SCIENCE AND THE ARTS

In the late eighteenth century, the gap separating the "two cultures" of science and art, as identified by C. P. Snow, was yet to materialize. Poets such as Alexander Pope praised Isaac Newton, while popular digests would set his discoveries to verse. Within a few decades, however, accelerating advances in knowledge and the increasing specialization of scientific activity were to place intolerable strains upon what had hitherto been the unitary pursuit of "natural philosophy." By the 1830s the emergence of increasingly separate and autonomous disciplines such as biology, chemistry, and geology had divided the arts and sciences forever, with William Whewell coining the term *scientist* and John Stuart Mill later declaring that poetry was the "logical opposite" of science.

Romanticism is generally associated with hostility toward the mechanistic natural philosophy and empirical, reductive world view of Newtonian science. Something of a sea change in sensibility brought about a reaction of the natural, organic, human spirit against the cold rationality of the Enlightenment. Several famous examples highlight this antipathy, most notably Johann Wolfgang von Goethe's attack on Newton's theories of light and color, Charles Lamb's toast "confusion to mathematics," and John Keats's lines from "Lamia" (1819): "Do not all charms fly / At the mere touch of cold philosophy?"

However, the Romantic view of science was not necessarily one of outright rejection, with many artists—most notably poets—embracing and adopting the metaphoric imagery offered by the scientific perception of the natural world. Where William Blake railed against Newton and all his works, Samuel Taylor Coleridge took great delight in "the beauty and neatness" of his experiments, and regularly incorporated scientific and philosophical thought into his poetry.

Scientific allusion is perhaps used most consistently in the poetry of Percy Bysshe Shelley. His lengthy 1813 work, *Queen Mab*, made extensive use of scientific imagery in both the verse and in the poet's own extensive notation, which exhibited his familiarity with the very latest theory and knowledge, including the work of Paul-Henri Dietrich Holbach and Pierre-Simon Laplace. His verse drama *Prometheus Unbound* (1819), though ostensibly set in the Aristotelian universe of classical mythology, nevertheless makes much use of contemporary Newtonian cosmology, and crackles with electrical imagery from the world of Sir Humphrey Davy. Several passages clearly echo the lectures of his childhood astronomy tutor Adam Walker, and the poem also owes much to the botanical poetry of Erasmus Darwin. Throughout the Shelley canon can be found imagery borrowed from the emerging earth sciences of geology and meteorology, vividly illustrating the poet's fascination with volcanoes, storms, and earthquakes, with descriptions of violent seismic upheaval often used allegorically to represent radical political opinion and revolutionary change.

Lord Byron, though himself somewhat aloof from the world of science, fathered Ada Lovelace, a prodigiously talented mathematician, whom he disdainfully labeled "the princess of parallelograms." In later life she would assist Charles Babbage, creator of the mechanical ancestor of the computer, and she has been credited with writing the world's first computer program.

The impact of Mary Shelley's gothic novel *Frankenstein: or, the Modern Prometheus* (1818) still resonates as one of the great literary metaphors for public perception of the role played by scientists in modern society, and fear of uncontrolled experimentation. Though often cited as a precursor of the science-fiction genre, her narrative makes only sparing use of scientific detail and method, and concentrates more upon the moral consequences of the creation of the creature.

Occasionally, practicing scientists themselves could be moved to verse. The physician Erasmus Darwin was renowned for producing lengthy biological verse-treatises such as *The Botanic Garden* (1791) and *Zoonomia* (1794–96), both of which contain protoevolutionary passages anticipating the work of his grandson, Charles Darwin. Humphry Davy, who had helped edit William Wordsworth's *Lyrical Ballads*, and whose public lectures vividly introduced such Romantic concepts as the sublime into popular perceptions of science, committed to poetry in his notebook how he had searched into nature's hidden and mysterious ways: "as poet, as philosopher, as sage."

The world of the visual arts was also transformed by the advent of industrial technology. The arrival of the argand lamp in 1780 gave a new dimension to the term *enlightenment*, providing cheap and effective artificial illumination for public places such as theaters and galleries. The French artist Anne-Louis Girodet de Roussy-Frioson's *Pygmalion* was both painted and exhibited by lamplight in 1819, while Wilhelm Bendz's depiction of a life class at the Charlottenburg Academy of Fine Arts in 1826 shows an assistant focusing a bank of argand lamps on the model. The iron foundries of the Industrial Revolution provided artists such as Jacques-Philippe de Loutherbourg with spectacularly volcanic explosions of color and light, such as that depicted in *Coalbrookdale by Night* (1801). More generally, J. M. W. Turner made some use of Goethe's theories of light and color, while William Blake famously depicted the figure of Newton vainly attempting to measure the poet's mystical cosmos with geometric calipers.

