Scientia and Transformation

Rethinking Medieval Science through Alchemy and Natural Philosophy

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Abstract

This study introduces a new framework for understanding medieval science by recognizing alchemy as a central mode of rational inquiry. Through the integration of theoretical reflection and material practice, alchemy shaped a vision of nature governed by intelligible processes and oriented toward perfection. The contribution of this work lies in its demonstration that medieval alchemical knowledge operated through experimental attention. Rather than isolating observation from metaphysical purpose, it forged a unified method where transformation became the pathway to understanding. By highlighting this coherence, the study redefines the historical foundations of chemistry and restores to alchemy its formative role in shaping scientific imagination.

Keywords: Alchemy, Medieval Science, Natural Philosophy, Epistemology, Transformation

Introduction

To approach the notion of science in the medieval period is to enter a terrain shaped as much by modern prejudice as by historical complexity. For centuries, the dominant narrative has cast the Middle Ages as an intellectual interregnum, wedged between the scientific clarity of antiquity and the rational awakening of the modern world. This view—fueled by Enlightenment rhetoric and the nineteenth-century cult of progress—has proved remarkably persistent, though recent scholarship has challenged it with increasing force. What emerges from a more nuanced reading of the sources is a landscape of scientific inquiry that was neither static nor wholly subordinate to theology. Rather, it was dynamic, internally diverse, and intellectually ambitious, even as it operated under metaphysical constraints unfamiliar to the modern scientific mind.

Yet medieval science was not "science" in the contemporary sense of the term. It lacked, for the most part, systematic experimentation and quantitative modeling. It did not seek falsifiability or empirical autonomy. What it did possess, however, was a coherent and often elaborate framework for understanding nature, rooted in classical philosophy, transmitted through Arabic and Latin traditions, and reshaped by Christian theological demands. Within this framework, disciplines that today would be considered separate—astronomy, medicine, natural philosophy, even what we now call chemistry—were united by the ambition to uncover the causes and principles governing both the heavens and the earth.

Alchemy deserves special attention here—not as a marginal or deluded cousin of chemistry, but as a legitimate mode of investigation situated at the intersection of matter, spirit, and transformation. Far from being a dark corner of medieval thought, alchemy represented a serious intellectual project. It operated with its own theoretical vocabulary, drew from Aristotelian and Neoplatonic ontologies, and relied on laboratory practices that, while symbolically encoded, were grounded in observation, manipulation, and change. The work of transmutation—of transforming base substances into noble ones—was not merely a quest for gold but a philosophical and often spiritual undertaking, in which the purification of matter mirrored the refinement of the self. That the history of chemistry is inseparable from this tradition is not a matter of accident but of genealogy.

To address these issues, it is essential to draw on studies that provide a scientific framework for understanding the premodern period. Two scholars in particular have developed a general framework for reflecting on the subjects under investigation: Pamela H. Smith and Pamela O. Long.

Pamela H. Smith has made significant contributions to the understanding of premodern science by emphasizing the central role of material experience and artisanal practice in the production of knowledge. Her work highlights how technical expertise was not peripheral to natural philosophy but often served as its empirical foundation, mediated through complex cultural and textual processes. At the core of her approach is the figure of the artisan as an epistemic agent, capable of translating lived experience into conceptual frameworks, methods, and scientific representations[1].

Pamela O. Long, on the other hand, has focused on the intersections between mechanical arts, technologies, and theoretical knowledge in premodern Europe. She has shown how the boundaries between these domains were fluid and mutually influential. Her scholarship underscores the intellectual value of so-called "lower" or practical arts, arguing that they played a crucial role in shaping early scientific

[1] Pamela H. Smith, *From Lived Experience to the Written Word: Reconstructing Practical Knowledge in the Early Modern World*, The University of Chicago Press, 2022.

thought. Through a historical-epistemological lens, Long challenges traditional hierarchies of knowledge and repositions technical practices as fundamental to the development of scientific culture[2].

