the history of science, in which the long-held positivist and Whig view of science as a teleologically structured body of experimental knowledge gave way, first in the 1960s to the postpositivist view of science as theory akin to speculative metaphysics, and then in the 1970s and 80s to the postmodernist view of science as a sociological entity shaped by the contingent constraints of specific agents practising in local contexts. Current interpretations of the Chemical Revolution, which run the gamut from the materialist view of an unchanging past to the idealist sense of its continual 'reconstruction' or 'renewal' by our attempts to understand it, are shaped by the complex intermingling and sedimentary layering of these interpretive styles.

This period of historiographical ferment and renewal is exciting and invigorating for specialist historians of chemistry, leading them into a deeper and more extensive understanding of the arcane details of their object of inquiry. But without the assistance of texts designed to offset the difficulties in communication that accompany the fragmentation involved in increased specialization, the resulting situation can be daunting for the student and intelligent lay-reader and problematic for the general scholar. This study tackles the problem of intelligibility and communication by revealing and exploring, beneath the welter and multiplicity of diverse specialist interpretations of the Chemical Revolution, the presence and influence of a small number of interpretive patterns, forms or styles, grounded in clearly defined sets of historiographical strategies and philosophical themes intelligible equally to the student, lay-reader, scholar and specialist. But this reflexive activity is not only an exercise in clarification and communication, intended to make accessible to a wider audience the results of more narrowly conceived scholarly interpretations of the Chemical Revolution; it is also designed

to further these scholarly inquiries by exploring their philosophical foundations and, hence, their proper scope and implications. Hopefully, it will also whet the growing appetite among historians, philosophers and sociologists of science for historical and critical accounts of their own disciplines as an end in itself. With these considerations in mind, this study offers, in tandem with a history of the history of the Chemical Revolution, an in-depth account of the broader philosophical and cultural movements that encapsulated these histories.

This kind of inquiry will be received differently by philosophers or sociologists of science, who are concerned with general historiographical issues and problems, and historians of science, who seldom explore the conceptual and methodological foundations of their work. Largely an empirical discipline, the history of science is marked by an 'individualism and particularism' that discourages explicit theorizing and which defines the task of the historian of science primarily in terms of specific bodies of empirical material and their accompanying narratives. This defensive empiricism characterized the reaction of an older generation of historians of science to the hegemonic inroads of philosophers of science like Imre Lakatos, who assigned to the historian of science the derivative task of providing 'rational reconstructions' of past science in terms of preconceived philosophical models of scientific knowledge and rationality. More recent historians have moved away from this defensive posture, manifesting a greater understanding of the inescapable presence of philosophical and historiographical presuppositions in their empirical inquiries and revealing a greater familiarity with the views of philosophers and sociologists of science such as T. S. Kuhn, Bruno Latour, and Michel Foucault, who in turn showed a greater willingness to learn from the history of science.<sup>3</sup> Nevertheless, the majority of historians of science continue to treat philosophy and historiography instrumentally, reaching into the toolbox of interpretive devices and strategies to illuminate or solve the empirical problems under scrutiny, but paying little or no attention to the philosophical intent or overall historiographical implications of the chosen analytical devices. Whether practising historians should, in the course of their everyday inquiries, become more historiographically self-conscious or continue in their instrumentalist ways is a question that is not addressed in this study. Whatever form the workaday relation between historical inquiry and historiographical reflection takes – whether they are actively mingled in the work of each investigator or divided among a community of specialists – this study aims to open up more cogent and compelling lines of communication between these distinct, but equally necessary, aspects of historical inquiry. Moving at times far afield from the paradigmatic domain of the history of chemistry, the basic aim of this study is to provide a clear and systematic account of the philosophical and historiographical dimensions of past and present interpretations of the Chemical Revolution which will not only sharpen our appreciation of the real

significance, relative worth and scope of available and competing interpretations of this crucial event in the history of chemistry, but will also accelerate its future comprehension. The burden of this introduction is to map out the more prominent features and contours of the philosophical and historiographical terrain occupied by these interpretive patterns, forms and strategies.

### Discipline of the History of Science

Interpretations of the Chemical Revolution have been shaped by interpretive strategies associated with the emergence and development of the discipline of the history of science. Since its inception in the Enlightenment, the discipline of the history of science has occupied a contested intellectual terrain, shaped by philosophical and ideological forces generated by the development and cultural entanglements of science itself.<sup>4</sup> In the eighteenth century, Jean d'Alembert and Joseph Priestley linked the discipline of the history of science to Enlightenment programmes of social and intellectual reform, while Adam Smith viewed it as a species of 'philosophical history' designed to elucidate the universal principles of the human mind.<sup>5</sup> During the last two centuries, a broad spectrum of religiously minded historians of science, including Joseph Priestley, Pierre Duhem and Stanley Jaki, also treated the history of science as 'a focal point of debate in the conflict between secular and religious cultures.'<sup>6</sup> While such religion-based historiographies played a significant role in shaping past and present interpretations of the Scientific Revolution, which involved a break with medieval religiosity, and the Darwinian Revolution, which rejected Christian accounts of the creation, they played no discernible role in the formation of past and present interpretations of the Chemical Revolution. This is decidedly not the case with positivist historiographies predicated on the repudiation of religion (and metaphysics); these historiographies played a crucial role in the work of nineteenth- and early twentieth-century historians who linked the Chemical Revolution to the emergence of chemistry as the first 'positive' science.