Although the Romantic reaction to the Enlightenment and the new worldview it presented to humanity was by no means a consistent or uniform one, Romantic artists could hardly disregard the immense effect that the Age of Reason had upon human consciousness of our place within the universe. To Romantic observers, the upheavals in humankind's perception of nature and the cosmos were every bit as significant in their seemingly endless implications for humanity as the political upheavals that had taken place in France and America. The pathway opened by the new advances in knowlege had, Coleridge noted, "been pursued with an eagerness and almost epidemic enthusiasm which, scarcely less than its political revolutions, characterize the spirit of the age." From the most practical advantages gained as aids in daily life to the highest levels of philosophical thought, humankind now lived, he said, in "an era of enlighteners, from the Gas Light Company to the dazzling Illuminati in the Temples of Reason."

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SCIENCE IN GERMANY

Although Germany in the Romantic era was not yet the scientific leader it would later become, it did have a very active scientific culture, and one particularly strongly influenced by Romanticism. This influence was manifested in both directions; German Romantics were nearly all interested in natural science, and only a few articulated the distrust of it expressed by some French and British Romantics.

As was the case elsewhere, interest in science was rising in late eighteenth-century Germany. The reorganization of the Berlin Academy in 1744 boosted German science, which was also strong in the universities, particularly the medical faculties. There was a significant eighteenth-century rise in the publication of German scientific periodicals in astronomy, botany, physics, physiology and chemistry by the end of the century. In medicine alone, nearly 200 new medical periodicals were launched in the last third of the century.

Although Germans were part of the international scientific community, German science also had a distinct national character and context. German scientists emphasized the relation of scientific knowledge to wealth and power, and sometimes asserted the superiority of German science over other national sciences—a particularly important source of pride, given Germany's political fragmentation. This sometimes had deleterious effects on German science. For example, acceptance of the French noble Antoine-Laurent Lavoisier's anti-phogistonic chemistry was delayed in Germany for several years because of pride in the German tradition of chemistry and distrust of French innovation.

The influence of Romanticism on German science in notable in many ways. Although some early German Romantics, such as J. G. Hamann, distrusted the materialism of science, other German writers took an interest in it, the most notable being Johann Wolfgang von Goethe. Goethe's anti-Newtonian stance, shared by other German scientists, was in part motivated by Romantic distrust of the mechanical and reductionist "Newtonian" universe. Germans, like other Romantics, tended to think in terms of historical development. German science was also historical, and the universe was considered to be in a state of development (one frequently-invoked metaphor was the idea of the universe as a pregnant woman). German biologists devoted a great deal of effort to embryology, tracing the stages of development of the embryo before birth. Geology, particularly as practiced by the great "Neptunist" school founded by Abraham Gottlob Werner, did not simply describe the current state of the earth, but endeavored to discover its past history and development. German geologists and other Romantic scientists were particularly fascinated with caves, which they believed offered direct access to the Earth's past. German Romantics were interested in archetypes, an interest which extended to scientists. Different botanical forms, for example, were understood as variants on an archetypal leaf. Applied to zoology, this led to an emphasis on the similarities of different living things. Goethe's discovery of the intramaxillary bone in human beings was prompted by his Romantic (but not evolutionary) belief that human beings were on a continuum with other creatures, notably monkeys and apes, who also possessed intramaxillary bones.

One of the most influential syntheses of German Romanticism and German science was known as Naturphilosophie. Its primary founder was Friedrich W. J. Schelling, who published the central document of the movement, *Ideas for a Philosophy of Nature,* in 1797. Another influential champion of the movement was the biologist Lorenz Oken (1779–1851). For *Naturphilosophen* (nature-philosophers), the investigation of nature was a spiritual quest with an ultimately spiritual goal. Nature itself was not a material phenomenon which existed outside humans, but ultimately a product of the human spirit. *Naturphilosophie* was not primarily oriented toward technological progress. The mission of *Naturphilosophie* was ultimately to restore, on a higher level, the original unity of man and nature believed to have existed in the Golden Age (i.e., before the Fall of man), when the products of the human spirit became separated from the human spirit itself. Nature itself was moved by spiritual forces, such as a drive to organization manifesting itself in the crystallization of minerals or the growth of living things. What the scientist should study was not phenomena taken in isolation, but systems. Only the *Naturphilosoph* (nature-philosopher), with his spiritual awareness, was able to truly understand nature. *Naturphilosophen* criticized traditional scientific methods and objectives as mere fact-gathering. *Naturphilosophen* and other German Romantic scientists were holists, emphasizing entities as wholes that worked in a certain, specific way, rather than collections of parts. Their holism was combined with dualism; *Naturphilosophen* saw the world as governed by pairs of opposed forces, and placed great emphasis on symmetry.

Naturphilosophen, despite their penchant for mystical language, were not outsiders in the scientific community. When they practiced science, they followed the classic experimental methods of early modern and Enlightenment science. *Naturphilosophie*'s mysticism and transcendental orientation led to its (partially deserved) poor reputation as an impediment to the development of science; nevertheless, it could also be scientifically productive on occasion. One example is the German Romantic physicist and *Naturphilosoph* Johann Wilhelm Ritter's (1776–1810) discovery of ultraviolet light. When Ritter learned of William Herschel's discovery of infrared light, he quickly theorized that, because the universe operated on a principle of duality, there must be something at the opposite end of the spectrum from infrared. He devised an ingenious series of tests