A special mention should be made of Sébastien Moureau, regarded as one of the leading experts on Arabo-Latin alchemy. His research has focused on the transmission of Arabic alchemical texts into medieval Latin culture, highlighting the role of translators and the circulation of manuscripts. Moureau's work is particularly valuable for its philological precision, which allows a clearer understanding of how technical terminology and symbolic language were adapted across linguistic and cultural boundaries[3].

This essay does not aim to redeem medieval science in a triumphalist way, nor to romanticize its limitations. Rather, it seeks to examine its epistemic foundations, institutional settings, and material practices, while drawing particular attention to the often-overlooked role of alchemy and proto-chemical experimentation. By comparing the medieval conception of knowledge with that of modern science, we may not only gain a more accurate historical picture but also challenge the assumptions that govern how we define science today. Each chapter will examine a different dimension of the medieval scientific worldview: its epistemological premises, the institutions and figures that shaped it, the domains of inquiry through which it operated, and finally, its most speculative and transformative practices—especially those tied to alchemy and the manipulation of matter.

Chapter 1: Knowledge and Method in the Medieval Scientific Imagination

To speak of "science" in the Middle Ages is already to risk anachronism. The Latin *scientia* denoted not a discrete field of empirical inquiry, but rather a form of systematic knowledge: demonstrable, coherent, and ordered according to rational principles. This knowledge was understood primarily in Aristotelian terms—as a syllogistic structure, deduced from first principles and oriented toward certainty. It was not about discovering the unknown through experimentation, but about articulating what could be known by necessity. In this sense, *scientia* was closer to geometry than to modern chemistry, though it applied itself to questions ranging from the movement of the stars to the functioning of the human body. And yet, despite this deductive orientation, medieval thinkers did not dismiss observation; they simply subordinated it to theoretical clarity.

Thomas Aquinas's engagement with Aristotle offers a paradigmatic case. In his *Commentary on the Posterior Analytics*, he interprets demonstrative knowledge as that which begins from causes "better known in themselves," moving logically toward conclusions "better known to us".[4] This reversal—starting from ontological priority rather than empirical data—encapsulates the medieval commitment to metaphysical realism. Knowledge was not constructed from observation upward, but derived from universal truths downward. Scientific thinking, in this light, was deeply theological, because it presupposed a rational cosmos whose structure could be deciphered precisely because it was created by a rational God[5].

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[2] Pamela O. Long, *Artisan/Practitioners and the Rise of the New Sciences, 1400-1600*, Oregon State University Press, 2011.

[3] Moureau Sébastien, *Min al-Kimiya' ad Alchimiam. The Transmission of Alchemy from the Arab-Muslim world to the Latin West in the Middle Ages* in *Micrologus 28. The Arabic Sciences in the Western World*, edited by Charles Burnett, Danielle Jacquart, and Agostino Paravicini Bagliani, pp. 87–141; Moureau Sébastien, *Laboratories and Technology: Alchemical Equipment in the Middle Ages* in a *Cultural History of Chemistry*. Vol. 2. Middle Ages, edited by Charles Burnett and Sébastien Moureau, 49–70, London: Bloomsbury, 2021.

[4] Thomas Aquinas, *Commentary on the Posterior Analytics*, trans. Larkin, Dumb Ox Books, Notre Dame, 2009, I.2 (72a1–5).

[5] Edward Grant, *God and Reason in the Middle Ages*, Cambridge University Press, 2001.

This orientation had real implications for how natural phenomena were investigated. In natural philosophy, the question was not merely *what* happened, but *why*—in the strongest, causal sense of the term. Explanations sought formal and final causes, not just efficient ones. Fire rose not only because of its lightness (in Aristotelian physics), but because its nature was oriented toward the heavens. The alchemist, too, operated within this metaphysical framework. When he heated a substance or dissolved it in acid, he was not simply producing reactions: he was, ideally, unveiling its hidden nature, moving it toward its perfected state. Matter was never inert. It had tendencies, orientations, even a kind of metaphysical yearning. The furnace, in this context, became a site not only of transformation, but of revelation[6].