Reinforced by Whig views of political and cultural progress, nineteenth-century positivism developed philosophies of history designed to uphold the Enlightenment view of the progressive disentanglement of science from non-science. Positivism's view of the 'cognitive monopoly of science' shaped the influential historiography of science developed by George Sarton in the opening decades of the twentieth century. Calling for the development of a 'new humanism', which tied human progress to scientific progress and sought to humanize science in a way that increased its present and future progress, Sarton appropriated the discipline of the history of science to the justificatory and celebratory needs of science itself. The resulting historiographical sentiments played an important role in the efforts Sarton, Charles Singer and William Osler made in the first part of the twentieth century to establish the history of science as a

recognizable and useful academic discipline and profession.<sup>7</sup> Somewhat eclipsed by the long and gloomy shadow of World War Two, these celebratory sentiments resurfaced among some historians of science in the 1980s and 1990s, as can be seen, for example, in Bill Brock's *Fontana History of Chemistry*, according to which 'the history of chemistry not only informs us about our great chemical heritage but justifies the future of chemistry itself'.<sup>8</sup> More recently still, a group of historians of biology, eager to resurrect Sarton's original perspective, have advocated the study of the history of science as a means of 'illuminating science and making it better', claiming that the adoption of this perspective 'on a larger scale' would 'transform not only science but the discipline of the history of science as well'.<sup>9</sup> The philosophical underpinnings and historiographical implications of positivism's justificatory and celebratory approach to the history of science and its impact on the historiography of the Chemical Revolution will be explored in Chapter 1.

The tumultuous years of the 1960s and early 70s saw the deconstruction of the positivist hegemony in the history and philosophy of science, together with the emergence of 'postpositivist' sensibilities in the works of W. V. O. Quine, Karl Popper, T. S. Kuhn, Imre Lakatos, Paul Feyerabend and Larry Laudan, among others. As will be seen in Chapter 4, postpositivism shared positivism's modernist heritage, generating justificatory and celebratory analyses of scientific knowledge and its unique rationality. But, in keeping with the speculative tenor of the time, postpositivism also adopted a less certain and more independent epistemic stance towards science. Besides replacing the positivist model of empirical certainty in science with fallibilistic accounts of its theoretical structure and status, postpositivist philosophers of science sought to project onto the history of science philosophically derived models of progress and rationality. Instead of appropriating the history of science to the justificatory and celebratory needs and interests of science itself, postpositivist historians and philosophers of science appropriated the history of science to the aims and interests of the philosophy of science. They sought the 'rational reconstruction' of the history of science in terms of philosophical models of rationality. The philosophical roots of these models and their influence on our understanding of the Chemical Revolution will be discussed in Chapters 2 and 3. This account will offset the tendency to downplay the historical significance and specificity of postpositivism that results from treating it as either a minor modification of positivism or a brief prelude to the emergence of postmodernism.<sup>10</sup> Despite its brief ascendancy in the pantheon of interpretive styles, postpositivism had a profound and productive influence on the historiography of the Chemical Revolution, and this study should enable us better to understand and appreciate its complex, variegated and important results.

But the positivist thesis of the epistemological and utilitarian pre-eminence of science did not go unchallenged by philosophical and cultural forces and movements designed to combat the hegemonic impulse of modern science, as can be seen in the emergence and development of Romanticism, German Idealism and American Transcendentalism in the nineteenth century, and Continental Phenomenology, Hermeneutics and Critical Theory in the twentieth century.<sup>11</sup> A similarly critical and sceptical stance towards modern science and its positivist boosters shaped sociological accounts of the development of science which came to the fore in the wake of postmodernism in the 1980s and 90s. As science developed in the nineteenth and twentieth centuries into a force of daunting proportions in the economic, political and cultural affairs of modern society, and as scientific beliefs and practices became more and more insinuated into the complex structures and institutions of those societies, so science itself became an unavoidable object of inquiry for anyone trying to understand those structures and institutions, as well as an obvious focus of opposition and concern for anyone adversely affected by them. Although this levelling stance was absent from the well-known Marxist historiographies of science that burst upon the Western scene in the 1930s, the perception by philosophical and ideological friends of science that 'by displaying its banal and practical origins', these materialist historiographies devalued science strengthened the hand of idealist and postpositivist historiographies of science that flourished in the United States during the anti-communist fervour of the 1950s and 60s.<sup>12</sup> As will be seen in Chapter 2, idealist and postpositivist philosophers of science enjoined historians of science to focus on the 'internal', conceptual content of science and to shun, or downplay, any reference to its 'external', social or psychological, circumstances, thereby countering the threat to the autonomy and rationality of science they perceived in Marxist, Freudian and other naturalistic accounts of science.<sup>13</sup> But, as will be seen in Chapters 4 and 5, sociologists of scientific knowledge working in the 1970s and 80s, in turn, rejected these celebratory and idealist historiographies of science, adopting instead a more neutral naturalistic approach towards the epistemological and utilitarian aspirations of science. These scholars treated science not as a privileged body of knowledge, but as a social activity on a par with other social activities. Challenging the normative distinction between the internal (cognitive) content of science and its external (material) circumstances, they deployed the concepts and methods of the social sciences, including sociology, psychology and anthropology, to describe and explain, rather than reconstruct and justify, scientific thought and practice. They replaced 'rational reconstructions' with 'sociological reconstructions' of the history of science. These developments in the sociology of scientific knowledge had a profound and lasting impact on the discipline of the history of science, and as

will be seen in Chapter 6, this impact left its mark on the historiography of the Chemical Revolution.