In contrast to modern scientific methods, the medieval world lacked standardized experimentation or statistical verification. Yet there were forms of repeated practice, especially in disciplines like alchemy and medicine, that produced cumulative bodies of empirical knowledge. The alchemist's operations—*calcination*, *coagulation*, *distillation*—were codified through experience, even if framed in symbolic or cosmological terms. What we might recognize today as chemical insight was mediated through a language of correspondences, analogies, and hidden signatures. To modern ears, the language of *sulphur* and *mercury* as elemental principles may sound opaque or even fantastic. But these were attempts to theorize material properties in dynamic terms: activity, volatility, fixity[7]. If modern chemistry emerged from this tradition, it did so by slowly stripping away its metaphysical scaffolding, not by rejecting its empirical core.

It is also worth noting that medieval thinkers were aware of the epistemological limits of their system. Robert Grosseteste, in the 13th century, argued for a form of experimental testing—not as a challenge to authority, but as a means to clarify the principles laid down by reason and tradition[8]. His treatise *De luce* attempted to reconcile metaphysical principles with geometric optics, suggesting that light was the fundamental agent of natural causation. Though this did not result in a full experimental program, it reveals a restlessness within the system—a sense that reason alone might not suffice.

Still, the boundary between speculative and empirical remained porous. In the alchemical texts attributed to pseudo-Geber, one finds a mixture of precise laboratory procedures and allegorical language. Recipes for the preparation of aqua regia or for the sublimation of mercury sit alongside claims about the spiritual purification of the operator. These texts were not irrational; they operated according to a different rationality—one that treated nature as intelligible not only through mathematics and logic, but through analogy, moral order, and even sacrament[9].

In sum, the medieval conception of scientific knowledge was not anti-empirical, but embedded within a metaphysical worldview that shaped how knowledge was defined, pursued, and justified. It did not aim to separate the knower from the known, but to harmonize the two within a cosmos charged with purpose and hierarchy. While this approach differs radically from the procedural skepticism (scepticism?) of modern science, it was neither static nor simplistic. It generated systems of thought—particularly in alchemy and early chemistry—that, for all their symbolic opacity, rested on genuine engagement with the material world.

Chapter 2: Institutions, Transmission, and the Material Infrastructure of Science

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[6] Lawrence M. Principe, *The Secrets of Alchemy*, University of Chicago Press, 2013.
[7] William R. Newman, *Atoms and Alchemy*, University of Chicago Press, 2006.
[8] David C. Lindberg, *The Beginnings of Western Science*, University of Chicago Press, 2007.
[9] William R. Newman, *The Summa Perfectionis of Pseudo-Geber*, Brill, Leiden, 1991.

Scientific knowledge in the medieval world did not circulate freely or chaotically. It required structures—material, intellectual, and institutional—capable of preserving, transmitting, and sometimes transforming complex bodies of thought. From the scriptorium to the university, from the apothecary's workshop to the private study of the alchemist, medieval science took shape within defined spaces and under particular conditions. To reduce these institutions to mere containers of ancient knowledge, as earlier historiography sometimes did, is to miss their function as active agents in the development of intellectual life.

Alchemy, in particular, moved in and out of academic respectability. While formal chairs in alchemy did not exist, alchemical texts were studied by university-trained thinkers, including Albertus Magnus, who treated them as part of natural philosophy. His *De mineralibus* includes passages clearly indebted to the Arabic alchemical tradition, and while Albertus remained cautious, his engagement was systematic. He even attempted to classify various chemical operations, noting the role of heat, dissolution, sublimation, and fixation—not as mystical gestures, but as methods of altering substance[10]. What is more, university libraries began to collect alchemical manuscripts, including Latin translations of works attributed to Jābir ibn Ḥayyān, pseudo-Aristotle, and Hermes Trismegistus. These were read not as occult curiosities, but as serious—if symbolically rich—attempts to understand material change.