The historian of science I. Bernard Cohen summarized the state of the profession and the multitude of historiographical options available to the discipline of the history of science in a 1977 paper entitled 'The Many Faces of the History of Science – A Font of Examples for Philosophers, a Scientific Type of History, an Archaeology of Discovery, a Branch of Sociology, a Variant of Intellectual or Social History – *Or What?*'<sup>14</sup> Partly rhetorical and certainly designed to celebrate the rich potential and interdisciplinary nature and significance of the discipline of the history of science, Cohen's question has lost none of its initial relevance and significance in the intervening years. On the contrary, subsequent developments in science studies have, if anything, served to render it more pressing and significant than when Cohen first formulated it. This study responds to Cohen's question with an exploration of the different disciplinary sources and pressures that have shaped past and present interpretations of the Chemical Revolution and, in Chapter 7, it answers his rhetorical 'Or What?' with 'History!' Instead of subsuming the history of science under the disciplinary hegemony of science (positivism), philosophy (postpositivism), or sociology (sociology of scientific knowledge), the interpretive model developed in Chapter 7 – 'robust contextualism' – emphasizes the historicity and, hence, temporality, of these appropriating disciplines.<sup>15</sup> Robust contextualism integrates the history of science in general and the Chemical Revolution in particular into a dynamic, open-ended historical ontology based on the specificity and irreducible complexity of *historical* events. In offering a substantive alternative to the interpretive models of the Chemical Revolution discussed in the rest of the book, Chapter 7 pays more attention to the Chemical Revolution as an object of inquiry, but like the previous chapters its main concern is with the method, sources and presuppositions of that inquiry.

### History of Science as History

As a metadiscipline, the object of which is the discipline of history, historiography is concerned with the interpretive presuppositions and principles that make possible and give coherence to historical inquiry. Like the objects and activity of that inquiry, historiography is itself an object of history, and shares in its multiplicity and complexity. Indeed the turbulent history and methodological variability of the discipline of the history of science lends credence to R. G. Collingwood's claim that 'no historical problem should be studied without studying ... the history of historical thought about it'.<sup>16</sup> The inextricability of history and historiography, expressed in Collingwood's notion of 'historical criticism', or 'the history of history', informs the current interest that many

historians of science have in 'the history of science as history'.<sup>17</sup> These reflexive sensibilities have surfaced recently among analytical philosophers and philosophers of science who hope to revitalize the hybrid discipline of the history *and* philosophy of science by stimulating a renewed cooperation between historians of science and philosophers (and sociologists) of science estranged in the wake of Kuhn's relativistic account of the history of science.<sup>18</sup> Adopting the spirit of this renewed endeavour, this study calls upon historians of the Chemical Revolution to pay close and critical attention to the current state, future development and philosophical status of their interpretive enterprise. It canvasses scholarly, critical and hermeneutic consideration to support this reflexive turn.

Reflecting on the state of current scholarship, a number of historians of eighteenth-century science and the Chemical Revolution have noted how in the absence of more synthetic interpretive considerations, the proliferation in the last forty years of studies dealing with particular problems, issues and individuals in the Chemical Revolution has produced a state of uncertainty verging on 'crisis', characterized by a breakdown of communication and the proliferation of dissensus in the historical community.<sup>19</sup> While dissensus itself is not a bad thing, clear guidance and critical reflection on the central themes and problems of the discipline would not only facilitate better communication and coordination among its practitioners, but also make the job of the student and lay-reader a lot easier and more productive. Some steps have been taken in this direction; but they are incomplete and partial, consisting in a few interpretive articles and anthologies summarizing the state of scholarship on selected problems and issues. However, there is still no systematic and coherent account of past and present interpretations of the Chemical Revolution, detailing and assessing their problems, methods and presuppositions. This study is designed to fill that gap.

As an exercise in the history of ideas, or intellectual history, the main body of this study shows how, since World War Two, the discipline of the history of science has passed through three historiographically distinct, but temporally overlapping, stages, yielding significantly different interpretations of the Chemical Revolution. The first stage, which stretched from the early nineteenth century to the middle of the twentieth century, projected the positivist-Whig view of science as a unitary and progressive body of experimental knowledge grounded in an algorithmic method of inquiry. This perspective gave way in the 1960s to the postpositivist identification of science with theory and the history of science with the exfoliation of global theoretical doctrines and research traditions. No sooner had postpositivism established itself in the community of historians and philosophers of science than it was challenged, in the 1970s, by the sociology of scientific knowledge, which treated science as a social activity rooted in the self-interested activities, or practices, of specific agents in local contexts. The result

is a reflexive narrative of the Chemical Revolution that draws attention to its multiple sources and variegated perspectives.

The critical dimension of this study links this survey of past and present interpretations of the Chemical Revolution to the formation of an interpretive model that weighs and balances the strengths and weaknesses of available perspectives and offers an alternative approach that is both novel and fruitful. It uses the logic of 'conjecture and refutation', associated with Collingwood's notion of 'historical criticism,' or 'the history of history', to link the description of past and present historiographical practices to the prescription of future historiographical strategies. Thus it describes different theories of history in the temporal order in which they occurred, while relating successive theories to attempts to remove the empirical and conceptual difficulties encountered by earlier ones. More particularly, in the last chapter, it explores and evaluates accounts of the Chemical Revolution based on the disciplinary directives of the disciplines of science, philosophy and sociology from the perspective of a *historical* model of the Chemical Revolution. But it does not posit a logic of history, based on the elimination of error and the discovery of a greater truth. Rather, it envisages a terrain of historiographical and philosophical diversity and multiplicity, reflexively mapped to reveal its objective contours and thereby to facilitate an easier passage for those who care to make this interesting and fruitful intellectual journey.