It would be misleading, however, to limit the history of medieval science to universities alone. Much of the hands-on work of observation, especially in the domains of medicine and chemistry, took place elsewhere: in apothecaries' shops, in the studios of glassmakers, in metallurgical sites, and, crucially, in private laboratories. The boundary between scholars and craftsmen was permeable. In some cases, they were one and the same. The alchemist had to know not only Latin and Aristotelian theory, but also how to manage heat, measure timing, handle corrosive substances, and work with rudimentary distillation apparatuses. The so-called *aludel*, the *athanor* furnace, and the *pelican* still were not philosophical metaphors—they were physical tools requiring skill and familiarity[11]. These techniques prefigure what would become laboratory science. And yet, because they were often embedded in a symbolic language of transmutation and spiritual purification, their status remained ambiguous within academic circles.

Transmission also mattered. The so-called "Toledo Translation Movement" of the 12th century brought a flood of Arabic texts into Latin Europe—not only philosophical works but also medical, astronomical, and chemical treatises. The translation of alchemical texts was particularly delicate, given the symbolic density and terminological instability of the originals. Translators had to make decisions: how to render *elixir*, or *iksir*? These choices affected how generations of Latin readers interpreted the operations of (the) matter. In some cases, translation was also interpretation—an act of synthesis or even revision[12].

This infrastructure—of texts, tools, institutions, and translation networks—enabled a form of scientific life that was less experimental than modern science, but no less methodical. It is not that medieval scholars did not observe; they are observed within frames shaped by inherited metaphysics, institutional hierarchies, and textual authority. The alchemist, manipulating substances by fire, was not violating the norms of knowledge; he was expanding them from within. That later generations would draw a line between chemistry and alchemy does not mean the line existed in the 13th century. In that world, to understand the world was also to transform it—and possibly, in doing so, to redeem it.

[10] Albertus Magnus, *De mineralibus*, in Borgnet, ed., *Opera Omnia*, Vivès, Paris, 1890.
[11] William R. Newman, *Promethean Ambitions*, University of Chicago Press, 2004.
[12] Charles Burnett, *Alchemy and Arabic Science*, Variorum, Aldershot, 2001.

Chapter 3: Transforming Nature — Alchemy, Early Chemistry, and the Practical Pursuit of Knowledge

If the medieval world imagined knowledge as the discovery of order, it imagined nature as something that could be perfected. Alchemy, far from occupying the fringes of medieval thought, offered one of the most sustained and technically sophisticated explorations of that possibility. It was not, as modern caricatures would have it, a naïve hunt for gold by charlatans in smoky chambers, nor was it merely a metaphorical language for spiritual ascent. It was a hybrid practice, combining close material observation with speculative reasoning, a practice that blurred the boundaries between what we now separate as chemistry, medicine, metaphysics, and even theology. To follow the alchemist in his laboratory—not merely through symbolic diagrams but through crucibles, furnaces, and volatile materials—is to enter a world in which matter and meaning were in constant negotiation.

By the thirteenth century, Latin Europe had access to an increasingly rich corpus of alchemical texts. Some came from the Arabic tradition, others were pseudoepigraphic, attributed to Hermes Trismegistus, Aristotle, or even Moses. What they shared was a conviction that all matters were in motion, not chaotically, but according to intelligible laws. Substances were not fixed: they could be transmuted. Metals, in particular, were seen not as immutable elements but as stages in a developmental hierarchy, from base to noble, lead to gold. The logic was not unlike that of Aristotelian biology, which understood natural beings as striving toward a perfected form[13].

Alchemical theory in this period revolved around two key principles: the existence of a "prime matter" (*prima materia*) and the use of a "philosopher's stone" or *elixir* capable of achieving transmutation. These were not metaphors, though they carried allegorical weight. The *prima materia* was postulated as the undifferentiated substrate of all things, invisible and inert until shaped by form. The elixir, on the other hand, was the agent of transformation—sometimes conceived as a tincture, other times as a red powder or a liquid distillate—that could accelerate or complete nature's work. The alchemist's role, in this view, was to assist nature by providing the right conditions: the correct sequence of purification, the appropriate regimen of heat, the proper timing. It was, in many ways, a practice of care—a chemistry of patience rather than force[14].

One cannot overstate the technical sophistication of many of these operations. The pseudo-Geberian corpus, in particular, outlines methods for distillation, sublimation, calcination, and crystallization, describing apparatuses that include cucurbits, aludels, and alembics—tools that would remain in use for centuries. These texts employ language that is sometimes symbolic but often precise, offering recipes and protocols that suggest actual laboratory experience. They discuss the corrosive power of *aqua fortis* (nitric acid), the dissolution of gold in *aqua regia*, the handling of mercury and sulfur, and the preparation of what we would now call mineral acids—processes that would later be central to modern inorganic chemistry[15].

What is striking is that none of this was conceived as in opposition to theoretical thought. On the contrary, alchemy was deeply philosophical. Scholars like Roger Bacon and Arnald of Villanova saw it as an extension of natural philosophy, one that could uncover the "hidden properties" of matter—those not accessible to syllogism alone. The scholastic distinction between *manifest* and *occult* qualities did not render the latter irrational; it simply acknowledged that not all causality was reducible to immediate sense perception or deduction. In this space of the hidden, chemistry began to take shape—not as a modern discipline, but as a rational art concerned with change, proportion, and material interaction.

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[13] William R. Newman, *The Summa Perfectionis of Pseudo-Geber*, Brill, Leiden, 1991.
[14] Lawrence M. Principe, *The Secrets of Alchemy*, University of Chicago Press, 2013.
[15] William R. Newman, *Atoms and Alchemy*, University of Chicago Press, 2006.

The moral and spiritual dimensions of this practice were not superficial additions. In many treatises, particularly those of the so-called *spiritual alchemists*, material purification was inseparable from ethical discipline. The alchemist's body had to mirror the purity of his operations. He was to abstain from greed, vanity, and impatience—vices thought to distort both the matter under treatment and the practitioner's own perception of nature's truth. The notion that the philosopher's stone could only be made by someone who had first transmuted his own soul was not metaphorical: it was methodological. Purity of work required purity of will[16].

This is perhaps the clearest point of divergence from modern chemistry. Where modern laboratories aim for objectivity and repeatability, medieval alchemy was self-reflective, even confessional. And yet, within this ethos, there emerged an empirical attention to detail that is unmistakable. Alchemists described colors, textures, fumes; they recorded reactions, failures, yields. Their works, though written in opaque and often deliberately cryptic language, preserved observations that later chemists would find intelligible and useful. In some cases, alchemical texts were reinterpreted in the seventeenth century as repositories of forgotten or disguised technical knowledge.

To dismiss these practices because they did not conform to modern expectations is to miss their historical role. Alchemy was not the primitive cousin of chemistry; it was its crucible. Its goals were often spiritual, its language symbolic, but its attention to the material processes was acute. If modern science stripped away the metaphysics and the soteriology, it did so after inheriting a corpus of methods, tools, and empirical insights that alchemy had painstakingly assembled. The transformation of matter, in the end, was never just about gold. It was about nature's potential, and humanity's responsibility to understand—and possibly, in some small way, to complete—it[17].

Chapter 4: Astrology, Cosmology, and the Permeable Borders of Science

The medieval world did not categorize knowledge in the ways we do. The disciplinary boundaries that today separate chemistry from astrology, physics from cosmology, or even theology from natural science were, in the thirteenth and fourteenth centuries, far more fluid—porous, even deliberately so. Studying the stars was not to escape the material world but to understand its patterns. To practice alchemy was not to abandon reason, but to follow nature more deeply, perhaps into its invisible or occult dimensions. The assumption that underpinned much of this intellectual culture was that all things were connected: macrocosm to microcosm, celestial to terrestrial, soul to element. The cosmos was ordered, readable, and meaningful, and it was the task of the philosopher-scientist—not yet a separate figure—to decipher it.