The success of this reflexive study of the history of the history of science requires further consideration of the familiar topic of the Whig interpretation of history and its powerful, pervasive effect on historians of science. Over forty years ago, in his epoch-making work *The Structure of Scientific Revolutions*, Kuhn highlighted the aspirations of a new generation of historians of science when he drew attention to an ongoing 'historiographical revolution', in which the traditional Whig concern with 'the permanent contribution of an older science to our present vantage' began to yield to contextualist attempts 'to display the integrity of the science in its own time'.<sup>20</sup> The notion of a historiographical struggle between the competing forces of whiggism and contextualism governed subsequent reflections on the state of the discipline of the history of science, with most commentators supporting Kuhn's view that the Whig interpretation of history was fast approaching oblivion. But, as will be seen in the course of this study, this conclusion was premature in the extreme. Not only did Whig (and positivist) sensibilities remain implicit, but undiminished, in a number of ostensibly anti-Whig interpretations of the Chemical Revolution generated by postpositivist and sociological historians of science, some scholars in the 1980s and 90s still insisted that, given the uniquely progressive nature of science, 'the whiggish idea of progress had inevitably to be built into the history of science'.<sup>21</sup> As the historian Herbert Butterfield noted over sixty years ago, whiggism is a highly viscous, intractable and alluring ideology. It is, according to Butterfield,

'the historian's pathetic fallacy', which involves 'an unexamined habit of mind historians may fall into' when they momentarily step back from their detailed research to communicate their results to a wider public.<sup>22</sup> Ironically, later in his own life, Butterfield succumbed to this fallacy when he abandoned the contextualist historiography of his 'misguided' youth in order to 'celebrate this Whig inheritance of ours with a robust but regulated pride.'<sup>23</sup>

This is not to deny that there has been real movement among recent historians of science along the axis from whiggism to contextualism. But, as this study will show, this movement has been more ambiguous, incomplete and confused than is usually supposed. It is furthermore accompanied by an impoverished (reflexive) understanding of whiggism, which overflows into a narrow and distorted assessment of the nature of the contextualist challenge and alternative historiographies. The tendency to identify the Whig interpretation of history with a retrospective, celebratory view of the past ignores the more abiding and significant ontological, epistemological and axiological underpinnings of this historiography. As will be seen in Chapter 1, an appreciation of the 'deeper' philosophical principles and presuppositions, concerned with the nature of agency, the role of structure and the place of values in history, is essential to a proper understanding of the different forms of whiggism (and positivism), its persistent hold on the imagination of historians and the variety of contextualist alternatives formulated more recently.

Similarly, the transition from positivist to postpositivist historiographies of science can be understood and evaluated only in relation to the more fundamental transformation in ontological, epistemological and methodological conceptions of science brought about by the emergence of theoreticism. Theoreticists replaced the positivist ideal of certain knowledge, grounded by algorithmic methodological procedures in the indubitable world of sense experience, with the notion of an inherently fallible knowledge, underdetermined by methodological principles and procedures, and dependent for its meaning and significance on prior theoretical presuppositions and commitments. As will be seen in Chapter 2, fallibilism encompassed a range of historiographical strategies generated by lively debates between realists and idealists about the ontological significance of scientific theories, between rationalists and relativists about the epistemological status and standing of scientific knowledge, and among methodologists who disagreed about whether to prioritize the conceptual (foundational) or the empirical dimensions of science.

Chapter 4 will show how the ensuing clash between postpositivist and sociological interpretations of the Chemical Revolution involved a 'deeper' polarity between theoreticism and sociologism, between a realist or globalist philosophy of science, which emphasized the unity of science and history, and the nominalism of postmodernism, which stressed the irreducible multiplicity and diversity

of scientific practices and historical contexts, including those of the sociology of scientific knowledge itself. An eclectic mixture of Continental philosophical influences, emanating from phenomenology, ethnomethodology, hermeneutics and poststructuralism, coalesced with Anglo-American philosophical sensibilities, associated with pragmatists, Wittgensteinians, Kuhnians, New Historicists, Cultural Marxists and the 'new empiricists', to shape the sociological notion of 'science as practice'. This notion generated a bewildering array of interpretations of the Chemical Revolution, depending on whether 'practice' was identified as material, instrumental, experimental, discursive, investigative, didactic, rhetorical or cultural.

Chapter 4 will also consider the role played by deeper or broader philosophical and cultural changes, associated with the transition from modernism to postmodernism, underlying the replacement of philosophical – positivist and postpositivist – with sociological interpretations of the Chemical Revolution. The struggles and divisions between philosophers of science and sociologists of scientific knowledge had a profound effect on the historiography of the Chemical Revolution, bearing witness to the more epoch-forming conflict between the modernist problematic of autonomy and legitimation, embedded in the notions of formal reason, representational thought and progressivist history, and postmodernist naturalism and nominalism, with its 'spacialized' sense of a fragmented and static world of fleeting simulations and interventions immune to the coherent movement of modernist 'temporality'.

The critical dimension of this study also points to the importance of 'deeper' philosophical principles and presuppositions in the formation and development of historiographical strategies and interpretive models. It argues that existing accounts of the Chemical Revolution are not *historical* to the extent that they subsume history under the disciplinary interests and strategies of science, philosophy or sociology. Instead of grasping the Chemical Revolution as a product of history, a specific mode of temporality, they view it as a scientific discovery, a moment of rationality, or a matrix of social interests that happen to have occurred in the past. In order to evaluate these disciplinary intrusions, and to answer Cohen's question 'or What?' with an unequivocal 'History', this study highlights the need to develop a clear sense of the priority and irreducibility of history and the methods used to study it. Instead of approaching history scientifically, philosophically or sociologically, it treats science, philosophy and sociology historically. Instead of viewing chemistry as a well-defined science, 'which has a history one can choose to study or ignore', it 'envisages this science as the *product* of history ... [as] a history in progress'.<sup>24</sup> Recalling the famous claim of Marx and Engels that there is only one science, 'the science of history', the final chapter of this study deploys consideration derived from historical materialism to articulate its sense of the priority and irreducibility of history.

The claim that existing accounts of the Chemical Revolution are not *historical* is intended not as an evaluation of their intellectual worth or scholarly competence, but as an assessment of the historiographical styles or patterns of interpretation that inform them. Following the path delineated by Louis Althusser and Michel Foucault in the 1960s, Chapter 7 argues for the priority and irreducibility of history by linking it to the concept of 'complexity'. The complexity involved here is not one of detail, or 'incidental circumstances', which can be captured in more adequate and complete philosophies or sociologies of science.<sup>25</sup> Historical complexity is fundamental; it is rooted in temporality and is irreducible to the unfolding of scientific experience, the instantiation of formal structures, the realization of material interests, or any simple conjunction thereof. To insist on the complexity of historical events in this sense is to reject the idea that the Chemical Revolution had a defining essence, or crucial moment, which ordered its different aspects into a unitary historical process. But this is not to defend a pluralistic conception of historical events as the simple conjunction of absolutely autonomous factors. To insist on the complexity of historical events is to treat them as 'decentered totalities', the parts of which display a 'relative autonomy'.<sup>26</sup> This study approaches the positive characterization of the notion of historical complexity and its applicability to the Chemical Revolution laid out in the last chapter by first examining existing histories of the Chemical Revolution and the way in which this concept eludes them.

The interest of historians of science in the history of the history of science is reinforced by hermeneutical considerations that make the consequences and subsequent interpretations of a historical event integral to the identity and meaning of the event itself. The notion that history is a narrative, or a story, which has a plot with a beginning and an end, supports the idea that an event becomes a historical event only in relation to later events, and that historical descriptions of an event are richer than empirical observations made at the time of the event. Unlike natural events, which have no history and are completely available for scientific analysis, historical events, as integral parts of patterns of historical change, are forever incomplete, dependent for their identity and meaning on subsequent events and developments.<sup>27</sup> Thus, when we claim that World War Two started in 1939, we consider the events of the year 1939 from the retrospective view of a war that ended in 1945. This view is shaped by events subsequent to 1939, and hence is beyond the interpretive focus of someone living in 1939. The identity and meaning of a historical event, in this case World War Two, is open to modification by subsequent events and consequences and the interpretations that accompany them. On this view, the goal of the historian is not the traditional unrealizable goal of a final objective knowledge of an independently existing past, so much as the construction and reconstruction of its ever evolving identity and meaning. Merging history with the history of history,

some recent historians of the Chemical Revolution have tried to display not the mythical original identity and meaning of this event so much as its unfolding identity and meaning through time.<sup>28</sup>

### Historiography and the Historian

As a metadiscipline, which takes as its object of study the discipline of history, historiography identifies or enunciates the philosophical commitments, ideological contexts and technical problem-field of a given historical analysis. A particular historical analysis can be philosophically classified as materialist, idealist, empiricist, historicist, structuralist or some hybrid of these and other philosophical styles and strategies, depending on its overall view of history and the nature and place of evidence, concepts and objects in historical inquiry.<sup>29</sup> Given the disciplinary and historical proximity of the history of science to other disciplines, especially philosophy and sociology, and given the ferment in this disciplinary matrix, it is not surprising to find considerable philosophical variety among historiographies of science. But this variety and multiplicity is not without some underlying unity and uniformity, provided, in part at least, by a pervasive polarity between, on the one hand, idealist and relativist philosophies of science and, on the other hand, materialist and realist philosophical sensibilities. As this study will show, idealist and relativist sensibilities, which prioritize scientific concepts over practices, assimilate objects to their interpretations, and question the capacity of science to represent an independently existing reality, have had a long and lasting impact on the historiography of science in general and the Chemical Revolution in particular. But the final chapter of this study will opt for the other side of the philosophical ledger, offering a historiography of the Chemical Revolution predicated on the representational function of scientific ideas and their embodiment in the material practices of history. More generally, this study registers the fluidity and variability of such philosophical terms as 'realism', 'relativism', 'idealism' and 'materialism', which include local variations among their core connotations.

In its articulation of the ideological and political dimensions of the discipline of the history of science, historiography stresses mutual implications rather than invariable correlations between ideologies and philosophies. Thus, the variety of philosophical and historiographical expressions and manifestations of Marxist politics and ideology, and the different political uses, both conservative and radical, to which Kuhn's philosophy of science can be put, support the more general claim that the relation between the ideological and philosophical dimensions of a historical analysis is historically variable, not conceptually necessary. While these ideological considerations point historiography in the direction of broader issues and considerations than those involved in the philosophical dimension,