Astrology, in this context, is a science of correspondences. It claimed that the configurations of heavenly bodies influenced, or reflected, events on earth—not deterministically, but with a logic of affinity. The moon affected tides; Mars, associated with heat and dryness, was thought to influence fevers and temperaments. This was not seen as magical thinking, but as part of the causal framework of the natural world. Thomas Aquinas himself allowed for a certain influence of the stars on human passions, though not on free will—an important distinction that placed astrology within the orbit of natural causality, not heretical fatalism[18]. Medical astrology became a standard part of practice: natal charts were used to

[16] Stanton J. Linden, *The Alchemy Reader*, Cambridge University Press, 2003.
[17] For an overview of the topic of alchemy, see Martelli Matteo, *L'alchimista antico: dall'Egitto greco-romano a Bisanzio*, Editrice Bibliografica, Milano, 2019.
[18] Thomas Aquinas, *Summa Theologiae*, I.115.4.

diagnose imbalances of the humors, to time bloodletting or childbirth. These applications, now marginalized or dismissed, were integrated into university medicine from Montpellier to Padua[19].

What interests us here is not whether astrology was "true" by modern standards, but how it functioned intellectually. Like alchemy, astrology operates with a balance of theory and observation. Astronomical ephemerides were compiled with real attention to precision. Instruments such as the astrolabe were calibrated, annotated, and taught in schools. The boundary between astronomy (considered a mathematical science) and astrology (a practical application of celestial patterns) was acknowledged, but rarely absolute. Ptolemy's *Tetrabiblos*, transmitted through Arabic commentary, was one of the core texts that shaped medieval astrological theory—not as superstition, but as a rational system of probabilistic causation[20].

The same desire to trace hidden affinities animated the practice of natural magic—a term that included everything from herbology to the crafting of talismans. This, too, was often adjacent to alchemy. Both relied on the idea that substances contained *occult virtues*—not in the sense of being supernatural, but of having properties not immediately perceptible. The doctrine of "signatures"—that plants or minerals bore marks indicating their uses—was widely accepted. A yellow flower, for example, might treat jaundice; red stones might aid in blood disorders. These were not irrational deductions, but part of a wider epistemology that read nature as a symbolic text[21].

Alchemy thrived in this environment. It borrowed language from astrology, geometry, medicine, and theology—rarely feeling the need to choose between them. The operations of fire, condensation, fermentation, and sublimation were timed according to planetary hours. Recipes were framed by numerology and esoteric cosmology. Sulfur, for instance, was associated not only with combustibility but with Mars, masculinity, dryness, and action. These symbolic mappings did not replace empirical observation—they framed it. The act of refining mercury was both a physical procedure and a cosmological gesture, situated within a worldview that saw all matter as participating in a divine architecture[22].

This fluid epistemic space also helps explain why thinkers like Raimundus Lullus or Marsilio Ficino moved so easily between theology and natural philosophy. Ficino's translations of Hermetic texts, for instance, helped shape Renaissance alchemical and astrological thought by asserting a divine continuity between mind, cosmos, and substance[23]. The medieval origins of this hermeticizing trend lie earlier, however, in the fertile synthesis of Aristotelianism, Neoplatonism, and Arabic cosmology that had taken root in the Latin West by the late 1200s. Alchemy, in this light, becomes less an outlier than a crystallization of medieval science's deepest instincts: to unify, to symbolize, to transform.

Indeed, the anxiety that eventually grew around these disciplines—especially in the fifteenth and sixteenth centuries—was not because they had failed to produce results, but because they challenged emergent categories of orthodoxy. Alchemy promised transformation of matter and soul; astrology suggested knowledge of the future; both implied that nature was knowable in ways that threatened institutional control. It is no coincidence that these sciences became increasingly suspect at the very moment that natural philosophy was being formalized into the early modern "scientific" model. In that transition, we do not witness the birth of science ex nihilo, but the narrowing of what would count as scientific.