the technical dimension involves a narrowing of focus. In its narrower technical dimension, the historiography of science articulates and prioritizes the issues and problems relevant to 'particular interpretations of a tightly-defined object of historical investigation', indicating, for example, the relative weight to be given to the role of matter theory and phlogistic chemistry in the Chemical Revolution, the part played by Neoplatonism in the genesis of the Copernican worldview or the validity of the Merton thesis concerning the relation between science and society in the seventeenth century.<sup>30</sup> Although the philosophical, ideological and technical dimensions of a historiography are closely intertwined, the main body of this study will focus on the philosophical and technical dimensions of past and present interpretations of the Chemical Revolution. But this restriction is not intended to downplay the significance of the ideological dimension of these historiographies. On the contrary, the historiographical model delineated in the last chapter of this study emphasizes the integral role of ideological and political parameters in the emergence and development of science and, by implication, its historiography. This narrowing of focus is necessary, however, to keep a vast and highly complex inquiry within manageable proportions. Thus, by and large, this study will consider political and ideological parameters and issues only to the extent that they exerted a direct and specific influence on the formation of philosophical and technical strategies articulated by the historiographies under scrutiny. A more thorough exploration of the complex web of mediated connections between the ideological, philosophical and technical dimensions of the historiographies of the Chemical Revolution considered in this study must await a future inquiry focused more on the political and ideological dimensions of the historiography of science. This strategy is entirely consistent with the historiographical model delineated in Chapter 7, which emphasizes the 'relative autonomy' of these dimensions and, hence, the need to recognize and characterize their 'specificity' before considering their relational identity, or connectedness.

The following characterization and classification of the historiographical principles and practices of historians of science is replete with 'isms'. It is more concerned with systems or patterns of beliefs, doctrines, practices and strategies than with their specific instantiations in particular texts or authors. Going against the grain of the prevailing sociological hegemony in the history of science community, which emphasizes the specificity and contingency of local practices and agents, this study revives an earlier interest in the determining role of temporally extended traditions and 'movements' in history. But this concern with general historiographical patterns rather than specific interpretive practices is not without its problems, many of which will be rehearsed in the course of this study. Among these problems is the vague and somewhat ambiguous nature of the language of 'isms'. Thus, there is no general consensus about the precise

meaning of such terms as 'positivism', 'postpositivism', 'realism' and 'relativism', which can vary from discourse to discourse and even within the same discourse. This is notoriously the case with the terms 'modernism' and 'postmodernism', as it is, for example, with the question of Foucault's identity as a 'structuralist' and Kuhn's relation to 'relativism'. Given these semantic vagaries and ambiguities, this study foregoes a systematic definition of its key philosophical terms, allowing them to be characterized more or less precisely as they emerge in the ensuing narrative.

While mainly concerned with historiographical styles and traditions, this study also has something general to say about their instantiation in particular interpretive texts and practices. Thus, it posits a relation of instantiation between a sequence of interpretive styles and a sequence of texts that is complex and uneven. Concerned with the specificity and multiplicity of historical events, working historians adopt an instrumentalist, or opportunistic, approach to the toolbox of available interpretive devices, choosing and using them more in accord with their narrative needs than with the requirements of doctrinal purity and philosophical rigour. When applied to the Chemical Revolution, this narrative focus produces texts which are mixtures or blends of different interpretive styles and modes of exemplification, so that each of the historiographical stages distinguished in this study are characterized by a dominant rather than an exclusive interpretive style. The temporal fit between historiographical paradigms and practitioners is also skewed by the uneven nature of historical development. While some scholars lag behind the curve of history, appearing outdated and old-fashioned in their historiographical affiliations, others stay ahead, playing the role of pioneers and precursors in the development of new historiographical styles and strategies. The relation between texts and styles, scholars and strategies, is further complicated by the interdisciplinary nature of the discipline of the history of science, which enables and encourages its practitioners to draw interpretive inspiration and guidance from such diverse disciplines as philosophy, sociology, literary theory, political history, religion, anthropology and science itself. Given these complexities, this study will focus on the description, evaluation and prescription of historiographical styles and strategies, using individual texts and authors primarily for purposes of exemplification, and leaving to another, longer inquiry a more detailed analysis of the relations between historiographical paradigms and their practitioners. This strategy is supported by the fact that no matter how mediated the relation is between style and text, strategy and scholar, paradigm and practitioner, historiographical styles, strategies and paradigms are real and effective forces in the formation of the interpretive texts and disciplinary identities of individual historians.

### Reflexivity and the Priority of History

Historiography is essentially reflexive. It involves historians reflecting on the methods as well as attending to the objects of their inquiry. The intense interest of contemporary historians of science in the nature of their discipline, in questions and recommendations about how and why it should be practised, derives not only from concerns about disciplinary identity and boundaries produced by the encroachment of other disciplines, but also from the reflexive orientation intrinsic to these disciplines. Predicated as they are on general theories of belief formation, the disciplines of the philosophy of science and the sociology of scientific knowledge imported into the historiographical arena the tenet of reflexivity, an unavoidable concern with the application of theories of belief formation to themselves. Latent and implicit in the philosophy of science, this commitment came to the fore among sociologists of scientific knowledge, though it dominated the interests of only a minority of these scholars. While not a major focus of this study, a brief consideration of the variable meaning and significance of 'reflexivity' in the scholarly community serves to highlight significant issues and differences between the philosophical, sociological and historical approaches to the history of science considered in the following pages.

As Larry Laudan noted, any 'perfectly *general* theory' of belief formation, scientific or 'avowedly *non-scientific*', must, on pain of inconsistency, 'necessarily be self-reflexive'.<sup>31</sup> In this vein, Lakatos replaced 'logico-epistemological' criticisms of competing models of scientific rationality with a historiographical one, claiming that his theory of scientific rationality, which identified scientific progress (rationality) with progressive scientific research programs, was progressive (rational) to the extent that it constituted a 'progressive "historiographical" research programme'.<sup>32</sup> But Lakatos's nod in the direction of reflexivity was something of an afterthought, tacked on to the end of his 'History of Science and Its Rational Reconstruction', but frequently omitted from anthologized versions of this seminal paper. David Bloor, on the other hand, made the tenet of reflexivity central to the sociology of scientific knowledge, identifying it as one of four necessary conditions for the scientificity of the 'Strong Programme' in the sociology of knowledge.<sup>33</sup> Whereas the proponents of rational theories of belief formation took the tenet of reflexivity in their stride, viewing it as a source of added strength and reinforcement for their position, sociologists of scientific knowledge encountered it as a problem, which some ignored while others pursued. As both proponents and opponents of the sociology of scientific knowledge agreed, 'if it were true that *all* beliefs were not the result of rational deliberation and enlightened evaluation, but were 'simply determined by the social situation of the believers', then the beliefs of the sociologists of scientific knowledge would

themselves 'have no relevant rational credentials,' and the whole enterprise would be 'self-indicting'.<sup>34</sup>

Not surprisingly, philosophical critics of the sociology of scientific knowledge were happy with this conclusion, noting that in order 'to avoid being hoisted by his own petard,' the sociologist of scientific knowledge must recognize that 'some beliefs are rationally well-founded, rather than socially determined'.<sup>35</sup> Equally unsurprisingly, sociologists of scientific knowledge vigorously resisted this conclusion and its destructive consequences for their discipline, adopting a variety of postures and attitudes – including denial, indifference and pursuit – towards the problem of reflexivity. Those sociologists who pursued the matter transformed the problem from a destructive dilemma into a heuristic challenge, treating it as an opportunity 'to pursue some fruitful lines of exploration which are opened up by a fresh attitude towards reflexivity'.<sup>36</sup> So motivated, these scholars deployed novel textual and rhetorical devices – such as mixed typographies, biographical statements and subversive paradoxes – all designed to provide an account of the world while drawing critical attention to the constructedness of the account and its relation to alternative accounts. As will be seen in Chapters 4 and 5, these sociological responses to the problem of reflexivity endorsed the more general postmodernist sense of history and historiography as fundamentally 'ironic', concerned more with narratives of 'self-concern' and 'self-exploration' than with representations of an independently existing reality, past or present. These chapters will also relate the difference between philosophers of science, who construed reflexivity as an irresolvable dilemma for the sociology of scientific knowledge, and sociological theorists, who grasped it as a research opportunity, to the deeper divide and wider gulf between the problematic of modernism, which valorized criticism and reform, and postmodernist naturalism, which sought to describe and explain rather than criticize and excoriate.

The historical model outlined in Chapter 7 offers a 'third way' of dealing with the issue of reflexivity, which eschews the formalism of philosophers and the relativism of sociologists in favour of a realist and materialist sense of its historicity. It locates the source and solution to the problem of reflexivity in neither the formal adequacy of ahistorical theories of rationality nor the heuristic practices of sociological inquiry, but in the specific historical conjuncture which, while transcending the scope of formal theories and individual narratives, governs and legitimates the production and dissemination of these theories and narratives. Thus, hermeneutical reflection makes conscious the tacit connection between the interpretive concepts and categories of historians and a prior understanding that is rooted in their sociohistorical context. In keeping with the hermeneutical idea that the possibility and objectivity of historical inquiry and understanding hinges on the objective context of dynamic historical traditions, which are embodied in the objects of historical inquiry and critically engaged by the

interpretations of those objects, the historical model, in its fullest development, neither reproduces nor reconstructs the past, so much as reflexively mediates it with the present.<sup>37</sup> The vehicles of this mediation are neither formal theories nor individual perspectives, but the temporally extended, materially grounded, critically engaged and mutually interacting traditions and movements of history. Though not pursued in any detail in this study, this construal of reflexivity serves to prioritize history in the manner of the philosophy of historical materialism, according to which humans, nature and society are formed and modified by concrete processes of development through time, rather than by the isolated instantiations of abstract and formal principles and theories or the accumulation and aggregation of the specific practices of isolated individuals.

### Scientific Change and the Chemical Revolution

The Chemical Revolution has generally been regarded as the very paradigm of a scientific revolution. It was recognized as a revolution in its own time, and has been so viewed by subsequent generations of historians and scientists. Spanning the last two decades of the eighteenth century, the Chemical Revolution occurred during a period of intense social and political upheaval in Europe, the dawn of a new 'Age of Revolution'.<sup>38</sup> The French Revolution was just beginning, the American Revolution was still unfolding, and the English Civil War was a distant but disturbing memory among the European elite when, in 1789, Lavoisier published the first systematic account of his new system of chemistry. These political events exerted a powerful influence on the thought of the day, leading to the development of new concepts of social, political and cultural revolutions, which were applied to the development of a new historiography of science. According to Cohen, throughout most of the eighteenth century there was 'some confusion and ambiguity about the sense of the word "revolution" in relation not only to science but to political events'. An 'older sense of "revolution" as a cyclical phenomenon ... or a repetition' intermingled with a new use of the term to describe 'a breach of continuity, or a secular change of real magnitude'.<sup>39</sup> This confused mode of thought was appropriate to the political compromise achieved by English society in the Glorious Revolution of 1688, providing contemporary historians and philosophers with a means of understanding Newton's towering contribution to the Scientific Revolution. After 1789, however, the new meaning of 'revolution' came to the fore, shaping the social, political and cultural sensibilities of the modern age. It is in the modern sense of the word that Lavoisier was the first scientist to refer to his work as 'revolutionary'. He associated his scientific activities with the political events of the day, denying the possibility of a return to the 'old order' in either politics or chemistry.<sup>40</sup> Similarly, Lavoisier's great adversary Priestley applied the concept

of 'revolution' to the political and scientific realms. Although he championed the American and French Revolutions, he bitterly opposed Lavoisier's Chemical Revolution, regarding it as a 'check' on the chemistry of gases, which was previously enjoying 'the most rapid and promising state of growth'.<sup>41</sup> Nevertheless, Priestley shared Lavoisier's exhilarating sense of living in an 'age of revolutions, philosophical as well as civil'.<sup>42</sup>