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[19] Pearl Kibre, *Hippocrates Latinus: Receptions of Astrology in Medieval Medical Education*, Variorum, London, 1985.
[20] Jim Tester, *A History of Western Astrology*, Boydell Press, Woodbridge, 1987.
[21] Allen G. Debus, *Man and Nature in the Renaissance*, Cambridge University Press, 1978.
[22] Lawrence M. Principe and Newman, *Alchemy Tried in the Fire*, Princeton University Press, 2002.
[23] Michela Pereira, *Lullian Alchemy: Aspects and Problems of the corpus of Alchemical Works Attributed to Ramon Llull*, Catalan Review, 1990, Vol. IV, 1-2: 41-54.

In the Middle Ages, the borders were not so fixed. Alchemy and astrology did not simply exist alongside natural philosophy—they were constitutive of it. The idea that knowledge required both *ratio* and *experientia* was common currency. One could observe a color change in a vessel, then interpret it astrologically, then explain it using Aristotelian qualities, then contemplate it as a reflection of divine order. This was not incoherence; it was integration. And for all the differences that separate their world from ours, that integrative ambition may be one of the most sophisticated—and least understood—legacies of medieval science.

Conclusion

To understand medieval science is not to measure it against modern standards, but to enter a different world of thought—one in which nature was saturated with meaning, and knowledge was inseparable from metaphysical, theological, and even moral concerns. It is tempting to treat the Middle Ages as a preparatory phase in the rise of scientific modernity, to isolate in hindsight the methods, theories, or tools that appear to anticipate Galileo, Boyle, or Lavoisier. But this kind of selective genealogy distorts more than it reveals. What matters more is how medieval thinkers conceived of inquiry itself: not as a mechanical extraction of facts, but as a form of participation in an intelligible cosmos, where observation, reasoning, and symbolic resonance were all seen as valid paths toward understanding.

This is especially evident in the alchemical tradition, which deserves far more than condescension or curiosity. Alchemy was not a failed science, nor merely a proto-science. It was, in its own time, a coherent and ambitious attempt to theorize and manipulate the material world, grounded in both philosophical speculation and hands-on experimentation. The fact that it operated within a symbolic register—drawing on astrology, cosmology, and soteriology—did not undermine its empirical insights. On the contrary, that symbolic dimension expanded the conceptual vocabulary available to its practitioners. If modern chemistry grew out of alchemy, it did so not by purging all that was unscientific, but by slowly disembedding itself from a different set of epistemological and spiritual commitments.

The institutions of medieval science—monasteries, universities, apothecaries' workshops—enabled not only the preservation of classical knowledge but its transformation[24]. Figures like Albertus Magnus, Roger Bacon, and the anonymous authors of alchemical treatises did not merely comment on Aristotle; they interrogated nature, manipulated matter, and speculated about causes in ways that would have been unthinkable just a century earlier. Their methods were uneven, their terminology unstable, their results sometimes opaque—but the intellectual ambition behind them was unmistakable.

And so, to speak of medieval science is to speak of a form of knowing that did not distinguish sharply between nature and spirit, cause and purpose, technique and transformation. It is to acknowledge a period in which science was still a branch of philosophy—and philosophy, in turn, was entangled with cosmology, morality, and theology. In this entanglement lay both its limitations and its richness. The modern separation of disciplines, for all its analytical power, has often obscured the ways in which earlier forms of science asked questions we are only beginning to ask again: How does knowledge relate to

[24] Sébastien Moureau, *Min al-Kimiyā' ad Alchimiam. The Transmission of Alchemy from the Arab-Muslim world to the Latin West in the Middle Ages* in *Micrologus 28. The Arabic Sciences in the Western World*, edited by Charles Burnett, Danielle Jacquart, and Agostino Paravicini Bagliani, pp. 87–141.

transformation? What does it mean to know something well enough to change it—ethically, materially, spiritually?

In that light, medieval science does not appear primitive or regressive, but differently configured. Its legacy is not merely the techniques it passed down, but the questions it dared to ask—and the conviction, still worth considering, that to understand nature is, at least in part, to be changed by it.

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