Not only did the Chemical Revolution occur in a self-consciously revolutionary period in modern history, it was, prior to postmodernism's historiographical devaluation of temporality, deployed in the service of numerous philosophical theories of scientific change and cognitive development. The suddenness, brevity and pace of the Chemical Revolution, together with the burst of new discoveries and foundational conflicts that accompanied it, marked it in the minds of many commentators as arguably the best example of a classic revolution in the history of science.<sup>43</sup> In this vein, Priestley spoke for his contemporaries, as well as for subsequent commentators, when he said,

'There have been few, if any, revolutions in science so great, so sudden and so general, as the prevalence of what is now usually termed *the new system of chemistry*, or that of the *Antiphlogistians*, over the doctrine of Stahl, which was at one time thought to have been the greatest discovery that had ever been made in the science'.<sup>44</sup>

This view of the Chemical Revolution was given its definitive modern form at the end of the nineteenth century, when the chemist and historian of chemistry Marcelin Berthelot used the occasion of the Académie des Sciences's centenary celebrations of the French Revolution to eulogize Lavoisier as the father of modern chemistry.<sup>45</sup> The thesis that the generative phase of modern chemistry involved a fundamental break with previous chemical theory and practice served to unite scholars of diverse historiographical persuasions and otherwise incompatible philosophical sensibilities in the twentieth century.

This study highlights two fundamental 'mentalities' encountered in existing models of scientific change. Emphasizing conceptual permanence, cognitive continuity and cumulative progress in the development of science, the positivist model rendered change in science problematic, if not impossible, and treated an episode like the Chemical Revolution as a transition from a prescientific or nonscientific form of consciousness to a scientific mode of thought. In contrast, postpositivist philosophers of science treated conceptual change, rather than cognitive continuity and permanence, as the normal state of affairs in science, regarding the Chemical Revolution merely as a more prominent feature in a landscape of cognitive upheaval. On both the positivist and postpositivist models, however, the Chemical Revolution appeared as a moment of radical discontinuity, in which Lavoisier ushered in the age of modernity in chemistry by making a fundamental break with prevailing traditions and practices, whether scientific or

philosophical. A corresponding incompatibility between the scientific sensibilities of Priestley and Lavoisier was an integral part of these scenarios. Although postmodernist scholars eventually broke with these Manichean sensibilities in their 'polymorphous and multipolar networks model[s]' of the Chemical Revolution, they did so only by abandoning the problematic of temporality and the reality and significance of scientific change associated with it.<sup>46</sup> In contrast, this study stays within the problematic of temporality, drawing attention to interpretations of the Chemical Revolution that offer more balanced accounts of the interrelatedness of the moments of continuity and discontinuity in scientific change and developing, in Chapter 7, a general interpretive model to sustain them. This model challenges prevailing monomial accounts of the Chemical Revolution, which mistake a single level or dimension of science for its complex, polynomial identity. Thus, whereas positivists identified *empirical* continuity with *scientific* continuity and postpositivists identified *theoretical* discontinuity with *scientific* discontinuity, the model outlined in Chapter 7 stresses the multidimensionality of science and the complexity of scientific change, insisting that continuity and cumulativeness at one level is perfectly compatible with discontinuity at another level. This analysis undercuts the fashionable thesis of incommensurability, according to which competing and historically successive theories are insufficiently incongruous to rule out the possibility of comparison on a shared set of criteria. On the contrary, scientific change, like science itself, is a complex phenomenon, constituted by the intermingling and interconnectedness of contrary moments, such as the continuous and discontinuous, the gradual and revolutionary and the progressive and retrogressive.

### Summary and Conclusion

This study offers an exegetical and critical survey of past and present interpretations of the Chemical Revolution, designed to lend clarity and direction to the current ferment of views and perspectives in the historiography of science. Aimed at a mixed audience of scholars, students and interested lay-readers, it adumbrates the philosophical presuppositions of these interpretations, and formulates an alternative interpretation in their stead. Concerned with patterns rather than particulars, with styles rather than the individuals who embody them, it divides the history of the history of science since World War Two into three distinct, though overlapping, stages, each characterized by a dominant, if not exclusive, interpretive style. It relates this sequence of interpretive styles – positivism, postpositivism and the sociology of scientific knowledge – to the emergence and development of philosophical and sociological models of science, and it shows how each of these styles marked the hegemony of science, philosophy or sociology in the historiography of science. It explores within

this framework a range of different interpretations of the Chemical Revolution, noting conflicts and tensions between rationalist and relativist, realist and antirealist, materialist and idealist and essentialist and nominalist philosophical sensibilities. Stressing the hegemonic status of science in the modern world, it draws attention to the constitutive and critical role played by a broad spectrum of Anglo-American and Continental philosophical traditions in shaping our cultural image of science and its history; it also references the contours of a cultural upheaval, associated with the transition from the modernist problematic of temporality and normativity to the nominalist spatiality of postmodernist naturalism, which underpinned significant developments and changes in this image. Finally, it outlines an alternative, *historical* interpretation of the Chemical Revolution, based on the idea of the ineluctable complexity of historical events and the priority of history, vis-à-vis science, philosophy and sociology, in the constitution and comprehension of the history of science. The *historical* model of the Chemical Revolution integrates the monomial, linear temporality of modernism and the dispersed spatiality of postmodernism into a more balanced account of the interrelatedness of the moments of continuity and discontinuity, identity and difference, permanence and mutability, in the phenomenon of scientific change.

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